

Construct Validation and Test–Retest Reliability of the Seniors in the Community: Risk Evaluation for Eating and Nutrition Questionnaire

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Background. We performed two studies. Study 1 was a construct validation of Seniors in the Community: Risk Evaluation for Eating and Nutrition (SCREEN), a 15-item questionnaire for assessing nutritional risk. In Study 2, we examined the test-retest reliability of SCREEN.

Methods. Study 1 was a cross-sectional study, and Study 2 was a cohort study. For Study 1, ten diverse community sites were used to recruit participants. A total of 128 older adults attended a clinic to provide medical and nutritional history and anthropometric measurements. A dietitian interviewed each participant. Dietitians used clinical judgment to rate the probability of nutritional risk from 1 (low risk) to 10 (high risk). Spearman's rho correlation and receiver operating characteristic curves were completed. An abbreviated SCREEN was developed through multiple linear regression analysis. In Study 2, SCREEN was randomly distributed to members of a seniors' recreation center where a self-selected sample ($n = 124$) completed two mailed SCREENs, 4 weeks apart. The test-retest reliability was estimated through paired correlations of total scores and individual items.

Results. In Study 1, total and abbreviated SCREEN scores were significantly associated with the dietitian nutritional risk rating ($\rho = -.47$ and $\rho = -.60$, respectively). Study 2 revealed that the test-retest reliability of SCREEN was adequate.

Conclusions. SCREEN appears to be a valid and reliable tool for identifying community-dwelling older adults at risk for impaired nutritional states.

SENIORS have an increased risk for impaired nutritional states (1–6). Seniors are frequently admitted to acute care facilities in a state of malnutrition, indicating parallel changes in nutrition and health status in the community (7). This deterioration in nutritional state is frequently unrecognized by primary care health professionals (7). Screening for nutritional risk in the community is an important step in preventative health care for seniors (5,8), and a variety of tools are being used in the community (1,2,7,8). Although self-administered assessment tools have recently been criticized (9,10), more complex tools, such as those used in home care or outpatient hospital settings, are rarely applicable to a wider population (8,11). There is a need for simple, feasible, valid, and reliable tools for determining nutritional risk in community-dwelling seniors (7,10,12,13).

Seniors in the Community: Risk Evaluation for Eating and Nutrition (SCREEN) is a simple, 15-item questionnaire for assessing nutritional risk. It can be self- or interviewer administered and can be used in a variety of settings. Each item has five possible response options ranging in score from 0 to 4. Lower scores on the continuous 60-point scale of SCREEN indicate increased nutritional risk. SCREEN was developed using an interactive process that involved researchers, practitioners, and seniors (14). Developmental analyses have shown that the tool has content validity and internal reliability (14). We describe two studies: the first

assessed the construct validation of SCREEN in a diverse group of community-dwelling seniors, and the second assessed the prevalence of nutritional risk in the membership of a seniors' recreation center and provided an opportunity to estimate the test-retest reliability of SCREEN.

METHODS

Study 1: Construct Validation

The assessment of nutritional status is complex, and there is no definitive, objective measure to act as the gold standard criterion. Thus, construct validation is appropriate (7,10,13,15,16). In this study, construct validation included comparison to other measures of the same construct (nutritional risk/status), comparison of extreme groups to determine if a hypothesized gradient exists, and correlation with other attributes believed to be associated with the construct (e.g., health status) (16).

Participants.—Participants were recruited from ten community sites in the Guelph area of Ontario. The recruitment sites were chosen to provide a diverse group of seniors: a day hospital and a rehabilitation center, three seniors' apartments, four supportive housing units, and a seniors' recreation center. Participants were recruited by supportive housing workers, mail, or advertisements; during nutrition information

seminars; or for those at the rehabilitation center and day hospital, directly by a dietitian. Participants were eligible for inclusion in the study if they were 55 years of age or older, lived in the community, and did not receive all their meals through a mandatory meal program.

