# Development of a Tool to Assess Psychosocial Indicators of Fruit and Vegetable Intake for 2 Federal Programs

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## ABSTRACT

***Objective:*** Development of an evaluation tool of psychosocial constructs for use by participants in 2 federal programs, Food Stamp Nutrition Education and the Expanded Food and Nutrition Education Program.

***Design:*** Cross-sectional data from a longitudinal study.

***Participants:*** Limited-resource women (n = 111) living in low-income communities.

***Measures:*** Test–retest reliability, internal consistency, ethnic differences, convergent validity.

***Analysis:*** Spearman rank order correlation, analysis of variance, principal components analysis.

***Results:*** Reliability coefficients ranged from a low of r = .18 (not significant) to r = .74 (P < .0001). Two items were deleted for not meeting criteria for reliability and 2 for redundancy. Ethnic differences at baseline were significant for 1 item. Domain constructs loaded on 4 to 5 factors for the biopsychosocial framework. Estimates of convergent validity of 9 constructs led to the deletion of 3 (ie, perceived barriers, social support, and perceived norms), with retention of perceived benefits, perceived control, self-efficacy, readiness to eat more fruit, readiness to eat more vegetables, and perceived diet quality. As an estimate of convergent validity, the final version of the tool with 6 constructs remaining showed significant correlations with indicators of diet quality: serum carotenoid values (r = .38, P < .001); hypothesized nutrients calculated from the mean of 3 24-hour dietary recalls (vitamin C, r = .47, P < .0001; vitamin A, r = .39, P < .0001; folate, r = .37, P < .0001; beta-carotene, r =.31, P < .001; and fiber, r = .46, P < .0001); fruit and vegetable servings (r = 0.55, P < .0001); Healthy Eating Index (r = .27, P < .05); and a fruit and vegetable behavioral scale (r = .60, P < .0001).

***Conclusion and Implications:*** This systematic process yielded a fruit and vegetable evaluation tool useful for practitioners and researchers. This is the first validation study of this type to estimate convergent validity with 5 indicators of diet quality, including a biomarker.

**KEY WORDS:** evaluation, health beliefs, Expanded Food and Nutrition Education Program (EFNEP), Food Stamp Nutrition Education (FSNE), low income, fruits, vegetables, Healthy Eating Index

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## INTRODUCTION

Evidence is compelling to suggest that eating fruits and vegetables reduces the risks of major chronic diseases, including cardiovascular disease and cancer.[1-3] Federally funded nutrition education interventions deliver educational experiences in the United States that include efforts to increase fruit and vegetable intakes among clients in low-income, minority communities: the Expanded Food and Nutrition Education Program (EFNEP) and Food Stamp Nutrition Education (FSNE) for the Food Stamp Program.[4] Valid and reliable evaluation tools for these programs are essential.[5,6]

Psychosocial factors predicting fruit and vegetable intakes, such as self-efficacy and perceived benefits for eating fruits and vegetables, can provide a foundation for developing effective education strategies for these federal programs and other education interventions serving low-income communities in the United States. These predictors for change are important targets for these 2 federal programs.[7] Measuring these predictors makes it possible to evaluate change in mediating factors for increased intakes of fruits and vegetables.[7,8]

In our review of the literature, "fruit and vegetable–focused" instruments designed for US adults covered some of the psychosocial variables related to fruit and vegetable education.[9-16] Only 2 studies, the Maryland Special Supplemental Program for Women, Infants and Children (WIC)[10,11] and the African American churches,[12] worked with low-income populations. Four of these reports specifically related to the staging algorithms for fruits and vegetables.[10,12-14] For these 8 citations, the method for comparison of the new

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instrument with an acceptable standard for dietary status was a food frequency questionnaire with length ranging from 4 items focusing on fruits and vegetables[13] to 88 items for the total diet.[9] None of the studies used a biomarker as an indicator of diet quality for instrument validation. In addition, these instruments were designed specifically for population surveillance or monitoring in a clinic setting, were intended for an audience other than low-income targets of these federal programs, or were intended for use as an evaluation tool but failed to report important psychometric characteristics.

Building on the previous studies, the purpose of this research was the development of an evaluation tool of psychosocial constructs for use by participants in 2 federal programs. This article describes the process of developing this measure by (1) identifying, selecting, and pretesting questionnaire items for face and content validity; (2) testing and analyzing data for item reduction; and (3) assessing constructs for convergent validity for further reduction of the evaluation tool. We hypothesized that this new instrument would be positively associated with the biomarker serum carotenoids and 4 indicators of diet quality (ie, relevant micronutrients for fruit and vegetable interventions, servings of fruit and vegetables, the Healthy Eating Index, and a fruit and vegetable behavioral scale). It is important to provide evidence that this new tool is positively associated with an indicator of health status because improving the health of program participants is the ultimate goal of these federal programs.

## METHODS

### Sample

Researchers at the University of California, Davis, and the University of California Cooperative Extension in 9 California counties conducted this study. Participants were English-speaking women who were eligible to receive Food Stamps and had at least 1 child less than 19 years of age living at home. To examine cultural differences in instrument response, an effort was made to recruit a sample that was approximately 50% non-Hispanic black. Participants (n = 132) were recruited through community organizations, clinics, and agencies serving low-income families eligible for food stamps. The participant received $50 if she agreed to receive 2 venipunctures in addition to providing the other data (eg, 24-hour dietary recalls) or $30 for her participation without the blood draws.

### Design and Protocol

The study protocol and instruments were reviewed and approved by the Office of Human Research Protection of the University of California, Davis. Of the 132 participants recruited for the study, 111 provided the 3 or 4 days of 24-hour dietary recalls prior to the intervention. Internal consistency and convergent validity with recalls and with the food behavior checklist were reported for the 111 participants with complete data. Convergent validity with the serum measure was reported for a subsample of 65 participants who, by design, were randomly selected for blood draws. Reliability was examined among an additional 55 women who completed a second survey instrument between 3 and 6 weeks after the initial interview with no intervening nutrition education intervention.

Data collected included demographic information, health beliefs, and food behaviors; 24-hour dietary recalls; and serum samples. To simulate the method for administering the survey during the first nutrition education class, each participant responded to the items without assistance from staff unless it was requested. In the latter case, the items were read to the participant by the data collection staff. All staff and supervisors participated in a 2-day intensive training to ensure that procedures and protocols were followed explicitly. Data were collected in February through April 1997. Instructions to participants for the health belief items included "These questions ask about your beliefs, opinions, and behaviors about food. There are no right or wrong answers. Most questions require 1 response from 3 choices."

