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Original article

Use of a nutrition-focused quality improvement program for community-living older adults at malnutrition risk is associated with better nutritional outcomes

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SUMMARY

Background & aims: Among older adults, malnutrition or its risk is common and is associated with increased morbidity and mortality plus increased need for healthcare utilization. We aimed to identify and treat malnutrition risk among older adults who received care at an outpatient clinic after a recent hospitalization and/or for management of a chronic disease.

Methods: From the outpatient clinic of Hospital Universitario San Ignacio, Bogotá, Colombia, we recruited older adults (>60 years) with malnutrition or its risk according to the Mini Nutritional Assessment-Short Form (MNA-SF). Patients were excluded if they had dementia or were not expected to live 90 days or more. Intervention was a nutrition-focused quality improvement program (QIP) including: i) education of patients and caregivers about the health importance of complete and balanced macro- and micro-nutrient intake plus physical exercise; and ii) nutritional intervention with dietary counseling and provision of oral nutritional supplements (ONS) for daily intake. To assess the effect of our intervention, we collected nutritional outcome data pre- and post-participation of patients in the nutrition-focused QIP. For pre-post comparisons, we used MNA-SF scores and calf circumference (a proxy for leg muscle mass) measures along with nutrition-related anthropometric determinations of body weight and body mass index (BMI). The ONS treatment phase was 60 days, with follow-up measurements up to 30 days after ONS treatment ended (90 days after intervention start).

Results: Of 677 enrolled patients, 618 completed the QIP, while 565 had complete anthropometric data. Patients had a mean age of 74.1 ± 8.7 years, an average of 2.6 comorbidities, included a high proportion of females (69.4%), with medium socioeconomic status (76%). After QIP intervention, 324 (52.4%) patients had improvement in nutritional outcomes; improvement was significant in all four measures (*P*-values < 0.001). Higher ONS adherence was associated with the highest improvement in nutritional status.

Conclusions: For community-living older adults receiving outpatient care, comprehensive nutritional care offered via a nutrition-focused QIP was associated with significant improvements in indicators of nutritional status (MNA-SF scores and calf circumference) and maintenance or improvements in nutrition-related anthropometric measures (body weight and BMI).

ClinicalTrials.gov identifier: NCT04042987.

Presentations: Portions of this study were presented at the 2021 American Society of Parenteral and Enteral Nutrition (ASPEN) and European Society of Parenteral and Enteral Nutrition (ESPEN) Virtual Meetings.

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1. Introduction

In North and South America [1–4], as elsewhere in the world [5–9], older adults are vulnerable to malnutrition, especially undernutrition. Undernutrition occurs when dietary intake is insufficient or of poor quality, when nutrient needs are high, or when nutrient absorption is impaired; such conditions often occur in the presence of chronic conditions or diseases [10]. A recent study revealed that malnutrition risk for all hospitalized patients in Colombia was 38%, as compared to 41% across Latin America, and 32% worldwide [11]. In a review of 66 studies in 12 Latin American countries, malnutrition or its risk was highly prevalent (40%–60% range) on admission to hospital from the community [12]. Similarly, a UK report noted that the vast majority (93%) of individuals experiencing malnutrition or its risk were living in the community [13].

Early and efficient identification of nutritional issues in older adults is important because the consequences of malnutrition or its risk can be serious. When malnutrition, especially inadequate calorie-protein intake, is associated with loss of muscle in older adults, adverse outcomes can include surgical and post-operative complications, longer hospital stays, lower physical function, poorer quality of life, and shorter survival [14]. In fact, dietary calorie-protein deficit among older adults in Colombia is a frequent cause of death due to malnutrition [11,15].

Dietary intake adequacy and quality represent key modifiable risk factors to help prevent and treat poor nutritional status [2], and comprehensive nutrition-focused Quality Improvement Programs (QIP) have been used to improve health outcomes and lower costs of care for hospitalized patients [16–18]. Until now however, few studies have examined the impact of identifying and treating malnutrition risk among older, community-living adults receiving care in outpatient or other healthcare facilities [2,8,19,20], and none of these studies were done in Latin American countries. For our present study, we sought to identify and treat malnutrition risk among community-living older adults that received care at an outpatient clinic between 2019 and 2020 in Bogotá, Colombia. We hypothesized that older, community-living adults who were malnourished or at risk would have improved nutritional status after they and their health caregivers participated in a nutritional QIP.

