Original Paper

Lifestyle Modifications to Lower or Control High Blood Pressure: Is Advice Associated With Action? The Behavioral Risk Factor Surveillance Survey

Anthony J. Viera, MD, MPH;[1] Abhijit V. Kshirsagar, MD, MPH;[2] Alan L. Hinderliter, MD[3]

Routine lifestyle modification advice for managing high blood pressure (BP) is of questionable effectiveness. Using data from the 2005 Behavior Risk Factor Surveillance System, we examined whether receipt of advice is associated with reported adoption of lifestyle modifications. We determined proportions of hypertensive adults taking action to change eating habits, reduce salt intake, exercise, or decrease alcohol consumption to control high BP. We then determined associations between reports of advice given and corresponding actions being taken: 70.1% of respondents reported changing eating habits, 78.7% reported reducing salt intake, 67.1% reported exercising, and 57.9% of those who drank alcohol reported decreasing their consumption. Compared with those who did not recall being given advice, hypertensive adults who recalled being given advice were more likely to change their eating habits (prevalence ratio [PR], 1.62; 95% confidence interval [CI], 1.56–1.67), reduce salt (PR, 1.53; 95% CI, 1.48–1.58), exercise (PR, 1.41; 95% CI, 1.36–1.47), and reduce alcohol consumption (PR, 1.78; 95% CI, 1.70–1.87). (J Clin Hypertens (Greenwich). 2008;10;105–111) ©*2008 Le Jacq*

From the Department of Family Medicine,[1] the Department of Medicine, Division of Nephrology and Hypertension,[2] and the Department of Medicine, Division of Cardiology,[3] University of North Carolina at Chapel Hill School of Medicine, Chapel Hill, NC
Address for correspondence:
Anthony J. Viera, MD, MPH, Department of Family Medicine, University of North Carolina at Chapel Hill, CB 7595, 590 Manning Drive, Chapel Hill, NC 27599-7595
E-mail: anthony_viera@med.unc.edu
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Several lifestyle modifications have been reported to be effective in lowering high blood pressure (BP). Regular aerobic exercise lowers systolic BP an average of 5 mm Hg and diastolic BP an average of 4 mm Hg.[1] Adequate reduction of salt (sodium) in the diet leads to a similar average reduction in BP.[2] Alcohol moderation (for those who drink) reduces systolic BP by approximately 4 mm Hg and diastolic BP by 2.5 mm Hg.[3] For those who are overweight or obese, weight loss of 3% to 9% results in approximately 3-mm Hg reductions in both systolic and diastolic BP.[4] Finally, the Dietary Approaches to Stopping Hypertension (DASH) diet—an eating plan low in saturated fats and high in fruits and vegetables—can reduce systolic BP an average of 11 mm Hg and diastolic BP an average of 5.5 mm Hg.[5] The combination of the DASH diet (food supplied by investigators) and sodium reduction to 1600 mg/d can lower BP as much as a single medication.[6]

These lifestyle modifications are an important component of the management of high BP in all individuals with hypertension. For many persons with stage 1 hypertension and no evidence of target organ damage, a trial of lifestyle modifications is warranted before initiating pharmacologic therapy.[7,8] For individuals who are treated with

Table I. Questions Used for Exposure (Advice) and Outcome (Action) Variables

A. Action questions

Are you now doing any of the following to help lower or control your high blood pressure?

- Changing your eating habits (to help lower or control your high blood pressure)?
- Cutting down on salt (to help lower or control your high blood pressure)?
- Reducing alcohol use (to help lower or control your high blood pressure)?
- Exercising (to help lower or control your high blood pressure)?

B. Advice questions

Has a doctor or other health professional ever advised you to do any of the following to help lower or control your high blood pressure?