### Biopsychosocial Framework

Based on System Theory, our framework recognized the hierarchical structure of psychosocial characteristics and behaviors, as well as their importance in understanding the health of an individual.[17] The framework included psychosocial, behavioral, dietary, and biological variables (Figure). The specific psychosocial constructs were selected from the behavioral change theories discussed below and were clustered into 3 domains: predisposing, enabling, and reinforcing factors using the work of Anderson[18] and Glanz et al.[9] Intention was added as a fourth domain; it was outlined in our framework for dietary change with the 3 domains preceding intention in the change process (see Figure), as reflected by the work of other researchers.[19,20] Attitudes and beliefs have been shown to be valid and reliable for predicting intention,[20,21] and intention is considered to be an important predictor of behavioral change.[19,20]

In addition, the 4 psychosocial domains precede the behavioral domain in the change process (see Figure).[17] We hypothesized that the behavioral domain impacts nutrient and food group intakes that influence biomarker status and, ultimately, health status. Our overall study collected data for all but 1 component of this conceptual framework (ie, morbidity for chronic disease). Because others have provided the link between fruit and vegetable intakes and serum carotenoids with morbidity, we have included morbidity in our framework.[1-3]

### Item Selection and Scaling

This step included development of the initial questionnaire items, their response options, and content validation. The selection of original items reflected the content of a theory-driven intervention model as it might be used by the EFNEP

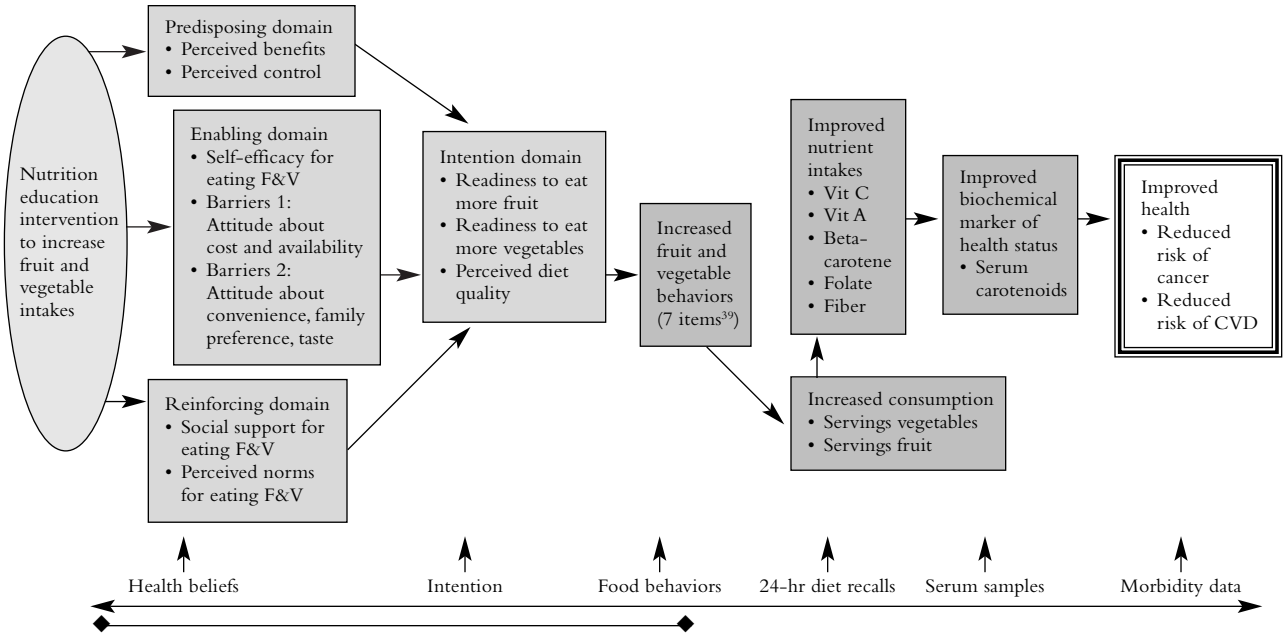


Figure. Biopsychosocial framework for validation of an assessment tool for an intervention to increase fruit and vegetable consumption. CVD = cardiovascular disease.

and FSNE. Of particular interest for designing interventions to promote fruit and vegetable intake are constructs derived from Social Cognitive Theory, the Theory of Planned Behavior, the Health Belief Model, and the Transtheoretical Model.[8, 22] The key elements of these theories have been shown to have relationships with many desired health behavior changes and are hypothesized to mediate behavior change in fruit and vegetable consumption.[7,8,13] Because these elements can be part of health promotion interventions about fruits and vegetables in low-income communities, we included them in this instrument. Items and their specific wording were adapted from previously published research.[9-11,15,23] Using the method described by Godin and Kok,[20] the first draft of the instrument was pilot-tested by the authors for comprehension, word usage, and clarity with 12 women who shared the same characteristics as the women to be studied. The women were asked to describe in their own words the meaning of each item using a cognitive testing protocol. Modifications were made to the wording of items that were not well understood, and revisions were further tested with individuals.[24] The revised instrument was pilot-tested by the authors and participating university staff with 3 groups of EFNEP participants. We discussed the item response options, sequence of items, and the overall evaluation tool with groups of 8 to 12 low-income women who were already attending EFNEP lessons. Based on feedback, the response option format was reduced from 4 to 3 options where applicable.

**Psychosocial constructs.** Items listed by construct are identified in Table 1. ***Perceived benefits of eating fruits and vegetables (3 items).*** These beliefs were outcome expectations within the Social Cognitive Theory and were defined as what a person believes will happen as a result of performing a behavior.[25] Outcome expectations provide motivation for eating fruits and vegetables.

***Perceived control (2 items).*** These items inquired about who is in charge of the food shopping and food preparation and refer to the perception of having control over the behavior.[26]

***Self-efficacy (7 items).*** Seven items assessed the confidence a participant felt about performing specific fruit and vegetable behaviors. Within the Social Cognitive Theory and the Health Belief Model, self-efficacy provides the confidence that barriers can be overcome. It has been shown to be an important mediator of behavior change.[25] For this study, self-efficacy was defined as a person's confidence that he or she can choose fruits and vegetables in a variety of circumstances or settings.