2. Methods

2.1. Study participants and sample size

We recruited older patients (>60 years) with risk or malnutrition according to the Mini Nutrition Assessment-Short Form (MNA-SF, score 0–7 *malnourished*, 8–11 *at risk for malnutrition*) at the outpatient clinical setting of the Hospital Universitario San Ignacio, in Bogotá, Colombia between September 2019–March 2020 with 90-days follow ups being completed in July 2020. For enrollment in the study, we excluded those with advanced dementia (Global Deterioration Scale [GDS] $\geq$ 6); delirium; intolerance or allergy to oral nutritional supplements (ONS); or life expectancy of less than 90 days. Each participant (or caregiver) signed the informed consent form. Our study protocol was approved by the Ethics and Research Committee of the Hospital Universitario San Ignacio, in Bogota, Colombia. This study is registered in ClinicalTrials.gov under identifier: NCT04042987.

The required sample size was determined to be 709 participants. Considering the emergency associated with the SARS-CoV-2 pandemic decreed by the World Health Organization in March 2020 and lockdown measures implemented in Colombia, any future study enrollment was stopped with a total of 707 participants recruited at this time. Fig. 1 outlines patient recruitment, enrollment and data availability.

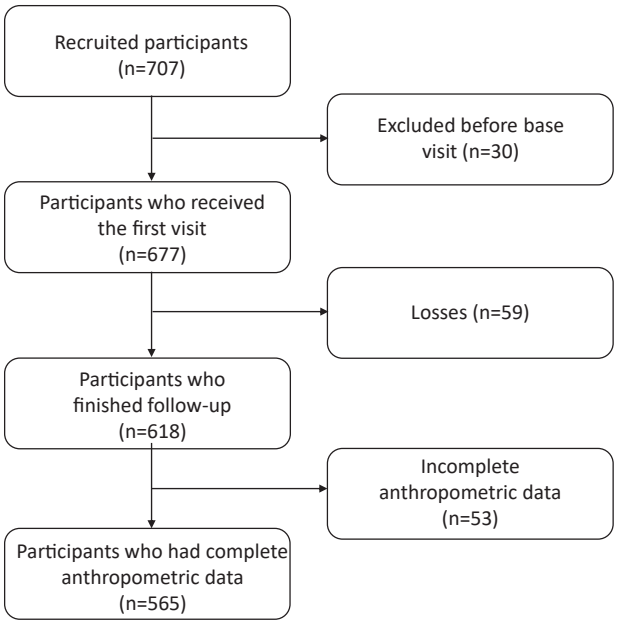

Fig. 1. Patient recruitment, enrollment, and data availability.

2.2. QIP intervention

A multi-dimensional and comprehensive nutrition-focused QIP similarly to the one previously assessed by Riley et al. [21], was implemented. Clinical staff (including nurses and physicians) received education and training prior to QIP implementation by the lead QIP investigators on QIP protocol, implementation steps, and timelines. The QIP itself consisted of a) nutritional screening (and functional test assessment as part of routine care) at baseline study visit; b) education of patients and caregivers about the importance of good nutrition (complete and balanced macro- and micronutrient intake), physical activity/exercise, and healthy lifestyle; c) nutritional intervention, including dietary counseling promoting optimization of food intake and provision of standard (Ensure, Abbott, USA) or diabetes-specific (Glucerna, Abbott, USA) ONS (1 bottle/day for 60 days) according to patient's dietary needs; and d) 4 follow-ups (at 4-, 8-, 10-, and 12-weeks post baseline visit) to reinforce education and compliance with the recommended nutrition regimen throughout the QIP while also assessing progress with different outcomes of interest. For example, in-person (pre-SARS-CoV-2 lockdown) or telehealth visits (post-SARS-CoV-2 lockdown) were informed at baseline, at 4-weeks and 10-weeks post-QIP enrollment, and were mainly conducted by the nurses and physicians, while follow up phone calls were informed at weeks 8 and 12 and were conducted by the nurses or research staff.

2.3. Variable measurements for recruitment and outcomes

For pre-post nutritional-status comparisons, we used MNA-SF scores and calf circumference (a proxy for leg muscle mass) measures along with nutrition-related anthropometric determinations of body weight and body mass index (BMI). Weight and height were measured, and BMI was determined post recruitment of patients. We used the MNA-SF score [6,22,23], to assess malnutrition or its risk (MNA-SF score 0–7 *malnourished*, score 8–11 *at risk for malnutrition*).

The ONS treatment phase was 1 bottle per day for 60 days, with follow-up measurements 30 days after ONS treatment ended, i.e.,

90 days after the QIP intervention began. ONS was delivered to patients' homes, 4 times over the course of the 60 days, with the first delivery taking place between 48 and 72 h post QIP enrollment. Participants were asked about adherence to ONS intake by a phone call conducted by nurses or research staff after their final QIP visit. Compliance with ONS was measured as the percentage of consumption out of the total of the 60 provided bottles.