- Change your eating habits (to lower or control your high blood pressure)?
- Cut down on salt (to lower or control your high blood pressure)?
- Reduce alcohol use (to lower or control your high blood pressure)?
- Exercise (to lower or control your high blood pressure)?

antihypertensive medications, lifestyle modifications are an important adjunct and may prevent or delay the need for additional antihypertensive medications.[6,8] There is also now some evidence that lifestyle modifications can lower the incidence of cardiovascular events.[9] The challenge with lifestyle modifications is actually getting patients to adopt them. Complex interventions and intensive counseling programs have demonstrated some efficacy in leading to certain lifestyle modifications.[10,11] Motivated individuals can even adopt several lifestyle modifications at once and sustain them for many months.[12] However, the routine advice given by health care professionals in day-to-day practice is of questionable effectiveness in actually leading to lifestyle modifications to lower or control high BP.

In an earlier study, we used data gathered from a large sample of US adults to analyze the prevalence of adults with known hypertension who reported receiving advice to adopt lifestyle modifications to lower or control their high BP.[13] We found that 90% of adults with known hypertension reported receiving advice to make at least one lifestyle modification to lower or control their high BP. Reports of receipt of the specific kinds of advice (diet, salt reduction, exercise, alcohol reduction) ranged from 43.5% to 78.0%, and certain groups (eg, those who were overweight/obese and those taking BP medications) were more likely to report receiving advice. It is important to know whether persons receiving this "routine" advice are making the recommended lifestyle modifications to lower or control their BP. The purposes of the present study were to (1) estimate the proportion of adults with known hypertension who are making specific lifestyle changes (taking action) to lower or control their BP and (2) describe the associations between reported advice given and action taken.

METHODS

Design

We used data from the 2005 Behavioral Risk Factor Surveillance System, a random-digit dial landline telephone survey of the noninstitutionalized US population aged 18 years and older. It is an ongoing survey administered by the Centers for Disease Control and Prevention primarily focusing on behaviors associated with the leading causes of morbidity and mortality. The core survey used a stratified, multistage probability sampling design and was administered to a nationally representative sample of US adults from all 50 states as well as the District of Columbia, Puerto Rico, and the US Virgin Islands. Most measures are of moderate or high reliability and validity, and reliability has been demonstrated in multiple ethnic groups.[14,15] Measures related to cardiovascular disease are notably of high reliability and validity.[14] Median annual response rate based on persons estimated to be eligible to participate was 51.1%.[16]

The core survey includes the question, "Have you ever been told by a doctor, nurse, or other health professional that you have high blood pressure?" In the 2005 survey, 16 states included a module containing items pertaining to receipt of lifestyle modification advice as well as report of actions taken to lower or control BP (Table I). During the survey, the set of action questions was asked before the set of advice questions. This module was included only for the 28,457 participants who answered in the core survey that they had been told by a health professional that they had high BP (excluding those who only had hypertension related to pregnancy). We selected all the participants who completed this module.

Variables

Our outcomes comprised reports of lifestyle modifications (actions) being taken by persons with

known hypertension to lower or control their BP (Table IA). We also created an "any action" variable defined as a report of taking action on any of the included lifestyle modifications. Our exposure variables were respondents' reports of advice given by a doctor or other health professional to lower or control high BP through lifestyle modification(s) (Table IB). We also created an "any advice" variable defined as report of receiving any of the included lifestyle modification recommendations.

We examined several potential covariates possibly associated with making lifestyle modifications to lower or control high BP. Age was divided into 3 groups. Race/ethnicity and education level were each divided into 4 groups. Body mass index was calculated based on reported weight and height and divided into 3 categories. The core survey included the question, "Do you have one person you think of as your personal doctor or health care provider?" If a respondent answered, "No," he or she was asked, "Is there more than one, or is there no person who you think of as your personal doctor or health care provider?" We considered a respondent to have a personal health care provider whether he or she had one person or more than one person considered to serve in that role. Other covariates included reported health status (5 categories), routine health checkup in the past 2 years (Yes/No), diabetes excluding gestational (Yes/No), and whether currently taking BP medication (Yes/No).

Analysis

After incorporating appropriate population weights, primary sampling units, and strata adjustments to account for the complex survey design, we first determined the weighted percentage of all respondents to the 2005 core survey who had been told they had hypertension. Of those participants, we then determined weighted percentages of persons who reported taking action (outcome) stratified by whether they reported receiving advice (exposure). We also determined weighted percentages of persons who reported taking action within categories of selected covariates. Differences within each category were tested for significance using Pearson's chi-square.

