

## Research and Professional Briefs

## Development and Reliability Testing for Measures of Psychosocial Constructs Associated with Adolescent Girls' Calcium Intake

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**ABSTRACT**

Early adolescence is an important period for assuring adequate calcium intake to achieve optimal bone health. This study was conducted to develop a measure of psychosocial constructs likely to be associated with young adolescent girls' consumption of high-calcium foods and to evaluate the test-retest reliability and factor structure of the measure. Methods involved: (a) generating a pool of items; (b) a cross-sectional pretest of the survey with a small group; (c) longitudinal administration of the revised survey with a larger group; and (d) statistical analysis to determine psychometric properties of the measures. Seventeen girls completed the pretest and debriefing, and 217 girls participated in the pilot test and test-retest (completion rate 95%). The study took place in Hawaii in late 2002. Coefficient  $\alpha$  was used to test internal consistency and test-retest reliabilities were calculated. Cluster analyses of the items were performed to evaluate the factor structure of the measure. The resulting measure was a 55-item questionnaire to assess key psychosocial variables in three categories: Social and Environmental Factors (Availability, Social Influence); Attitudes and Preferences (Health Benefits; Preferences; Taste; Weight; Tolerance; Convenience); and Knowledge. The survey had high internal consistency reliability ( $\alpha > .75$ ) and good test-retest reliability (0.73 to 0.78 except for Knowledge, where Spearman's  $\rho = 0.41$ ). The study developed a measure with high internal consistency and test-retest reliability to assess constructs that can be used in descriptive, prospective, and intervention

research and as possible explanatory or mediating variables.

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**B**one health is critically important to lifelong health and quality of life, and getting enough dietary calcium is a key recommendation for assuring bone health and preventing osteoporosis (1). Early adolescence is an important period for assuring adequate calcium intake to achieve optimal bone health (2-7), and many adolescents do not consume enough calcium-rich foods (1,8). There is a need for targeted interventions to improve calcium intake in adolescent girls (9).

Efforts to improve calcium intake in adolescent girls are underpinned by hypotheses about the factors influencing consumption of calcium-rich foods. These factors, often grouped under the broad category of "psychosocial variables," should be assessed in intervention studies to make it possible to learn about the presumed mechanisms of intervention effects. Questionnaires designed to measure these factors need to be relevant to the audience, theoretically consistent with the intervention, and internally consistent and reproducible. Such measures should also be relatively brief to reduce the burden of data collection.

This article reports on the development and psychometric evaluation of measures of psychosocial constructs likely to be associated with consumption of high-calcium foods in young adolescent girls participating in the Adequate Calcium Today Study.

**METHODS**

This research involved four steps: (a) generating a pool of items; (b) a cross-sectional pretest with a small group and revising the instrument based on their input (Phase 1 field work); (c) longitudinal administration of the revised survey with a larger group (Phase 2 field work); and (d) statistical analysis to determine the psychometric properties and statistically sound schemes for creating composites and data reduction. Each step is described below.

**Step 1. Initial Survey Development**

To identify items and constructs, the investigators first reviewed several sources of related items, including available surveys (10-12), published measures (8,13,14), and other relevant literature. Face validity of items was assessed by the research team. The selection of constructs

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and items was based on previous empirical findings and applicable theories of human behavior, mainly Social Cognitive Theory (15).

An inventory of 130 items was created, iteratively categorized, and classified into nine categories: Availability, Social Influence, Self-Efficacy, Taste, Attitudes, Knowledge, Intentions, Behavior, and Preferences. Because there was overlap across items, investigators worked to achieve consistent wording and response choices for similar items. Using this information, the initial pretest version of the measure was drafted. It included 61 items focusing on the following constructs, identified a priori: Availability, Social Influence, Attitudes/Barriers-Motivators (eg, weight, taste, preference), Tolerance/Health Beliefs, and Knowledge.

**Participants in the Pretest and Pilot Test.** The measurement study was conducted in Hawaii in late 2002 with preadolescent female students aged 11 to 14 years. Seven private schools on three islands (Oahu, the Big Island of Hawaii, and Maui) took part in the study: two schools in the pretest and debriefing and five schools in the pilot test and retest. The majority of participating students (93.3%) were in the sixth to eighth grades. Participants were mainly from sixth (27.0%), seventh (33.8%), and eighth (32.4%) grades and were of white (61.0%), Asian American (35.1%), and Native Hawaiian/Pacific Islander (3.9%) race/ethnic backgrounds.

The Institutional Review Board of the University of Hawaii approved the project and all procedures. Consent forms were sent home with the children 1 week before data collection took place, and student assent occurred on the day of the (first) survey.

