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Nutritional Risk and Body Mass Index Predict Hospitalization, Nursing Home Admissions, and Mortality in Community-Dwelling Older Adults: Results From the UAB Study of Aging With 8.5 Years of Follow-Up

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Background. Nutritional risk and low BMI are common among community-dwelling older adults, but it is unclear what associations these factors have with health services utilization and mortality over long-term follow-up. The aim of this study was to assess prospective associations of nutritional risk and BMI with all-cause, nonsurgical, and surgical hospitalization; nursing home admission; and mortality over 8.5 years.

Methods. Data are from 1,000 participants in the University of Alabama at Birmingham Study of Aging, a longitudinal, observational study of older black and white residents of Alabama aged 65 and older. Nutritional risk was assessed using questions associated with the DETERMINE checklist. BMI was categorized as underweight (<18.5), normal weight (18.5–24.9), overweight (25.0–29.9), class I obese (30.0–34.9), and classes II and III obese (≥35.0). Cox proportional hazards models were fit to assess risk of all-cause, nonsurgical, and surgical hospitalization; nursing home admission; and mortality. Covariates included social support, social isolation, comorbidities, and demographic measures.

Results. In adjusted models, persons with high nutritional risk had 51% greater risk of all-cause hospitalization (95% confidence interval: 1.14–2.00) and 50% greater risk of nonsurgical hospitalizations (95% confidence interval: 1.11–2.01; referent: low nutritional risk). Persons with moderate nutritional risk had 54% greater risk of death (95% confidence interval: 1.19–1.99). BMI was not associated with any outcomes in adjusted models.

Conclusions. Nutritional risk was associated with all-cause hospitalizations, nonsurgical hospitalizations, and mortality. Nutritional risk may affect the disablement process that leads to health services utilization and death. These findings point to the need for more attention on nutritional assessment, interventions, and services for community-dwelling older adults.

Key Words: Nutritional risk—BMI—Health services utilization—Mortality.

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HEALTHY nutritional status is crucial for independent living across the life span and especially for older adults (1). However, numerous studies indicate that older adults may be at increased risk for poor nutritional outcomes (2,3). For example, the Institute of Medicine reported that 20% of women and 12% of men 60 years and older fail to consume adequate protein and have deficiencies of other key nutrients (4). The reasons that many older adults do not consume a nutritious diet are numerous and varied, including poor dentition; impaired sensory function, including low vision and loss of taste and smell; grief and depression associated with loss of friends and spouses; and functional declines that impede older adults' ability to drive to grocery stores to purchase foods or to prepare their meals (5–9).

Poor nutrition among aging populations is a key factor affecting health outcomes and possibly health services utilization and mortality (2,10). Recent work has demonstrated that nutritional risk and low BMI are both associated with poor health-related outcomes and mortality among some older adults (10–17). Additionally, Jensen and colleagues (18,19) found that obesity was associated with both functional decline and homebound status among a large cohort of community-dwelling older adults. Furthermore, recent work by Shahar and colleagues (20) demonstrated that consumption of a Mediterranean diet was associated with faster walking speed in a cohort of more than 2000 adults aged 70 and older, which suggests that healthier diets may be protective against frailty and functional decline.

Although much work has demonstrated associations between nutritional risk and adverse clinical outcomes, little is known about the prospective relationship of nutritional risk and BMI with health services utilization, including hospitalization and nursing home admission. Furthermore, although numerous studies have found associations between low BMI and death, few have examined the prospective association between nutritional risk and death. In particular, no studies known to the authors have addressed these important questions among a heterogeneous group of community-dwelling older adults over a long-term follow-up period.

Nutritional risk can be estimated with simple questionnaires. One such questionnaire, the DETERMINE checklist, is a brief 10-item assessment, developed jointly by the American Dietetic Association, the American Academy of Family Physicians, and the National Council on Aging to aid health professionals and providers of nutritional support services in identifying older adults at-risk for malnutrition. It has been used by researchers investigating risk factors for poor nutritional health (21–28). Additionally, an unintended decrease in or low BMI is a useful clinical signal for declining health and mortality, and it can be easily calculated using one's height and weight.

The aim of this study was to evaluate the association between nutritional risk, using questions based on the DETERMINE checklist, and BMI with subsequent hospitalization, nursing home admission, and mortality over 8.5 years, adjusting for social support, social isolation, comorbidities, and other demographic measures.