Because reported action on the lifestyle modifications was so common, we chose not to report odds ratios derived from logistic regression. Odds ratios would greatly overestimate the association one sees with a prevalence ratio (PR) estimate.[17] Such numbers could easily be misinterpreted to imply that routine lifestyle modification advice exerts a stronger effect than it truly does. For that reason, we used Poisson regression with robust error variance to allow estimation of unadjusted and adjusted PRs and their 95% confidence intervals (CIs).[17] Missing values were handled by exclusion, as were refusals and responses of "don't know/not sure." In the event that a stratum with only one primary sampling unit was encountered, data were reassigned to another stratum.

All analyses were performed using Stata 8.1 statistical software (StataCorp, College Station, TX).

Table II. Characteristics of Adults Reporting Hypertension from 16 US States, 2005 (Unweighted N=27,163–28,625)

Characteristic	Weighted Percent	95% Confidence Interval
Age group, y		
18–39	13.5	12.7–14.3
40–59	38.5	37.5–39.4
≥60	48.0	47.1–49.0
Sex		
Male	48.0	47.1–49.0
Female	52.0	51.0–53.0
Race/ethnicity		
White	70.7	69.7–71.6
Black	16.1	15.4–16.8
Hispanic	8.6	7.9–9.3
Other	4.7	4.2–5.2
Education level		
<High school graduate	15.4	14.7–16.1
High school graduate	34.1	33.2–35.0
Some college	24.4	23.6–25.2
College graduate	26.1	25.3–26.9
Reported health status		
Excellent	8.0	7.5–8.6
Very good	23.8	23.0–24.6
Good	35.3	34.4–36.2
Fair	21.6	20.9–22.4
Poor	11.3	10.7–11.9
Personal healthcare provider(s)	89.9	89.2–90.5
Routine health checkup in past 2 years	90.4	89.8–90.9
Body mass index		
Underweight or healthy weight (<25.0 kg/m^2)	23.6	22.8–24.4
Overweight (25.0–29.9 kg/m^2)	39.1	38.1–40.1
Obese (≥30 kg/m^2)	37.3	36.4–38.3
Diabetes	19.8	19.0–20.6
Currently taking blood pressure medication	80.4	79.5–81.2

Study Approval

A report of our plan to conduct this secondary analysis using publicly available data was submitted to and exempted from human subjects review by the Office of Human Research Ethics of the University of North Carolina at Chapel Hill School of Medicine.

RESULTS

In 2005, more than one-fourth (26.4%) of US adults from the 16 samples states reported that they had been told by a health professional they had high BP. The majority (86.5%) of these individuals were 40 years and older, were overweight or obese (76.4%), had one or more individuals who they considered their personal health care provider(s) (89.9%), and had a routine health checkup within the past 2 years (Table II). Slightly more than 80% were taking BP medication. Approximately 20% also reported being told they had diabetes.

Nearly all respondents in the 16 sample states (96.2%) with known hypertension reported making at least one lifestyle modification (taking action) to lower or control their high BP (Table III). The most commonly reported lifestyle action taken by respondents was reducing salt intake (78.7%) and the least commonly reported was reducing alcohol intake (57.9% of those who drank). Approximately 7 of 10 respondents reported changing their eating habits, and 67.1% reported increasing exercise to lower or control their high BP.

For each of the lifestyle modifications examined, there was a significant difference in the percentage of respondents reporting taking action according to whether they reported receiving advice to do so. Of those who reported getting any type of advice, 97.8% reported making at least one lifestyle modification, compared with 80.0% of those who reported not receiving any advice. The magnitude of the differences in percentages of respondents reporting changing eating habits, reducing salt, exercising, or reducing alcohol between those reportedly given advice and those not given advice ranged from 21.3% to 34.3%. There was also a significant difference in the percentage of respondents reporting taking action in nearly every category of covariate we included, but these differences were not nearly as uniformly pronounced (Table III).