Data Collection.—Previous validation studies of nutrition screening tools have focused on one or a few measures to act as the criteria within the constellation of parameters used to assess nutritional status (7,12,14,17). Thus, it could be argued that these tools do not fully represent the construct of nutritional status (10,14). As a result, the clinical judgment of a dietitian was considered the best alternative for determining the validity of SCREEN (7,18). This clinical judgment was made on the basis of data collected at two time points: first, during a clinic appointment, and second, during a one-on-one interview with a dietitian. Clinic appointments were conducted at the recruitment site to promote efficiency of data collection. Standardized checklists and measures were completed by two trained research assistants. After consent was obtained, participants self-administered SCREEN; 14 participants required the help of a research assistant (J.M.) to complete the questionnaire. The self-administered SCREEN question stems are provided in the Appendix A.

The first research assistant then administered a checklist to obtain demographic information; medical problems; use of medications, vitamins, minerals, herbal remedies, meal supplements, and alcohol; perceived health status; hospitalizations and surgeries in the past year; dentition; swallowing problems; smoking; gastrointestinal problems; appetite, taste, and smell changes; specialized diets; assistance with cooking or shopping; meal delivery programs; and average grocery expenditures. After the participants completed the checklist, another trained research assistant (A.K.) completed anthropometric measurements on all participants. Standardized techniques were used to collect triceps and subscapular skinfolds, knee height, weight, and mid-arm, wrist, and calf circumferences, and comparisons were made to accepted references (15,19–21,22).

Three trained registered dietitians completed one-on-one clinical interviews with the participants. The interview was used to clarify nutrition problems identified during the clinic assessment and to collect a seven-day diet history (23,24). All information, except the SCREEN results, was provided to the dietitians before the interviews, ensuring blinding of the dietitians to the self-administered SCREEN. Using clinical judgment and the collected anthropometric, diet history, and medical information, dietitians provided a probability rating on the participant's nutritional risk using a standardized framework (Appendix B). This nutritional risk rating, which used a 10-point scale (1 = low risk, 10 = high risk), was the primary method used for construct validation of SCREEN. To determine and verify the comparability of nutritional risk assessments by the dietitians, 13 cases were randomly selected from the sample for rating by each dietitian. An intra-class correlation was calculated to be $r = .75$, indicating that subject variance was greater than observer or rater variance (16).

Construct validity was also assessed by comparing ex-

treme groups on the basis of recruitment site and health-problem acuity. As well, the reported medical history information provided an opportunity to compare SCREEN scores with variables believed to be associated with nutritional status: perceived health status, hospital use, number of medical problems, and use of medications.

Study 2: Test-Retest Reliability of SCREEN

A random sample of 425 members of a local seniors' recreation center was used to estimate the test-retest reliability of SCREEN (H.H. Keller and M.R. Hedley, unpublished data). Surveys were sent out by mail and included SCREEN, demographic information, and questions on the use of the recreation programs, as well as a request for participants to complete a second SCREEN form to assess reliability. This second SCREEN was completed approximately 4 weeks after the first SCREEN.

Statistical Analyses

Study 1.—Spearman's rho correlation was used to determine the association between the dietitian rating, number of medical problems, and medications with SCREEN. Comparisons of hospitalizations in the past year, perceived health status, and emergency room visits in the past year were made using a one-way analysis of variance. To develop an abbreviated form of SCREEN, multiple linear regression analysis using a stepwise backward procedure was done with the dependent variable being the dietitian's risk rating. Associations were considered significant at the $p < .05$ level, and analyses were completed with SPSS 8.0 and SAS 6.12.

Receiver operating characteristic (ROC) curves for the full SCREEN and the abbreviated SCREEN were derived to evaluate sensitivity and specificity (16). ROC curves and areas under the curve (AUC) were calculated for the construct standards of a cut-point of ≥ 5 on the dietitian probability rating, a cut-point of 8 on the dietitian probability rating, and perceived health status. The best ROC curve was provided when the first construct standard was used (≥ 5 on dietitian rating) and will be presented only for the total SCREEN.

Study 2.—The test-retest reliability of total and abbreviated SCREEN were assessed using paired t test comparisons of mean item scores and total SCREEN score, intra-class correlation (ICC) of total SCREEN scores, and paired sample correlation (25).

