The Prevalence of Malnutrition and its Risk Factors in Elderly Patients with Diabetes and its Association with Glycemic Status and Insulin Resistance

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Abstract

Background. There is an increasing population of elderly patients with diabetes. Malnutrition has been associated to higher morbidity and mortality among these patients. Currently, there are limited data on malnutrition and its risk factors among elderly patients with diabetes in the Philippines.

Objectives. This study determined the prevalence, clinical profile and risk factors associated with malnutrition and identify the association of malnutrition with glycemic status and insulin resistance among elderly patients with diabetes.

Methodology. This is a cross-sectional study involving 117 elderly patients with diabetes seen at a tertiary hospital in Manila, Philippines. Demographic, anthropometric, and clinical data were collected. Mini-Nutritional Assessment-Short form (MNA-SF), Simple FRAIL questionnaire and Mini-cog assessment were administered. Patients were categorized into normal, at risk for malnutrition, and malnourished using the MNA-SF. Comparative and logistic regression analyses were performed to identify the clinical profile and possible risk factors.

Results. The prevalence of malnutrition was 1.71% with 29.06% at risk for malnutrition. There was no significant difference in demographic, anthropometric and biochemical parameters between the different nutrition statuses. High BMI, central obesity, and increased insulin resistance were observed across all nutrition status. Frail patients had almost five times increased likelihood (OR=4.94, *p=0.043*) of developing malnutrition. Good glycemic control had two-fold decreased likelihood (OR=0.44, *p=0.050*) of malnutrition. Insulin resistance was not associated with malnutrition.

Conclusion. Malnutrition is prevalent among elderly patients with diabetes. Frailty and poor glycemic control increased the risk of malnutrition. Therefore, malnutrition screening should be routinely performed among these patients. Diabetes management among elderly patients should include maintaining good glycemic control and preventing frailty and its complications.

Keywords: malnutrition, diabetes mellitus in elderly, glycemic control, insulin resistance

Introduction

The aging population is rapidly growing worldwide. In Asia alone, the Asian Development Bank estimates that by 2050, one in four people will be over 60 years old.[1] While increasing life expectancy may be reflective of improved healthcare systems and technology, this also increases the number of people with multiple comorbidities requiring special attention.

Many factors have been found to affect glycemic control among elderly patients with diabetes. Among which, nutritional status has been shown to have significant impact on diabetes management in this population. Malnutrition was found to be related to longer length of hospital stay and higher mortality among elderly patients with diabetes. Malnutrition was also associated with other mechanisms of aging complicating diabetes management including frailty and cognitive impairment. Kulkarni et al reported that malnourished elderlies are more at risk of developing frailty and this was associated with poor glycemic control.[3] Cognitive impairment, likewise, has an impact in diabetes management as there is a bidirectional relationship between dementia and risk of both hypoglycemia and hyperglycemia. Other risk factors for malnutrition identified in elderly patients with diabetes include a long duration of diabetes and an increased body mass index (BMI).[5] However, some

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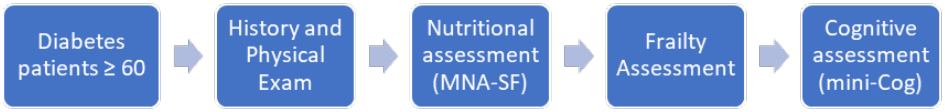

Figure 1. Study Flow

studies showed malnutrition occurred regardless of BMI.[2]

Currently, there are few data on the prevalence of malnutrition especially in the elderly patients with diabetes in the Philippines. A local study by Ramos et al reported the prevalence of malnutrition in hospitalized adults with type 2 diabetes mellitus was 83.8% and this was associated with greater length of stay among these patients.[6] However, this study included all adults with type 2 diabetes mellitus admitted at a tertiary hospital although the mean age of the population was 67.4 years. Likewise, there are limited studies on the impact of malnutrition on the glycemic status and insulin resistance. This study aimed to identify the prevalence of malnutrition among elderly patients with type 2 diabetes mellitus locally and to determine the clinical profile and risk factors associated with malnutrition. This also sought to identify the association between glycemic status and insulin resistance and malnutrition, two conditions commonly present among the elderly population.

Methodology

Subjects and Study Design. This is a cross-sectional study including 117 patients aged 60 years and above diagnosed with Type 2 diabetes mellitus with annual comprehensive medical evaluation done one month from recruitment and referred to the Endocrinology outpatient clinic of a tertiary hospital in Manila, Philippines from January 2022 to June 2024. Sample size was computed based on the study of Mamo, Bekele, Nigussie, & Zewudie (2019) where the odds of good glycemic control with good nutritional status was 2.43, with a null prevalence or proportion of good glycemic control of 31.20%.[7] With the odds ratio, an R^2-value of 0.057 was estimated and with a minimum power of 80% at a significance level of 5% (two-tailed), the sample size with 10% attrition was 73 respondents. Convenience sampling was employed for recruitment of participants. Patients unable to write and follow commands and patients with type 1 diabetes and other types of diabetes were excluded. All patients recruited to the study completed the data collection process.