***Perceived barriers and attitudes about taste, cost, convenience, availability, and family preference (10 items).*** Ten items (5 for fruits and 5 for vegetables) were assessed for this construct from the Health Belief Model. Previous work identified these impediments to eating fruits and vegetables among limited-resource families.[11,23]

***Social support (1 item).*** One item with 6 yes/no response options was assessed. Respondents were instructed to select as many affirmative responses as apply.

***Perceived norms (2 items).*** As a component of the Theory of Planned Behavior,[20] perceived norms are thought to influ-

Table 1. Psychometric Properties of Test Items Underlying Proposed 9 Constructs in a Tool to Assess Psychosocial Indicators of Fruit and Vegetable Intake in Low-Income Communities

| Items Grouped by Construct | Item Mean<br>Mean (SD)<br>(0-1) (n = 107) | Test–Retest Reliability<br>r<br>(n = 55) | Total Inter-item Correlation (Subscale)<br>r<br>(n = 109) | Reliability (Internal Consistency of Subscale)<br>α<br>(n = 107) | Baseline Differences by Ethnicity<br>(White, n = 26; Black, n = 52; Hispanic, n = 27) | Comment |
|---|---|---|---|---|---|---|
| 1. Perceived benefit[a] | | | | .37 | | |
| I feel that I am helping my body by eating more fruits and vegetables. | .92 (.21) | .49**** | .19 | | NS | |
| I feel my family's long-term health will benefit if I serve more fruits and vegetables. | .96 (.16) | .24 | .21 | | NS | Reliability not acceptable. Deleted from further analysis. |
| I may develop health problems if I do not eat fruits and vegetables. | .79 (.34) | .53**** | .22 | | NS | |
| 2. Perceived control[b] | | | | .14 | | Alpha inadequate, but recommend further testing. |
| In your household, who is in charge of what foods to buy? | 1.00 (0) | .74**** | NA | | NS | |
| In your household, who is in charge of how to prepare the food? | .89 (.24) | .65**** | NA | | NS | |
| 3. Self-efficacy[a] | | | | .76 (6 items), .77 (7 items) | | |
| I feel that I can buy more fruit the next time I shop. | .82 (.31) | .60**** | .38 | | NS | Item redundant. Alpha = .76 if item deleted. Deleted from further analysis. |
| I feel that I can plan meals or snacks with more fruit during the next week. | .83 (.26) | .41** | .56 | | NS | |
| I feel that I can buy more vegetables the next time I shop. | .81 (.31) | .47** | .50 | | NS | |
| I feel that I can plan meals with more vegetables during the next week. | .87 (.24) | .42** | .48 | | NS | |
| I feel that I can eat fruits or vegetables as snacks. | .90 (.22) | .32* | .43 | | NS | |
| I feel that I can add extra vegetables to casseroles and stews. | .81 (.28) | .43*** | .45 | | NS | |
| I feel that I can eat 2 or more servings of vegetables at dinner. | .82 (.29) | .30* | .43 | | NS | |

*(Continued)*

Table 1. Continued

| Items Grouped by Construct | Item Mean<br>Mean (SD)<br>(0-1) (n = 107) | Test–Retest Reliability<br>r<br>(n = 55) | Total Inter-item Correlation (Subscale)<br>r<br>(n = 109) | Reliability (Internal Consistency of Subscale)<br>α<br>(n = 107) | Baseline Differences by Ethnicity<br>(White, n = 26; Black, n = 52; Hispanic, n = 27) | Comment |
|---|---|---|---|---|---|---|
| 4. Perceived barriers[†] | | | | .76 for 10 items, .75 for 9 items | | |
| I feel that fruit is too expensive. | .49 (.43) | .71**** | .34 | | NS | |
| I feel that fruit is not always available. | .63 (.42) | .58**** | .35 | | NS | |
| I feel that fruit is time consuming to prepare. | .82 (.30) | .18 | .46 | | NS | Reliability not acceptable. Deleted from further analysis. |
| I feel that fruit is not liked by my family. | .91 (.21) | .50**** | .49 | | NS | |
| I feel that fruit is not tasty. | .94 (.18) | .63**** | .49 | | NS | |
| I feel that vegetables are too expensive. | .63 (.40) | .40** | .33 | | NS | |
| I feel that vegetables are not always available. | .76 (.37) | .43** | .44 | | NS | |
| I feel that vegetables are time consuming to prepare. | .82 (.30) | .58**** | .52 | | NS | |
| I feel that vegetables are not liked by my family. | .77 (.35) | .39** | .27 | | NS | Item redundant. Alpha = .75 if item deleted. Deleted from further analysis. |
| I feel that vegetables are not tasty. | .79 (.35) | .33* | .41 | | NS | |
| 5. Social support[d] | | | | NA | | |
| Are there other people encouraging you to buy, prepare, and eat fruits and vegetables? | | | .23 | | Blacks, .36; Hispanic, .67, P < .03 | Response varied by ethnic group. Deleted from further analysis. |
| My children | .23 (.43) | .53**** | | | | |
| My partner | .19 (.39) | .72**** | | | | |
| My mother | .23 (.42) | .70**** | | | | |
| My father | .03 (.19) | .64**** | | | | |
| Other | .16 (.37) | .46**** | | | | |
| No one | .49 (.50) | .46**** | | | | |
| 6. Perceived norms[a] | | | | .63 | | |
| People in my family think I should eat more fruits and vegetables. | .60 (.41) | .55**** | .12 | | NS | Inter-item correlation < .2. Deleted from further analysis. |
| My doctor (or WIC nutritionist or FSNE assistant) tells me to eat more fruits | .64 (.40) | .39** | .15 | | NS | Inter-item correlation < .2. Deleted from further analysis. |