RESULTS

Study 1

A total of 128 seniors completed the clinic appointment and dietitian interview. Seventy-three percent were women, 44% were widowed, and 64% lived alone. The average age was 74 years (SD , 9.1 years). Recruitment sites differed for several participant demographic, nutrition risk, and health variables (Table 1). The mean dietitian nutritional risk rating was 4.8, and the mean SCREEN score was 46.6 (range 23–60). Lower scores on SCREEN indicate increased risk for impaired nutritional states.

Table 1. Site Comparison for Health and Nutrition Variables in the Validation Sample

Variable	Sites				
	Recreation/Condos (<i>n</i> = 34)	Seniors' Apartments (<i>n</i> = 32)	Supportive Housing (<i>n</i> = 39)	Day Hospital Rehabilitation (<i>n</i> = 23)	Total Sample (<i>N</i> = 128)
	Mean Value (S.D.)				
Dietitian Rating of Risk	3.5 (1.5) [†]	3.0 (1.7)	5.6 (2.1)	7.6 (1.8)	4.8 (2.4)*
Total SCREEN Score	49.5 (6.9)	47.1 (6.4)	46.0 (8.3)	42.5 (5.8)	46.6 (7.4)*
Abbreviated SCREEN	41.4 (4.1)	38.3 (6.6)	36.5 (7.4)	31.0 (6.5)	37.3 (7.1)*
Number of Medical Problems	4.5 (2.6)	5.1 (2.5)	5.2 (2.9)	6.0 (2.8)	5.2 (2.8)
Number of Medications	2.5 (2.0)	4.2 (3.5)	4.1 (3.3)	7.4 (3.5)	4.2 (3.5)*
Dietitian Rating, %					
Low risk (<5)	70.6	84.4	35.9	8.7	52.3*
Moderate risk (5–7)	29.4	12.5	35.9	34.8	28.1
High risk (>7)	0	3.1	28.2	56.5	19.5*
SCREEN ≤45, %	14.7	43.8	41	73.9	40.6*
SCREEN ≤50, %	50	65.5	64.1	95.7	66.4*
Emergency Room Admission in Past Year, %	8.8	18.8	23.1	68.2	26.8*
Hospitalization in Past Year, %	21.2	21.9	23.1	95.7	35.4*
Perceived Health Status, %					
Excellent	26.5	9.4	30.8	0	18.8*
Very good	32.4	28.1	33.3	39.1	32.8
Good	38.2	43.8	20.5	21.7	31.3
Fair	0	15.6	7.7	34.8	12.5
Poor	2.9	3.1	7.7	4.3	4.7

Note: SCREEN = Seniors in the Community: Risk Evaluation for Eating Nutrition.

*Differences significant among sites at $p < .01$.

[†]Values are means with SD in parentheses.

SCREEN demonstrates construct validity in that scores compared by recruitment site were significantly different ($F = 4.6, p = .004$) and followed the hypothesized gradient of low nutritional risk at recreation sites, where healthy seniors predominated, to higher nutritional risk at the rehabilitation center, where participants were in a state of health vulnerability (Table 1). A similar gradient was found for the dietitian ratings of nutritional risk ($F = 37.7, p < .001$).

SCREEN was significantly correlated with the dietitian nutritional risk rating ($\rho = -.47$). In the final multiple linear regression analysis, a model containing eight individual SCREEN items (items 1, 3, 4, 6, 8, 9, 11, 12) accounted for 39% of the variance in the dietitian nutritional risk rating. An abbreviated SCREEN score (maximum = 48) was derived by double weighting the four significant items and single weighting the nonsignificant items from this multiple linear regression model. This abbreviated SCREEN score was more highly associated with the dietitian rating ($\rho = -.60$) than the total SCREEN score and was associated with recruitment site ($F = 12.8, p < .001$) (Table 1).

Construct validity was further tested for the total and abbreviated SCREEN and dietitian rating by correlating scores with measures of health status believed to be associated with nutritional risk; scores were significantly ($p < .001$) associated with the number of reported medications ($\rho = -.37, -.37, \text{ and } .46$, respectively) and the number of reported medical problems ($\rho = -.36, -.31, \text{ and } .42$, respectively). Associations were seen for perceived health status with the total SCREEN score ($F = 8.0, p < .001$), abbreviated SCREEN score ($F = 6.4, p < .001$), and dietitian rating ($F = 7.9, p < .001$). An emergency room visit in the past year was associated only with the dietitian rating ($F = 14.2, p < .001$) and the abbreviated SCREEN score ($F =$

4.6, $p < .05$); however, hospitalizations in the past year were associated with all three measures: the dietitian rating ($F = 34.2, p < .001$), total SCREEN score ($F = 9.6, p < .01$), and abbreviated SCREEN score ($F = 18.5, p < .001$).

