Community-Dwelling Adults at Nutrition Risk: Characteristics in Relation to the Consumption of Oral Nutritional Supplements

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Abstract

Purpose: Nutrition risk and utilization rate of simple but effective interventions such as oral nutritional supplementation (ONS) in community settings in the United States, particularly among older adults, has received little emphasis. We conducted a cross-sectional study of community-dwelling adults ≥55 years of age and living independently to assess their risk of poor nutrition and characteristics in relation to ONS consumption. **Methods:** Demographic characteristics, activities of daily living (ADL), and health care resource utilization in the past 6 months were also collected via telephone survey. Nutrition risk was assessed with the abridged Patient-Generated Subjective Global Assessment (abPG-SGA) and the DETERMINE Checklist. A logistic regression model tested possible predictors of ONS use. **Results:** Of 1001 participants surveyed, 996 provided data on ONS use and 11% (n = 114) reported consuming ONS during the past 6 months. ONS users were more likely to be at high nutrition risk than nonusers based on both abPG-SGA (43% vs 24%, $P < .001$) and DETERMINE Checklist (68% vs 48%, $P < .001$) scores. ONS users reported less functional independence based on ADL scores (86% vs 92%, $P = .03$), taking ≥3 medications/day (77% vs 53%, $P < .001$), and utilizing more health care services. Higher nutrition risk (per abPG-SGA), lower body mass index, hospitalization in the past 6 months, and ≥3 medications/day were each independently associated with ONS use ($P < .05$). **Conclusions:** Although one in four, urban community-dwelling adults (≥55 years of age) were classified as at high nutrition risk in our study, only 11% reported consuming ONS—a simple and effective nutrition intervention. Efforts to improve identification of nutrition risk and implement ONS interventions could benefit nutritionally vulnerable, community-dwelling adults.

Keywords

nutrition risk, community-dwelling adults, oral nutritional supplements, minority health

Introduction

Research on malnutrition in hospitals and other acute-care settings is long-standing.[1,2] However, in spite of efforts to increase awareness of the importance of nutrition screening and possible intervention, rates of malnutrition in the United States remain high and up to 50% of adults are malnourished when hospitalized or experience a further decline in their nutrition status during hospitalization.[3-6] Effective nutrition interventions are intended to improve nutrition status and treat or prevent malnutrition as well as reduce medical treatment costs and help relieve some of the financial burden imposed by malnutrition on patients and healthcare systems.[7,8]

Malnutrition has traditionally been studied in the institutional setting, which offers an accessible population and the ability to collect and record data, consistently. While institutional settings are often the source of nutrition-related data in the United States, researchers from other countries study malnutrition/risk and associated risk factors in community settings. For example, an 11-year longitudinal study in Sweden found that nearly 25% of community-dwelling older adults were at risk of malnutrition.[9] A study of elderly adults entering the hospital for major surgery in Belgium

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found that the risk of malnutrition increased with age, reaching 66% for those aged older than 70 years.[10] In a meta-analysis of malnutrition in European adults ≥65 years of age, prevalence rates of malnutrition risk were reported for 3 settings: hospitals, residential care, and the community.[11] Pooled prevalence rates of high malnutrition risk for these 3 settings were 28.0%, 17.5%, and 8.5%, respectively.

There has been less emphasis on nutrition risk and implementation of simple but effective interventions such as oral nutritional supplementation (ONS) utilization in community settings in the United States, particularly among the older adult population.[12,13] The goals of the present study were to (1) explore the utilization rate of ONS use among community-dwelling adults ≥55 years of age, (2) describe characteristics of ONS users versus non-ONS users, and (3) understand predictors of ONS consumption. We hypothesized that ONS usage will be greater for adults at high versus low nutrition risk.