### Step 2. Pretest, Debriefing, and Revisions (Phase 1 Field Work)

The first round of pretesting and debriefing was conducted to determine how long the survey took to complete, whether the items were easy for the girls to understand (and if not, why not), and to refine question wording and relevance for the audience (young adolescent girls). Seventeen girls at two schools took part in this phase of the study.

The field staff first gave the survey to the girls to complete, and then asked a series of questions in a small group. The questions asked for their reactions; whether some questions were easy or difficult to understand and answer, or did not make sense; for suggestions to improve this questionnaire; and for other thoughts or reactions. The project team reviewed the surveys to identify whether any items or groups of items had highly skewed or limited distributions. A summary was compiled and reviewed by the researchers and consultant.

The length of time for completion of the 61-item survey was 10 minutes or less for all of the students and was deemed to be short enough. Most of the students thought the survey made sense. They had several minor suggestions. Survey revisions included changes in the wording of several items and clarification of the instructions for the knowledge questions. No items were added or dropped after Phase 1.

### Step 3. Pilot Testing Revised Survey, Test-Retest Reliability (Phase 2 Field Work)

The first and second survey administrations were completed in the classrooms by project staff. Two-hundred and ten students completed the baseline survey and 199 of those students completed the follow-up, administered 1 to 2 weeks later, for a completion rate of 95%.

The survey included 61 items, which were provisionally categorized a priori into three major categories and 11 subscales or categories: Social and environmental factors (20 scaled items plus two categorical items): Availability (10 items); Social Influence (10 items); Friends/Family Usually Drink/Serve (two categorical items, used separately); Attitudes and preferences (29 items): Convenience (one item); Health Benefits (six items); Preferences (six items); Temperature (two items); Tolerance (two items); Taste (nine items); Weight Concerns (three items); and Knowledge (10 items).

### STATISTICAL METHODS

Statistical analyses were completed using SAS statistical software (version 8.2, 1999, SAS Institute Inc, Cary, NC). Preliminary analyses included univariate analyses and correlations of items within scales and subscales. Coefficient alphas were computed for each a priori scale and subscale to evaluate internal consistency, and items or subscales were eliminated if the omission substantially increased the  $\alpha$  for a subscale. Composite scores were created for each of the scales and subscales where  $\alpha > .5$ . A knowledge score was computed as the sum of items correctly answered. For these analyses, all baseline and follow-up surveys were included.

Next, analysis of test-retest reliability was completed on the 199 complete sets of surveys. Spearman's  $\rho$  was used for the scaled items and simple  $\kappa$  was used for the two categorical items (16,17). A general linear model was used to test the association of the categorical variables with the subscales. Finally, cluster analysis of the items was conducted to see how the items with the same response choices grouped together statistically using an oblique principal component cluster analysis (ie, PROC VARCLUS). Internal consistency and test-retest reliabilities were also calculated for each cluster.

### RESULTS AND DISCUSSION

#### Internal Consistency

Table 1 presents the coefficient alphas indicating the internal consistency for every global scale and subscale. After review of the baseline  $\alpha$  results, six items were omitted and  $\alpha$  was recalculated for the scale and subscales that were affected by this deletion.

**Test-Retest Reliability for Composite Indices.** Table 2 presents the test-retest reliability results. Most of the results were in the good range, except for Convenience and Weight Concerns (moderate to good), and Knowledge (moderate) (16,17).

**Categorical Variables' Relation to Subscales.** The two categorical items asking what friends and family drink at meals were conceptually related to the Social Influences subscale and this association was tested with a general linear model using the baseline data. The drink choices were

**Table 1.** Coefficient  $\alpha$  internal consistency for psychosocial scales and subscales related to female adolescents' calcium intake

Scales/subscales	Baseline Administration (n=209)				Retest (n=206)	
	No. of items	$\alpha$	Revised no. of items <sup>a</sup>	Revised $\alpha$	$\alpha$	Revised $\alpha$
Attitudes and preferences	29	.77	25	.80	.75	.79
Convenience	1	NA <sup>b</sup>			NA	
Health benefits	6	.87			.88	
Preferences	6	.39	5	.59	.51	.67
Temperature	2	.15	0	NA	.09	NA
Tolerance	2	.76			.72	
Taste	9	.41	8	.53	.47	.62
Weight	3	.51			.47	
Social and environmental	20	.73	18	.75	.79	.82
Availability	10	.49	9	.56	.66	.71
Social influence	10	.74	9	.78	.74	.77
Knowledge	10	.72			.73	

<sup>a</sup>Based on baseline  $\alpha$  analyses, items were excluded or a subscale was eliminated if the omission substantially increased the  $\alpha$  for a subscale.  
<sup>b</sup>NA=not applicable.