The best ROC curve was found when the presence or absence of nutritional risk was dichotomized using a cut-point of 5 on the dietitian rating (Figure 1 and Table 2). The AUC for this comparison was 78%. A score of 50 on the full SCREEN was estimated to be the maximum cut-point for "screening" nutritional risk; this score corresponded with a sensitivity of 94%, a specificity of 32%, a positive predictive value of 46%, a negative predictive value of 86%, a

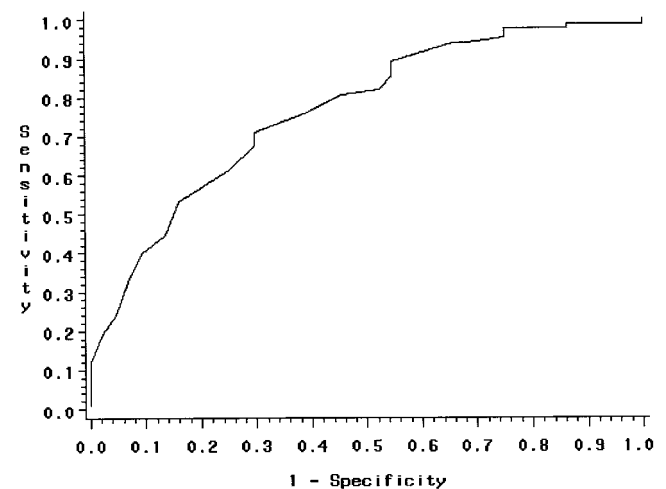


Figure 1. Receiver operating characteristic curve for total SCREEN and dietitian rating (cut-point ≥ 5).

Table 2. Sensitivity, 1-Specificity, True-Positive, and False-Positive Values for Various Cut-Points for the Total SCREEN Using Dietitian Rating (>5) as the Standard for Nutritional Risk

Cut-Point	True Positives	False Positives	Sensitivity	1-Specificity
<23	1	0	0.012	0.000
24	4	0	0.048	0.000
31	5	0	0.060	0.000
32	7	0	0.084	0.000
33	10	0	0.120	0.000
34	16	1	0.193	0.000
35	20	2	0.241	0.045
36	27	3	0.325	0.068
37	33	4	0.398	0.091
38	37	6	0.446	0.136
39	44	7	0.530	0.159
40	51	11	0.614	0.250
41	56	13	0.675	0.295
42	59	14	0.711	0.295
43	61	15	0.735	0.341
44	63	17	0.759	0.386
45	67	20	0.807	0.455
46	68	23	0.819	0.523
47	71	23	0.855	0.545
48	74	24	0.892	0.545
49	78	29	0.940	0.659
50	78	30	0.940	0.682
51	79	33	0.952	0.750
52	81	33	0.976	0.750
53	81	36	0.976	0.818
54	81	38	0.976	0.864
55	82	38	0.988	0.864
56	82	41	0.988	0.932
57	82	42	0.988	0.955
58	82	43	0.988	0.977
59	82	44	0.988	1.000
60	83	44	1.000	1.000

Note: To calculate 1-specificity, subtract column value from 1.0. Suggested cut-points of 45 and 50 are in bold type.

SCREEN = Seniors in the Community: Risk Evaluation for Eating and Nutrition.

likelihood ratio for a positive test of 1.38, and a likelihood ratio for a negative test of 0.189. A score of 45 was estimated to be the maximum cut-point for epidemiological research, with fewer false positives; this score corresponded with a sensitivity of 81%, a specificity of 55%, a positive predictive value of 58%, a negative predictive value of 80%, a likelihood ratio for a positive test of 1.77, and a likelihood ratio for a negative test of 0.354. The abbreviated SCREEN appears to have slightly better ROC curves and AUC (Figure 2) than the total SCREEN.

