



Disease-focused Nutritional Care is Associated with Improved Outcomes for Older Adults with Diabetes and Malnutrition or its Risk

Carlos Cano-Gutierrez^{1,2*}, Felipe Botero-Rodríguez^{1,2}, Diego Andres Chavarro-Carvajal^{1,2}, Elkin Garcia-Cifuentes^{1,2}, Gabriel Gomez³, Juan Diego Misas³, Daniela Alejandra Gracia³, Suela Sulo⁴, Bjoern Schwander⁵, Luis Carlos Venegas-Sanabria^{6,7}

¹Ageing Institute, Medical School Pontificia Universidad Javeriana, Bogotá, Colombia

²Hospital Universitario San Ignacio, Bogotá, Colombia

³Abbott Laboratories, Bogotá, Colombia

⁴Abbott Laboratories, Abbott Park, Illinois, USA

⁵AHEAD GmbH, Bietigheim-Bissingen, Germany

⁶Universidad del Rosario, Bogotá, Colombia

⁷Hospital Universitario Mayor, Bogotá, Colombia

ABSTRACT

Introduction: Diabetes imposes clinical and economic burdens on healthcare systems worldwide. For people with diabetes, having poor nutritional status increases risks for complications and poor outcomes, thus raising costs for healthcare. Our analysis assessed the impact of a nutrition-focused quality improvement program (QIP) on outcomes for older community-living adults with diabetes.

Research design and methods: Eligible patients were ≥ 60 years and receiving care at an outpatient clinic in Bogotá, Colombia. Enrollees had malnutrition or its risk by Mini Nutritional Assessment-Short Form (MNA-SF) scores. We tracked a subpopulation of patients with diabetes who participated in QIP intervention as

(i) Education on healthy diet+physical exercise,
(ii) Individualized dietary counseling, and
(iii) Diabetes-specific oral nutritional supplements (ONS; Glucerna[®], Abbott, USA) for daily intake over 60 days. Follow-up measures of nutritional outcomes (MNA-SF, calf circumference), physical functionality (Short Physical Performance Battery, SPPB), and healthcare utilization (hospitalizations, emergency department and outpatient visits) were monitored to 30 days after ONS intake ended (90 days after intervention start). Economic modeling was used to estimate corresponding healthcare costs.

Results and conclusion: 618 patients completed intervention and follow-up; of these, 114 (18.4%) had diabetes diagnoses. Patients with diabetes were older adults (74.8 ± 8.5 years) with $3.4 (\pm 1.5)$ comorbid conditions. Comparing pre-and post-QIP measures, we found improvements in nutritional status (MNA-SF scores 9.2 vs 11.7, $p < 0.001$, and calf circumference 30.9 cm vs 32.8 cm, $p < 0.001$) and functionality (SPPB scores 6.70 to 7.13, $p = 0.027$). Healthcare utilization was significantly decreased (2.99 vs 1.92 incidents, $p < 0.001$). With intervention, relative risk reductions were significant for hospitalizations ($\downarrow 88\%$), emergency department visits ($\downarrow 63\%$), and outpatient visits ($\downarrow 24\%$). Per-patient cost savings were \$ 270 for the 90-day study interval. Nutrition-focused intervention for undernourished, older, community-living adults with diabetes was associated with improved nutritional status, higher functionality, and reduced healthcare use/costs-highlighting 'value' in nutritional support.

Keywords: Colombia; Community-living; Diabetes; Malnutrition; Older adults; Oral nutritional supplement

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Corresponding author Carlos Cano-Gutierrez, Ageing Institute, Medical School Pontificia Universidad Javeriana, Bogota, Colombia, E-mail: ccano@javeriana.edu.co