Methods

Population and Design

Data from the University of Alabama at Birmingham Study of Aging were analyzed. The Study of Aging began in 1999–2001 and is an observational, longitudinal study of 1,000 community-dwelling persons aged 65 and older. Participants were living in five rural and urban counties in central Alabama and represent a stratified random sample of Medicare beneficiaries from a list provided by the Centers for Medicare and Medicaid Services. The population was balanced at baseline based on gender, race (blacks and whites), and rural or urban residence, resulting in sample that was 50% black, 50% men, and 51% rural. Standardized assessments of mobility, social and demographic status, medical history, and BMI were collected at baseline in the home and in subsequent telephone interviews every 6 months. This study reports on 978 persons—those for whom complete data on primary dependent and independent variables were available. The study protocol was reviewed and approved by the University of Alabama at Birmingham Institutional Review Board.

Measurement: Dependent Variables

At each follow-up interview, participants were queried about hospitalizations during the previous 6 months. Self-reported dates and reasons for inpatient, overnight hospitalizations were subsequently classified by physician-researchers as nonsurgical or surgical. Surgical admissions included cardiac, thoracic, gastrointestinal, orthopedic, vascular, and urologic surgeries. All other overnight hospitalizations were classified as nonsurgical admissions, including those for procedures such as colonoscopies and angioplasties (29). Hospitalizations were not assessed for emergency versus nonemergency classification; and outpatient or emergency department visits were not included in these models. Nursing home admission was assessed by self- or proxy report with month and year of admission. All-cause mortality was verified through the National Death Index (30).

Measurement: Independent Variables

Nutritional risk.—Nutritional risk was calculated using questions based on the Nutrition Screening Initiative's DETERMINE checklist (31), which asks patients about having poor appetite, skipped meals, high alcohol use, oral health problems, financial difficulties, eating alone, polypharmacy, excessive weight changes (greater or less than 10 pounds), and shopping difficulties. Scores in the original measure range from 0 (lowest risk) to 21 (highest risk); however, in this study, one item, "I eat few fruits or vegetables, or milk products," was not ascertained, resulting in scores ranging from 0–19. Values of ≥6 indicate high nutritional risk; 3–5 indicate moderate risk, and 0–2 indicate low risk. The DETERMINE questions, the indicators used in this study to assess each item, and the scores assigned to each item are included in the Supplementary Appendix and are further described in a previous article by Locher and colleagues (8).

Body mass index.—BMI was assessed by obtaining height and weight of all participants who were able to stand. For participants unable to stand, height and weight were calculated from knee-height measures and arm circumference ($n = 89$). If knee height was unavailable, self-reported height and weight were used ($n = 37$). The correlation between self-reported and measured weight among the 180 participants who provided both was 0.98 (32). BMI was calculated from weight in kilograms divided by height in meters squared and was categorized according to the National Heart, Lung, and Blood Institute Clinical Guidelines as follows: underweight (<18.5), normal weight (18.5–24.9; referent category), overweight (25.0–29.9), class I obesity (30.0–34.9), class II obesity (35.0–39.9), and extreme or class III obesity (≥40) (33). Because so few participants were classified with class III obesity, they were combined with class II obesity for this analysis.

Measurement: Covariates

Social support.—An adapted version of the Arthritis Impact Measurement Scale for Social Support was used to assess general perceptions of social support (34). Items included "How often did you feel that your family or friends would be around if you needed assistance? How often did you feel that your family or friends were sensitive to your personal needs? How often did you feel that your family or friends were interested in helping you solve problems? How often did you feel that your family or friends understood how getting older has affected you?" Response categories were always (0), very often (1), sometimes (2), almost never (3), and never (4). Scores were summed, with a range of possible scores from 0–16. Higher scores indicate less perceived support.

Social isolation.—Social isolation was captured using a mobility assessment and rural versus urban living status (8). Mobility was measured using the University of Alabama at Birmingham Study of Aging's Independent Life-Space Assessment (35). The Independent Life-Space Assessment reflects the level of community mobility individuals achieve without help from another person or any equipment during the 4 weeks prior to the interview. Levels of independent life-space mobility include being limited to the room where one sleeps (0), limited to within one's dwelling (1), limited to the space just proximal to one's personal living space (2), limited to one's neighborhood (3), limited to one's town (4), and unlimited, getting outside one's town (5). Rural versus urban residence was defined for individuals based on the U.S. Census Bureau definition of the county where they lived.

