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Between-group differences in nutrition- and health- related psychosocial factors among US adults and their associations with diet, exercise, and weight status

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Abstract

Background—Large disparities exist across ethnic and socioeconomic status (SES) groups regarding obesity and other chronic diseases. Eliminating health disparities is a national priority in the US.

Objective—To test between-group differences in nutrition- and health-related psychosocial factors (NHRPF) and their associations with US adults' diet, exercise, and weight status.

Design and participants/setting—Nationally representative data from the Continuing Survey of Food Intakes by Individuals and the Diet and Health Knowledge Survey in 1994–96 from 4,356 US adults aged 20–65 years were used. Diet was assessed using 24-hour recalls; NHRPF, by 25 questions; weight status, by self-reported weight and height. Index scores were created to measure NHRPF. Diet quality was assessed using the US Department of Agriculture 2005 Healthy Eating Index (HEI).

Statistical analyses—Multivariate linear and logistic regression models were conducted to examine the associations.

Results—Some ethnic differences in NHRPF existed but were small. There were statistically significant ($P < 0.05$) and large ethnic differences in diet (blacks had the worst average HEI; whites, the best, at 47.6 vs. 52.3, respectively). Groups with higher SES had better NHRPF (had better nutrition knowledge and beliefs, made better food choices, and had better awareness of nutrition-related health risks) and HEI. Subjects with high school education had higher NHRPF score (37.2 vs. 35.7) and HEI (54.5 vs. 49.5) than those with less than a high school education.

Conclusions—Ethnic differences among American adults' NHRPF were small, but SES differences were greater. More efforts are needed to study the influences of the complex interactions between individual and social environmental factors that affect Americans' diet and weight status and to explain related ethnic disparities.

Keywords

ethnicity; nutrition; psychosocial; dietary intake; weight status; disparity

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INTRODUCTION

Nationally representative data show large disparities across ethnic and socioeconomic status (SES) groups regarding obesity and many other chronic diseases in the US (1). Eliminating health disparities is a national priority (2, 3). The determinants of health disparities in the US are still poorly understood, and there are many controversies. Obesity is the result of a large number of biological, behavioral, social, environmental, and economic factors and the complex interactions between them that promote a positive energy balance (4). Speculations have been made regarding the major contributors based on a growing body of literature, which has largely focused on individual factors such as SES, body image and lifestyle factors. Some recent studies have focused on selected community characteristics separately based on cross-sectional data and non-representative samples (1, 5-7).

The between-group differences in nutrition- and health-related psychosocial factors (NHRPF), including nutrition knowledge and beliefs (NKB), may play an important role in the large ethnic and SES differences observed in US adults' dietary intakes, physical activity, and weight status (1). Recently, we have observed some evidence suggesting associations between SES, perceived economic barriers and nutritional benefits and overall diet quality among US adults (8, 9). Previous research has found positive associations of nutrition knowledge and self-efficacy and beliefs with diet and health (10-13). To our knowledge, few studies have examined the ethnic differences in NHRPF.

Using nationally representative data, we examined between-group differences in NHRPF and their associations with dietary intakes, exercise, and weight status in US adults. We first studied the differences in NHRPF across ethnic and SES groups. Next, we examined the associations between these psychosocial factors and dietary intakes, exercise, and weight status. In addition, we studied reported intention of making changes to improve diet and their correlates.

METHODS

The 1994-96 Continuing Survey of Food Intakes by Individuals (CSFII) and the Diet and Health Knowledge Survey (DHKS)

Data from the US Department of Agriculture (USDA) Continuing Survey of Food Intakes by Individuals (CSFII) 1994-96 were used (14). A nationally representative multi-stage stratified sample of 16,103 non-institutionalized persons aged 0 to 90 years residing in the US provided one to two days of dietary intake information in 24-hour recalls conducted 3-10 days apart. The 24-hour recalls utilized an automated 5-stage multiple-pass approach (15). Demographic, socioeconomic and lifestyle data were collected for all CSFII participants.

One adult aged 20 years or older per household who provided at least the first day of dietary intake data completed the Diet and Health Knowledge Survey (DHKS). The DHKS participants were asked about their self-perceptions of the adequacy of dietary intake levels of nutrients and other dietary components, awareness of diet-health relationships, perceived importance of following dietary guidance for specific nutrients and other dietary components, behaviors related to fat and food safety, knowledge about food sources of fats and cholesterol, and self-perceptions about weight status (see Appendices A and B) (16).

Although these data sets are more than 10 years old, to our knowledge they are the only available data sets that provide comprehensive, nationally representative data on all the needed study variables for our study, including detailed information on NHRPF. This information has not been collected in other more recent national surveys such as the

National Health and Nutrition Examination Surveys (NHANES). Use of the DHKS data is further supported by the fact that there appear to be few major changes in the NHRPF reflected in these results and their associations with diet and obesity in the US over the past decade. The recent NHANES data have showed that Americans' dietary intake quality has improved little since the mid 1990s (17-19).

Study population

Of the 16,103 CSFII 1994-96 participants, 9,872 adults aged 20 years and older provided at least one day of dietary recall data. Of these, 5,765 completed the DHKS. Ninety DHKS participants who provided only one day of dietary recall data were excluded. A total of 1,319 participants aged over 65 were also excluded in order to obtain a sample of relatively healthy individuals with no potentially special dietary needs due to some uncommon comorbidities and aging issues, even though some young people also need a special diet (17). A final sample of 4,356 individuals (2,219 men and 2,137 women) aged 20-65 were included in the study.

Key measures and study variables—Our exposure variables included sex, race/ethnicity, SES and psychosocial factors. Outcomes included diet, exercise and obesity.

Nutrition- and health-related psychosocial factors (NHRPF)

Study participants answered a number of questions regarding NHRPF. Based on their answers, scores were assessed for each question and then corresponding index scores were created for each category (see below).

1. **Nutrition knowledge and beliefs (NKB).** One adult survey participant from each household was asked about his/her NKB in the DHKS by using the following 11 questions: "To you personally, is it very important, somewhat important, not too important, or not at all important to: 1) Use salt or sodium only in moderation? 2) Choose a diet low in saturated fat? 3) Choose a diet with plenty of fruits and vegetables? 4) Use sugars only in moderation? 5) Choose a diet with adequate fiber? 6) Eat a variety of foods? 7) Maintain a healthy weight? 8) Choose a diet low in fat? 9) Choose a diet low in cholesterol? 10) Choose a diet with plenty of breads, cereals, rice and pasta? 11) Eat at least two servings of dairy products daily?"