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INTRODUCTION

Diabetes is a common chronic illness that requires continuous medical care and implementation of multiple risk-reduction strategies. Nutritional management is recognized as a key component of diabetes care [1]. Specifically, people with diabetes can benefit from education on self-managing nutrition to prevent acute complications and reduce risk of long-term complications. In fact, experts in diabetes care have developed consensus guidelines on dietary management with the ultimate aims of improving clinical care and educational services, bettering the health of individuals and populations with diabetes, and reducing diabetes-associated per capita health costs [2]. People of older age are at high risk for developing diabetes and are also vulnerable to undernutrition. Studies from North and South America showed that malnutrition, as undernutrition, was common among older adults; similar age-related risk has been reported worldwide [3-11]. 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 [12]. Relevant to diabetes, type 2 diabetes (T2D) accounts for more than 90% of cases, and it is most commonly diagnosed in older adults in Colombia, as well as worldwide [13-15]. It remains unclear whether the association of diabetes and poor nutrition derives from diabetes-related malnutrition or from malnutrition-related diabetes or is a coincidence of the two age-related conditions [16,17]. Diabetes, undernutrition, frailty, and cognitive dysfunction are closely related to the mechanisms of aging [18]. In fact, insulin resistance (T2D), chronic inflammation, oxidative stress, and mitochondrial dysfunction may be common mechanisms shared by aging-related physical frailty and cognitive impairment [18].

In general, people with poor nutritional status also have higher costs for healthcare. Based on a systematic review of studies done in Europe, Abizanda, et al. found that total costs associated with care for malnourished, community-dwelling, older adults were considerably higher than those of well-nourished ones [19]. The larger costs were mainly due to higher use of healthcare resources (primary care consultations, hospitalizations, health care monitoring, and treatments) [19]. Similar results on higher healthcare costs attributable to malnutrition/risk, especially disease-associated malnutrition, have been reported from clinical studies worldwide [20-25].

In our prior Strengthening Health in Colombia Malnourished (SALUD) study of poorly nourished older adults living in the Bogotá community, we showed that use of a nutritionally focused Quality-improvement Program (QIP) could significantly improve markers of nutritional status [26]. In this Colombian population, we further showed that nutritional QIP interventions led to significant improvements in physical and cognitive function, psychological wellness, and health-related quality of life [27]. As well, we found that nutritionally focused care was associated with lower costs for healthcare [28]. The aim of our present analysis was to evaluate outcomes of the nutritional QIP intervention in a subpopulation of older adults with diabetes. The program included patient education on diet and exercise, individualized dietary counseling, and provision of a 60-day supply of diabetes-specific ONS (DS-ONS). We specifically assessed the impact of the QIP on measures of

nutritional health, physical functionality, healthcare resource utilization, and on costs attributed to use of healthcare resources.

METHODS

Study Design

The Strengthening Health in Colombia Malnourished (SALUD) study was conducted from September 2019 through July 2020. The overall study design is illustrated; procedures and definitions are detailed in sections that follow.

Approximately 2,000 neonates are admitted annually to the fifty six (56)-bed NICU. There was scarcity of Hand-washing facilities throughout the unit. Though limited practice, use of alcohol-based hand rub has been the primary method for hand hygiene. The NICU ward Infrastructure design is lacking the minimum recommended NICU Design Standards [13,14]. The WHO recommended IPC guideline Implementation status was below the expected (0-200) [10].

Study Participants and Ethical Approval

From outpatient clinical settings of Hospital Universitario San Ignacio, Bogotá, Colombia, we recruited older adults (≥ 60 years) with malnutrition or its risk. The study protocol excluded candidates with advanced dementia (Global Deterioration Scale score ≥ 6); delirium; intolerance or allergy to ONS; or life expectancy less than 90 days [29]. The study population included many individuals considered to be in 'transitional care,' a critical period for people recovering from acute disease or hospital stay and having chronic diseases, e.g., cardiac conditions, pulmonary disorders, diabetes. Such patients are often not fully independent in the community; many require additional homecare or assistance from caregivers. For the present analysis, we used medical records to identify a subset of patients with a diabetes diagnosis.

Each participant (or his or her caregiver) signed an informed consent form. Our study protocol was approved by the Ethics and Research Committee of the Hospital Universitario San Ignacio and was registered in ClinicalTrials.gov under Identifier: NCT04042987.