2.4. Statistical analyses

Descriptive analyses at baseline were performed estimating proportions for categorical variables and means for quantitative variables. Also, a comparison between the two nutrition subgroups (at-risk vs. malnourished per MNA-SF scores) was performed using Student's t-test for comparison of continuous variables and the Pearson's chi-square test for categorical variables. To assess the difference pre and post QIP intervention on the outcomes of interest, a paired sample t-test was performed and the effect size was assessed using the Cohen's d statistic defining a low, medium, and high effect size as 0.2, 0.5, and 0.8, respectively [24]. The participants with missing data in the interest variables were excluded from the analysis.

The participants were also categorized into two subgroups according to the post intervention nutritional status based on the MNA-SF score—*improved* versus *not improved*. Differences between these two groups were evaluated using Pearson's chi-squared test for categorical variables and Student's t-test for quantitative variables. Due to the cross-sectional and dichotomous nature of the data, logistic regression analysis was also performed to assess the impact of calf circumference, comorbidities and ONS compliance — common variables affecting individual's nutrition status — on nutritional status improvement. Further, to improve the fit of the models to explain nutritional improvement observed, we estimated the same regression models (with no interaction effects) by adjusting for sex and age. The significance level was defined as a *P*-value <0.05. Statistical analyses were performed using STATA 14® (StataCorp, Texas, USA).

3. Results

3.1. Study participants

Based on difference assumptions, the required sample size was calculated to be 709 participants. The 2020–2021 SARS-CoV-2 pandemic necessitated lockdowns and other restrictions, which affected personnel and healthcare-seeking behaviors; including in-person clinic visit restrictions. We thus stopped study enrollment at 707 participants. Of enrollees, 618 (87.4%) completed the full QIP study protocol, and full anthropometric data were available for 565 (91.4%) participants (Fig. 1).

3.2. Baseline characteristics of enrollees: demographic, anthropometric, and nutrition-related

Of the 618 patients who completed the QIP participation, 528 (85%) were at risk of malnutrition, and 90 (15%) were malnourished. Mean age was 74.1 ± 8.7 years, 69.4% of the sample was female, and 76% had medium socioeconomic status. The overall mean number of comorbidities was 2.6 (±1.5). Older adults with malnutrition had significantly lower mean values for calf circumference, weight, BMI, and comorbidities compared to mean values of patients at risk for malnutrition (Table 1).

After the 90-day intervention program, pre- and post-intervention analyses showed statistically significant improvement in nutritional status, evidenced by increases in mean MNA-SF score by 2.11 points and calf circumference by 1.72 cm, which showed high (Cohen's d = 1.11) and medium (Cohen's d = 0.42) effect sizes, respectively (*P*-values < 0.001). Small effect sizes were observed for weight and BMI score changes reported post QIP intervention (Cohen's d = 0.05); thus, demonstrating that patients either maintained or had improved weight and BMI (*P*-values > 0.001; Table 2). For example, weight was maintained in 5.1% of QIP patients and was improved in 67.1% of QIP patients.

After the QIP intervention, 52.4% participants (n = 324) showed improvement in their nutritional status (Fig. 2). For subjects with malnutrition risk (n = 528), improvement was evidenced by change to adequate nutrition nutritional status (45.6%; n = 241). For subjects with malnutrition (n = 90), improvement was quantified by change to adequate nutritional status or to malnutrition risk (92.2%; n = 83).

We used between-group analyses to compare study participants whose nutrition status improved versus those with no improvement (Table 3). Participants who were most likely to have improvement in nutritional status were those who initially had worse MNA-SF scores, smaller calf circumference, and a larger number of comorbidities at baseline. More favorable changes were observed among those who were compliant with the nutrition-focused QIP, i.e., a statistically significant association of compliance with the QIP-directed ONS intake compliance and nutritional status improvement—86% ONS compliance was reported in the improved group but only 78% ONS compliance was reported in the group without improvement.

Logistic regression analysis showed that patients with small calf circumference (≤30 cm), ≥3 comorbidities, and high levels of ONS

Table 1
Baseline characteristics by nutritional status (risk of malnutrition, malnutrition).