Study 2

A total of 247 useable surveys were returned from members of the recreation center. Further details on the sample are reported elsewhere (H.H. Keller and M.R. Hedley, unpublished data). Of the original survey participants, 124 comprised the test-retest reliability sample. This reliability sample was not significantly different from the survey participants for age, gender distribution, total SCREEN score, proportion at risk (using 50 or 45 SCREEN scores as cut-

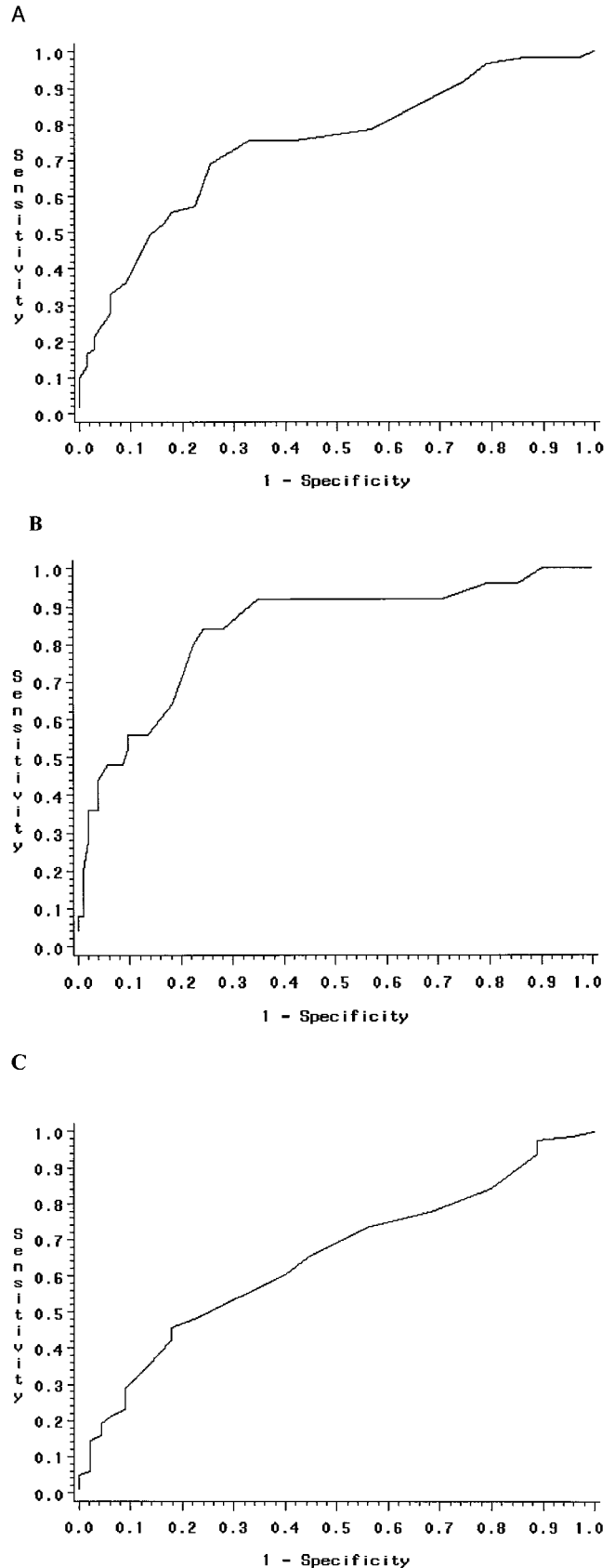


Figure 2. Receiver operating characteristic curves for abbreviated SCREEN. A, Dietitian Rating Cut-Point ≥5; B, Dietitian Rating Cut-Point ≥8; C, good to excellent perceived health.

Table 3. Paired Correlations for Test-Retest Administration of SCREEN in Reliability Sample ($n = 124$)

SCREEN Variable	Paired Correlation (r^*)
Weight change	.56
Food restriction	.76
Frequency of eating	.43
Fruit and vegetable intake	.67
Meat and alternative intake	.54
Milk and milk product intake	.65
Fluid intake	.40
Difficulty chewing	.63
Difficulty swallowing	.57
Quality of meals when eating alone	.66
Use of meal supplements	.67
Appetite	.71
Adequacy of finances for groceries	.56
Difficulty cooking	.77
Difficulty grocery shopping	.26
Total SCREEN Score	.68

Note: SCREEN = Seniors in the Community: Risk Evaluation for Eating and Nutrition.