Nutritional QIP Intervention

As described previously, we used a comprehensive, multi-dimensional nutritional QIP intervention for study participants who were malnourished or at risk [26,27]. Enrollees took part in a nutrition-focused QIP intervention that included

- Education of participants on diabetes-appropriate dietary intake plus physical exercise,
- Individualized diabetes-specific dietary counseling, and
- Provision of DS-ONS (Glucerna®, Abbott, USA) sufficient for daily intake over 60 days.

Compared to standard Oral Nutritional Supplements (ONS), diabetes-specific formulas have lower carbohydrate content and use a higher proportion of carbohydrates that have a low glycemic index and are slowly digestible, e.g., by replacement of high glycemic-index maltodextrin, starch, and sucrose with

low glycemic-index carbohydrates such as digestion-resistant maltodextrin, isomaltulose, and sucromalt, and non-hydrolyzed starches. To meet energy needs and promote digestive health, the DS-ONS also has fat content enriched in unsaturated fatty acids and higher fiber content [30].

Outcome Measures

Outcome parameters were measured at baseline, with follow-up measurements 30 days after ONS treatment ended, i.e., 90 days after the intervention began.

Nutritional Status: For pre-and post-QIP comparisons of nutritional status, a validated Spanish version of the Mini Nutrition Assessment-Short Form (MNA-SF) was used; a total of 14 points is possible. Specified cutoffs for malnutrition were scores 0-7; at risk for malnutrition scores were 8-11; scores of 11-14 were considered normal [31,32].

Muscle mass: Calf circumference is used as a practical proxy measure for skeletal muscle mass in the geriatric outpatient setting [33,34]. Patients with a circumference greater than 30 centimeters were considered in good status, and those who showed post-intervention increases in calf circumference were improved.

Physical function: Each participant's physical functionality was measured by the Short Physical Performance Battery (SPPB), which measures three components-balance, gait speed-a short (4 m) walk at usual pace, and standing up from a chair five times consecutively [35]. SPPB scores range from 0 to 12. Study participants with SPPB scores of 10-12 at the beginning and end of the intervention were considered in good status with 'maintained' function. Patients with lower scores that increased post-intervention were reported as 'improved'.

Proxy measures of muscle health and function: We also used proxy measures for muscle mass and physical functionality-handgrip strength and Barthel Index scores [36-38]. Report cutoffs used to interpret findings in your study.

Healthcare resource use: Uses of healthcare resources were counted as incident hospitalizations, emergency department (ED) visits, or outpatient visits for general or specialty care. Costs of healthcare resource used were based on a recent publication by Buitrago, et al. [39].

Statistical Analyses

For baseline characteristics, we used descriptive analyses to estimate proportions for categorical variables and mean values for quantitative variables. To assess the difference pre-and post-QIP intervention on the outcomes of interest, the paired-sample t-test was performed. Participants with missing data in the variables of interest were excluded from the analysis.

We used logistic regression to identify variables that predicted increased likelihood of post-QIP improvement in nutritional status. Independent variables were low calf circumference (less than 30 centimeters) at baseline, more than 3 comorbidities, female sex, and age older than 75 years. Regarding healthcare utilization, we report frequencies in hospitalizations, ED visits, and outpatient's clinic visits, and the relative risk reduction

(RRR) by medical services. We collected outcome data at baseline, 30, 60 and 90 days after the start of the QIP nutritional intervention.

Cost Modeling

The economic model was developed to perform a Budget Impact Analysis (BIA) from a Colombian third-party payer perspective. The BIA model enables simulations for a 90-day base case time horizon, according to the observation period of the underlying study; therefore, no discounting was applied. The model enables the simulation of the cost consequences of the nutritional QIP intervention (post-QIP) compared to baseline (pre-QIP).

As previously reported, all costs were calculated from the perspective of a third-party payer, corresponding to costs generated for care in the Colombian health system and reported in year 2022 US dollars (USD) [28]. Categories of costs included in the model were QIP implementation costs and healthcare resource utilization costs.