We calculated an overall NKB score (range: 11-44) to summarize subjects' answers to these questions. First, subjects who answered "not at all important," "not too important," "somewhat important" or "very important" were assigned a score of 1, 2, 3 or 4, respectively; then the total score was summed. A high total score indicated a better NKB.

2. **Considerations of key factors affecting food choices.** Subjects were asked to identify factors they considered important when buying foods, including safety, taste, ease of preparation (convenience), how well the food keeps (freshness), nutrition, and food price. Responses to each question were measured on a 4-point Likert scale from (a) "not at all important" to (d) "very important". To summarize these questions, we first reversed the score for two of these 6 questions (ie, taste and food price; the lower the score was, the more the individual might take into account high quality of food), since previous research has suggested that taste and food price may negatively affect food choice, e.g., people who considered food taste and price too much may tend to choose the tastier and cheaper but less nutritious food (20). We then computed a total score for considerations of food choices (range: 6-24). The higher the score was, the more the individual took into account high food quality when buying foods.

In addition, we chose the question “Now think about buying food. When you buy food, how important is nutrition – very important, somewhat important, not too important, or not at all important?” to evaluate subjects’ consideration of the importance of nutrition at the time of food purchase. Subjects who answered “very important” were categorized as the “nutrition importance” group. Those who provided the other responses served as the reference group in our models.

3. **Awareness of nutrition-related health risks.** Subjects were asked to respond “yes” or “no” to a question about whether they had heard about any health problems caused by unhealthy eating, such as eating too much fat, salt, cholesterol or sugar, but not enough fiber or calcium. This was evaluated by counting the number of 7 health problems caused by unhealthy eating of which subjects were aware (range: 0-7). The higher the number, the more awareness of nutrition-related health risks that subjects had. Further, the subjects were categorized into two groups: (i) the “awareness” group if they were aware of all 7 of these nutrition-related health risks; and (ii) the others.
4. **Intention to improve diet.** Subjects were also asked to identify whether they thought about their current diet habits and would be willing to make changes: “The things that I eat and drink are healthy, and there is no reason for me to make changes.” Their intention to make change was assessed by using a 4-point Likert scale (“strongly disagree,” “somewhat disagree,” “somewhat agree” and “strongly agree”). For our analyses, subjects who answered “strongly disagree” or “somewhat disagree” were grouped as “intention to improve diet” and those reporting “strongly agree” or “somewhat agree” served as the reference group.
5. **Overall NHRPF index.** We created several indices to summarize these NHRPF: Those who had better NKB (score – median of NKB score), more food choice consideration (food choice score – median), and more awareness of the 7 nutrition-related health risks (“awareness” group) were categorized as the “good NHRPF” group, while the others were treated as the “poor NHRPF” group. Note that we only counted the importance of nutrition once when creating the NHRPF index.

The Cronbach’s α coefficients were 0.86 for NKB (0.86 for NH Whites or for NH Blacks; 0.85 for Hispanics; 0.87 for “others”), and 0.74 for awareness of nutrition-related health risks (NH Whites: 0.74; NH Blacks or Hispanics: 0.73; others: 0.79). Overall, the internal consistency reliability of NHRPF measures in this study was acceptable.

Dietary intakes

Information on dietary intakes was collected from the CSFII 1994-96. Nutrient intakes from foods were calculated by the USDA from the weight of portion sizes reported in the 24-hour recalls and data from a nutrient database.

The USDA’s 2005 Healthy Eating Index (HEI) was used to assess the overall quality of diet (21). The 2005 HEI reflects the 2005 Dietary Guidelines for Americans and consists of 12 components: total energy; saturated fat; sodium; and the food groups including total fruit; whole fruit; total vegetables; dark green and orange vegetables; legumes; total grains; milk; meat; beans; and oil. HEI scores range from 0 (worst) to 100 (best). The HEI has been described in detail elsewhere (21, 22). Although there were some changes in dietary guidelines between the time of the survey and 2005, this should not be a major concern for our study as we aimed to assess dietary quality using appropriate knowledge reflected by the 2005 USDA HEI.

In this study, nutrient intakes from the two 24-hour recalls were averaged and included total energy, fat as a percent of total energy, cholesterol, sodium, calcium and fiber. We selected these nutrients because they are highly associated with chronic diseases (e.g., obesity, diabetes, hypertension, etc.). As appropriate, foods reported in the 24-hour recalls were grouped into dairy products, fruits and vegetables (FV) categories; and daily averaged grams of foods in each group were used in our analysis.

Exercise and sedentary behaviors

Exercise was evaluated by asking: “How often do you exercise vigorously enough to work up a sweat?”, with “1” being daily and “6” being rarely or never. A sedentary lifestyle was operationalized as those who reported “rarely or never.” Also, the average TV-watching time during the two-day interviews was calculated.

Weight status

Body mass index (BMI, kg/m²) was calculated based on self-reported weight and height. Overweight was defined as 25 ≤ BMI < 30; and obesity, BMI ≥ 30.

Sociodemographic characteristics

Based on self-reported information, subjects were grouped as non-Hispanic (NH) whites, NH blacks, Hispanics and all others.

SES was assessed using education and household income. Education based on “< high school” (< 12 years), “high school” and “> high school”. Household income levels based on poverty income ratio (PIR): 0-130% (poor, eligible for food stamps), 131-350% (middle income), and > 350% (high income).

Other covariates

We included the following covariates, considering their potential correlation with our study variables of interest: a) Comorbidity (chronic diseases): Subjects were asked about the existence of chronic diseases diagnosed by their doctors, including diabetes, high blood pressure, heart disease, cancer, osteoporosis, high blood cholesterol and stroke; b) Self-rated health: This was assessed based on the following question: “In general, would you say that your health is 1) excellent; 2) very good; 3) good; 4) fair; 5) poor.” Subjects with answers of “fair” or “poor” were categorized as being in “fair/poor health.”; c) Survey year; d) Geographic region (Northeast, Midwest, South and West); e) Degree of urbanization of the geographical area (metropolitan statistical area-central city, suburban, and rural).