Methods

A detailed description of the study methods has been published previously.[12,13] Briefly, this was a cross-sectional study conducted in Chicago, Illinois, United States, an urban environment rich in ethnic variability and health disparities.[14] The study was led by the Survey Research Laboratory at the University of Illinois at Chicago. Data were collected by the Interviewing Service of America (ISA, Van Nuys, California). Interviews were conducted by English- and Spanish-speaking, trained ISA interviewers over the course of four months in 2017. The sample frame included both listed and random-digit-dial (RDD) phone numbers (cell and landline). For additional details, see Sheean et al[12] and McKeever et al.[13]

Participants with a land or cell line with a Chicago area code and residing within the city's limits were eligible based on self-affirmation that they were age 55 years or older; non-Hispanic white, non-Hispanic black, or Hispanic; English- or Spanish-speakers; and willing to participate in the study. To maximize the likelihood of capturing various aspects of nutrition risk via telephone survey, we used two tools to classify participants. Neither tool necessitated in-person assessment of physical measures. The first was the abridged Patient-Generated Subjective Global Assessment (abPG-SGA), which is often used in the oncology setting.[15] The abPG-SGA is relevant to the current study because it includes specific nutrition-impact symptoms (eg, anorexia, constipation, dry mouth) that are clinically relevant, not captured in other commonly used screening tools, such as the MUST, DETERMINE, or SNAQ65+ and easily assessed over the phone.[16-18] Additionally, abPG-SGA was chosen over the SNAQ65+ due to the targeted age group for our study population being less than 65 years of age. A score greater than 6 on the abPG-SGA indicates high nutrition risk, while a score less than 6 indicates a low risk.

The second tool used to assess nutrition risk was the DETERMINE Checklist, which calculates a nutrition risk score based on "yes/no" answers to questions related to nutritional health in older adults. While originally tested in adults >70 years of age, it has been validated for use in adults as young as age 60 years.[19] Additionally, the checklist was not designed as a stand-alone screening tool and its main focus is to offer to clinicians important information about the unique dietary and nutrition education needs of older adults.[20,21] Scores range from 0 to 21, with 0 to 2 considered good, 3 to 5 as moderate nutrition risk, and ≥6 as high nutrition risk. The DETERMINE Checklist questions utilized in this study have been previously published.[13,17]

We asked respondents to describe themselves as "dependent" (needing supervision, direction, personal assistance, or total care) or "independent" (not needing supervision, direction, or personal assistance) in performing 6 activities of daily living (ADLs).[22] We also asked if they "ate alone most of the time" as a proxy for social isolation.

Respondents were asked a set of questions related to their utilization of health care services in the past 6 months, including visits to the emergency room (ER), hospital, admission to skilled nursing and/or inpatient rehabilitation facilities, and the receipt of home care services. We asked if participants "took 3 or more different prescribed or over-the-counter medications per day" as a proxy for polypharmacy. This wording is supported by the DETERMINE Checklist.[20]

Participants were asked whether they had consumed ONS in the past 6 months. We described ONS as supplements that typically come in a liquid form (as a beverage) and explained that people may drink these when their diet alone cannot meet their daily calorie, protein, and other nutrient needs. We also mentioned that people may drink ONS when they have trouble chewing, when they do not have the appetite or time to eat or cook, or to supplement their diet with extra nutrition. We told respondents that ONS are found in the pharmacy area of the grocery store or in a special section at the drug store. We shared examples of ONS (eg, Ensure, Glucerna, etc) and noted that there are other liquid beverages, which are not considered ONS (eg, yogurt smoothies, protein shakes, etc).

Respondents who reported consuming ONS in the past 6 months were compared with those who did not on a variety of demographic, nutrition risk, ADL, and health care utilization variables using 2-sample *t* tests for continuous variables, tests for row mean score difference for ordinal variables, and chi-square or Fisher's exact tests for other categorical variables. A logistic regression model applying stepwise selection was used to explore independent predictors of ONS use. Records with missing values for any of the covariates were excluded from the analysis. Covariates were tested for collinearity, with a Pearson correlation coefficient >0.8, tolerance <0.1, or a variance inflation factor >10 considered to be indicators of multicollinearity. All

Table 1. Demographic Characteristics.