*(Continued)*

Table 1. Continued

| Items Grouped by Construct | Item Mean<br>Mean (SD)<br>(0-1) (n = 107) | Test–Retest Reliability<br>r<br>(n = 55) | Total Inter-item Correlation (Subscale)<br>r<br>(n = 109) | Reliability (Internal Consistency of Subscale)<br>α<br>(n = 107) | Baseline Differences by Ethnicity<br>(White, n = 26; Black, n = 52; Hispanic, n = 27) | Comment |
|---|---|---|---|---|---|---|
| 7. Readiness to eat more fruit[e] | .78 (.25) | .62**** | NA | NA | NS | |
| I am not thinking about eating more fruit. | | | | | | |
| I am thinking about eating more fruit. | | | | | | |
| Planning to start within 6 months. | | | | | | |
| I am definitely planning to eat more fruit in the next month. | | | | | | |
| I am trying to eat more fruit now. | | | | | | |
| I am already eating 2 or more servings of fruit a day. | | | | | | |
| 8. Readiness to eat more vegetables | .79 (.24) | .59**** | NA | NA | NS | |
| I am not thinking about eating more vegetables.[e] | | | | | | |
| I am thinking about eating more vegetables. | | | | | | |
| Planning to start within 6 months. | | | | | | |
| I am definitely planning to eat more vegetables in the next month. | | | | | | |
| I am trying to eat vegetables now. | | | | | | |
| I am already eating 2 or more servings of vegetables a day. | | | | | | |
| 9. Perceived diet quality[f] | | | | | | |
| How would you describe your diet? | .46 (.19) | .73**** | NA | NA | NS | |

[†]Perceived barriers included attitudes about taste, cost, convenience, availability, and family preference.
*P < .05; **P < .01; ***P < .001; ****P < .0001.
FSNE indicates Food Stamp Nutrition Education; NA, not applicable; NS, not significant; WIC, Special Supplemental Nutrition Program for Women, Infants and Children.
[a]Agree = 2; either agree or disagree = 1; disagree = 0.
[b]Other = 0; shared decision = .5; I am = 1.
[c]Agree = 0; either agree or disagree = 1; disagree = 2.
[d]Instructions to client: "Check as many as apply." Coding: no = 0 = no support; yes = 1 = support by one person; yes = 2 = support by ≥ 2 persons.
[e]Instructions to client: "Check one." Participants who reported consuming the Food Guide Pyramid (FGP) serving recommendations using the diet recall results were categorized as being in maintenance and coded as 5. Respondents who reported eating less than the FGP recommendations and were not thinking about eating more fruits and vegetables were placed in the precontemplation stage (coded as 1). Those who indicated less than the FGP recommendations, were thinking about eating more fruits and vegetables, and were planning to begin within 6 months were placed in the contemplation stage (coded as 2). Those who indicated less than the FGP recommendations, were thinking about eating more fruits and vegetables, and were definitely planning to begin within the month (30 days) were placed in the preparation stage (coded as 3). Those who indicated less than the FGP recommendations, were thinking about eating more fruits and vegetables, and were already trying to eat more now were placed in the action stage (coded as 4).
[f]Excellent = 5; very good = 4; good = 3; fair = 2; poor = 1.

ence health behaviors. We defined this variable as the respondent's perception of pressure from family members, friends, and their doctors or other health professionals to eat fruits and vegetables.

***Readiness to eat more fruits and readiness to eat more vegetables (2 items).*** Using previously reported work, readiness was examined for 2 behavioral outcomes: eating more fruits and eating more vegetables.[10] Eating more fruits and vegetables referred to increasing the current intakes of fruits and vegetables compared with the amount eaten in the past. Readiness for change, measured by the stage of change algorithm, is the temporal dimension of the Transtheoretical Model.[27] Using the method reported by Feldman et al[10] and Campbell et al,[14] participants were grouped into 1 of 5 categories.

***Perceived diet quality (1 item).*** Considered an indicator of behavior, perceived diet quality was assessed.[11]

**Scoring.** Because a limited number of response options is recommended for low-literacy audiences,[28] we used a 3-point scale (agree, neither agree nor disagree, disagree) or yes/no response categories.[29,30] Each construct was represented by the mean of the items in its subscale and was calculated as the sum of item scores divided by the number of items.[31] The score for each construct was a minimum of 0 and a maximum of 1. To achieve a maximum score of 1 point for a construct, each item in the construct subscale required an affirmative response. The purpose of this procedure was to give constructs equal weighting. The social support construct was somewhat different in that affirmative responses were summed with a maximum of 2 points and then divided by 2 for the usual range per construct of 0 to 1. For the perceived control items, a score of 1 represented exclusive control by the participant for both food shopping and food preparation. A score of 0 represented complete control by others for both jobs. Shared control was scored as 0.25 points for each job.

**Demographic characteristics.** Data on age, race or ethnicity, gender, and education of the participant; income for the household; and names, ages, and roles of family members living in the household were collected.

### Item Testing and Reduction

Because our goal was the development of a parsimonious tool for use in a community setting, performance criteria were established to delete items that detracted from or did not contribute to the usefulness of the instrument using the method of Kirshner and Guyatt.[32] *SPSS/PC, version 10.0* (SPSS Inc., Chicago, Ill), was used for the analyses. Inclusion in the final version of the evaluation tool meant that a minimum standard was met by the item and construct for the estimates of convergent validity, internal consistency, inter-item correlations, temporal reliability, and ethnic differences.

**Summary statistic.** Mean ± SD was calculated for each item. Items with values over .8 would not ordinarily be useful for an evaluation because there is little room for change in the expected direction.

**Temporal reliability.** Using the method described by Carmines and Zeller,[33] a group of participants sharing the same characteristics as those in the main study completed the survey on 2 occasions 3 to 6 weeks apart with no known intervention. Reliability was defined as the coefficient from the Spearman rank order correlation between the scores for that item at the 2 time points for the same individuals.[33] Items were deleted that were not statistically significant at $p < .05$.

**Factor analysis.** Subscales with ≥ 5 items were factor analyzed using principal components with varimax rotation.[34] Two criteria were considered to determine which solution best explained the data. A scree plot was examined to determine the most appropriate number of factors. The factor loadings were examined to see if the items clustered into intuitively meaningful groups. The 10 barrier and 7 self-efficacy items were analyzed using these procedures.

**Internal consistency.** This form of reliability addressed the issue of homogeneity and was determined by Cronbach coefficient $\alpha$.[35] A coefficient $\alpha$ was calculated for each construct. For constructs of 4 or more items, items were deleted for maximum $\alpha$ level, with consideration of theoretical justification for retaining or deleting items.[33]

**Interitem correlations.** Interitem correlations, another form of reliability, were calculated to examine the extent of the relationship between each item with the rest of the items in the construct. An item is a good discriminator if performance on the item is positively correlated with performance of all items composing the construct. Values greater than +.2 are desirable in educational measurement for item analysis.[36]

**Ethnic differences.** Ideally, items should score similarly for each ethnic group, but we recognized that cultural differences in food patterns or interpretation of the items existed. Potential response differences for 3 ethnic groups (non-Hispanic white, non-Hispanic black, Hispanic) were examined using analysis of variance (ANOVA). When the overall ANOVA test showed significant differences among means ($P < .05$), Tukey's test for multiple comparisons was used post hoc to determine which means were different from each other.