Statistical analysis

First, by using the analysis of variance (ANOVA) and χ^2 tests, the differences in NHRPF (the NHRPF index and the individual NHRPF factors) by sociodemographic and lifestyle characteristics were tested.

Next, multivariable linear and logistic regression models were conducted to examine the associations of NHRPF with HEI, weight status, and exercise. By using normal weight (BMI < 25) as the reference, multinomial logistic regression models were fit to assess the association with overweight and obesity.

Third, stratified analyses were conducted to test potential sex and ethnic differences in the associations between NHRPF and overweight and obesity, high HEI, and exercise. In addition, interaction terms for the NHRPF index and the individual NHRPF factors with sex and race/ethnicity were included and tested in separate multivariable models.

Finally, we studied reported intention of making changes to improve diet, the correlates among all participants, and among those with poor diet (HEI < 20th percentile). We tested whether those with better NHRPF were more likely to intend to improve their diet.

In all multivariable analyses, survey year, age, sex, region, degree of urbanization, chronic disease, and self-rated health were considered as potential confounders. The variance inflation factor (VIF) was used to check multicollinearity in the models. All variables' VIF values were less than 3, indicating no multicollinearity.

All analyses were conducted using the survey procedures in SAS (version 9.2; release year: 2008; SAS Institute, Inc., Cary, North Carolina) to take complex sampling design into account to produce nationally representative estimates and correct estimates of standard errors (SE). Statistical significance was set at $P < 0.05$.

RESULTS

Between-group differences in the NHRPF index and individual NHRPF measures, and between HEI and total energy intake

Table 1 shows some between-group differences in these outcomes. There were some ethnic differences in the individual NHRPF factors, including nutrition importance, making food choices, and awareness of nutrition-related health risks, but most were small. Ethnic differences in mean HEI were larger, with blacks having the lowest HEI. In general, the associations between SES and these outcomes including NHRPF were as expected.

Intention to improve diet—As indicated in Table 2, only approximately half of them reported an intention to improve their diet (49.4% of men and 54.1% of women). The figures were slightly higher among those with a poor diet (HEI < 20th percentile): 53.1% of men, and 64.5% of women. Among subjects with a poor diet, those who were females, had more than a high school education or had co-morbidities were more likely to report the intention (all $P < 0.05$).

Associations between NHRPF and dietary intakes, exercise and weight status, and ethnic and gender differences in the associations

NHRPF were not significantly associated with BMI (Table 3). Those who intended to improve their diet had higher BMI (beta = 1.01, $p < 0.001$). Several NHRPF measures (had better NKB, nutrition importance, made better food choices, and had better awareness of nutrition-related health risks) showed desirable associations with healthy eating, as indicated by HEI, intakes of energy, fat, fiber and FV. For example, those with better NKB had higher HEI (by 3.71 unit, $p < 0.001$), lower fat intake (by 1.51 percentage points, $p < 0.001$), and higher FV intake (by 35.80 grams/day, $p < 0.05$).

Table 4 shows that overweight and obese subjects were more likely to intend to improve their diet (by 40%, 69%, respectively). Those with better NKB or who considered nutrition important were about 90-126% more likely to have high HEI and were approximately 60% more likely to participate in exercise compared to the others. Those who were aware of the risks of unhealthy eating were 40% more likely to have high HEI. Americans with better NKB, who reported considering nutrition importance, having more food choice consideration, being better aware of nutrition-related health risks and having better NHRPF index were less likely to have a poor diet (HEI < 20th percentile).

The beneficial effects of high NHRPF index on high HEI were significantly stronger in NH whites, but not among other racial/ethnic groups. The significant association between better NKB and high diet quality was observed among NH whites and Hispanics, while blacks saw

weaker beneficial effects than the other ethnic groups. The associations of the NHRPF index, NKB, and nutrition importance with exercise were statistically significant only for whites. In general, the ethnic differences in the associations of the NHRPF index, NKB, nutrition importance, and food choice with overweight/obesity (BMI ≥ 25) were small ($P > 0.05$ for all ORs and $P_{\text{interaction}} > 0.05$).

The gender differences were also tested in the associations of NHRPF measures with weight status and diet quality. Few of the differences in the associations for overweight/obesity were significant and most were small (not shown), but we detected some gender differences in the associations for high HEI (Figure 1), e.g., better NKB and awareness of nutrition-related health risks showed stronger beneficial effects in men than in women, while women showed stronger nutrition importance for high HEI than men. However, none of these differences reached statistical significance (all $P > 0.05$).

Association between NHRPF and intention to improve diet among those with poor diet

We fit logistic regression models to test whether those with better NHRPF were more likely to report an intention to improve their diet. However, there were no such significant associations in the total, sex- or ethnicity-specific groups (Table 5).

DISCUSSION

To our knowledge, no previous research has used nationally representative data to examine ethnic differences in NHRPF and their associations with eating and weight status among Americans. This study showed several important findings that could enhance understanding of the complex factors that affect Americans' diet, exercise, and weight status and the related disparities across ethnic and SES groups. Those with better NKB and better awareness of nutrition-related health risks were more likely to have a higher diet quality. Some other important findings were:

First, overall, the ethnic differences in NHRPF are smaller than what we anticipated. However, we found large racial/ethnic differences in dietary intakes (measured by HEI and the intakes of energy and individual nutrients and food groups). The average HEI (on a 0 to 100 scale) was 47.6 for blacks, which is lower than that for whites (52.3). We found that NH blacks had the lowest FV consumption (347 grams/d) compared to NH whites (368 gram/d), Hispanics (388.4 gram/d) and the "others" group (461 gram/d). This is consistent with one of our previous studies based on the 1999-2002 NHANES data (23).

A study that used the Stages of Change Model among 242 low-income, medically underserved US adults (47% blacks, 27% whites and 26% "others"), did not find significant ethnic differences with respect to current attitudes and intentions regarding nutrition and physical activity (24). Our findings suggest that a key reason why blacks have lower diet quality may not be due to their less-desirable NHRPF but may be due to their other challenges, such as low income and lack of access to healthy food choices (7, 25).

Second, our findings show large SES differences in NHRPF and HEI. Overall, groups with high SES had better NHRPF and better HEI. Worth noting is that one of our recent studies using CSFII data, but fewer NKB measures, suggests that NKB may modify the association between SES factors and diet quality. We found that better SES independently improved the likelihood of adequate FV intake and overall diet quality. In several cases, NKB acted as an effect modifier. In particular, SES showed no association with diet quality among subjects in the lowest NKB tertile, while the association was consistently stronger in the highest tertile (9).