| Variable[a] | ONS, N = 114 (11%) | | No ONS, N = 882 (89%) | | |
	n	Mean ± SD or n (%)	n	Mean ± SD or n (%)	P[b]
Age, years	111	67.9 ± 7.2	836	66.8 ± 6.3	.08
Sex	114		882		.053
Male		44 (39)		262 (30)	
Female		70 (61)		620 (70)	
Race	114		882		.67
White		39 (34)		333 (38)	
Black		42 (37)		324 (37)	
Hispanic		33 (29)		225 (26)	
Education	104		802		.12
Not a high school (HS) graduate		22 (21)		128 (16)	
HS graduate or GED		17 (16)		147 (18)	
Some college		33 (32)		205 (26)	
College graduate		32 (31)		322 (40)	
BMI, kg/m^2	108	28.8 ± 6.7	826	29.5 ± 6.7	.31
BMI categories	108		826		.50
Underweight (<18.5)		2 (2)		5 (1)	
Normal weight (18.5-24.9)		33 (31)		211 (26)	
Overweight (25.0-29.9)		30 (28)		297 (36)	
Obese (≥30)		43 (40)		313 (38)	

Abbreviations: BMI, body mass index; GED, General Equivalence Diploma; ONS, oral nutritional supplementation; SD, standard deviation.
[a]Responses of "don't know" or "refused" were treated as missing and excluded from the denominator. Five participants who did not know whether they had consumed ONS in the past 6 months were excluded from the analysis.
[b]Tests for differences between participants who consumed and did not consume ONS: *t* tests with pooled variance for age and BMI, test for row mean score difference for ordinal variables (education and BMI categories), and chi-square tests for other categorical variables.

statistical analyses were conducted using SAS (version 9.4); a *P* value <.05 denoted statistical significance.

Results

From the 64 445 phone numbers available in the ISA database, 7064 contacts were made. A total of 1166 respondents were eligible for the study and 1001 completed the interview, reflecting an 85.8% response rate. Of the 1001 participants surveyed, 996 (99.5%) participants provided data on ONS use in the past 6 months, which was reported to be 11% (114) and will form our analytic sample moving forward. High nutrition risk was confirmed in 26% (n = 261) of the respondents according to their abPG-SGA score.

There were few demographic differences between ONS users and nonusers in our sample. The average age of ONS users was 67.9 ± 7.2 years, which was slightly older than the average age of non-ONS users (66.8 ± 6.3 years), though the difference was not statistically significant (*P* = .08). ONS users were somewhat less likely to be female than the nonusers (61% vs 70%, *P* = .053). Race, education, and body mass index (BMI) did not differ significantly between ONS users and nonusers in our sample (Table 1).

The average amount of ONS consumed by those able to quantify their intake (n = 103/114) was 4.7 ± 4.4 cans or bottles per week. Among ONS users, 37% had received a recommendation to use it from their primary care physician or a specialist.

Comparing ONS users to nonusers, ONS users were more likely to be at high nutrition risk based on both abPG-SGA (43% vs 24%, *P* < .001) and DETERMINE (68% vs 48%, *P* < .001) scores (Table 2). ONS users were also less likely to report functioning independently based on all 6 ADLs (86% vs 92%, *P* = .03). In terms of health care utilization, ONS users were significantly more likely to have reported an ER visit, a hospital admission, a skilled nursing facility admission, or receipt of home health care services than nonusers (all *P* values <.05, Table 2). They were also significantly more likely to take ≥3 medications/day (77% vs 53%, *P* < .001), a proxy measure we use to assess the potential risk of polypharmacy.

We estimated a logistic regression model to explore the impact of each predictor on ONS use. Results revealed (Table 3) a higher nutrition risk score (per abPG-SGA) was significantly associated with ONS use (odds ratio [OR] = 2.07, 95% confidence interval [CI] =1.26-3.42; *P* = .004), as was taking ≥3 medications/day (OR = 2.47, 95% CI = 1.41-4.32; *P* = .002). Lower BMI and having been hospitalized in the past 6 months were also independently significantly (*P* < .05) associated with ONS use (OR = 0.95, 95% CI = 0.92-0.99 and OR = 2.09, 95% CI = 1.12-3.92,

Table 2. Nutrition Risk, Activities of Daily Living, and Health Care Utilization.