### Convergent Validity

Validity is an important characteristic or dimension of an evaluation measure for these federal programs[5,6] and is

defined as an estimate of the accuracy of the instrument.[33,37] Specifically, it is defined as the extent to which a measuring instrument (item or scale) measures what it is intended to measure.[5,6,33,37] Reports of perceptions or beliefs cannot be "validated," strictly speaking. However, they can be calibrated and then compared with a standard.[33] Using Spearman rank order correlations, validity was assessed using 5 approaches. We compared the composite score with a biochemical marker of fruit and vegetable intakes, serum carotenoids, the hypothesized nutrients from the mean of 3 24-hour recalls, servings of fruit and vegetables from these recalls, the Healthy Eating Index, and a fruit and vegetable behavioral scale previously shown to be valid.[38] A construct was considered valid if a statistically significant relationship existed between that construct and 1 or more of the 5 indicators of diet quality (previously listed).

**Dietary assessment.** Three 24-hour dietary recalls were collected from each participant on 2 weekdays and 1 weekend day. A modified 3-pass method was used to obtain a detailed description of all foods and beverages the subjects consumed during the previous 24 hours.[39] The details of these recalls are reported elsewhere.[38,40]

**Serum carotenoids.** Serum carotenoids were selected as the biomarker because of their presence in fruits and vegetables and role in the prevention of chronic disease.[1,41] Total serum carotenoids were measured by a spectrophotometric method after conjugation to trifluoroacetic acid.[42] The details are reported elsewhere.[38,40]

## RESULTS

### Sample Characteristics

The average participant was 32.6 ± 9.1 (mean ± SD) years of age. She had 11.9 ± 1.9 years (mean ± SD) of education with a minimum of 1 year of schooling and a maximum of 16 years. Average household size was 3.9 ± 1.4 members. The sample self-identified as 50% non-Hispanic black, 25% English-speaking Hispanic, 24% non-Hispanic white, and 2% other groups (ie, Asian, Native American). Fruit and vegetable intakes and income were not statistically different by race. The randomly selected subsample from whom biochemical measures were obtained (n = 65) was not statistically different from the full sample (data not shown).

### Item Selection and Scaling

The item means indicated that 14 of the psychosocial items were within the midrange of the response distributions (between .2 and .8 on a scale of 0 to 1) (see Table 1). Five items were highly skewed toward agreement with item means > .90. All respondents indicated that they had control of the household food shopping (1.00). No respondents scored the maximum points on all items.

### Item Testing and Reduction

Items and constructs were systematically removed from the item pool. For 2 of the items (ie, *I feel my family's long term health will benefit if I serve more fruit and vegetables* and *I feel that fruit is time consuming to prepare*), participants were not consistent in their responses to these items on repeat administration of the survey. The 2 items were deleted. The remaining 9 barrier items loaded on 2 factors (not shown). Factor 1, called barriers 1, included 2 items for cost (factors .73, .78) and 2 for availability (.49, .53). The second factor containing 5 items, called barriers 2, included 1 item for taste (.50), 2 for convenience (.63, .75), and 2 for family preference (.66, .74). The 7 self-efficacy items loaded on 1 factor (not shown).

A self-efficacy item (ie, *I feel that I can buy more fruit the next time I shop*) did not contribute sufficiently to the meaning of the construct. We opted to delete this item because the $\alpha$ was essentially the same for the self-efficacy subscale with and without the item. Cronbach $\alpha$ correlation coefficient for 7 self-efficacy items indicated moderately high internal consistency (.77). However, the $\alpha$ was essentially identical at .76 with 6 items (see Table 1). For the perceived barriers (barriers 1 and 2) for eating fruits and vegetables, internal consistency was low for each subscale (Cronbach $\alpha$ = .57 and .58, respectively) (not shown). The $\alpha$ was .76 for the perceived barriers as 1 subscale with 10 items and .75 with 9 items. Consequently, in the interest of parsimony, we deleted *I feel that vegetables are not liked by my family* (see Table 1).

Potential response differences for 3 ethnic groups (ie, non-Hispanic white, n = 26; non-Hispanic black, n = 52; Hispanic, n = 27) were examined using ANOVA. Because the sample size was small, 2 participants who self-reported as Asian, Native American, or "other" were not included in this analysis. The response to 1 item (ie, *Are there other people encouraging you to buy, prepare, and eat fruits and vegetables?*) was significantly different by group and was subsequently deleted (see Table 1). The mean response for the non-Hispanic black participants (.36) differed from that of Hispanic participants (.67, $P$ = .03) but not that of non-Hispanic white participants.

Distributions for 14 items exceeded the boundaries of our .2 to .8 cutpoints. These items would not ordinarily be useful for assessing change following the EFNEP experience because there would be little room for change in the expected direction. Our study attracted individuals who were interested in nutrition, unlike many of our actual program participants. These participants were willing to provide extensive data at multiple time points, including 2 blood samples. Consequently, we decided to retain the skewed items and recommend further testing of these items in a setting separate from this complex protocol to confirm the potential to change following the education intervention.

### Biopsychosocial Framework

The final psychosocial constructs were factor analyzed using the procedures mentioned above for the purpose of con-

firming the psychosocial domains in the biopsychosocial conceptual framework. A scree plot identified 4 or 5 factors as appropriate. Using the work of Glanz et al,[9] domain names were applied to the factors as appropriate (see Figure). All items loaded above .55. Perceived benefits (.70) and perceived control (.78) loaded on 1 factor termed *predisposing domain*. Perceived norms (.86) and social support (.85) loaded on 1 factor termed *reinforcing domain*. Readiness to eat more fruit (.72), readiness to eat more vegetables (.73), and perceived diet quality (.72) loaded on 1 factor termed *intention*. Barriers 1 (.58, .60) loaded on 2 factors with barriers 2 (.58, .88) termed *enabling #1* and separately with self-efficacy (.60, .86) termed *enabling #2*. Because of theory guiding our conceptual framework (ie, Social Cognitive Theory and the Health Belief Model) and the relationship between the 2 constructs (ie, self-efficacy and perceived barriers), plus considering the work of Glanz et al,[9] we were comfortable grouping barriers 1, barriers 2, and self-efficacy as one factor labeled *enabling domain*.