Moreover, this study and others show that Americans' dietary intakes are far from ideal, efforts are needed to improve Americans' diet, and the efforts should cover all racial/ethnic and SES groups. For example, in CSFII 1994-96, Americans' average HEI was only 58 (the USDA recommended an HEI > 80) and even the HEIs of whites and high SES groups were not much better. The NHANES 2003-04 showed the same low average HEI for Americans (57.5 for all; 56.5 and 57.8 for low- and high-income groups, respectively) (19). The NHANES 1988-94 and 2001-06 data showed that among Americans aged 40-74, adherence to a healthy lifestyle dropped from 15% to 8% during the period, and it decreased more rapidly among whites; the rate was consistently lower among blacks than in other ethnic groups (26).

However, this study found that only about half of US adults (49% of men and 54% of women) reported having the intention to improve their diet. Even among those with a poor diet (HEI < 20th percentile), only 53% of men and 64% of women had the intention. Those with at least a high school education were more likely to do so (62% vs. 41%) than the others. Americans with better NHRPF were less likely to report intention to improve diet among those with low diet quality. However, there are limitations in such self-reported measures. Further research is warranted to confirm the association we observed.

The present study has important strengths: a) It is based on nationally representative data collected from a large sample and included rich data regarding NHRPF; b) We created a set of index scores for different categories of NHRPF and for overall dietary quality scores based on the USDA's 2005 HEI. These help us to better measure these study variables and better utilize the data; and c) We fit various models to examine the associations between study variables, which helped detecting robust findings. These findings help shed light on the underlying causes of the health disparities in the U.S. and can help guide future intervention efforts.

This study also has limitations. First, only self-reported weight and height were collected in CSFII. Although some research suggests that self-reported anthropometrics are valid and they are widely used in epidemiologic studies (27), they are prone to measurement error, weight in particular (28). Second, this study is based on cross-sectional data and although it is unlikely that people's dietary intakes will affect their NKB, people may have changed their diet and NHRPF factors due to their weight status. The data could not assess the causal relationship between NHRPF and subjects' weight changes in the past or the future. Third, the dataset is more than 10 years old. However, to our knowledge, this is the only available national survey dataset that provides all the related measures. Further, recent evidence shows no improvement in Americans' dietary intakes over what is reflected in these data sets (18, 19), so it is unlikely that the associations between our key study variables have changed much over the past decade.

CONCLUSIONS

This study shows that, in general, racial/ethnic differences in American adults' nutrition- and health-related psychosocial factors are small, which is different from what we and others have expected, although the ethnic differences in dietary intakes and weight status are large. Americans with better psychosocial factors had better dietary intake patterns (e.g., better HEI scores and intakes of selected nutrients and food groups). The beneficial effects of higher SES on these psychosocial factors and dietary intakes seem to be consistent. Americans' dietary intakes are far from ideal, and only a small proportion met the dietary guidelines. However, even among Americans with poor dietary intakes, only about half reported having the intention to improve their intakes. More efforts are needed to study the influence of complex interactions between individual and social environmental factors that

affect Americans' dietary intakes and weight status, and to explain the related ethnic disparities. Improving awareness of nutrition and health related psychosocial factors may help improve patients' diet quality. Dietitians and nutritionists can play an important role in this effort. National intervention efforts should target social and environmental factors to help empower all Americans to have healthy eating habits.

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Appendix A

Assigned score to each answer to each question regarding nutrition knowledge and beliefs and food choices in this study

Items/assigned scores	a. Not at all important	b. Not too important	c. Somewhat important	d. Very important ^
A. Nutrition knowledge and beliefs (NKB)				
1. Use salt in moderation	1	2	3	4
2. Choose a diet low in saturated fat	1	2	3	4
3. Choose a diet with plenty of fruits and vegetables	1	2	3	4
4. Use sugars in moderation	1	2	3	4
5. Choose a diet with adequate fiber	1	2	3	4
6. Eat a variety of foods	1	2	3	4
7. Maintain a healthy weight	1	2	3	4
8. Choose a diet low in fat	1	2	3	4
9. Choose a diet low in cholesterol	1	2	3	4
10. Choose a diet with plenty of breads, cereals, etc	1	2	3	4
11. Eat two servings of dairy products daily	1	2	3	4
B. Considerations of food choices				
1. Safety	1	2	3	4
2. Taste*	4	3	2	1
3. Convenience	1	2	3	4
4. Freshness	1	2	3	4
5. Nutrition	1	2	3	4
6. price*	4	3	2	1

^ This was considered as desirable and was assigned the highest score for most except for those marked with *;

* Score was reversed because we believed those who considered them important might view the others less important and had worse food choices.

Appendix B

I. For each of the following questions, the answer choices were

1 = Not at all important 2 = Not too important 3 = Somewhat important
4 = Very important 8 = Don't know 9 = Not ascertained

1. Nutrition knowledge and beliefs (NKB: 11 questions)

- A. To you personally, is it very important, somewhat important, not too important, or not at all important to use salt or sodium only in moderation?
- B. To you personally, is it very important, somewhat important, not too important, or not at all important to choose a diet low in saturated fat?
- C. To you personally, is it very important, somewhat important, not too important, or not at all important to choose a diet with plenty of fruits and vegetables?
- D. To you personally, is it very important, somewhat important, not too important, or not at all important to use sugars only in moderation?
- E. To you personally, is it very important, somewhat important, not too important, or not at all important to choose a diet with adequate fiber?
- F. To you personally, is it very important, somewhat important, not too important, or not at all important to eat a variety of foods?
- G. To you personally, is it very important, somewhat important, not too important, or not at all important to maintain a healthy weight?
- H. To you personally, is it very important, somewhat important, not too important, or not at all important to choose a diet low in fat?
- I. To you personally, is it very important, somewhat important, not too important, or not at all important to choose a diet low in cholesterol?
- J. To you personally, is it very important, somewhat important, not too important, or not at all important to choose a diet with plenty of breads, cereals, rice, and pasta?
- K. To you personally, is it very important, somewhat important, not too important, or not at all important to eat at least two servings of dairy products daily?