QIP implementation costs (fixed and variables costs) were estimated based on records of professional staff time for completing QIP training and other QIP related tasks including patient nutrition screening/assessment, patient education provision, delivery of ONS, follow-up calls and follow-up data collection. The cost categories reported are similar to those reported for other QIP studies [28,40-42]. Hourly-wage rates for staff positions (e.g., clinicians, administrative and research staff) were taken from publicly available, Colombian wage statistics [43]. Healthcare resource utilization costs were estimated based on the costs incurred from hospitalizations, ED visits, and outpatient visits using multiple data sources outlined.

RESULTS

Patient Characteristics at Baseline

Of 618 enrolled QIP patients, 114 (18.4%) were patients with diabetes. Patients with diabetes were older adults (74.8 years \pm 8.52 years) and a majority female (71%). At baseline, they had 3.4 (\pm 1.5) comorbid conditions, and mean body weight was 64.15 (\pm 10.55) kg. The mean baseline body mass index (BMI) score for study participants with diabetes was 26.3 (\pm 4.36) kg/m². For older adults, BMI values from 27.0 kg/m² to 27.9 kg/m² have been associated with the least risk for death, while those at the lower end of the spectrum were at greater risk [44]. Low BMI has also been associated with poor nutritional status and low physical functioning in older adults [45]. Although study participants were generally not at highest risk for mortality according to BMI, many had other indicators of compromised nutritional status-MNA-SF scores (mean value 9.2 \pm 1.59) and small calf circumference (mean value 30.9 cm \pm 5.15 cm).

Nutrition-related and Physical Function Measures Pre-and Post-QIP

Post-intervention, values were significantly improved for nutritional status, calf circumference (lower limb muscle mass proxy), and physical functionality by SPPB (Table 1).

Table 1: Pre/Post-QIP nutritional and health-related characteristics in study participants with diabetes

Clinical Outcome	n	Pre-QIP	Post-QIP	Difference	P-value
MNA-SF Score	114	9.22 (\pm 1.59)	11.68 (\pm 1.91)	2.46	<0.001
Calf circumference, cm	99	30.92 (\pm 5.15)	32.82 (\pm 3.53)	1.9	<0.001
SPPB, Overall score	99	6.70 (\pm 2.15)	7.13 (\pm 2.01)	0.43	0.027

Note: Data are presented as mean \pm SD unless stated otherwise. MNA-SF, Mini Nutritional Assessment-Short Form; SPPB, Short Physical Performance Battery

Maintenance of Good Nutritional Status or Improvement Post-QIP

Our findings showed that more than half of the study participants experienced post-QIP improvement in nutritional status (MNA-SF scores), and more than a third experienced improvements in proxy measures of skeletal muscle mass and functionality (Table 2). Further, more than half of QIP-

participants maintained calf muscle measures, indicating little or no loss of lower limb skeletal muscle mass. Findings from the individual SPPB components of patients with compromised physical functionality at baseline show that the measures of balance, gait speed, and five-times chair stand were improved for 56%, 73%, and 68% of compromised participants, respectively.

Table 2: Percent of QIP participants with diabetes who improved or maintained good status for nutritional and functional characteristics post-QIP intervention

	MNA-SF score N=114	Calf circumference N=99	Barthel Index N=114	Grip strength N=99	SPPB N=99
Improved status, N (%)	64 (56.1%)	37 (37.4%)	27 (23.7%)	48 (48.5%)	39 (39.4%)
Maintained good status, N (%)	0 (0%)	58 (58.6%)	25 (22.0%)	44 (44.4%)	9 (9.1%)
Total with improved or maintained good status N (%)	64 (56.1%)	95 (96%)	52 (45.6%)	92 (92.9%)	48 (48.5%)

Relative Risk Reduction for Hospitalization, Emergency Department Visits, and Outpatient Visits

Overall use of healthcare resources was significantly reduced; at 30, 60, and 90 days, changes corresponded to relative risk

reductions of 48.7%, 25.1%, and 30.8%, respectively (Table 3). By specific healthcare resource (hospitalizations, ED visits, and outpatient visits), utilization was significantly lowered across the 90-day study interval, i.e., hospitalizations by 87.5% ($p=0.002$), ED visits by 63% ($p=0.011$). While outpatient visits were reduced 23.5%, but this change did not reach $p<.05$ level for statistical significance, i.e., $p=0.152$ (Table 3).