Comorbidities.—A list of comorbidities used in the Charlson Comorbidity Index (36) were assessed and verified at baseline. Conditions were considered verified as present if the participant (i) used a medication for a self-reported condition, (ii) had a primary care physician confirm the condition on a questionnaire, or (iii) had the condition documented on a hospitalization or discharge summary within 3 years of the baseline assessment. A count of verified comorbidities was calculated without consideration for the severity of any of the conditions and used as a continuous variable.

Demographic measures.—Demographic measures included marital status, assessed by asking "Are you now married, or are you widowed, separated, divorced or have you never been married?" and was coded as either married or not married, based on current status; age, included as a continuous variable; race (black vs white); gender; and education, included as an indicator of socioeconomic status. Education was coded as an ordinal variable representing the highest level of education completed, categorized as sixth grade or less, between sixth and twelfth, high school graduate, or beyond high school.

Statistical Analysis

Descriptive statistics, including frequencies and measures of central tendency, were used to characterize the sample overall and by category of nutritional risk. Chi square tests were used to assess significance of item-wise differences in the nutritional risk questions by the nutritional risk categories. Chi square and ANOVA were also used to test for differences in continuous variables among nutritional risk categories. Cox proportional hazards models were used to assess the effects of nutritional risk and BMI on the risk of hospitalization, nursing home admission, and mortality among participants in the 8.5-year period after enrollment in the study. Analysis of hospitalization was repeated separately for nonsurgical and surgical hospitalizations. The proportional hazards assumption was tested using the proportionality test statement in the SAS 9.3 Proc PHREG command; the relative risk was proportional over the maximum 8.5 years of observation for each of the analyses. Bivariate Cox proportional hazards models were fit first to assess crude associations of nutritional risk and BMI with each outcome; then, fully adjusted models were fit that included nutritional risk, BMI, and all covariates. Hazard ratios and 95% confidence intervals were calculated from the models. Participants were censored at death, last known interview, or 8.5 years postenrollment. Significance was set at 5%. All analyses were conducted with SAS 9.3 (SAS, Cary, NC).

Sensitivity Analyses

Three sets of sensitivity analyses were conducted. First, because 70 participants had both a nonsurgical and surgical admissions, a sensitivity analysis was conducted to assess for changes in estimates when including those participants in only one of those categories, not allowing them to be present in both sets of models. Second, sensitivity analyses were conducted to assess the effects of including versus excluding cases where BMI was estimated from knee-height measures and arm circumference and from self-reported weight and height. Third, because the modified version of the DETERMINE checklist omits one question, a sensitivity analysis was conducted with rescaled, proportional cutoffs for high, moderate, and low nutritional risks. There were no differences in the significance, direction, or magnitude of the results; therefore, we present the models that included the original DETERMINE checklist risk categories.

Results

Item-wise descriptions of the nutritional risk questions are presented in Table 1 both for the full sample and by nutritional risk categories; 443 (45.2%) persons had low nutritional risk, 333 (33.9%) had moderate nutritional risk, and 205 (20.9%) had high nutritional risk. Differences in responses between nutritional risk categories were assessed using Chi square tests. Persons in the high nutritional risk category reported higher proportions of having a poor appetite, skipped meals, oral health problems, financial difficulty, eating alone, excessive weight changes, and shopping limitations.

Descriptive statistics for the independent and dependent variables are presented in Table 2. BMI categories were composed of the following: 21 (2.1%) underweight; 288 (29.4%) normal weight; 369 (37.6%) overweight; 200 (20.5%) class I obesity; and 103 (10.4%) classes II and III obesity. Those at high nutritional risk were more likely to have low BMIs ($p = .004$), and those with low nutritional risk were more likely to be overweight ($p = .005$).

Hospital admission occurred at least once for 495 (50.6%) persons over 8.5 years. Furthermore, 430 (44%) of the participants experienced at least one nonsurgical admission and 135 (13.8%) experienced at least one surgical admission. Additionally, 74 (7.6%) of the participants experienced a nursing home admission, and 382 (39%) died during the study.