*All paired correlations are significant at $p < .05$.

offs), and education level. The total SCREEN scores for test and retest in these 124 participants were significantly and highly correlated ($r = .68$, $p < .001$, $ICC = .57$). All individual items were significantly correlated for the test and retest, with paired sample correlations ranging from 0.26 to 0.77 (Table 3). The test-retest reliability was higher for the abbreviated score ($r = .72$, $ICC = 0.72$). It should be noted that the items with low-paired sample correlations were not included in this abbreviated score.

The dietitian rating of nutritional risk demonstrated some level of unreliability ($r = .75$) when 13 participants were rated by each dietitian in the validation study, and SCREEN has some unreliability as evidenced above. Therefore, it is possible that the validity correlation coefficient between these two measures of nutritional risk may be attenuated (16). The unbiased validity correlation coefficient that would exist between these measures if reliability were perfect can be estimated; for the total SCREEN $r = -.72$, and for the abbreviated SCREEN $r = -.82$ (16).

DISCUSSION

SCREEN was designed to identify community-dwelling seniors who may be at nutritional risk. Two cut-off points have been identified for the total SCREEN. The first, a score of 50 or less, has high sensitivity but lower specificity, which is appropriate for initial "screening" of nutritional states. The second, a score of 45 or less, has adequate sensitivity and specificity, which is more appropriate for epidemiological research. Compared with other self-administered nutritional screening tools, these cut-points for SCREEN have higher sensitivity, lower specificity, and similar positive predictive values (17). However, interviewer-administered tools have demonstrated higher sensitivity and specificity values (26). The primary difference between the validation process of SCREEN and that of other nutritional screening tools is the comparison to clinical judgment (7,12,17,26), which may

account for the differences in sensitivity, specificity, and positive predictive values.

Previous health measurement development has relied on the use of clinical judgment as the criterion for comparison when the construct lacks an objective gold standard (27–30). In the area of construct validation where the construct can be measured in similar ways, by similar tools, criterion contamination bias is often a problem (16,25,28,30). Other nutritional risk screening validation studies have been subject to this bias (12,13). This bias was reduced in this study by having the dietitians visit the seniors in their own homes, observing them in their own environment. Bias was also reduced by self-administration of SCREEN, the blinding of the dietitians to SCREEN scores, and the training of dietitians to ensure consistency in the dietitian risk ratings.

Cross validation of the cut-points is required in a more representative sample of seniors. An abbreviated SCREEN appears to be possible, but it is believed that the items included in this tool are dependent on the sample chosen. Further validation will help to determine an abbreviated set of SCREEN items that can be applied with confidence.

The self-administered SCREEN has acceptable test-retest reliability (16), especially because multiple response categories are available for each question, a four-week time span was used for completion of the retest, instructions were static and provided only through the mail-out, and the construct of nutritional risk is a difficult concept to assess subjectively. Two questions demonstrated poor correlations in test-retest comparisons. These questions may truly have reliability problems, the behaviors may have changed during the period between the two completion times, or the administration of the initial test may have changed behavior. Change in behavior as a result of completing the SCREEN may have occurred for the fluid intake question; respondents may have realized that they were not consuming an adequate amount of fluid at the initial test and perhaps changed this behavior. However, the low correlation on the grocery-shopping item is not as readily explained. The abbreviated score, which may be a better measure of nutritional risk, also demonstrated higher reliability in this analysis. This is not surprising, as the items with lowest paired correlations are not included in the draft abbreviated form of SCREEN.

Although these findings were not based on highly generalizable samples, the prevalence of nutrition problems supports the knowledge that nutritional risk is common in community-dwelling seniors. The high proportion of participants found to be at nutritional risk by the dietitian rating, as well as the frequency of reported nutrition problems, suggests that further work on identifying community-dwelling seniors at risk with SCREEN is warranted.