Variable[a]	ONS, N = 114		No ONS, N = 882		P[b]
	n	Mean ± SD or n (%)	n	Mean ± SD or n (%)	
Nutrition risk, abPG-SGA[c]	114		882		<.0001
Low risk (<6)		65 (57)		670 (76)	
High risk (≥6)		49 (43)		212 (24)	
Nutrition health score, DETERMINE[d]	114		882		<.0001
Good (0-2)		10 (9)		203 (23)	
Moderate risk (3-5)		26 (23)		259 (29)	
High risk (≥6)		78 (68)		420 (48)	
Independence with ADLs					
Bathing	114	107 (94)	880	853 (97)	.10
Dressing	114	108 (95)	882	861 (98)	.11
Toileting	114	113 (99)	882	866 (98)	.71
Transferring	114	108 (95)	882	853 (97)	.28
Continence	114	107 (94)	872	831 (95)	.49
Feeding	114	113 (99)	880	868 (99)	1.00
All 6 ADLs	114	98 (86)	869	800 (92)	.03
Health care utilization					
ER visit	114	33 (29)	879	139 (16)	.0005
Hospital admission	114	31 (27)	879	96 (11)	<.0001
SNF admission	114	5 (4)	879	12 (1)	.04
Home care services	114	22 (19)	880	82 (9)	.001
Eat alone most of the time	113	62 (55)	879	416 (47)	.13
Take ≥3 medications/day	114	88 (77)	878	469 (53)	<.0001

Abbreviations: abPG-SGA, abridged Patient-Generated Subjective Global Assessment; ADLs, activities of daily living; ER, emergency room; ONS, oral nutritional supplementation; SD, standard deviation; SNF, skilled nursing facility.

[a]Responses of "don't know" or "refused" were treated as missing and excluded from the denominator. Five participants who did not know whether they had consumed ONS in the past 6 months were excluded from the analysis.

[b]Tests for differences between participants who consumed and did not consume ONS: test for row mean score difference for ordinal variables (Nutrition Health Score), Fisher's exact test for individual ADLs and SNF admission, and chi-square tests for other categorical variables.

[c]Nutrition risk as defined by the abPG-SGA with scores <6 points = low risk and scores ≥6 points = high risk.

[d]Based on the DETERMINE checklist developed by the Nutrition Screening Initiative.

respectively). There were no indications of multicollinearity; the lowest tolerance value was 0.6, and the highest variance inflation factor was 1.6.

Discussion

Our study found that 1 in 4 (26%) urban community-dwelling adults (≥55 years of age) was at nutrition risk. The overall ONS consumption rate in the past 6 months among our sample was 11%, while participants classified as high nutrition risk were twice more likely to consume ONS than participants classified as low nutrition risk.

Preventing and treating malnutrition or poor nutrition in older adults is a public health priority. In comparison to adequately nourished patients, malnourished patients are at increased risk of death and have fewer quality-adjusted life years.[23] Patients with malnutrition are also more likely to have longer hospital stays and higher readmission rates.[24,25] The ONS users in our study were significantly more likely to have reported an ER visit, hospital admission, skilled nursing facility admission, or home

health care services than nonusers and significantly more likely to take ≥3 medications/day (a proxy for risk of polypharmacy).

Our results build on a separate analysis of the same group of community-dwelling older adults.[13] In that study, McKeever and colleagues evaluated factors predictive of "inadequate dietary intake" (≤2 meals/day) and/or "poor diet quality" (consumption of few fruits, vegetables, or milk products). Their goal was to identify factors that could help predict which participants would benefit most from ONS. The significant, independent predictors of likely benefit from ONS included those who reported social isolation, low income, less educational attainment, heavy daily alcohol intake (≥3 drinks/day), compromised ADLs, and polypharmacy (≥3 medications/day). Recent data found that malnutrition disproportionately affects people with lower incomes and those aged 65 years and older.[24,25] The findings are consistent with the present study. These findings are helping define factors that can be targeted for improved nutrition assessments and interventions, both of which can be implemented in primary care and community health settings. In our study, 37% of ONS users had

Table 3. Logistic Regression Analysis for Predicting Consumption of Oral Nutritional Supplements (ONS) Use (N = 807)[a]