Tables 3 and 4 present results from the Cox proportional hazards models.

Nutritional Risk

High nutritional risk was associated with 51% increased risk of all-cause hospitalization (hazard ratio = 1.51; 95% confidence interval: 1.14–2.00) in adjusted models over 8.5 years. This increased risk was similar for nonsurgical hospitalizations (hazard ratio = 1.50; 95% confidence interval: 1.11–2.01); however, there was no association between nutritional risk and surgical admissions (Table 3). High nutritional risk was significantly associated with nursing home admission, but only in crude analysis. When adjusted, the association weakened and was no longer significant. Independent life-space was the characteristic that, when adjusted for, accounted for the loss of association. Nutritional risk had a nonlinear association with mortality, that is, moderate and high nutritional risk were associated with comparable increased risks of mortality and twofold increased risks in crude analysis. This association was reduced to 54% and 24% greater risk for moderate and high nutritional risk, respectively, in adjusted analysis and was significant only for moderate nutritional risk in the adjusted model (Table 4).

Body Mass Index

BMI was not associated with risk of all-cause, nonsurgical, or surgical hospitalizations (Table 3). However, underweight persons were 1.85 times more likely to die over the course of the study in the crude analysis. When adjusted, the association weakened and lost significance; independent life-space accounted for the loss in association (Table 4).

Conclusion

Our findings demonstrate that nutritional risk was prospectively associated with all-cause and nonsurgical hospitalizations and with nursing home admission and mortality in unadjusted models. After adjusting for other possible risk factors, the association between high nutritional risk and all-cause and nonsurgical hospitalizations remained significant. The association between moderate nutritional risk and mortality also remained significant.

These findings are consistent with previous work showing that nutritional risk, as measured by the Mini-Nutritional Assessment, is associated with hospitalization, nursing home admission, and mortality, as well as emergency department use, over 1 year of follow-up (10). Nutritional risk may be part of the disablement process whereby individuals become frail, dependent on health care resources, including hospitalization and nursing home

Table 1. Item-wise Risk Score Results by Nutritional Risk Category

		DETERMINE Risk Assessment			
	Total (978/100%)	Low (442/45.2%)	Moderate (333/34.1%)	High (203/20.8%)	*p* Value
Poor appetite	165/16.9%	6/1.4%	63/18.9%	96/47.3%	<.001
Skipped meals	29/3.0%	0/0.0%	15/4.5%	14/6.9%	<.001
High alcohol use	34/3.5%	4/0.9%	19/5.7%	11/5.4%	<.001
Oral health problems	129/13.2%	9/2.0%	42/12.6%	78/38.4%	<.001
Financial difficulty	124/12.7%	0/0.0%	20/6.0%	104/51.2%	<.001
Eats alone	312/31.9%	104/23.5%	111/33.3%	97/48.8%	<.001
Polypharmacy	808/82.6%	330/74.7%	294/88.3%	184/90.6%	0.952
Excessive weight change	283/28.9%	29/6.6%	135/40.5%	119/58.6%	<.001
Shopping limitations	264/27.0%	5/1.1%	118/35.4%	141/69.4%	<.001

Table 2. Characteristics of Participants in the University of Alabama at Birmingham Study of Aging ($n = 978$)