Variable	Risk of malnutrition	Malnutrition	Total	*P* value
	n = 528	n = 90	n = 618	
Age, years, mean (±SD)	73.4 (8.6)	75.4 (8.8)	74.1 (8.7)	0.101
Female, n (%)	370 (70.1)	59 (65.6)	429 (69.4)	0.390
Socioeconomic level, n (%)				0.271
Low	110 (20.8)	17 (18.9)	127 (21)	
Medium	400 (76)	67 (74.4)	467 (76)	
High	17 (3.2)	6 (6.7)	23 (4)	
Comorbidities, mean number (±SD)	2.5 (1.4)	2.9 (1.8)	2.6 (1.5)	0.003
Weight, kg, mean (±SD)	61.0 (9.3)	55.3 (9.8)	60.2 (9.6)	<0.001
BMI, kg/m^2, mean (±SD)	25.3 (3.6)	22.6 (4.0)	24.9 (3.7)	<0.001
MNA-SF, mean (±SD)	9.84 (0.9)	6.12 (1.0)	9.30 (1.6)	<0.001
Calf circumference, cm, mean (±SD)	30.7 (4.0)	29.2 (4.3)	30.5 (4.1)	0.002

Abbreviations: MNA-SF, Mini Nutrition Assessment-Short Form; BMI, Body Mass Index; SD, standard deviation.

Table 2
Outcomes pre- and post-QIP.

		Post-intervention	Pre-intervention	Difference	Significance	Effect size
Variable	n	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	*P* value	*Cohen's d*
MNA-SF, score	618	11.42 (11.25–11.45)	9.30 (9.17, 9.43)	2.11 (1.92, 2.31)	<0.001	1.11
Calf circumference, cm	565	32.02 (31.75–32.28)	30.29 (29.95, 30.64)	1.72 (1.43, 2.00)	<0.001	0.42
Weight, kg	566	60.74 (59.94–61.53)	59.94 (59.15, 60.73)	0.79 (0.56, 1.03)	<0.001	0.05
BMI, kg/m^2	566	25.13 (24.80–25.44)	24.78 (24.47, 25.09)	0.33 (0.23, 0.43)	<0.001	0.05

Abbreviations: MNA-SF, mini nutrition assessment-short form; BMI, body mass index; CI, confidence interval.

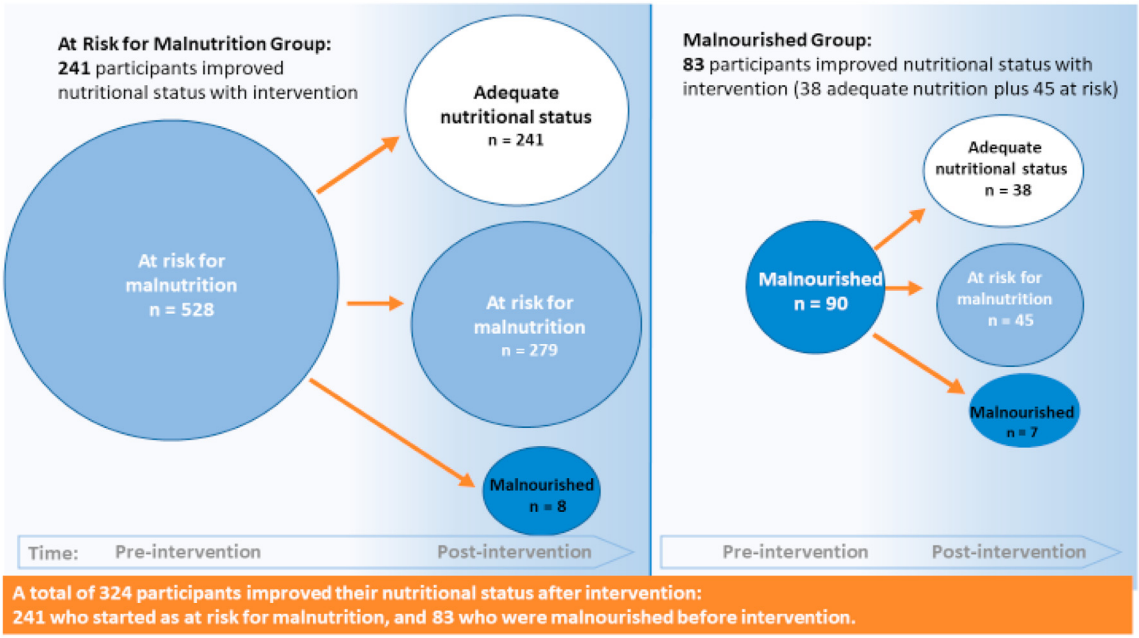

Fig. 2. Improvement in nutritional status following use of a nutrition-focused QIP among participants who were initially at risk for malnutrition or malnourished.

compliance were more likely to achieve improved nutritional status (also evidenced by an increase in their MNA-SF score). These findings were supported by the results of the adjusted logistic regression analysis, controlling for age and sex. More specifically, patients with smaller calf circumference (≤30 cm) were 2.3 (95% CI: 1.64–3.2) times more likely to experience improved nutritional status compared to patients with larger calf circumference. Patients with ≥3 comorbidities were 1.45 (95% CI: 1.03–2.04) times more likely to experience improved nutritional status than those with <3 comorbidities. Finally, patients with higher levels of ONS compliance were 1.8 (95% CI: 1.17–2.77) times more likely to experience improved nutritional status relative to the patients who reported partial ONS adherence as part of the nutrition-focused QIP (Table 4).