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Appendix A

Item Stems From SCREEN

- 1) Weight Change: In the past 6 months I have gained/lost . . .
- 2) Diet: The number of foods I limit or avoid because of a health condition or because they disagree with me is:
- 3) Frequency of Eating: I usually eat . . .
- 4) Fruits and Vegetables: Each day, I usually eat fruits or vegetables (canned, fresh, frozen, or juice) . . .
- 5) Meat and Alternatives: I usually eat meat, eggs, fish poultry or meat alternatives (dried peas, beans, lentils nuts or tofu) . . .
- 6) Milk and Foods Made with Milk: I usually drink milk or eat foods made with milk (cheese, yogurt, or milk puddings) . . .
- 7) Fluid: Each day, I usually drink 1 cup (250ml.) of fluid (tea, coffee, juice, water, soft drinks or milk) . . .
- 8) Chewing and Biting Food: I find it hard to bite or chew food . . .
- 9) Swallowing Food: I choke, cough, or have pain when I swallow food or fluids
- 10) Eating Alone: When I am alone, I eat good, healthy meals.
- 11) Meal Replacements/Drink Supplements: I take meal replacements or drink supplements (such as Boost, Ensure, Ensure Pudding, Sustacal) . . .
- 12) Appetite: My appetite is usually . . .
- 13) Money for Food: Indicate your agreement with the following statement “I have enough money to buy the food I need”.
- 14) Cooking: I find cooking difficult (physically, lack of interest, stressful, lack skill).
- 15) Grocery Shopping: I find grocery shopping difficult (physically, lack transportation, poor weather, lack of interest, stressful).

Appendix B

Standardized Criteria for Nutritional Risk Rating by a Dietitian

Nutritional Risk Domain	Low Risk (Ranking 1–4)	Moderate Risk (Ranking 5–7)	High Risk (Ranking 8–10)
Body composition (skinfolds, weight, circumferences)	25–75th percentile [†] 80–110% IBW 85–110% UBW BMI 22–30	75–95th percentile 10–25th percentile 70–79% IBW >110% IBW/UBW 75–84% UBW BMI 20–22 or >30	>95th percentile <10th percentile <70% IBW/UBW BMI < 20
Weight change	None	(±) 0–2% in 1 wk 2–5% in 1 mo 5–7.5% in 3 mo 5–10% in 6 mo	(±) >2% in 1 wk >5% in 1 mo >7.5% in 3 mo >10% in 6 mo
Diagnosis	Constipation Mild food allergy	Chronic GI problem Significant food allergies Uncontrolled DM High cholesterol/heart disease Significant arthritis/rheumatism	Recent infection (UTI, URI) Acute GI distress/diarrhea/ malabsorption Anorexia/nausea/vomiting New diabetic/uncontrolled Dialysis, liver disease Cancer, COPD Disability influencing food intake (e.g., stroke) Recent surgery/fracture Dementia Severe arthritis/pain
Diet-related risk factors	None	Decreased taste/smell Some restrictions/preferences Irregular meal pattern Therapeutic diet Some difficulty chewing	Dysphagia Extreme restrictions/preferences Use of food supplements Feeding problems Decreased intake Poor appetite Significant chewing problem/mouth pain
Other risk factors	Appropriate use of vitamin/ mineral/herbal products	Vision/hearing difficulties Some dependence in meal preparation/shopping Excess alcohol Smoke Lives alone and receives support Polypharmacy (>5 including OTC) Some use of vitamin/mineral/herbal products with questionable efficacy	Recent hospitalization ER visits in past year Significant dependence for meal preparation/shopping Bereavement/stress Lives alone with no support Polypharmacy (>10) Extensive use of vitamins/minerals/ herbal products with questionable efficacy
Diet	No food groups above CFGHE minimum 1–2 nutrients <67% recommendation [‡]	1–2 food groups above CFGHE minimum 3–5 nutrients <67% recommendation	>2 food groups below CFGHE minimum or misses 1 food group totally >5 nutrients <67% recommendation

Note: IBW = ideal body weight; UBW = usual body weight; BMI = body mass index; UTI = urinary tract infection; URI = upper respiratory infection; GI = gastrointestinal tract; COPD = chronic obstructive pulmonary disease; OTC = over-the-counter medication; CFGHE = Canada's Food Guide to Healthy Eating.

[†]Of standard.

[‡]Recommended nutrient intakes for Canadians.