	DETERMINE Risk Assessment				Total	
	Low (442/45.2%)	Moderate (333/34.1%)	High (203/20.8%)	*p* Value*	978	
Independent variables (baseline)						
BMI						
<18.5	2/0.5%	11/3.3%	8/3.9%	.004	21	2.2%
18.5–24.9	136/30.8%	87/26.1%	64/31.5%	.278	287	29.4%
25.0–29.9	185/41.9%	125/37.5%	58/28.6%	.005	368	37.6%
30.0–34.9	80/18.1%	75/22.5%	45/21.2%	.253	200	20.5%
≥35	39/8.8%	35/10.5%	28/13.8%	.159	102	10.4%
Independent life-space	4.3/1.3 SD	3.1/1.9 SD	2.2/2.0 SD	<.001	3.4	1.9 SD
Marital status (married)	281/63.4%	159/47.8%	62/30.5%	<.001	502	51.3%
Social support	5.8/2.7 SD	6.2/3.3 SD	6.3/3.3 SD	.085	6.1	3.0 SD
Comorbidity score	2/1.4 SD	2.8/1.7 SD	3/1.8 SD	<.001	2.5	1.7 SD
Age (y)	74/6.3 SD	75.9/6.8 SD	77.1/7.1 SD	<.001	75.3	6.7 SD
Rural residence	200/45.3%	178/53.5%	126/62.1%	<.001	504	51.5%
Race (black)	186/42.1%	164/49.3%	134/66.0%	<.001	484	49.5%
Gender (female)	196/44.3%	49.3/14.8%	123/60.6%	<.001	483	49.4%
Education						
Less than sixth grade	63/14.3%	65/19.5%	70/34.5%	<.001	198	20.2%
Sixth to twelfth grade	90/20.4%	115/34.5%	79/38.9%		287	29.3%
Completed high school	193/43.7%	104/31.2%	37/18.2%		334	34.2%
Beyond high school	96/21.7%	49/14.7%	17/8.4%		162	16.6%
Dependent variables (follow-up)						
All-cause hospital admissions	226/51.1%	156/46.9%	113/55.7%	.167	495	50.6%
First nonsurgical admission	189/42.8%	136/40.8%	105/51.7%	.038	430	44.0%
First surgical admission	66/14.9%	45/13.5%	24/11.8%	.558	135	13.8%
Nursing home admission	21/4.8%	24/7.2%	29/14.3%	<.001	74	7.6%
Death	126/28.5%	157/47.2%	99/48.8%	<.001	382	39.0%

*Chi Square or ANOVA tests of significance between DETERMINE Risk Assessment Groups.

Table 3. Risk of Hospitalization (all-cause, nonsurgical, and surgical) Over 8.5 Years in the University of Alabama at Birmingham Study of Aging ($n = 978$)

	All-Cause Hospital Admission			Nonsurgical Admission			Surgical Admission		
	(Crude)	(Adjusted)†		(Crude)	(Adjusted)†		(Crude)	(Adjusted)†	
Exposure	HR	HR	CI	HR	HR	CI	HR	HR	CI
Nutritional risk									
Low	—	—	—	—	—	—	—	—	—
Moderate	1.17	1.12	0.90–1.40	1.23	1.10	0.86–1.40	1.01	1.19	0.79–1.80
High	1.53***	1.51**	1.14–2.00	1.72***	1.50**	1.11–2.01	0.90	1.11	0.64–1.94
BMI									
≤18.5^	0.57	0.58	0.26–1.33	0.72	0.72	0.31–1.64	0.32	0.31	0.04–2.36
>18.5, ≤25	—	—	—	—	—	—	—	—	—
>25, <30^	0.96	1.05	0.84–1.31	0.93	1.04	0.82–1.33	1.24	1.26	0.81–1.86
>30, <35^	0.90	0.98	0.75–1.28	0.89	0.98	0.74–1.31	1.04	1.08	0.63–1.86
≥35^	0.97	0.96	0.68–1.35	0.95	0.92	0.64–1.33	1.07	1.12	0.57–2.19

Notes: HR = hazard ratio; CI = confidence interval.
$^*p < .05$, $^{**}p < .01$, $^{***}p < .001$.
†Adjusted for independent life-space, marital status, social support, comorbidity score, age, rural versus urban, race, gender, education, and previous surgical and non-surgical hospitalization for the second and third sets of models.

admission, and ultimately die. The authors speculate that the nonsignificant and negative association between nutritional risk and surgical hospitalizations is because older adults are more thoroughly screened before surgical procedures. Those with higher nutritional risk may have conditions that preclude them from being approved for surgery for elective surgeries.

The Life-Space Assessment, a comprehensive measure of mobility that is broadly associated with and an indicator of general well-being, was the single factor that accounted for the loss of significance in the relationship between nutritional risk and nursing home admission; between high nutritional risk and mortality; and between underweight BMI and mortality. This may point to the importance of

Table 4. Risk of Nursing Home Admission and Mortality Over 8.5 Years in the University of Alabama at Birmingham Study of Aging (*n* = 978)