4. Discussion

Results of our current QIP study provided evidence in support of nutritional interventions (nutritional education plus use of ONS) to improve nutritional status for older, community-living adults with malnutrition or its risk and receiving care in outpatient clinics post hospital discharge and/or for management of chronic disease. We found that ONS intervention for a 60-day interval is an effective way to improve nutritional status. After the 90-day QIP, comparison of pre- and post-intervention measures showed statistically significant improvement in nutritional status, which was evidenced by increases in study subjects' mean MNA-SF scores and calf circumferences as well as maintenance or improvement of weight and BMI. More than half of the study participants had improvement in nutritional status. The greatest nutritional gains were seen in those who needed them most. Participants who were most likely to have improved nutritional status were those who initially had worse MNA-SF scores, smaller calf circumferences (a proxy for low leg muscle mass), and a greater number of comorbid conditions. Favorable changes in nutritional status were seen among those individuals who were most compliant with the ONS intake. Specifically, compliance with the QIP-directed ONS intake was significantly more likely to yield improvement in nutritional status (86% compliance in the improved group but only 78% in the group without improvement, $P = 0.014$).

4.1. Perspectives and clinical implications of our study findings

Early identification and treatment of nutritional problems can lead to improved outcomes and better quality of life, issues that are especially important to older adults who want to continue living independently in their communities [10]. To this end, all older adults living in the community should be screened routinely for nutritional issues [25] regardless of socio-demographic or clinical characteristics, i.e., socioeconomic status, comorbid conditions. Such nutritional screening is now widely used when older adults are diagnosed with chronic or acute health conditions [26–28] or when they are admitted to hospitals or care homes [29,30]. However, routine screening is not yet common for those receiving care

Table 3
Characterization of groups according to post-QIP changes in nutritional status.

Variables	No improvement N = 294	improvement N = 324	*P* value
Age, mean years (±SD)	74.24 (9.1)	73.93 (8.2)	0.661
BMI, mean kg/m^2 (±SD)	24.98 (3.7)	24.83 (3.9)	0.582
Weight, mean kg (±SD)	60.45 (9.7)	60.02 (9.6)	0.576
MNA-SF, mean score (±SD)	9.73 (1.16)	8.9 (1.92)	<0.001
Calf circumference, mean cm (±SD)	31.2 (3.8)	29.8 (4.2)	<0.001
Comorbidities, mean number (±SD)	2.44 (1.40)	2.67 (1.55)	0.057
ONS compliance (%)	78	86	0.014

Abbreviations: SD, Standard Deviation; BMI, Body Mass Index; MNA-SF, Mini Nutrition Assessment-Short Form; ONS, Oral Nutritional Supplement.

Table 4
Logistic regression results assessing impact of calf circumference, comorbidities and ONS compliance on nutritional status improvement.

	Unadjusted regression			Adjusted regression[a]		
	OR	95% CI	*P* value	OR	95% CI	*P* value
Calf-circumference, small ≤ 30 cm	2.09	1.52–2.89	<0.001	2.29	1.64–3.20	<0.001
Comorbidities, ≥3	1.11	0.99–1.23	0.058	1.45	1.033–2.04	0.031
ONS compliance	1.67	1.10–2.53	0.015	1.80	1.17–2.77	0.007

Abbreviations: OR, Odds ratio; CI, confidence interval; ONS, oral nutritional supplement.
[a] Adjusted by age and female sex.

at outpatient clinics or in primary care practices [8]. For these older outpatients, we encourage nutrition screening and periodic rescreening at intervals determined by individual clinical and nutritional status. Based on the findings from our present nutrition-focused QIP, we recommend patient-directed nutritional and exercise education and ONS when nutritional screening identifies malnutrition or its risk.

4.2. Nutritional status affects health outcomes of aging in older adults

Nutritional status is related to proper functioning of body systems, and it is an important element of the aging process and health in the older population [31]. Malnutrition is defined as a state resulting from inadequate intake or uptake of nutrition that predisposes to altered body composition and body cell mass, in turn leading to diminished physical and mental function and impaired clinical outcomes from disease [32]. Malnutrition can result in adverse outcomes such as increased likelihood of hospitalizations, falls, functional or cognitive decline, and mortality [33].