When the unadjusted PRs were compared to the adjusted PRs, the effects of adjusting for these selected covariates were minimal. Compared with respondents who did not receive advice to change their eating habits, those who reported that they received such advice were 1.62 (95% CI, 1.56–1.67) times more likely to report changing their eating habits. Similarly, compared with those respondents who did not receive advice to reduce their salt intake, those who did receive such advice were approximately 1.53 (95% CI, 1.48–1.58) times more likely to report reducing their salt intake. This pattern continued for the other lifestyle modifications. Compared with those respondents who did not receive advice to exercise, those who did receive such advice were 1.41 (95% CI, 1.36–1.47) times more likely to report exercising, and compared with those respondents (who drank alcohol) who did not receive advice to reduce their alcohol intake, those who did receive such advice were 1.78 (95% CI, 1.70–1.87) times more likely to report reducing their alcohol intake.

DISCUSSION

In this analysis of data from a large sample of US adults with known hypertension, we found that individuals were more likely to report making lifestyle modifications to lower or control their high BP when they recalled being given advice to do so from a doctor or other health professional. This was true regardless of a person's sex, age, race/ethnicity, education level, reported health status, or use of antihypertensive medications. In our full models (data not shown), reported advice was also more strongly associated with taking action than was having a personal health care provider or having a routine checkup in the past 2 years.

It is worth noting that about half of patients with hypertension who reported not receiving each kind of lifestyle advice also reported making each of the lifestyle modifications. This study suggests nevertheless that "routine" advice given by doctors and other health professionals has some effectiveness. We consider it routine because in a representative sample of patients with hypertension from a large sample of the US population, it is unlikely that very many people are being given referrals for specialized counseling, attending group classes, or receiving more complex interventions. However, we were only able to determine the effect of reports of advice received on reports of action taken to lower or control high BP. We cannot be certain whether those who report receiving advice actually were given the advice, or when they were, to what extent. We also do not know whether those who report taking action are actually making the lifestyle modifications or when they are, to what degree. It would be pleasantly surprising if 7 to 8 of 10 adults with high BP given each kind of lifestyle advice were truly making those lifestyle

Table III. Weighted Percentages of Known Hypertensive Adults from 16 US States Reporting Taking Action(s) to Lower or Control Blood Pressure

	Any Action	*P* Value	Changing Eating Habits	*P* Value	Reducing Salt	*P* Value	Increasing Exercise	*P* Value	Reducing Alcohol	*P* Value
All ages	96.2		70.1		78.7		67.1		57.9	
Advice given										
Yes	97.8	<.001	82.1	<.001	87.9	<.001	72.5	<.001	78.1	<.001
No	80.0		50.8		57.3		51.2		43.8	
Age group, y										
18–39	93.6	<.001	64.7	<.001	69.8	<.001	70.2	.001	60.2	<.001
40–59	96.4		75.3		78.8		68.4		63.0	
≥60	96.7		67.4		81.2		65.1		51.9	
Sex										
Male	97.2	<.001	67.4	<.001	75.1	<.001	68.7	<.001	56.2	.003
Female	95.2		72.6		82.1		65.5		60.2	
Race/ethnicity										
White	95.8	<.001	68.3	<.001	76.7	<.001	66.6	.09	54.3	<.001
Black	98.4		79.9		89.3		69.0		71.8	
Hispanic	95.0		66.8		74.7		64.7		66.2	
Other	98.3		72.4		80.0		71.5		65.2	
Education level										
<High school graduate	95.6	.21	67.0	.003	80.6	<.001	58.6	<.001	58.2	<.001
High school graduate	96.7		69.4		79.8		65.1		63.1	
Some college	96.4		71.6		79.1		67.5		60.4	
College graduate	95.8		71.6		75.9		74.0		51.0	
Health status										
Excellent	94.7	.01	65.7	.01	72.5	<.001	77.3	<.001	52.9	<.001
Very good	95.4		69.5		75.6		75.0		54.3	
Good	96.7		71.1		79.6		68.7		59.4	
Fair	96.3		69.7		80.9		61.1		62.2	
Poor	97.4		72.7		82.7		48.8		60.7	
Personal health care provider(s)										
Yes	96.7	<.001	71.3	<.001	79.8	<.001	67.8	<.001	58.2	.27
No	91.3		59.9		68.6		60.7		55.3	
Routine checkup in past 2 years										
Yes	96.5	<.001	71.2	<.001	79.8	<.001	68.1	<.001	58.9	<.001
No	93.1		60.1		68.4		56.8		49.0	
Body mass index										
Underweight or healthy weight	95.0	<.001	62.0	<.001	75.9	<.001	67.9	<.001	51.6	<.001
Overweight	96.2		70.7		78.7		70.8		57.0	
Obese	97.0		74.3		80.6		63.1		62.9	
Diabetes										
Yes	98.5	<.001	77.9	<.001	85.6	<.001	66.9	.90	66.1	<.001
No	95.6		68.2		77.0		67.1		56.5	
Currently taking BP medication										
Yes	97.3	<.001	72.5	<.001	82.2	<.001	67.5	.10	60.1	<.001
No	91.6		60.2		64.6		65.3		50.9	