	Nursing Home Admission			Mortality		
	(Crude)	(Adjusted)†		(Crude)	(Adjusted)†	
Exposure	HR	HR	CI	HR	HR	CI
Nutritional risk						
Low	—	—	—	—	—	—
Moderate	1.97*	1.16	0.61–2.19	2.12***	1.54**	1.19–1.99
High	4.04***	1.46	0.72–2.95	2.24***	1.24	0.90–1.70
BMI						
≤18.5^	0.66	0.62	0.08–4.67	1.85*	1.57	0.88–2.82
>18.5, ≤25	—	—	—	—	—	—
>25, <30^	0.71	1.10	0.08–4.66	0.85	0.94	0.73–1.21
>30, <35^	0.80	1.04	0.51–2.10	0.78	0.80	0.58–1.09
≥35^	0.93	1.13	0.48–2.65	0.80	0.73	0.49–1.09

Notes: HR = hazard ratio; CI = confidence interval.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.
†Adjusted for independent life-space, marital status, social support, comorbidity score, age, rural versus urban, race, gender, and education.

using such measures of mobility, in addition to nutritional risk measures, in clinical care settings as risk predictors. However, more work is needed to determine how these factors interact and could be used in tandem with each other.

Additionally, persons who were underweight, determined by BMI had higher rates of mortality over the course of the study in the crude analysis. In both crude and adjusted models, higher levels of obesity were protective against mortality, though not statistically significant. These findings are consistent with other work in this area and may indicate that obese individuals have greater reserves and stores of nutrients from which to draw when they become ill (10,11). However, some research indicates that while obesity's relative risk in older adulthood declines, its absolute effect is still harmful (37). More work is needed to determine what the effects of obesity are with advanced age and with respect to heath services utilization.

A limitation of this study is that it is observational, and there may be unobserved factors that influence both health service utilization and mortality. Additionally, the generalizability of these findings is limited by the use of data from individuals in the Southeastern region of the United States. The numbers of persons with a low BMI were small, limiting our ability to detect a difference in outcomes based on this predictor. Future research in a larger sample might replicate this approach and have stronger power to detect an effect of low BMI on adverse outcomes. Another limitation is that omission of one question in the DETERMINE checklist with 2 points in value may result in an underestimate of nutritional risk; however, the point estimates in the results may underestimate—or conservatively estimate—the true effect of nutritional risk on the outcomes. Also, as in all studies that use BMI, it may be that distribution of body fat, specifically intra-abdominal fat, and/or physical fitness are better predictors of outcomes. Future work might investigate these hypothesized associations with more precise measures.

Strengths and Implications

Older adults comprise an increasing proportion of the population who disproportionately experience functional decline and increased health services utilization. Identification of modifiable risk factors that may impede healthy aging processes and increase the use of health services is important. This study points to one such modifiable factor—nutritional risk. Many programs targeting older adults with nutritional needs already exist, including the federally funded Older Americans Act services such as home-delivered and congregate meals, state-level programs for nutritionally at-risk older adults, and Medicare policies that support nutrition counseling for diabetes and renal disease (38,39). The efficiency of these programs and their ability to curtail nutritional risk should be examined in future work.

Additionally, these findings highlight the potential value of routine nutritional screening of all older adults. The DETERMINE checklist or a similar tool may be used in community-based settings and in primary care clinical settings to inform physicians, nurses, dietitians, social workers, or other practitioners of patients' or clients' need for assistance with their nutritional health and related physical or social factors.

Future Work

This study raises important questions for future work on the mechanisms by which nutritional risk and BMI affect older adults' health services utilization and death. More research is needed to assess if nutritional intake is actually in the pathway between risk assessments, like the DETERMINE checklist, and health-related outcomes. Furthermore, this study points to the need for more work with larger samples that can allow for a broader range of subgroups of older adults characterized by age, life-space, physical or social activity levels, activities of daily living status, and cognitive impairment to evaluate among which subgroups nutritional risk is most important.

Also because costs of care are a growing concern, future work might examine specific costs associated with increased nutritional risk and BMI. Future work may also focus on other valid methods for assessing nutritional risk and understanding what health-related outcomes these assessments predict. Finally, because there is a growing body of work, including this article, showing that nutritional factors matter for older adults' health and health services–related outcomes, there may be an increased need for innovative, cost-effective strategies directed toward addressing nutritional risk for older adults living in the community. Increased screening may help in this endeavor.

Supplementary Material

Supplementary material can be found at: http://biomedgerontology.oxfordjournals.org/

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