2. Nutrition important (1 question)

Now think about buying food. When you buy food, how important is: nutrition – very important, somewhat important, not too important, or not at all important?

3. Perceived food choice barriers (6 questions)

- A. Now think about buying food. When you buy food, how important is: how safe the food is to eat - very important, somewhat important, not too important, or not at all important?
- B. Now think about buying food. When you buy food, how important is: nutrition – very important, somewhat important, not too important, or not at all important?
- C. Now think about buying food. When you buy food, how important is: price – very important, somewhat important, not too important, or not at all important?
- D. Now think about buying food. When you buy food, how important is: how well the food keeps - very important, somewhat important, not too important, or not at all important?
- E. Now think about buying food. When you buy food, how important is: how easy the food is to prepare - very important, somewhat important, not too important, or not at all important?

- F. Now think about buying food. When you buy food, how important is: taste – very important, somewhat important, not too important, or not at all important?

II. For each of the following questions except for question #5, the answer choices were

1 = Yes 2 = No 8 = Don't know 9 = Not ascertained

4. Awareness of unhealthy eating related health risks (7 questions)

- A. Have you heard about any health problems caused by eating too much fat?
- B. Have you heard about any health problems caused by not eating enough fiber?
- C. Have you heard about any health problems caused by eating too much salt or sodium?
- D. Have you heard about any health problems caused by not eating enough calcium?
- E. Have you heard about any health problems caused by eating too much cholesterol?
- F. Have you heard about any health problems caused by eating too much sugar?
- G. Have you heard about any health problems caused by being overweight?

5. Intention to make change in dieting behavior (1 question)

Please tell me if you strongly agree, somewhat agree, somewhat disagree, or strongly disagree with the statement: The things I eat and drink now are healthy so there is no reason for me to make changes.

1 = Strongly disagree 2 = Somewhat disagree 3 = Somewhat agree
4 = Strongly agree 8 = Don't know 9 = Not ascertained

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Figure 1.

Associations (OR and 95% CI) between nutrition- and health-related psychological factors and high diet quality (HEI 80th percentile) in US men and women. NKB: nutrition knowledge and beliefs; HEI: healthy eating index; NHRPF: nutrition- and health-related psychological factors. Separate multivariable logistic regression models were fit for individual NHRPF measures and NHRPF index and for men and women, respectively. Each model adjusted for survey year, age, education, poverty income ratio, region, urbanization, comorbidity, and self-rated health.

Table 1

Nutrition- and health-related psychosocial factors (NHRPF), by sociodemographic and lifestyle characteristics^a

Characteristic	n	NKB score ^f			Nutrition importance ^g			Food choice ^h			Awareness ⁱ			Better NHRPF ^j			HEI			Energy intake (kcal/d)		
		Mean	SE	%	SE	Mean	SE	Mean	SE	Mean	SE	%	SE	Mean	SE	Mean	SE					
Sex																						
Men	2219	35.50	0.23	***	52.83	1.73	***	16.52	0.05	***	5.72	0.05	***	15.41	1.00	***	50.69	0.36	***	2515.83	46.28	***
Women	2137	37.70	0.17		69.25	1.36		16.97	0.04		6.11	0.04		26.82	1.34		53.85	0.50		1670.10	14.62	
Age (yrs)																						
20-34	1165	35.56	0.26	***	54.65	1.67	***	16.52	0.07	***	5.64	0.06	***	13.96	1.22	***	50.44	0.65	***	2263.86	41.27	***
35-49	1507	37.04	0.20		62.09	1.59		16.86	0.05		6.04	0.04		23.42	1.63		52.16	0.47		2068.46	55.21	
50-65	1684	37.54	0.21		69.55	1.57		16.91	0.05		6.15	0.04		28.59	1.65		55.23	0.43		1847.81	21.75	
Ethnicity																						
NH whites	3285	36.67	0.19		58.40	1.20	***	16.65	0.05	**	6.04	0.04	***	21.78	0.87		52.28	0.40	***	2083.34	21.81	
NH blacks	512	36.34	0.32		71.39	3.26		17.26	0.13		5.58	0.10		20.96	3.06		47.60	0.55		2145.30	170.11	
Hispanics	411	36.77	0.46		71.58	3.29		16.92	0.18		5.49	0.11		17.93	2.21		54.36	1.02		2009.80	57.91	
Others	148	36.11	0.65		58.42	6.53		16.69	0.28		5.78	0.15		20.33	4.72		59.29	1.69		2123.93	131.09	
Education																						
<High school	731	35.71	0.37	***	66.03	3.67		16.91	0.08		5.17	0.10	***	10.72	1.18	***	49.41	0.64	***	2022.65	140.71	
High school	1552	36.03	0.29		60.17	1.90		16.70	0.08		5.69	0.05		18.46	1.21		49.91	0.49		2049.19	34.10	
>High school	2073	37.20	0.17		60.78	1.17		16.75	0.06		6.24	0.03		25.43	1.21		54.50	0.41		2122.34	24.27	
Income																						
Low	1079	36.18	0.29	*	64.83	2.58		16.75	0.09		5.39	0.06	***	12.90	1.49	***	49.49	0.75	***	2105.09	129.63	
Middle	1543	36.40	0.23		61.94	1.45		16.75	0.06		5.85	0.05		20.07	1.60		50.97	0.46		2079.91	30.00	
High	1734	36.95	0.20		59.41	1.50		16.76	0.05		6.15	0.05		24.94	1.31		54.37	0.45		2082.73	29.62	
BMI category																						
BMI<25	1803	36.61	0.25		61.10	1.65		16.71	0.06		5.96	0.05		20.63	1.29		53.04	0.55	*	2029.61	29.44	***
25-29.9	1540	36.49	0.24		59.67	1.76		16.8	0.06		5.86	0.05		21.33	1.40		52.17	0.48		2232.37	57.23	
BMI 30	916	36.83	0.23		62.71	2.10		16.78	0.09		5.95	0.06		22.39	1.89		50.54	0.62		1989.22	40.71	
Comorbidity^k																						
0	2830	36.28	0.22	***	58.88	1.21	***	16.70	0.04	*	5.83	0.04	***	18.94	1.14	***	51.80	0.41	***	2142.09	33.01	***