Abbreviation: BP, blood pressure. For alcohol reduction advice, unweighted No. varied from 12,521 to 13,142; for other categories, unweighted No. varied from 23,508 to 26,900.

modifications to the degree needed to actually lower BP. One could argue that any lifestyle modification is better than none, and that from a health care provider's perspective, routine advice is the starting point. However, if a large proportion of hypertensive patients aggressively adopted lifestyle modifications, the health care cost savings and public health impact could be substantial.[18]

A 2007 national survey of 1245 hypertensive individuals 45 years and older conducted for the Hypertension Education Foundation (HEF) also obtained data on actions being taken to treat hypertension.[19] Approximately 60% of respondents said they were following a healthy diet, a percentage that did not vary significantly by race/ethnicity. Approximately 60% of the total sample also stated they were limiting dietary salt intake, but this percentage was higher (74%) among African Americans. Our finding that compared with other races and ethnic groups, more African Americans

reported limiting their salt intake is similar. The HEF survey also found lower percentages of persons exercising regularly (42%) or limiting alcohol (32%) than did our survey. Interestingly, more than one-fourth (27%) of the sample said that the reason they were not exercising regularly was they were taking medication that controlled their BP.

Limitations

One of the limitations of this study is related to the way the questions were asked during the survey. While individuals could indicate that they did not drink alcohol at all, the alcohol reduction advice and action questions assumed that patients who did drink alcohol were doing so in greater than the currently acceptable amounts (>1 drink per day for women, >2 drinks per day for men). If 42% of patients with hypertension who drink alcohol are doing so within the acceptable limits, then 58% is about the "right" percentage of those who should be taking action to reduce their alcohol intake.

The potential for measurement bias throughout the survey must be considered. Measurement of our outcomes may be affected by social desirability bias. Respondents may report taking action even if they are not, because they feel (or know) they should be. This may be particularly true of those who received advice. The effect would be an overreporting of actions taken by patients who recall being given advice and a bias away from the null. During the survey, the set of action questions was asked before the set of advice questions. Therefore, a more likely potential bias would be from differential measurement of the exposures. Measurement of our exposures is dependent on recall. Respondents may not recall whether they were given advice by a doctor or other health professional or whether the advice was given specifically, or in part, to lower or control high BP. If those who are taking action recall being given the advice more than those not taking action, our results will be biased away from the null. Nonresponse bias must also be considered. We do not know whether persons who did not respond to the survey differ in important ways from those who did participate. We do not know if the effect sizes seen in this study can be fully accounted for by these potential biases. As this study was a cross-sectional analysis, we also cannot infer any causal relationships between our exposures and outcomes. That is, we cannot be certain that the advice is what actually led to the action. Finally, while the results should be generalizable to the 16 states that participated in the module, the data are not necessarily generalizable to all of the United States.