Table 3: Healthcare utilization by patients with diabetes at time points after start of nutritional QIP intervention

Healthcare Resources	30 Days				60 Days				90 Days			
	Pre	Post	RRR (%)	P value	Pre	Post	RRR (%)	P value	Pre	Post	RRR (%)	P value
Hospitalizations	0.07	0.02	71.4	0.096	0.14	0.02	85.7	0.004	0.16	0.02	87.5	0.002
Emergency Department Visits	0.11	0.02	81.8	0.004	0.25	0.08	68.0	0.005	0.27	0.1	63.0	0.011
Outpatients Visits	1.33	0.74	44.4	0.000	1.93	1.64	15.0	0.130	2.47	1.89	23.5	0.152
Overall	1.5	0.77	48.7	0.000	2.31	1.73	25.1	0.058	2.89	2.0	30.8	0.000

Cost Savings Analysis

As presented in Table 4, QIP intervention resulted in cost-savings for each category of healthcare resource use, and the total savings, related to the 114 diabetes patients included in the study, were higher than the costs of the QIP intervention. The pre-QIP total healthcare costs amounted to \$ 65,284 (95% CI: \$ 37,514-\$ 92,458) vs post-QIP cost of \$ 34,449 (95% CI: \$ 25,655-\$ 46,127) (\$ 17,743 healthcare resource use plus \$ 16,705 QIP intervention costs). Consequently, the budget

impact was negative reflected by total cost savings of \$ 30,836 (95% CI: \$ 11,859-\$ 46,33) or \$ 270 (95% CI: \$ 104-\$406) per-patient over the 90-day study period. Total cost savings equated to twice the initial investment for QIP intervention, i.e., the per-dollar return on investment was \$ 1.85 (95% CI: \$ 0.71-\$ 2.77).

Predictors of Response to Nutritional QIP

Patients with low calf circumference (<30 cm) at baseline showed higher probability of improved nutritional status (odds

ratio, 3.47; 95 % CI, 1.54 to 7.79; P=0.003) with the nutritional intervention (Table 5). Similarly, patients with diabetes and more than three comorbidities had a greater likelihood for improved nutritional status after the nutritional QIP intervention (odds ratio, 2.54; 95% CI, 1.02 to 6.34; P=0.045). The non-significant

association with female sex indicated that male and female participants did not differ in response. Similarly, people older (>75 years) were no more likely to improve than the entire population of older people (≥ 60 years).

Table 4: 90-day cost-savings based on reduced healthcare resource utilization

	Pre-QIP Amount (95% CI), USD\$	Post-QIP Amount (95% CI), USD\$
Hospitalization costs	\$ 47,008 (\$ 23,504-\$ 70,512)	\$ 5,876 (\$ 0-\$ 14,690)
Outpatient visit costs	\$12,913 (\$11,031-\$14,795)	\$ 9,880 (\$8,155-\$11,553)
Emergency department visit costs	\$ 5,364 (\$ 2,980-\$ 7,152)	\$1,987 (\$ 3,178-\$ 795)
Total healthcare resource costs	\$65,284 (\$37,514-\$92,458)	\$ 17,743 (\$ 8,950-\$ 29,422)
Total QIP intervention cost	\$ 0	\$ 16,705
Total healthcare costs	\$ 65,284 (\$ 37,514-\$ 92,458)	\$ 34,449 (\$ 25,655-\$ 46,127)
Savings for QIP population (n=114)		\$ 30,836 (\$ 11,859-\$ 46,33)
Savings per-patient		\$ 270 (\$ 104-\$ 406)