Characteristic	n	NKB score [¶]		Nutrition importance [§]		Food choice [∫]		Awareness [∅]		Better NHRPF [§]		HEI		Energy intake (kcal/d)	
		Mean	SE	%	SE	Mean	SE	Mean	SE	%	SE	Mean	SE	Mean	SE
1	951	37.27	0.18	64.63	1.88	16.86	0.07	6.12	0.05	24.89	1.95	52.94	0.59	1978.59	42.52
2	575	37.88	0.42	72.08	2.75	16.96	0.12	6.17	0.07	31.29	3.35	54.80	0.73	1862.16	54.12
Self-rated health															
Excellent/very good	2451	36.64	0.23	59.69	1.28	16.67	0.05	5.92	0.05	21.56	1.06	52.70	0.52	2168.67	41.39
Good	1264	36.69	0.22	62.98	1.92	16.93	0.06	5.97	0.06	19.51	1.48	52.02	0.50	1974.00	31.32
Fair/poor	641	36.30	0.45	65.16	3.16	16.79	0.14	5.79	0.08	23.64	2.62	50.85	0.76	1905.77	39.85
Exercise participation															
No	1511	36.02	0.22	58.68	1.96	16.75	0.08	5.83	0.05	20.56	1.81	50.94	0.47	1932.87	28.59
Yes	2830	36.94	0.20	62.58	1.17	16.75	0.04	5.97	0.05	21.65	1.30	53.03	0.44	2158.43	36.89
TV watching (hrs/d)															
2	2392	37.06	0.20	62.86	1.30	16.81	0.06	6.06	0.04	23.32	1.15	53.71	0.47	2024.13	21.21
>2	1964	36.03	0.24	59.00	1.59	16.68	0.07	5.73	0.05	18.44	1.34	50.42	0.40	2166.00	48.58

Abbreviations: SE, standard error; HEI, healthy eating index; BMI, body mass index; NKB, nutrition knowledge and beliefs; NHRPF, nutrition- and health-related psychosocial factors.

[^] Controlled for complex survey design. Values are shown as mean or proportion with its standard error. P value from ANOVA and/or χ^2 test for continuous and categorical variables, respectively.

[¶]NKB: consisting of eleven questions as 'To you personally, is it very important (score: 4), somewhat important (3), not too important (score: 2), or not at all important (score: 1) to consume the following nutrients or foods at appropriate levels: salt/sodium, saturated fat, fiber, cholesterol, fruits and vegetables, sugar, dairy products, etc?' The higher the score, the better nutrition knowledge and beliefs (range: 11-44).

[§]Subjects' consideration about the importance of nutrition at food purchase was assessed by asking: 'When you buy food, how important is nutrition?' Response 'very important' was categorized as 'nutrition important' group, while subjects with other responses served as the reference group.

[∫]Food choice: Subjects took considerations of 6 key factors affecting food choices, including food safety, nutrition, price, freshness, convenience, and taste. The higher the score, the more consideration in buying food (score range: 6-24).

[∅]Awareness: Subjects were aware of the number of 7 nutrition-related health risks (e.g., high fat, cholesterol, sodium; low fiber and calcium). The higher the score, the more awareness of nutrition-related health risks.

[§]Better NHRPF was summarized from the individual NHRPF factors: those with better NKB (score=>median), more food choice consideration (score median), and more awareness of nutrition-related health risks.

^{*}Number of diagnosed chronic conditions, such as hypertension, diabetes. 0 means no diagnosed chronic disease; 1 means one diagnosed chronic disease; 2 means two or more chronic diseases.

* P<0.05;

** P<0.01;

P<0.001.

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Table 2Percentage of US adults with intention to improve diet, by sociodemographic and lifestyle characteristics[^]

Characteristic	<u>In all American adults</u>		<u>In those with poor diet (HEI<20th percentile)</u>	
	%	SE	%	SE
Sex				
Men	49.4	2.4	53.1	5.0 *
Women	54.1	1.8	64.5	3.5
Age (yrs)				
20-34	54.8	2.4 **	56.4	5.6
35-49	52.7	2.3	62.0	4.7
50-65	46.1	1.7	50.0	4.1
Ethnicity				
NH whites	54.2	1.7 *	59.1	3.6
NH blacks	48.7	4.3	59.6	9.5
Hispanics	41.3	3.3	46.1	8.1
Others	45.2	7.7	39.3	30.8
Education				
<High school	42.4	2.8 **	41.0	6.4 **
High school	52.4	2.1	61.7	5.4
>High school	53.6	2.1	62.0	4.3
Income				
Low	48.4	2.4	59.7	6.4
Middle	51.8	2.3	53.2	5.1
High	52.9	1.8	62.1	5.3
BMI category				
BMI<25	47.8	1.8 ***	51.9	4.6
25-29.9	53.3	2.3	63.9	6.4
BMI ≥ 30	58.5	2.8	57.7	5.3
Comorbidity[†]				
0	51.8	2.0	55.0	4.4 *
1	52.0	2.0	68.3	4.4
2	51.5	3.5	59.0	6.6
Self-rated health				
Excellent/very good	49.8	1.8 *	54.6	4.8
Good	53.4	2.5	61.9	5.5
Fair/poor	58.3	3.3	60.6	6.2
Exercise participation				
No	55.8	3.0 *	59.5	5.4
Yes	49.8	1.6	56.9	3.9
TV watching (hrs/d)				
2	51.0	1.7	56.9	5.7

Characteristic	<u>In all American adults</u>		<u>In those with poor diet (HEI<20th percentile)</u>	
	%	SE	%	SE
>2	52.9	2.4	58.4	4.5

Abbreviations: SE, standard error; HEI, healthy eating index; BMI, body mass index.

^ Controlled for complex survey design. Values are shown as proportion with its standard error.

* Number of diagnosed chronic conditions, such as hypertension, diabetes. 0: without comorbidity; 1: one chronic condition; 2: two or more chronic conditions.