4.3. Other studies showing benefits from nutritional care

Disease-related malnutrition has long been recognized as a prevalent condition in Latin American hospitals, which imposed considerable health and economic burdens [1,12,34,35]. Nutrition-focused QIP have been used by other researchers to improve patient outcomes. Sriram et al. first reported on a multimodal QIP intervention in acute care settings of a large United States healthcare system [16]; findings from this study and its follow-up showed lower 30-day hospital readmission rates and lengths of hospital stays with resultant lowering of healthcare costs [17]. Comprehensive QIP studies that are nutrition-focused have thus become an effective model for examining the value of nutrition care in other hospital and healthcare settings, including home health, outpatient clinics, and post-hospital rehabilitation settings [18,21,36–38].

Results of a recent randomized, controlled clinical trial confirmed and extended positive benefits of nutritional interventions. In Singaporean community-dwelling adults at risk of malnutrition, Chew et al. examined the impact of intervention (oral nutritional supplementation along with dietary counseling vs placebo with dietary counseling) on clinical, nutritional, and functional outcomes [39]. The primary composite outcome in this study was survival without hospital (re)admission and with at least 5% weight gain by day 180; a higher proportion in the intervention group met the 180-day primary composite outcome compared to placebo (33.4% vs. 8.7%, $P < 0.001$) [39]. Further, the odds of having better nutritional status during the study were significantly higher in the intervention group compared to placebo (OR = 2.68, $P < 0.001$) [39].

4.4. Strength and limitations of our study

Recent studies in Colombia have examined adverse consequences of malnutrition in hospitalized patients [15,40], and economic modeling analyses have shown that use of nutritional interventions can lessen cost burdens for care [41]. However, our present nutritional QIP is the first and largest study of its kind both in Colombia and in Latin America. While other studies have been done in hospitalized patients, our study addressed nutritional risks of older, community-living adults who were attending outpatient clinics for management of chronic disease or for post-hospitalization follow-up. Additionally, our application of QIP to nutritional care was the first to be conducted in Latin America; similar nutritional QIPs have been used by US research teams [16–18,21,36,37,42]. Like other observational real-world QIP studies, our study had inherent limitations associated with non-randomized study designs. Another limitation was that we relied on self-reported data for ONS compliance. For practical reasons, our study was limited to 90-day follow-up; it would indeed be interesting to have outcome results of a longer study without rescreening versus compared to routine rescreening (and continued use of ONS when indicated). In Europe, such continued screening and ONS-use strategies are recommended for people undergoing cancer treatments [43–46].

In terms of generalizability, the population of older people in communities of Colombia may not be exactly representative of populations in higher-income countries. However, patients with different socio-economic status were included in our QIP. Also, the 2020 Global Nutrition Report shows a profile of Colombia that

generally reflects nutritional changes elsewhere in the world—undernutrition is present but declining among adults and children, while overweight and obesity are becoming increasingly prevalent [47].

5. Conclusions

For community-living, older adults (in Bogotá, Colombia) who were attending outpatient clinics following hospitalization and/or for chronic disease management, our study results highlighted benefits to nutritional care. We found improved nutritional status following a QIP-based program of (i) identifying people with malnutrition or its risk, (ii) providing education on the importance of diet and exercise to overall health, (iii) prescribing 60-day ONS use, and (iv) conducting 90-day follow-up with a clinician (physician or nurse) or research team member. We observed significant improvements in indicators of nutritional status (MNA-SF scores and calf circumference) and maintenance or improvement of nutrition-related anthropometric measures (body weight and BMI). Such findings provide a rationale for implementing comprehensive nutrition-focused programs for community-dwelling older Colombian adults receiving care in outpatient clinics.

Financial disclosure

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Statement of authorship

DAC, LCV, CC were involved in patient enrollment and data collection. DAC, AMA, LCV and JDM were responsible for the data analysis and interpretation of data. DAC, CC, and SS drafted the manuscript, and all authors contributing to critical revision of the manuscript. SS, GG, JDM and CC was responsible for obtaining funding. The corresponding author had full access to all data used and shared final responsibility for the accuracy of the analyzed data.

Declaration of competing interest

Drs. Gomez and Sulo and Mr Misas are employees and stockholders of Abbott. Dr Cano has received speaker honoraria from Abbott outside of present work. Other authors have no conflicts of interest to report.