Table 5: Factors associated with improved nutritional status by logistic regression

	Odds ratio	P value	95% CI	Savings per-patient
Low calf circumference	3.47	0.003	1.54	7.79
More than 3 comorbidities	2.54	0.045	1.02	6.34
Female	0.55	0.219	0.22	1.41
More than 75 years	0.73	0.443	0.33	1.62
Constant	0.68	0.454	0.26	1.83

DISCUSSION

SALUD Colombia Diabetes Findings in Review and in Perspective

Our previous SALUD Colombia reports showed benefits of nutritional intervention for older people living in Bogotá communities [26,27]. Our present SALUD Colombia analysis was on a subpopulation of poorly nourished older patients with diabetes. People with diabetes were slightly older (74.8 years \pm 8.52 years vs 74.1 years \pm 8.7 years) and had more comorbid conditions (3.4 \pm 1.5 vs 2.6 \pm 1.5) [26,27]. In this SALUD Colombia diabetes study, the nutritional intervention was tailored to include

- Participant education on diabetes-appropriate dietary intake and physical exercise,
- Individualized diabetes-specific dietary counseling, and
- Provision of DS-ONS sufficient for daily intake over 60 days.

When comparing pre-and post-QIP health measures in this population with diabetes, we found significant improvements in indicators of nutritional status (MNA-SF scores of 9.2 vs 11.7, $p < 0.001$; calf circumference of 30.9 cm vs 32.8 cm, < 0.001). Such findings suggest that the nutritional QIP was an effective strategy for improving health and functionality of older, community-living adults with diabetes. Overall, healthcare utilization (hospitalizations, ED, and outpatient visits) was significantly decreased with use of the diabetes nutritional QIP (2.99 vs 1.92 visits, $p < 0.001$). At day 90 follow-up, results

showed significant reductions in hospitalizations and ED visits, and a trend toward reduction of outpatient visits. Based on cost modeling, the estimated per-patient cost savings associated with reduced healthcare utilization was \$ 270 for the 90-day study interval.

From a global health economic perspective, caring for community-living older people with diabetes has been widely recognized to carry a substantial burden on healthcare resources utilization, which translates into increased overall costs of care. Diabetes increases costs for healthcare, especially among older adults, and costs are further increased when the patient is also undernourished. A systematic review of studies conducted in Europe showed that total costs associated with disease-related under-nutrition in institutionalized and community-dwelling older adults were considerably higher than those of well-nourished adults, largely due to a higher use of health care resources (physician consultations, hospitalizations, health care monitoring, and treatments) [19]. This review further found that interventions to reduce the prevalence of malnutrition, e.g., the use of ONS, led to a decrease in-hospital admissions and medical visits [19]. Another study done retrospectively on US public health data clearly showed that beneficiaries with malnutrition and diabetes had worsened survival and increased healthcare costs [46]. Yet another study from the US showed that older people with diagnosed diabetes incur average medical expenditures of approximately \$ 16,750 per year, of which approximately \$ 9,600 is attributed to diabetes. Notably, people with diagnosed diabetes have average medical expenditures approximately 2.3 times higher than what expenditures would be in the absence of diabetes [47].

Updated Views from around the World on Nutrition Education and Treatments for People with Diabetes

Better understanding of the diabetic condition and its treatments can lead to better nutritional status and muscle mass with metabolic stability-outcomes that are important to older people living in the community. A randomized, controlled trial from Taiwan demonstrated benefits of patient health coaching on nutrition and physical activity; results showed a significant decrease in hemoglobin A1c (HbA1c) levels and improvements in diet quality with implementation of a 6-month health-coaching program [48]. However, there remains room for improvement, as shown in a recent survey of people with diabetes attending an academic medical center in Mexico [49]. While most respondents (90%) in this study agreed that adherence to medication would control diabetes and improve quality of life, 30% to 40% were not certain that it would translate to fewer disease complications [49]. Further, Japanese experts recently proposed that nutrition-focused management of older people with diabetes should be shifted from treating metabolic syndrome to preventing frailty [18]. In fact, both strategies are relevant when applied appropriately to the individual patient's condition of under- or over nutrition in association with diabetes. Taken together, these findings underscore the importance of counseling older patients with diabetes on the importance of healthful diet and physical activity. As well, it appears that undernutrition and frailty threaten longevity more so than overweight in older adults. Further study is needed to confirm this relationship.