	OR	95% CI	b	P
Intercept		—	−2.925	.04
Nutrition risk (ref = low risk)[b]	2.07	1.26-3.42	0.729	.004
Moderate or high risk Nutrition Health Score (ref = good)[c]	2.14	0.94-4.88	0.762	.07
Age, years	1.01	0.98-1.05	0.011	.54
Female (ref = male)	0.83	0.52-1.34	−0.185	.45
Race (ref = white)				.30
Black	0.76	0.43-1.37	−0.269	.37
Hispanic	1.25	0.65-2.39	0.220	.51
Education (ref = college graduate)				.30
Not HS graduate	1.10	0.52-2.35	0.098	.80
HS graduate/GED	0.72	0.35-1.48	−0.330	.37
Some college	1.40	0.78-2.53	0.339	.26
BMI, kg/m^2	0.95	0.92-0.99	−0.049	.01
Dependent for ≥1 ADL (ref = independent for all 6 ADLs)	1.10	0.48-2.52	0.096	.82
ER visit (ref = none)	1.19	0.65-2.17	0.174	.57
Hospital admission (ref = none)	2.09	1.12-3.92	0.739	.02
Home care services (ref = none)	1.20	0.61-2.37	0.185	.59
Eat alone most of the time (ref = no)	0.93	0.58-1.47	−0.077	.75
Take ≥3 medications/day (ref = no)	2.47	1.41-4.32	0.903	.002

Abbreviations: ADLs, activities of daily living; BMI, body mass index; CI, confidence internal; ER, emergency room; GED, General Equivalency Diploma; HS, high school; ONS, oral nutritional supplementation; OR, odds ratio; ref, referent group.
[a]Results from a logistic regression model applying stepwise selection predicting the use of ONS in the past 6 months. Some observations were excluded from the model due to missing data for ONS or covariates.
[b]From the abridged Patient-Generated Subjective Global Assessment.
[c]From DETERMINE Checklist.

received a recommendation for ONS use from a primary care physician or specialist.

Quality improvement programs (QIPs) focused on nutrition risk and malnutrition have been shown to alleviate the burden of malnutrition in the hospital setting, to ameliorate negative outcomes for patients with or at risk of malnutrition,[26-28] and to create potential cost-savings by reducing both 30-day readmissions and length of hospital stays.[29] Riley et al[26] reported on a nutrition-focused QIP conducted in a home health agency (HHA) setting. Their study included over 1,500 at-risk/malnourished patients screened via the Nutritional Health Screen tool (utilized by Medicare-certified HHAs). Hospitalization rates and healthcare costs incurred within 90 days of HHA enrollment were substantially reduced in comparison to both historic and concurrent control groups, with an average per-patient savings from reduced health care resource utilization of $1500 (total savings was estimated at over $2.3 million).

Sriram et al[28] published results of a separate nutrition-focused QIP that included nutrition screening and early provision of ONS to over 1200 inpatients determined to be at-risk/malnourished at admission via the Malnutrition Screening Tool. They found an approximately 4% reduction in 30-day readmission rates (relative risk reduction [RRR] of 19.5%), and a reduction in hospital length of stay of nearly 2 days post-QIP compared with the pre-QIP control group (25% RRR). These improvements resulted in cost-savings of over $4.8 million total or net savings of over $3800.[29] The findings of both hospital and home health-based nutrition QIPs provide important insights on potential actions that clinicians and administrators of primary care and community health clinics can undertake to optimize nutrition care for their patient population. Such initiatives included nutrition screening, patient education, ONS supplementation, and follow up mechanisms to promote patient compliance with recommended nutrition regimens.[26-29]

Although malnutrition is commonly associated with undernutrition, it is important to note that the average BMI of our study population was 29.3 kg/m^2, thus confirming that many community-dwelling adults at nutrition risk are either overweight or obese. Overnutrition is a major public health priority in the United States since more than 1 in 3 adults is overweight or obese.[30] However, nutrition interventions including ONS have been proven effective in the treatment of overnutrition and assisting patients with their weight management goals (similarly to the underweight patient populations). More specifically, ONS that have high-protein and low-caloric formulations for weight loss or diabetes-specific formulations for control of blood glucose have been found to improve the health outcomes of diabetes patients (eg, physical functioning, general health, etc).[31-33]