### Convergent Validity

As estimates of convergent validity, the constructs showed significant correlations with hypothesized dietary recall variables for fruit and vegetable interventions (ie, micronutrients, fruit and vegetable servings, Healthy Eating Index), as well as with the behavioral scale for fruits and vegetables and the biomarker. Six constructs produced a statistically significant result in the expected direction and were retained. These constructs included perceived benefits, perceived control, self-efficacy for eating fruits and vegetables, readiness to eat more fruits, readiness to eat more vegetables, and perceived diet quality (Table 2). The social support and perceived barriers constructs were not associated with any of the indicators of diet quality and were subsequently deleted (see Table 2). One construct, perceived norms, generated a correlation with serum carotenoids in the direction opposite to that expected ($r = -.19$, $P < .05$) and was also subsequently deleted.

Of the 3 remaining domains with their 6 constructs, the intention domain showed the strongest association with serum carotenoids ($r = .42$, $P < .001$) (Table 3). The predisposing domain was weakly correlated with the biomarker ($r = .27$, $P < .05$). The results for the enabling domain with the biomarker indicated a trend ($r = .18$, $P < .10$). Using hypothesized nutrients from the 24-hour dietary recalls, those same domains were related to various hypothesized micronutrients ($r = .20$ to $.41$) (see Table 3). Predisposing and intention domains were also related to fruit and vegetable servings ($r = .30$, $P < .001$ and $r = .52$, $P < .0001$), the Healthy Eating Index ($r = .24$, $P < .01$ and $r = .28$, $P < .01$), and food behaviors ($r = .19$, $P < .05$ and $r = .67$, $P < .0001$) (see Table 3). The total score for the revised instrument showed a significant correlation with serum carotenoid values ($r = .38$, $P < .001$); nutrients calculated from the mean of 3 24-hour dietary recalls (folate, $r = .37$, $P < .0001$; vitamin C, $r = .47$, $P < .0001$; vitamin A, $r = .39$, $P < .0001$; beta-carotene, $r = .31$, $P < .001$; fiber, $r = .46$, $P < .0001$); fruit and vegetable servings ($r = .55$, $P < .0001$); the Healthy Eating Index ($r = .27$, $P < .05$); and food behaviors ($r = .60$, $P < .0001$). A list of these expected associations and results are shown in Table 3.

## DISCUSSION

Our primary purpose was to develop and test an evaluation tool for use by 2 federally funded community education interventions. We assessed psychometric properties and used those results to systematically reduce the number of items on this tool. To our knowledge, this is the first study to report psychometric properties for a fruit and vegetable tool of psychosocial antecedents of behavior that includes convergent validity with 5 indicators of diet quality, including a biological marker**.** Our 13-item tool with 6 constructs with its maximum scoring of 6 points compares favorably with the longer and more time-consuming method of collecting multiple 24-hour dietary recalls. These results suggest that the tool is appropriate for use as an evaluation instrument for fruit and vegetable education interventions in low-income communities in California. We recommend its use with a valid assessment of fruit and vegetable behaviors such as the behavioral scale previously reported with this audience.[38]

A summation score, with equal weighting to each of the 6 constructs, is the most practical approach to providing EFNEP and FSNE practitioners with a method for giving each client 1 total score for the pretest and a second total score for the posttest.

Despite our pretesting of items for comprehension and clarity, it is possible that knowledge was embedded in the response or the wording of the 2 unreliable items. The individual items in the final version of the scale appear to be reasonably reliable.[33]

The degree of internal consistency needed for this scale depends on its intended use.[30] To make decisions about a group of clients, $\alpha$ coefficients in the .30 to .49 range are acceptable. For use with individual clients, reliability coefficients > .60 are necessary.[34,37] The results suggest that the constructs with 4 items or more are sufficiently consistent for use with non-Hispanic black, English-speaking Hispanic, and non-Hispanic white clients in our state.

Our results showed that 1 item generated statistically different responses by ethnic group. Other more subtle differences among the 3 ethnic groups may not have been detected owing to our small sample size for each subgroup. Consequently, our findings are not definitive. This type of analysis is particularly important for researchers in our state, where low-income populations are culturally and ethnically diverse. Our findings are also important for interpretation of data by practitioners using this instrument.

The 5 indicators of diet quality used in this study for convergent validity corresponded fairly well, suggesting a

Table 2. Comparison of 9 Psychosocial Constructs with a Biomarker, Nutrients and Servings from 3 24-Hour Dietary Recalls, the Healthy Eating Index, and a Food Behavior Scale Focusing on Fruits and Vegetables[†‡]

| Constructs | Items, n | Points (Minimum, Maximum) | Biomarker: Serum Carotenoids | Dietary Recalls: Nutrients | Dietary Recalls: Fruits and Vegetables, Serving | Healthy Eating Index[§] | Behavior Scale: 7 Fruit and Vegetable Items[‖] | Comment |
|---|---|---|---|---|---|---|---|---|
| | | | r (n = 65) | r (n = 111) | r (n = 111) | (n = 111) | r (n = 111) | |
| Perceived benefits for eating fruits and vegetables | 3 | 0-1 | .25* | .26** vitamin C<br>.21* vitamin A<br>.19* fiber | .20* | .17* | NS | |
| Perceived control for eating fruits and vegetables | 2 | 0-1 | NS | .19* vitamin C | NS | NS | NS | |
| Self-efficacy for eating fruits and vegetables | 7 | 0-1 | .18[#] | NS | NS | NS | .18* | |
| Perceived barriers: attitude about cost, availability, convenience, family preference, and taste | 10 | 0-1 | NS | NS | NS | NS | NS | No statistical significance. Deleted from further analysis. |
| Social support for eating fruits and vegetables | 1 | 0-1 | NS | NS | NS | NS | NS | No statistical significance. Deleted from further analysis. |
| Perceived norms for eating fruits and vegetables | 2 | 0-1 | –.19* | NS | NS | NS | NS | No positive statistical significance. Deleted from further analysis. |
| Readiness to eat more fruit | 1 | 0-1 | .31** | .41**** vitamin C<br>.33**** vitamin A<br>.34**** beta-carotene<br>.28*** folate<br>.39**** fiber | .50**** | .41**** | .57**** | |
| Readiness to eat more vegetables | 1 | 0-1 | .17[#] | .32**** vitamin C<br>.29*** vitamin A<br>.33**** beta-carotene<br>.27*** folate<br>.39**** fiber | .54**** | NS | .44**** | |
| Perceived diet quality | 1 | 0-1 | .45**** | .23**** vitamin C<br>.16** vitamin A<br>.21** fiber | .32**** | .22* | .48**** | |

[†]The indicators are serum carotenoids as the hypothesized biomarker; hypothesized nutrients from the 3 24-hour dietary recalls: vitamins A and C, beta-carotene, folate, fiber; hypothesized servings of fruits and vegetables from the 3 24-hour dietary recalls; and a fruit and vegetable behavioral scale of 7 items.