Use of QIP to Update and Enhance Nutritional Care

In healthcare, quality is defined by the extent to which health services are consistent with current professional knowledge and increase the likelihood of desired health outcomes for individuals and populations. Quality Improvement (QI) as a QIP is a framework used to systematically improve care. QI seeks to standardize processes and structure to reduce variation, achieve predictable results, and improve outcomes for patients, healthcare systems, and organizations [50]. QIP methods have been widely used to enhance nutritional care in clinical settings-including hospitals, nursing homes, home health, and community settings [40-42,51-54]. In fact, our Colombian team has previously reported use of QIP for nutritional remediation in older malnourished outpatients in Bogotá [26,27]. Such studies have demonstrated patient health benefits such as improved cognitive and physical functions, better affective disorder status, and enhanced health-related quality of life, along with practical benefits such as reduced hospital admissions, emergency department visits, and outpatient visits at clinics [27,28]. As such, strong evidence supports the efficacy and cost-effectiveness of nutrition therapy as a component of quality diabetes care, including its integration into the medical management of diabetes. It is thus important that all members of the health care team know and champion the benefits of

nutrition therapy and key nutrition messages [1].

Strengths and Limitations of this Study

In Colombia and South America, this nutritional study was the first of its kind to focus on patients with diabetes. 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. Like other observational real-world QIP studies, our study had inherent limitations associated with nonrandomized trial designs. Based on our observations of lowered use of healthcare resources, we used cost modeling to estimate associated reductions in costs for care. Other limitations associated with the use of a QIP study design and cost modelling utilized are previously reported [26-28]. Future health economic studies are needed to test the hypothesis that nutrition-focused outpatient care for older, community-living people with diabetes can be directly linked to lowered healthcare costs.

Learnings from our Study Results on Managing Older, Community-living People with Diabetes

Our findings from this nutritionally focused QIP study in Colombia have the following implications for clinical care of older people with diabetes who are living in the community.

- Identification and treatment of nutritional problems can lead to improved outcomes.
- Nutritional screening is now widely used when older adults are admitted to hospitals or care homes. However, routine nutritional screening is not yet common for those receiving care at outpatient clinics or in primary care practices.
- As such, we advise that all older adults with diabetes should be screened routinely for nutritional status during outpatient visits.
- For older, community-living people with diabetes, nutritional counseling and diabetes-targeted nutritional care can lead to better health outcomes with potential for cost savings.
- Since older people with diabetes experience more complications and use more healthcare resources than those without diabetes, further research is needed to confirm and quantify benefits of nutritional care in this at-risk population [55].

CONCLUSION

Nutrition-focused care in outpatient clinics for at-risk/malnourished older Colombian adults with diabetes was associated with improved nutritional outcomes and reduced healthcare resource use, thus supporting health improvement and lowered healthcare costs. These results indicate 'value' in nutritional care for this population, an observation of importance to patients, healthcare systems, and policymakers alike.

CONTRIBUTORS

CCG, GG, LVS, SS and JDM contributed to the development of study proposal and protocol. DAG, LVS and BS performed the analysis of the cohort data and economic analysis. DCC, FBR and EGC contributed to the writing team. CCG, GG, SS, BS and JDM drafted the final manuscript. All authors contributed to the data interpretation, critically revised the manuscript and approved the final version for publication. CCG is the guarantor of this manuscript and accepts full responsibility for the work and the conduct of the study, had access to the data, and controlled the decision to publish. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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CONFLICT OF INTEREST

Drs. Gomez and Sulo and Mr. Misas and Ms. Gracia. 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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