This study has several limitations. Based on our cross-sectional survey design, we were unable to infer causality from any of the assessed associations. We also chose a sample frame based on telephone access, so that anyone without a cell phone or landline was excluded from our survey. This may have led to selection bias and resulted in a less representative sampling of the population than we intended. While our response rate was good, about 15% of our sample frame did not respond and it is possible that the nonresponders differed from respondents in meaningful ways. Recall bias is another limitation of this study as ONS use and healthcare utilization were self-reported by an older population (mean age of 67.4 years) who may experience poor or incomplete memory recall. Therefore, future studies should employ study designs that can help reduce respondent's recall bias. Additionally, we did not collect information regarding the type of ONS products consumed and patterns. Finally, information around other factors that could have affected ONS use, such as certain underlying health conditions that were not collected in the survey were not addressed as residual confounders and should be accounted in future research. Despite these limitations, we surveyed a large sample of adults ≥55 years of age, multiethnic, urban, community-dwelling individuals and combined the results of 2 tools (abPG-SGA and the DETERMINE Checklist) to assess nutrition risk. Our results support the importance of implementing nutrition-related programs to address the nutrition needs of community-dwelling adults.

Conclusions

Because malnutrition is both underrecognized and undertreated, there is an urgent need for more effective screening processes to identify and assess at-risk patients across different care settings—not just in hospitals.[13,34] To this end, an international group of experts (The Global Leadership Initiative on Malnutrition, or GLIM) has been working toward the goal of defining and promoting an agreed-upon set of criteria to diagnose malnutrition.[35] The GLIM has proposed a scale that is derived from readily available, validated tools using phenotypic and etiologic criteria. Although use of this scale has not yet been validated or become common practice, it represents a logical and simple advancement for the identification of patients at risk of malnutrition. It also allows for grading of the severity of the phenotypic criteria (eg, low body mass index, nonvolitional weight loss, or reduced muscle mass) and suggests that etiologic criteria (eg, reduced food intake or assimilation, and inflammation or disease burden) can be used to help guide nutrition-related interventions. Adoption of such an approach requires global dedication to continuously educating healthcare professionals on the importance of preventing and treating malnutrition across different settings of care.

In our study of urban community-dwellers aged 55 years and older, only 11% reported ONS consumption even though more than 25% were at high risk for malnutrition. We found that the adults most likely to use ONS were those who had functional limitations and health conditions requiring multiple medications. This suggests that wider use of ONS, in patients at nutrition risk, could yield positive health outcomes. Greater efforts are needed to identify older adults at nutrition risk in community settings and outpatient clinics, paired with methods to implement effective nutrition education and ONS recommendations. Future research studies should focus on further exploring effective strategies to optimize how community-dwellers get screened, educated regarding different nutrition risk factors including weight management techniques (weight loss or gain), and offer nutrition interventions that can improve their health and economic outcomes.

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References

1. Kirkland LL, Kashiwagi DT, Brantley S, Scheurer D, Varkey P. Nutrition in the hospitalized patient. *J Hosp Med*. 2013;8:52-58. doi:10.1002/jhm.1969
2. Singh H, Watt K, Veitch R, Cantor M, Duerksen DR. Malnutrition is prevalent in hospitalized medical patients: are house staff identifying the malnourished patient? *Nutrition*. 2006;22:350-354. doi:10.1016/j.nut.2005.08.009
3. Norman K, Pichard C, Lochs H, Pirlich M. Prognostic impact of disease-related malnutrition. *Clin Nutr*. 2008;27:5-15. doi:10.1016/j.clnu.2007.10.007
4. McWhirter JP, Pennington CR. Incidence and recognition of malnutrition in hospital. *BMJ*. 1994;308:945-948. doi:10.1136/bmj.308.6934.945

5. Tappenden KA, Quatrara B, Parkhurst ML, Malone AM, Fanjiang G, Ziegler TR. Critical role of nutrition in improving quality of care: an interdisciplinary call to action to address adult hospital malnutrition. *J Acad Nutr Diet*. 2013;113:1219-1237. doi:10.1016/j.jand.2013.05.015

6. Braunschweig C, Gomez S, Sheean PM. Impact of declines in nutritional status on outcomes in adult patients hospitalized for more than 7 days. *J Am Diet Assoc*. 2000;100:1316-1322. doi:10.1016/S0002-8223(00)00373-4

7. Philipson TJ, Snider JT, Lakdawalla DN, Stryckman B, Goldman DP. Impact of oral nutritional supplementation on hospital outcomes. *Am J Manag Care*. 2013;19:121-128.