CONCLUSIONS

Adults with known hypertension who recall being given advice by a doctor or other health professional to make lifestyle changes to lower or control their BP are more likely to report making such lifestyle modifications than those who do not recall being given such advice. Whether this routine advice actually leads to lifestyle modifications to the extent required to lower BP is uncertain. Given the substantial potential public health benefits from aggressive lifestyle modification in the population, continued efforts to help patients successfully adopt them—whether by providing routine advice or more intensive approaches—are needed.

REFERENCES

1 Whelton SP, Chin A, Xin X, et al. Effect of aerobic exercise on blood pressure: a meta-analysis of randomized, controlled trials. *Ann Intern Med.* 2002;136:493–503.
2 He FJ, MacGregor GA. Effect of longer-term modest salt reduction on blood pressure. *Cochrane Database Syst Rev.* 2004;(3):CD004937.
3 Xin X, He J, Frontini MG, et al. Effects of alcohol reduction on blood pressure: a meta-analysis of randomized controlled trials. *Hypertension.* 2001;38:1112–1117.
4 Mulrow CD, Chiquette E, Angel L, et al. Dieting to reduce body weight for controlling hypertension in adults. *Cochrane Database Syst Rev.* 2000;(2):CD000484.
5 Appel LJ, Moore TJ, Obarzanek E, et al. A clinical trial of the effects of dietary patterns on blood pressure. DASH Collaborative Research Group. *N EngI J Med.* 1997;336:1117–1124.
6 The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. *JAMA.* 2003;289:2560–2572.
7 Moser M. Are lifestyle interventions in the management of hypertension effective? How long should you wait before starting specific medical therapy? An ongoing debate. *J Clin Hypertens (Greenwich).* 2005;7:324–326.
8 Appel LJ. Lifestyle modification as a means to prevent and treat high blood pressure. *J Am Soc Nephrol.* 2003;14:S99–S102.
9 Cook NR, Cutler JA, Obarzanek E, et al. Long term effects of dietary sodium restriction on cardiovascular disease outcomes: observational follow-up of the trials of hypertension prevention (TOHP). *BMJ.* 2007;334(7599):885.
10 Brunner EJ, Thorogood M, Rees K, et al. Dietary advice for reducing cardiovascular risk. *Cochrane Database Syst Rev.* 2005;(4):CD002128.
11 Viera AJ, Jamieson B, Dealleaume L. Clinical inquiries: how effective are hypertension self-care interventions? *J Fam Pract.* 2007;56:229–231.
12 Appel LJ, Champagne CM, Harsha DW, et al.; Writing Group of the PREMIER Collaborative Research Group. Effects of comprehensive lifestyle modification on blood pressure control: main results of the PREMIER clinical trial. *JAMA.* 2003;289:2083–2093.
13 Viera AJ, Kshirsagar AV, Hinderliter AL. Lifestyle modification advice for lowering or controlling high blood pressure: who's getting it? *J Clin Hypertens (Greenwich).* 2007;9(11):850–858.
14 Nelson DE, Holtzman D, Bolen J, et al. Reliability and validity of measures from the Behavioral Risk Factor Surveillance System (BRFSS). *Soz Praventivmed.* 2001;46(suppl 1):S3–S42.
15 Shea S, Stein AD, Lantigua R, et al. Reliability of the

behavioral risk factor survey in a triethnic population. *Am J Epidemiol*. 1991;133(5):489–500.
16 Centers for Disease Control and Prevention. *2005 Behavioral Risk Factor Surveillance System Summary Data Quality Report*. Atlanta, GA: US Dept of Health and Human Services; 2006.
17 McNutt LA, Wu C, Xue X, et al. Estimating the relative risk in cohort studies and clinical trials of common outcomes. *Am J Epidemiol*. 2003;157:940–943.
18 Whelton PK, He J, Appel LJ, et al.; National High Blood Pressure Education Program Coordinating Committee. Primary prevention of hypertension: clinical and public health advisory from The National High Blood Pressure Education Program. *JAMA*. 2002;288(15):1882–1888.
19 Moser M, Franklin SS. Hypertension management: results of a new national survey for the Hypertension Education Foundation: Harris Interactive. *J Clin Hypertens (Greenwich)*. 2007;9:316–323.