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References

[1] Correia MI, Hegazi RA, Diaz-Pizarro Graf JI, Gomez-Morales G, Fuentes Gutierrez C, Goldin MF, et al. Addressing disease-related malnutrition in healthcare: a Latin American perspective. J Parenter Enter Nutr 2016;40:319–25.
[2] 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 Pract 2019;8:7–14.
[3] Sheean P, Farrar IC, Sulo S, Partridge J, Schiffer L, Fitzgibbon M. Nutrition risk among an ethnically diverse sample of community-dwelling older adults. Public Health Nutr 2019;22:894–902.
[4] Eggersdorfer M, Akobundu U, Bailey RL, Shlisky J, Beaudreault AR, Bergeron G, et al. Hidden hunger: solutions for America's aging populations. Nutrients 2018;10.
[5] Wolters M, Volkert D, Streicher M, Kiesswetter E, Torbahn G, O'Connor EM, et al. Prevalence of malnutrition using harmonized definitions in older adults from different settings – a MaNuEL study. Clin Nutr 2019;38:2389–98.
[6] Kaiser MJ, Bauer JM, Ramsch C, Uter W, Guigoz Y, Cederholm T, et al. Frequency of malnutrition in older adults: a multinational perspective using the mini nutritional assessment. J Am Geriatr Soc 2010;58:1734–8.
[7] Wei JM, Li S, Claytor L, Partridge J, Goates S. Prevalence and predictors of malnutrition in elderly Chinese adults: results from the China Health and Retirement Longitudinal Study. Public Health Nutr 2018;21:3129–34.
[8] Sharman Moser S, Doyev R, Cohen B, Kurz R, Sulo S, Shalev V, et al. Prevalence and characteristics of malnutrition among community-dwelling older adults in Israel. Clin Nutr ESPEN 2018;28:179–85.
[9] Crichton M, Craven D, Mackay H, Marx W, de van der Schueren M, Marshall S. A systematic review, meta-analysis and meta-regression of the prevalence of protein-energy malnutrition: associations with geographical region and sex. Age Ageing 2019;48:38–48.
[10] Agarwal E, Miller M, Yaxley A, Isenring E. Malnutrition in the elderly: a narrative review. Maturitas 2013;76:296–302.
[11] Cardenas D, Bermudez C, Perez A, Diaz G, Cortes LY, Contreras CP, et al. Nutritional risk is associated with an increase of in-hospital mortality and a reduction of being discharged home: results of the 2009-2015 nutritionDay survey. Clin Nutr ESPEN 2020;38:138–45.
[12] Correia MITD, Perman MI, Waitzberg DL. Hospital malnutrition in Latin America: a systematic review. Clin Nutr 2017;36:958–67.
[13] Elia M, Russell C. Combating malnutrition: recommendations for action. Redditch, England: BAPEN; 2009.
[14] Prado CM, Purcell SA, Alish C, Pereira SL, Deutz NE, Heyland DK, et al. Implications of low muscle mass across the continuum of care: a narrative review. Ann Med 2018;50:675–93.
[15] Rodriguez MG, Sichaca EG. Mortality due to malnutrition in older adults, Colombia, 2014-2016. Biomedica 2019;39:663–72.
[16] Sriram K, Sulo S, VanDerBosch G, Partridge J, Feldstein J, Hegazi RA, et al. A comprehensive nutrition-focused quality improvement program reduces 30-day readmissions and length of stay in hospitalized patients. J Parenter Enter Nutr 2017;41:384–91.
[17] 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;10:262–70.
[18] Sulo S, Gramlich L, Benjamin J, McCauley S, Powers J, Sriram K, et al. Nutrition interventions deliver value in healthcare: real-world evidence. Nutr Diet Suppl 2020;12:139–46.
[19] Sulo S, Schiffer L, Sheean P, Farrar I, Partridge J, Fitzgibbon M. Community-dwelling adults at nutrition risk: characteristics in relation to the consumption of oral nutritional supplements. J Prim Care Community Health 2020;11:2150132720922716.
[20] Smith TR, Cawood AL, Walters ER, Guildford N, Stratton RJ. Ready-made oral nutritional supplements improve nutritional outcomes and reduce health care use-a randomised trial in older malnourished people in primary care. Nutrients 2020;12.
[21] Riley K, Sulo S, Dabbous F, Partridge J, Kozmic S, Landow W, et al. Reducing hospitalizations and costs: a home health nutrition-focused quality improvement program. J Parenter Enter Nutr 2020;44:58–68.
[22] Lera L, Sanchez H, Angel B, Albala C. Mini nutritional assessment short-form: validation in five Latin American Cities. SABE study. J Nutr Health Aging 2016;20:797–805.
[23] Isautier JMJ, Bosnic M, Yeung SSY, Trappenburg MC, Meskers CGM, Whittaker AC, et al. Validity of nutritional screening tools for community-dwelling older adults: a systematic Review and meta-analysis. J Am Med Dir Assoc 2019;20. 1351 e13–e25.
[24] Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed. Lawrence Erlbaum Associates; 1988.
[25] Hamirudin AH, Charlton K, Walton K. Outcomes related to nutrition screening in community living older adults: a systematic literature review. Arch Gerontol Geriatr 2016;62:9–25.
[26] Garcia RS, Tavares LR, Pastore CA. Nutritional screening in surgical patients of a teaching hospital from Southern Brazil: the impact of nutritional risk in clinical outcomes. Einstein 2013;11:147–52.
[27] Prado CM, Purcell SA, Laviano A. Nutrition interventions to treat low muscle mass in cancer. J Cachexia Sarcopenia Muscle 2020;11:366–80.
[28] Pirlich M, Schutz T, Kemps M, Luhman N, Burmester GR, Baumann G, et al. Prevalence of malnutrition in hospitalized medical patients: impact of underlying disease. Dig Dis 2003;21:245–51.
[29] Graham J, Fan L, Meadows ES, Hang L, Partridge J, Goates S. Addressing malnutrition across the continuum of care: which patients are likely to receive oral nutritional supplements. J Aging Res Healthc 2017;1:18–27.