[‡]Rank order correlation coefficients were calculated for the estimation of convergent validity.

[§]Total score calculated on a 10-point system.

[‖]Designed for use with the food behavior scale previously shown to be valid and reliable.[38,40] The 7 items are: Do you eat more than 1 kind of fruit daily? During the past week, did you have citrus fruit (such as orange or grapefruit) or citrus juice? Do you eat more than 1 kind of vegetable a day? How many servings of vegetables do you eat each day? Do you eat 2 or more servings of vegetables at your main meal? Do you eat fruits or vegetables as snacks? How many servings of fruit do you eat each day?

[#]$P < .10$ applies to analyses with serum carotenoids because of the small subsample.

*$P < .05$; **$P < .01$; ***$P < .001$; ****$P < .0001$.

Table 3. Psychometric Properties of Final Psychosocial Tool for Fruit and Vegetable Promotion Interventions in Low-Income Communities

| Domain | Items | Points | Biomarker: Serum Carotenoids r (n = 65) | Dietary Recalls: Nutrients r (n = 111) | Dietary Recalls: Fruits and Vegetables, Serving r (n = 111) | Healthy Eating Index r (n = 111) | Behavior Scale: 7 Fruit and Vegetable Items r (n = 111) | Intention r |
|---|---|---|---|---|---|---|---|---|
| Predisposing (Cronbach $\alpha$ = .41) | 4 | 0-2 | .27* | .33**** vitamin C<br>.20* vitamin A<br>.22* folate<br>.31*** fiber | .30*** | .24** | .19* | .24** |
| Perceived benefit[a] | | | | | | | | |
| I feel that I am helping my body by eating more fruits and vegetables. | | | | | | | | |
| I may develop health problems if I do not eat fruits and vegetables. | | | | | | | | |
| Perceived control[b] | | | | | | | | |
| In your household, who is in charge of what foods to buy? | | | | | | | | |
| In your household, who is in charge of how to prepare the food? | | | | | | | | |
| Enabling (Cronbach $\alpha$ = .76 ) | | | .18‡ | NS | NS | NS | .18* | NS |
| Self-efficacy[a] | | | | | | | | |
| I feel that I can plan meals or snacks with more fruit during the next week. | | | | | | | | |
| I feel that I can buy more vegetables the next time I shop. | | | | | | | | |
| I feel that I can plan meals with more vegetables during the next week. | | | | | | | | |
| I feel that I can eat fruits or vegetables as snacks. | | | | | | | | |
| I feel that I can add extra vegetables to casseroles and stews. | | | | | | | | |
| I feel that I can eat 2 or more servings of vegetables at dinner. | | | | | | | | |
| Intention (Cronbach $\alpha$ = .57) | 3 | 0-3 | .42*** | .37**** vitamin C<br>.31*** vitamin A<br>.28** beta-carotene<br>.33**** folate<br>.41**** fiber | .52**** | .28** | .67**** | NA |
| Readiness to eat more fruit[c] | | | | | | | | |
| I am not thinking about eating more fruit. | | | | | | | | |
| I am thinking about eating more fruit. | | | | | | | | |
| I am planning to start within 6 months. | | | | | | | | |
| I am definitely planning to eat more fruit in the next month. | | | | | | | | |
| I am trying to eat more fruit now. | | | | | | | | |
| I am already eating 2 or more servings of fruit a day. | | | | | | | | |
| Readiness to eat more vegetables[c] | | | | | | | | |
| I am not thinking about eating more vegetables. | | | | | | | | |
| I am thinking about eating more vegetables. | | | | | | | | |
| I am planning to start within 6 months. | | | | | | | | |
| I am definitely planning to eat more vegetables in the next month. | | | | | | | | |
| I am trying to eat vegetables now. | | | | | | | | |
| I am already eating 2 or more servings of vegetables a day. | | | | | | | | |
| Perceived diet quality[d] | | | | | | | | |
| How would you describe your diet? | | | | | | | | |

*(Continued)*

Table 3. Continued

| Domain | Items | Points | Biomarker: Serum Carotenoids r (n = 65) | Dietary Recalls: Nutrients r (n = 111) | Dietary Recalls: Fruits and Vegetables, Serving r (n = 111) | Healthy Eating Index r (n = 111) | Behavior Scale: 7 Fruit and Vegetable Items r (n = 111) | Intention r |
|---|---|---|---|---|---|---|---|---|
| Total scale (6 pts) | 13 | 0-6 | .38*** | .47**** vitamin C<br>.39**** vitamin A<br>.31*** beta-carotene<br>.37**** folate<br>.46**** fiber | .55**** | .27* | .60**** | NA |
| Predisposing (perceived benefits, perceived control) | | | | | | | | |
| Enabling (self-efficacy) and | | | | | | | | |
| Intention (readiness to eat more fruit, readiness to eat more vegetables, perceived quality of diet) | | | | | | | | |

[†]Designed for use with food behavior scale previously shown to be valid and reliable.[38,40] The 7 items are: Do you eat more than 1 kind of fruit daily? During the past week, did you have citrus fruit (such as orange or grapefruit) or citrus juice? Do you eat more than 1 kind of vegetable a day? How many servings of vegetables do you eat each day? Do you eat 2 or more servings of vegetables at your main meal? Do you eat fruit or vegetables as snacks? How many servings of fruit do you eat each day?

[‡]$P < .10$ for serum carotenoids because n is a sub-sample.

*$P < .05$; **$P < .01$; ***$P < .001$; ****$P < .0001$.

[a]Response options: agree; either agree or disagree; disagree.

[b]Response options: I am; shared decision; my partner; female relative; my children; other person.