8. Hegazi RA, Hustead DS, Evans DC. Preoperative standard oral nutrition supplements vs immunonutrition: results of a systematic review and meta-analysis. *J Am Coll Surg*. 2014;219:1078-1087. doi:10.1016/j.jamcollsurg.2014.06.016

9. Shakersain B, Santoni G, Faxen-Irving G, Rizzuto D, Fratiglioni L, Xu W. Nutritional status and survival among old adults: an 11-year population-based longitudinal study. *Eur J Clin Nutr*. 2016;70:320-325. doi:10.1038/ejcn.2015.109

10. Geurden B, Franck E, Weyler J, Ysebaert D. The risk of malnutrition in community-living elderly on admission to hospital for major surgery. *Acta Chir Belg*. 2015;115:341-347.

11. Leij-Halfwerk S, Verwijs MH, van Houdt S, et al. Prevalence of protein-energy malnutrition risk in European older adults in community, residential and hospital settings, according to 22 malnutrition screening tools validated for use in adults ≥65 years: a systematic review and meta-analysis. *Maturitas*. 2019;126:80-89. doi:10.1016/j.maturitas.2019.05.006

12. Sheean P, Farrar IC, Sulo S, Partridge J, Schiffer L, Fitzgibbon M. Nutrition risk among an ethnically diverse sample of community-dwelling adults. *Public Health Nutr*. 2019;22:894-902. doi:10.1017/S1368980018002902

13. McKeever L, Farrar I, Sulo S, Partridge J, Sheean P, Fitzgibbon M. Nutritional adequacy and oral nutritional supplementation in older community-dwelling adults. *J Aging Res Clin Practice*. 2019;8:7-14. doi:10.14283/jarcp.2019.2

14. Whitman S, Silva A, Shah A, Ansell D. Diversity and disparity: GIS and small-area analysis in six Chicago neighborhoods. *J Med Syst*. 2004;28:397-411. doi:10.1023/b:joms.0000032854.99522.0d

15. Gabrielson DK, Scaffidi D, Leung E, et al. Use of an abridged scored Patient-Generated Subjective Global Assessment (abPG-SGA) as a nutritional screening tool for cancer patients in an outpatient setting. *Nutr Cancer*. 2013;65:234-239. doi:10.1080/01635581.2013.755554

16. Kvamme JM, Gronli O, Jacobsen BK, Florholmen J. Risk of malnutrition and zinc deficiency in community-living elderly men and women: the Tromso Study. *Public Health Nutr*. 2015;18:1907-1913. doi:10.1017/S1368980014002420

17. Bagley B. Nutrition and health. *Am Fam Physician*. 1998;57:933-934.

18. Wijnhoven HAH, Schilp J, van Bokhorst-de van der Schueren MA, et al. Development and validation of criteria for determining undernutrition in community-dwelling older men and women: the Short Nutritional Assessment Questionnaire 65+. *Clin Nutr*. 2012;31:351-358. doi:10.1016/j.clnu.2011.10.013

19. Posner BM, Jette AM, Smith KW, Miller DR. Nutrition and health risks in the elderly: the nutrition screening initiative. *Am J Public Health*. 1993;83:972-978. doi:10.2105/ajph.83.7.972

20. Sinnett S, Bengle R, Brown A, Glass AP, Johnson MA, Lee JS. The validity of Nutrition Screening Initiative DETERMINE Checklist responses in older Georgians. *J Nutr Elder*. 2010;29:393-409. doi:10.1080/01639366.2010.521031