[30] Holyday M, Daniells S, Bare M, Caplan GA, Petocz P, Bolin T. Malnutrition screening and early nutrition intervention in hospitalised patients in acute aged care: a randomised controlled trial. J Nutr Health Aging 2012;16:562–8.
[31] Ahmed T, Haboubi N. Assessment and management of nutrition in older people and its importance to health. Clin Interv Aging 2010;5:207–16.
[32] Cederholm T, Barazzoni R, Austin P, Ballmer P, Biolo G, Bischoff SC, et al. ESPEN guidelines on definitions and terminology of clinical nutrition. Clin Nutr 2017;36:49–64.
[33] Volkert D, Beck AM, Cederholm T, Cereda E, Cruz-Jentoft A, Goisser S, et al. Management of malnutrition in older patients-current approaches, evidence and open questions. J Clin Med 2019;8.
[34] Correia MI, Waitzberg DL. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. Clin Nutr 2003;22:235–9.
[35] Correia MITD, Perman MI, Pradelli L, Omaralsaleh AJ, Waitzberg DL. Economic burden of hospital malnutrition and the cost-benefit of supplemental parenteral nutrition in critically ill patients in Latin America. J Med Econ 2018;21:1047–56.
[36] Sulo S, Lanctin D, Feldstein J, Schwander B, Partridge J, Landow W, et al. Budget impact analysis of a home-based nutrition program for adults at risk for malnutrition. Am Health Drug Benefits 2020;13:95–101.
[37] Valladares AF, Kilgore KM, Partridge J, Sulo S, Kerr KW, McCauley S. How a malnutrition quality improvement initiative furthers malnutrition measurement and care: results from a hospital learning collaborative. J Parenter Enter Nutr 2021;45:366–71.
[38] Wills-Gallagher J, Kerr KW, Macintosh B, Valladares AF, Kilgore KM, Sulo S. Implementation of malnutrition quality improvement reveals opportunities for better nutrition care delivery for hospitalized patients. J Parenter Enter Nutr 2022;46(1):243–8. https://doi.org/10.1002/jpen.2086.
[39] Chew STH, Tan NC, Cheong M, Oliver J, Baggs G, Choe Y, et al. Impact of specialized oral nutritional supplement on clinical, nutritional, and functional outcomes: a randomized, placebo-controlled trial in community-dwelling older adults at risk of malnutrition. Clin Nutr 2021;40:1879–92.
[40] Ruiz AJ, Buitrago G, Rodriguez N, Gomez G, Sulo S, Gomez C, et al. Clinical and economic outcomes associated with malnutrition in hospitalized patients. Clin Nutr 2019;38:1310–6.
[41] Buitrago G, Vargas J, Sulo S, Partridge JS, Guevara-Nieto M, Gomez G, et al. Targeting malnutrition: nutrition programs yield cost savings for hospitalized patients. Clin Nutr 2020;19:2896–901.
[42] 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;31:217–23.
[43] Arends J, Bachmann P, Baracos V, Barthelemy N, Bertz H, Bozzetti F, et al. ESPEN guidelines on nutrition in cancer patients. Clin Nutr 2017;36:11–48.
[44] Arends J, Baracos V, Bertz H, Bozzetti F, Calder PC, Deutz NEP, et al. ESPEN expert group recommendations for action against cancer-related malnutrition. Clin Nutr 2017;36:1187–96.
[45] Muscaritoli M, Corsaro E, Molfino A. Awareness of cancer-related malnutrition and its management: analysis of the results from a survey conducted among medical oncologists. Front Oncol 2021;11:682999.
[46] Muscaritoli M, Lucia S, Farcomeni A, Lorusso V, Saracino V, Barone C, et al. Prevalence of malnutrition in patients at first medical oncology visit: the PreMiO study. Oncotarget 2017;8:79884–96.
[47] Global Nutrition Report Independent Expert Group. 2020 global nutrition report: action on equity to end malnutrition. Bristol, UK: Development initiatives; 2020.