[c]Participants who reported consuming the Food Guide Pyramid (FGP) serving recommendations using the diet recall results were categorized as being in maintenance and coded as 5. Respondents who reported eating less than the FGP recommendations and were not thinking about eating more fruits and vegetables were placed in the precontemplation stage (coded as 1). Those who indicated less than the FGP recommendations, were thinking about eating more fruits and vegetables, and were planning to begin within 6 months were placed in the contemplation stage (coded as 2). Those who indicated less than the FGP recommendations, were thinking about eating more fruits and vegetables, and were definitely planning to begin within the month (30 days) were placed in the preparation stage (coded as 3). Those who indicated less than the FGP recommendations, were thinking about eating more fruits and vegetables, and were already trying to eat more now were placed in the action stage (coded as 4).

[d]Response options: excellent; very good; good; fair; poor.

NA indicates not applicable; NS, not statistically significant.

A copy of the instrument is available from the first author by e-mail (mstownsend@ucdavis.edu) or by telephone (530-754-9222).

better estimate of validity than if only one external measure was used. None of the 8 citations reported previously offered multiple validation sources. In addition, none of the reports available for comparison with this study used a biomarker. Of the 8 reports, the Glanz et al study with employees at worksites was the most similar to ours.[9] The worksite study sought to validate an instrument of psychosocial constructs influencing fat- and fiber-related behavior. A tool practical for community health promotion programs was the goal for both studies. Item means for the worksite study were more midrange compared with ours. This probably reflects, in part, the differences in the study participants and quantity of data provided by each participant. Glanz et al also found that self-efficacy and perceived barriers were not associated with fiber using a 22- or 88-item food frequency.[9] Our findings are similar in that self-efficacy and perceived barriers were not correlated with dietary fiber. For the perceived benefits (belief) construct in the worksite study, the correlation for fiber was $r = -.21$ ($P < .05$). Our findings were positive and generally stronger for the predisposing domain composed of perceived benefits and perceived control, with the comparison standard being 4 nutrients ($r = .20$ to $.33$); servings fruits and vegetables ($r = .30$, $P < .001$), Healthy Eating Index ($r = .24$, $P < .01$), behavioral scale ($r = .19$, $P < .05$), intentions ($r = .24$, $P < .01$), and serum carotenoids ($r = .27$, $P < .05$) (see Table 3).

Although our purpose differed from that of Havas et al, the Maryland WIC study found that self-efficacy, perceived benefits, and barriers were weakly correlated with consumption estimated by a 7-item food frequency questionnaire.[11] Our tool, with its multiple constructs, was the most similar in content to the Maryland WIC instrument.[10,11] The WIC instrument was compared with a valid 7-item food frequency questionnaire, whereas our tool was compared with 5 indicators of diet quality, including a biomarker. In both cases, the findings support the validity of the measures.

Similar to Havas et al,[11] mean scores were all or mostly affirmative for perceived control of shopping and control of food preparation. We decided to retain these items for further testing with more typical EFNEP and FSNE audiences than participants in our study. We did not anticipate that EFNEP and FSNE interventions would be likely to change these constructs. Instead, responses to these items would provide important information about clients to the EFNEP and FSNE teaching staff. If a client perceives that she has no control over food shopping and food preparation, she is less likely to respond to EFNEP and FSNE lessons.

The revised version of this tool is correlated with dietary and serum measures. Given that the tool focuses on mediators of behavior change or antecedents to change and not on the relevant behaviors, we should expect lower correlations than between dietary and serum measures with behaviors. Using the guidance of Nunnally and Bernstein,[36] correlations based on a single predictor score such as this tool rarely exceed 0.3 to 0.4 because people are far too complex to permit a highly accurate estimate of psychosocial variables. Given that we are using psychosocial variables as predictors of diet quality, it is important to note that 4 of the validity coefficients for the final version of the evaluation tool exceeded 0.4. Other coefficients were low, although statistically significant, and were considered acceptable.

The strongest correlation among psychosocial domains with the diet quality indicators was for the intention domain composed of 2 readiness to change items and 1 perceived diet quality item (see Table 2). These results support our biopsychosocial framework, with intention acting as an intervening variable between the fruit and vegetable behaviors and other psychosocial domains (see Figure).

These results suggest that overall scores of participants' perceptions of psychosocial determinants of fruit and vegetable intakes were consistent with the biomarker and their externally reported food intakes. The biomarker (ie, serum carotenoids) was more closely correlated to our instrument ($r = .38$ , $P < .001$) than to the servings of fruits and vegetables from the 3 24-hour dietary recalls ($r = .33$, $P = .004$, not shown). Considering that this tool is easier than the 3 recalls to administer and score by the health paraprofessionals, this is an important finding in support of this new instrument. In their work with low-income clients, paraprofessional staff in California reported that they prefer to administer a checklist style evaluation tool rather than the more complex 24-hour dietary recall. A copy of the instrument is available from the first author by electronic mail (mstownsend@ucdavis.edu) or by telephone (530-754-9222).

This study has a number of limitations that should be addressed. First, the small number of items for assessing each construct is a limitation but a necessary one given our goal of a parsimonious tool for multiple psychosocial constructs. Variability in participant responses may have been less than that seen in our general limited-resource audience because these women volunteered to participate. Their education was higher than our general FSNE audience, although they qualified for and received Food Stamps. Consequently, selection bias must be considered a potential threat to the external validity of the study.[43] Known as the Hawthorne effect, the diet recalls themselves may have been a motivator for better food selection.[44] Our social support items estimated the number of people offering support for eating fruits and vegetables but not the strength of that support. Last, we could only test ethnic differences with a small sample of non-Hispanic black, non-Hispanic white, and English-speaking Latino participants. Although our participants were ethnically diverse, we recognize that testing this instrument with other ethnic and cultural groups is essential.

## IMPLICATIONS FOR RESEARCH AND PRACTICE

Interpretation of evaluation results for community education interventions can be successfully accomplished only with use of an assessment tool shown to be accurate and reliable,

such as this one.[5,6] This research can provide others with a tool containing identifiable conceptual foundations and known measurement properties. The findings reported here showed acceptable levels of reliability and validity for continued use and testing of this version of the evaluation tool. Now containing 13 items in 3 domains, this tool is a work in progress. We recommend its use with a valid assessment of fruit and vegetable behaviors, similar to that previously reported.[38,39] Further work is recommended to test the instrument in other low-income populations and assess its ability to capture change longitudinally. Using the tool as a pretest has the potential to be helpful to the EFNEP and FSNE paraprofessionals. They could use the result to tailor lesson content to the needs of clients. Nutrition researchers in other states may find this articulated process and our results useful when designing instruments for fruit and vegetable promotion programs with similar content and target audience. Other potential programs with audiences for testing this tool are WIC and 5 A Day for Better Health.

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