21. Sharkey JR, Branch LG, Zohoori N, Giuliani C, Busby-Whitehead J, Haines PS. Inadequate nutrient intakes among homebound elderly and their correlation with individual characteristics and health-related factors. *Am J Clin Nutr*. 2002;76:1435-1445. doi:10.1093/ajcn/76.6.1435

22. Katz S. Assessing self-maintenance: activities of daily living, mobility, and instrumental activities of daily living. *J Am Geriatr Soc*. 1983;31:721-727. doi:10.1111/j.1532-5415.1983.tb03391.x

23. Barrett M, Baily M, Owens P. Non-maternal and non-neonatal inpatient stays in the United States involving malnutrition, 2016. Accessed April 18, 2020. https://www.hcup-us.ahrq.gov/reports/HCUPMalnutritionHospReport_083018.pdf

24. Weiss AJ, Fingar KR, Barrett ML, et al. Characteristics of hospital stays involving malnutrition, 2013. HCUP Statistical Brief #210. Agency for Healthcare Research and Quality; 2016. Accessed April 18, 2020. https://www.ncbi.nlm.nih.gov/books/NBK396064/

25. Fingar KR, Weiss AJ, Barrett ML, et al. All-cause readmissions following hospital stays for patients with malnutrition, 2013. HCUP Statistical Brief #218. Agency for Healthcare Research and Quality; 2016. https://www.ncbi.nlm.nih.gov/books/NBK52651/. Accessed April 18, 2020.

26. Riley K, Sulo S, Dabbous F, et al. Reducing hospitalizations and costs: a nutrition-focused quality improvement program by a home health agency. *JPEN J Parenter Enteral Nutr*. 2020;44:58-68. doi:10.1002/jpen.1606

27. Meehan A, Loose C, Bell J, Partridge J, Nelson J, Goates S. Health system quality improvement: impact of prompt nutrition care on patient outcomes and health care costs. *J Nurs Care Qual*. 2016;31:217-223. doi:10.1097/NCQ.0000000000000177

28. Sriram K, Sulo S, VanDerBosch G, et al. A comprehensive nutrition-focused Quality Improvement Program reduces 30-day readmissions and length of stay in hospitalized patients. *JPEN J Parenter Enteral Nutr*. 2017;41:384-391. doi:10.1177/0148607116681468

29. Sulo S, Feldstein J, Partridge J, Schwander B, Sriram K, Summerfelt WT. Budget impact of a comprehensive nutrition-focused Quality Improvement Program for malnourished hospitalized patients. *Am Health Drug Benefits*. 2017;10:262-270.

30. National Institute of Diabetes and Digestive and Kidney Diseases. Overweight & obesity statistics. Accessed March 17, 2020. https://www.niddk.nih.gov/health-information/health-statistics/overweight-obesity

31. Wang WQ, Zhang YF, Zhou DJ, et al. Open-label, randomized, multiple-center, parallel study comparing glycemic responses and safety profiles of Glucerna versus Fresubin in subjects of type 2 diabetes mellitus. *Endocrine*. 2008;33:45-52. doi:10.1007/s12020-008-9059-9

32. Magnoni D, Rouws CHFC, Lansink M, van Laere KMJ, Campos AC. Long-term use of a diabetes-specific oral nutritional supplement results in a low-postprandial glucose response in diabetes patients. *Diabetes Res Clin Pract*. 2008;80:75-82. doi:10.1016/j.diabres.2007.10.027

33. Frestedt JL, Young LR, Bell M. Meal replacement beverage twice a day in overweight and obese adults (MDRC2012-001). *Curr Nutr Food Sci*. 2012;8:320-329. doi:10.2174/1573 40112803832156

34. Tobert CM, Mott SL, Nepple KG. Malnutrition diagnosis during adult inpatient hospitalizations: analysis of a multi-institutional collaborative database of academic medical centers. *J Acad Nutr Diet*. 2018;118:125-131. doi:10.1016/j. jand.2016.12.019

35. Jensen GL, Cederholm T, Correia MITD, et al. GLIM criteria for the diagnosis of malnutrition: a Consensus Report from the Global Clinical Nutrition Community. *JPEN J Parenter Enteral Nutr*. 2019;43:32-40. doi:10.1002/jpen.1440