**Table 2.** Test-retest reliability for psychosocial scales and subscales related to female adolescents' calcium intake

Subscale	Correlation
Attitudes and preferences	0.78
Convenience	0.51
Health benefits	0.71
Preferences	0.82
Temperature	NA <sup>a</sup>
Tolerance	0.67
Taste	0.71
Weight	0.59
Social and environmental	0.76
Social influences	0.74
Availability	0.74
Knowledge	0.41
Categorical items	<b>Simple <math>\kappa</math></b>
Friends drink at lunch (3 categories)	0.73
Parents serve at dinner (3 categories)	0.73

<sup>a</sup>NA=not applicable.

grouped into three categories: milk; water or juice; and soda/punch or other. The beverage parents serve at dinner was significantly related to Social Influences [ $F(2,195)=21.81, P<0.0001$ ], with milk associated with the higher scores for Social Influences than the other two drink categories. What friends drink at lunch was not significantly related to Social Influences, which was not surprising because all items on that revised scale relate to parental or other adult influences.

**Cluster Analysis.** Items with the same response scales were clustered together. A three-cluster solution accounted for 44% of the variance and grouped items in a manner similar to the a priori subscales. Social Influence items are loaded in cluster 1 with one Availability item. Clusters 2 and 3 contain Availability items. The final four-cluster solution accounted for 52% of the variance of the original items. It differed from the above three-cluster

solution in that "mother and dad make me drink milk" items were split from cluster 1 and became a new cluster.

The second cluster analysis was conducted on the final 29 recommended items using the five-point response scale anchored by Strongly Disagree and Strongly Agree. The final eight-cluster solution accounted for 53% of the variance (data not shown; available from the authors).

**Final Questionnaire and Constructs.** On the basis of the measurement study, 55 of the 61 items were retained to measure three broad categories of psychosocial constructs: Social and Environmental Factors (18 scaled items + two categorical items); Attitudes and Preferences (25 items); and Knowledge (10 items) (see Figure). These major categories have good-to-excellent internal consistency and test-retest reliability. Reliability of both types is equal to or better than what has been found in similar studies with children and adolescents (14,18,22). The survey takes <10 minutes to complete. Alternatively, the composites that emerged from the cluster analyses can be used as an alternate scheme for data reduction.

The measure assesses key constructs from Social Cognitive Theory (15) and builds on preliminary work by the study investigators with similar samples (10). These key constructs have also been studied by other adolescent nutrition investigators (6,13,14,18-22). The focus on motivators such as availability, taste, friend and family influence, perceived health benefit; and barriers such as intolerance, weight concern, and knowledge of calcium sources, seems to be robust. The items can be used as grouped or can be used in subgroups or as individual indicators or correlates of other factors such as age, ethnicity, weight status/body mass index, treatment arm, and so on.

**Limitations.** Both the measure and this study have several limitations. Self-report measures may lead to social desirability bias or misunderstanding. The limited number of items meant that only a few calcium-rich foods were included. Some potentially important variables may have been left out. Though the study was conducted in Hawaii, the measures are likely to be useful in a variety of racial/