* P<0.05;

** P<0.01;

*** P<0.001.

Table 3

Linear regression models: Associations of dietary intakes and BMI with nutrition- and health-related psychosocial factors (NHRPF)

Key predictor	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Better NHRPF [§]	β SE	Better NKB [¶]	β SE	Nutrition importance [§]	β SE	Food choice [§]	β SE	Awareness [¶]	β SE	Intention to improve diet ^θ	β SE
Dietary intakes												
HEI	2.75	0.6 ***	3.71	0.64 ***	4.37	0.40 ***	0.67	0.50	2.66	0.63 ***	-2.76	0.49 ***
Energy (kcal/d)	-72.02	37	-57.33	53.27	-165.66	56.20 **	-139.95	44.28 **	19.47	29.95	76.40	52.60
Fat (% kcal)	-1.24	0.41 **	-1.51	0.39 ***	-1.66	0.28 ***	-0.79	0.29 *	-0.27	0.29	0.99	0.35 **
Cholesterol (mg/d)	-20.98	8.34 *	-12.96	12.13	-25.96	9.64 *	-14.35	8.30	-19.47	7.12 **	13.30	9.34
Sodium (mg/d)	-138.39	76.51	-90.39	113.21	-271.83	104.65 *	-228.72	79.64 **	-10.75	64.44	94.76	94.43
Calcium (mg/d)	20.90	18.82	27.84	24.19	-7.18	26.44	-44.22	22.93	35.73	18.43	11.25	26.75
Fiber (g/d)	1.42	0.48 **	1.84	0.46 ***	1.30	0.38 **	-0.27	0.36	2.18	0.36 ***	-1.16	0.40 **
Dairy product (g/d)	16.04	8.75	13.10	11.43	13.71	11.23	-20.23	10.94	9.55	9.89	-4.91	12.79
FV (g/d)	35.29	14.22 *	35.80	11.09 **	37.89	12.53 **	-6.51	15.05	57.54	11.85 ***	-50.76	13.44 ***
BMI (kg/m2)	-0.18	0.23	-0.26	0.24	-0.28	0.22	0.00	0.26	-0.07	0.21	1.01	0.21 ***

Abbreviation: NHRPF, nutrition- and health-related psychosocial factors; NKB, nutrition knowledge and beliefs; HEI, healthy eating index; FV, fruits and vegetables; BMI, body mass index.

* Each model adjusted for survey year, sex, age, education, poverty income ratio, region, urbanization, comorbidity, and self-rated health.

Separate models were fit for each categorical exposure (e.g., better NKB) and continuous outcome (e.g., BMI) variables.

§ Better NHRPF was those with better nutrition knowledge and beliefs (NKB score median), more food choice consideration (score median), and more awareness of nutrition-related health risks.

¶ NKB: It consisted of 11 questions as 'To you personally, is it very important (score: 4), somewhat important (3), not too important (score: 2), or not at all important (score: 1) to consume the following nutrients/foods at appropriate levels: salt/sodium, saturated fat, fiber, cholesterol, fruits and vegetables, sugar, dairy products, etc?' (total score range: 11-44). Better NKB was defined as NKB score 80th percentile, while a score <80th percentile as reference.

§ Nutrition importance was assessed by asking participants: 'When you buy food, how important is nutrition?' Response 'very important' was categorized as 'nutrition importance' group, while subjects with other responses served as the reference group.

§ Food choice: Subjects took considerations of 6 key factors affecting food choices, including food safety, nutrition, price, freshness, convenience, and taste (score range: 6-24). More food choice consideration was defined as a total score 80th percentile, while a score <80th percentile served as the reference.

θ Subjects were categorized in the "awareness" group if they were aware of all 7 nutrition-related health risks (e.g., high fat, cholesterol, sodium; low fiber and calcium) vs. the other participants who were less aware of.

^g Intention to improve diet was assessed by asking subjects whether they thought about their current diet habits and would be willing to make changes: "The things that I eat and drink are healthy, and there is no reason for me to make changes." (4-point Likert scale: strongly disagree, somewhat disagree, somewhat agree, and strongly agree. Those who answered "strongly disagree" or "somewhat disagree" were grouped as "intention to improve diet" and those reporting "strongly agree" or "somewhat agree" served as the reference group.

* P<0.05;

** P<0.01;

*** P<0.001.

Table 4

Logistic regression models: Associations (OR and 95% CI) of having good (HEI score 80th percentile) or poor diet (HEI score <20th percentile), exercise participation and overweight/obesity with nutrition- and health-related psychosocial factors (NHRPF)^Δ

Key predictors	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Better NHRPF ^Δ OR (95% CI)	Better NKB ^Δ OR (95% CI)	Nutrition importance ^Δ OR (95% CI)	Food choice ^Δ OR (95% CI)	Awareness ^Δ OR (95% CI)	Intention to improve diet ^Δ OR (95% CI)
1. For whole sample						
HEI 80th vs. <80th percentile	1.52 (1.23, 1.88)*	1.90 (1.49, 2.42)*	2.26 (1.77, 2.90)**	1.14 (0.89, 1.46)	1.40 (1.08, 1.82)*	0.57 (0.47, 0.69)*
HEI <20th vs. 20th percentile	0.68 (0.48, 0.98)*	0.61 (0.41, 0.91)*	0.47 (0.38, 0.59)**	0.84 (0.71, 0.99)*	0.67 (0.52, 0.86)*	1.37 (1.04, 1.79)*
Exercise participation	1.25 (0.93, 1.67)	1.68 (1.38, 2.05)*	1.57 (1.30, 1.90)*	1.09 (0.89, 1.33)	1.09 (0.83, 1.43)	0.75 (0.60, 0.93)*
Weight status^{ΔΔ}						
Overweight (BMI: 25-29.9)	1.11 (0.89, 1.39)	0.99 (0.80, 1.23)	0.96 (0.76, 1.21)	1.15 (0.94, 1.40)	0.93 (0.80, 1.09)	1.40 (1.14, 1.71)*
Obesity (BMI 30)	1.04 (0.78, 1.38)	0.93 (0.69, 1.25)	0.91 (0.69, 1.19)	1.11 (0.83, 1.47)	1.03 (0.85, 1.26)	1.69 (1.36, 2.10)*
2. Stratified by race/ethnicity^Δ						
1) HEI 80th percentile						
NH whites	1.49 (1.16, 1.91)*	1.86 (1.46, 2.38)*	2.45 (1.92, 3.14)***	1.10 (0.80, 1.53)	1.33 (1.03, 1.73)*	0.61 (0.50, 0.73)*
NH blacks	1.10 (0.47, 2.55)	1.38 (0.61, 3.12)	1.32 (0.67, 2.57)	1.26 (0.71, 2.23)	0.99 (0.46, 2.16)	0.31 (0.13, 0.78)*
Hispanics	1.14 (0.47, 2.77)	2.23 (1.01, 4.96)*	0.95 (0.37, 2.44)	0.50 (0.27, 0.94)**	2.24 (0.88, 2.16)	0.76 (0.28, 2.06)
<i>P value for interaction</i>	0.655	0.994	0.103	0.006	0.760	0.212
2) Exercise participation						
NH whites	1.32 (0.99, 1.77)	1.68 (1.38, 2.04)*	1.48 (1.23, 1.78)*	0.96 (0.78, 1.18)	1.19 (0.91, 1.54)	0.68 (0.54, 0.85)*
NH blacks	0.83 (0.36, 1.87)	1.41 (0.72, 2.76)	1.60 (0.96, 2.64)	0.98 (0.56, 1.72)	0.64 (0.32, 1.26)	0.94 (0.53, 1.68)
Hispanics	0.79 (0.43, 1.45)	1.00 (0.59, 1.71)	1.48 (0.65, 3.39)	1.33 (0.79, 2.26)	1.24 (0.70, 2.19)	1.12 (0.66, 1.91)
<i>P value for interaction</i>	0.008	<0.001	0.095	0.026	0.354	0.391
3) BMI 25						
NH whites	1.20 (0.98, 1.48)	1.16 (0.91, 1.46)	0.96 (0.77, 1.20)	1.17 (0.92, 1.48)	0.98 (0.81, 1.18)	1.54 (1.28, 1.86)*
NH blacks	0.90 (0.45, 1.82)	0.62 (0.34, 1.11)	0.87 (0.50, 1.51)	0.81 (0.49, 1.34)	1.15 (0.75, 1.75)	1.54 (0.95, 2.51)
Hispanics	0.61 (0.31, 1.22)	0.57 (0.25, 1.29)	1.26 (0.48, 3.31)	1.72 (0.97, 3.04)	0.61 (0.37, 1.01)	0.64 (0.32, 1.29)
<i>P value for interaction</i>	0.176	0.181	0.576	0.439	0.008	0.084