<p><b>Social and Environmental Factors</b> (18 scaled items+2 categorical items)</p> <p><b>Availability</b> (9 items) (5-point scale; Never to Everyday)</p> <ol style="list-style-type: none"> <li>1. There is milk in my home.</li> <li>2. There is yogurt in my home.</li> <li>3. There is frozen yogurt in my home.</li> <li>4. There is ice cream in my home.</li> <li>5. There is cheese in my home.</li> <li>6. There is calcium-fortified orange juice in my home.</li> <li>7. There is cereal at home.</li> <li>8. There are vegetables at home.</li> <li>9. There are corn tortillas at home.</li> </ol> <p><b>Social Influence</b> (9 items) (5-point-scale; Never to Everyday)</p> <ol style="list-style-type: none"> <li>1. My mother makes me drink milk.</li> <li>2. My dad makes me drink milk.</li> <li>3. Everyone in my family drinks milk.</li> <li>4. My mother drinks milk.</li> <li>5. My dad drinks milk.</li> </ol> <p>(5-point scale; Strongly Disagree to Strongly Agree)</p> <ol style="list-style-type: none"> <li>6. I drink milk because my coach says to.</li> <li>7. My family makes me take calcium supplements.</li> <li>8. My mom or female guardian regularly drinks milk or eats calcium-rich foods.</li> <li>9. My dad or male guardian regularly drinks milk or eats calcium-rich food.</li> </ol> <p><b>Social Influence</b> (what friends/family usually drink/serve; 2 categorical items)</p> <ol style="list-style-type: none"> <li>1. What do most of your friends drink at lunch? (milk, soda, juice, punch, water, other).</li> <li>2. What do your parents give you to drink at dinner/supper most nights? (milk, soda, juice, punch, water, other).</li> </ol> <p><b>Attitudes and Preferences</b> (25 scaled items)</p> <p><b>Health Benefits</b> (6 items) (5-point scale; Strongly Disagree to Strongly Agree)</p> <ol style="list-style-type: none"> <li>1. I drink milk so I can have strong bones now.</li> <li>2. If I drink milk now, my bones will be strong when I am older.</li> <li>3. Milk is not healthy (Reverse score).</li> <li>4. I know it is important for people my age to drink milk.</li> <li>5. Only little kids need milk.</li> <li>6. I drink milk because it is good for me (Reverse score).</li> </ol>	<p><b>Preferences</b> (5 items) (5-point scale; Strongly Disagree to Strongly Agree)</p> <ol style="list-style-type: none"> <li>1. I like tofu.</li> <li>2. I like to eat seaweed.</li> <li>3. I like to eat pudding.</li> <li>4. I like to eat green vegetables.</li> <li>5. I like to eat stir-fry dinners.</li> </ol> <p><b>Taste</b> (8 items) (5-point scale; Strongly Disagree to Strongly Agree)</p> <ol style="list-style-type: none"> <li>1. When it is cold outside, I like to drink cocoa.</li> <li>2. Now that I'm older, I'd rather drink soda pop or coffee instead of milk (Reverse score).</li> <li>3. I like the taste of soda (Reverse score).</li> <li>4. Milk tastes good.</li> <li>5. Whole milk is too thick (Reverse score).</li> <li>6. Skim milk tastes gross (Reverse score).</li> <li>7. Milk at school tastes bad (Reverse score).</li> <li>8. I love chocolate milk.</li> </ol> <p><b>Weight</b> (3 items) (5-point scale; Strongly Disagree to Strongly Agree)</p> <ol style="list-style-type: none"> <li>1. I don't drink milk because it is fattening.</li> <li>2. I am trying to lose weight, so I don't drink milk.</li> <li>3. Milk is high in calories.</li> </ol> <p><b>Tolerance</b> (2 items) (5-point scale; Strongly Disagree to Strongly Agree)</p> <ol style="list-style-type: none"> <li>1. Milk makes me sick/I am allergic to it.</li> <li>2. After I drink milk, my stomach hurts.</li> </ol> <p><b>Convenience</b> (1 item) (5-point scale; Strongly Disagree to Strongly Agree)</p> <ol style="list-style-type: none"> <li>1. Soda pop and other drinks are easier to take with you than milk (Reverse score).</li> </ol> <p><b>Knowledge</b> (10 items) "Which foods are high in calcium or not high in calcium..?" (Scored 1=correct; 0=incorrect or not sure)</p> <ol style="list-style-type: none"> <li>1. Broccoli (yes)</li> <li>2. Chicken (no)</li> <li>3. Bananas (no)</li> <li>4. Fish (no)</li> <li>5. Strawberries (no)</li> <li>6. Milk (yes)</li> <li>7. Yogurt (yes)</li> <li>8. Seaweed (yes)</li> <li>9. Soda (no)</li> <li>10. Cheese (yes)</li> </ol>
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**Figure.** Questionnaire items, constructs, and subscales for measures of psychosocial constructs associated with girls' calcium intake.

ethnic population groups, based on the modest ethnic differences found in previous studies of multiethnic youth and calcium (2,10). In addition, they do not emphasize ethnic-specific foods. The measures are being used in a multiethnic sample in the Adequate Calcium Today study.

Because there was no measurement of calcium intake in participating girls in this measurement study, it was not possible to assess criterion validity of the psychosocial measures. Future research should examine this question. Importantly, this survey does not assess correlates of physical activity, another important determinant of bone strength for this age group (23).

## CONCLUSIONS

This study developed a measure of psychosocial factors related to adolescents' calcium intake that assesses constructs that are consistent with previous studies of other dietary behaviors, and has high test-retest reliability and internal consistency. The items can be used as grouped, in subgroups, or as individual indicators or correlates of eating behavior. Results of the cluster analyses suggest alternate schemes for creating composites for data reduction. These measures have several possible uses in future research. In intervention studies, the measures may be used at baseline and posttest, for preintervention assess-

ment; pre-post comparisons; and as possible explanatory or mediating variables. They can also be used in other descriptive and prospective research on this topic.

Although there are several available measurement tools for knowledge, attitudes, beliefs, and perceptions related to osteoporosis prevention that have been reported for women (24-26), there are few published questionnaires on this topic for use with adolescent girls (22). This brief 55-item self-administered survey will be useful in the Adequate Calcium Today study and in future research aimed at understanding and improving adolescents' bone health.

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