Abbreviation: NHRPF, nutrition- and health-related psychosocial factors; NKB, nutrition knowledge and beliefs; HEI, healthy eating index; OR, odds ratio; 95% CI, 95% confidence interval; BMI, body mass index.

Each model adjusted for survey year, sex, age, education, poverty income ratio, region, urbanization, comorbidity, and self-rated health.

5 Better NHRPF was those with better nutrition knowledge and beliefs (NKB score median), more food choice consideration (score median), and more awareness of nutrition-related health risks.

6 NKB: It consisted of 11 questions as "To you personally, is it very important (score: 4), somewhat important (score: 3), not too important (score: 2), or not at all important (score: 1) to consume the following nutrients/foods at appropriate levels: salt/sodium, saturated fat, fiber, cholesterol, fruits and vegetables, sugar, dairy products, etc?" (total score range: 11-44). Better NKB was defined as NKB score 80th percentile, while a score <80th percentile as reference.

7 Nutrition importance was assessed by asking participants: "When you buy food, how important is nutrition?" Response 'very important' was categorized as 'nutrition importance' group, while subjects with other responses served as the reference group.

8 Food choice: Subjects took considerations of 6 key factors affecting food choices, including food safety, nutrition, price, freshness, convenience, and taste (score range: 6-24). More food choice consideration was defined as a total score 80th percentile, while a score <80th percentile served as the reference.

9 Subjects were categorized in the "awareness" group if they were aware of all 7 nutrition-related health risks (e.g., high fat, cholesterol, sodium; low fiber and calcium) vs. the other participants who were less aware of.

0 Intention to improve diet was assessed by asking subjects whether they thought about their current diet habits and would be willing to make changes: "The things that I eat and drink are healthy, and there is no reason for me to make changes." (4-point Likert scale: strongly disagree, somewhat disagree, somewhat agree, and strongly agree. Those who answered "strongly disagree" or "somewhat disagree" were grouped as "intention to improve diet" and those reporting "strongly agree" or "somewhat agree" served as the reference group.

1 Multinomial logistic regression models were conducted, subjects with BMI <25 served as the reference.

2 Interaction terms for NHRPF with race/ethnicity. Results for 'Others' group were not presented although this group was included in the interaction term analysis.

* P<0.05;

** P<0.01;

*** P<0.001.

Associations of reported intention to improve diet with nutrition- and health-related psychosocial factors (NHRPF) in US adults with poor diet quality (HEI <20th percentile)

Table 5

Characteristic	Better NKB ^f		Better NHRPF ^g	
	OR	(95% CI)	95% CI	
Men and women	1.17	(0.69, 1.99)	0.82	(0.41, 1.62)
By sex ^h				
Men	1.93	(0.78, 4.77)	0.67	(0.26, 1.72)
Women	0.76	(0.38, 1.55)	1.41	(0.68, 2.92)
P value for interaction	0.110		0.253	
By race/ethnicity ^δ				
NH whites	0.86	(0.42, 1.73)	0.59	(0.27, 1.28)
NH blacks	2.82	(0.64, 12.53)	5.05	(0.35, 72.22)
Hispanics	0.40	(0.02, 7.53)	1.26	(0.08, 19.54)
P value for interaction	0.077		<0.001	

^h Adjusted for survey year, sex, age, education, poverty income ratio, race/ethnicity, region, urbanization, comorbidity, and self-rated health. All the ORs were not statistically significant (P>0.05).

^f NKB: It consisted of 11 questions as ‘To you personally, is it very important (score: 4), somewhat important (score: 3), not too important (score: 2), or not at all important (score: 1) to consume the following nutrients/foods at appropriate levels: salt/sodium, saturated fat, fiber, cholesterol, fruits and vegetables, sugar, dairy products, etc?’ (total score range: 11–44). Better NKB was defined as NKB score ≥ 80th percentile; a lower score <80th percentile served as the reference.

^g Better NHRPF was those with better nutrition knowledge and beliefs (NKB score ≥ median), more food choice consideration (score ≥ median), and more awareness of nutrition-related health risks; worse NHRPF was defined as those with the others.

^h Interaction terms for NKB and NHRPF index with sex.

^δ Interaction terms for NKB and NHRPF index with race/ethnicity. Results for ‘Others’ group were not presented, although this group was included in the interaction term analysis.