Data Collection. Medical history was obtained including demographic data (age, gender, socio-economic status, and educational level), duration of diabetes, current treatment regimen, other comorbidities, and lifestyle behaviors (frequency of structured exercise, smoking, and alcohol intake). Recent laboratory evaluation was also collected, including HbA1c, fasting blood glucose and lipid profile.

A physical examination was done composed of blood pressure, heart rate and anthropometric measurements (weight, height, waist circumference, hip circumference). Body mass index, waist-to-height ratio and waist-to-hip ratio were subsequently computed.

A three-part physician-administered questionnaire was administered solely by the primary investigator for all participants to avoid questionnaire bias. English or Tagalog language were also utilized, depending on the participants' language fluency to avoid language bias. Each questionnaire took approximately 5 minutes to complete (*see Figure 1*). It consisted of the following:

1. *The Mini Nutritional Assessment Short Form (MNA-SF)*

This locally validated nutritional screening tool has 92% accuracy in identifying individuals with malnutrition and at risk for malnutrition. It consists of six items pertaining to food intake, involuntary weight loss, mobility, acute disease or psychological stress, neuropsychological problems, and BMI. Respondents are divided into three groups: malnourished (0–7 points), at risk of malnutrition (8–11 points) and normal nutritional status (12–14 points).[8]

2. *The Simple Frail Questionnaire*

This screening tool has a sensitivity of 88%, specificity of 85.71% and accuracy 85.98%.[9] This tool was subjected to a reliability analysis using the Kuder-Ricardson Formula 20 and 0.72 was computed from a subset of 84 participants. It met the minimum reliability coefficient for a previously-developed and adopted instrument. It consists of five questions assessing for fatigue, resistance, aerobic, illness and weight loss. Each 'YES' response corresponds to a score of 1 with a maximum score of 5 and a minimum score of 0. The respondent is considered in the frail group if the total score was 3–5 and non-frail if the total score was 0–2.[9]

3. *The Mini-Cog Assessment*

This assessment tool has been found to be as effective in detecting dementia compared to longer screening and assessment tools. It consists of three-item recall and clock drawing. A total score of 0-2 indicates a positive dementia screen while a score of 3-5 indicates a negative dementia screening.[10]

After data collection, subjects were grouped into different nutritional status. Study variables, glycemic control and insulin resistance were analyzed in each subgroup to identify association with malnutrition.

Definition of Terms

1. *Good glycemic control* – defined by an HBA1c <7.5% based on the ADA guidelines for older adults with type 2 diabetes belonging to category 1 in which all participants were categorized into.[11]

2. *Insulin resistance (IR)* – defined as having a TyG index > 4.68, computed using the formula of ln (TG in mg/dL × FBG in mg/dL/2) as it was reported to have the highest sensitivity (96.5%) and specificity (85.0%) by Guerrero-Romero et al.[12]
3. *Waist-to-height ratio (WHtR)* – computed as waist circumference divided by height as a measure of central obesity. A cut-off of 0.5 was utilized for obesity based on recent study by Cho et al.[13]
4. *Waist-to-hip ratio (WHR)* – computed as waist circumference divided by hip circumference to identify central obesity. A cut-off of 0.90 in men and 0.85 in women was utilized based on a local study by Toledano and Vilela.[14]

Statistical Analysis. Statistical analyses were performed using *STATA MP – Parallel Edition Statistical Software*, Version 18, College Station, TX: *StataCorp LP*. A $p \leq 0.05$

Table I. Demographic and Clinical Characteristics according to Nutrition Status (N = 117)

Demographic and Clinical Characteristics	Nutrition Status (N = 117) Normal (n = 81)	At Risk (n = 34)	Malnourished (n = 2)	Total (N = 117)	Test Statistic	*p*-value (Two-Tailed)
Age (Years; $\bar{x}$, SD)	67.11 (5.92)	68.18 (6.12)	69.00 (0.00)	67.45 (5.92)	0.45	0.637
Sex (*f*, %)					1.33	0.644
Male	30 (37.04%)	11 (32.35%)	0 (0.00%)	41 (35.04%)		
Female	51 (62.96%)	23 (67.65%)	2 (100.00%)	76 (64.96%)		
Educational Attainment (*f*, %)					1.95	0.743
Primary Education	16 (19.75%)	7 (20.59%)	0 (0.00%)	20 (19.66%)		
Secondary Education	25 (30.86%)	14 (41.18%)	1 (50.00%)	40 (34.19%)		
Tertiary Education	40 (49.38%)	13 (38.24%)	1 (50.00%)	54 (46.15%)		
Socio-economic status (*f*, %)					3.11	0.231
Low socio-economic status	50 (61.73%)	20 (58.82%)	0 (0.00%)	70 (59.83%)		
High socio-economic status	31 (38.27%)	14 (41.18%)	2 (100.00%)	47 (40.17%)		
Comorbidities (*f*, %)						
Hypertension	58 (71.60%)	23 (67.65%)	2 (100.00%)	83 (70.94%)	1.02	0.830
Heart Disease	16 (19.75%)	11 (32.35%)	0 (0.00%)	27 (23.08%)	2.75	0.262
Chronic Kidney Disease	10 (12.35%)	8 (23.53%)	0 (0.00%)	18 (15.38%)	2.67	0.289
Liver Disease	2 (2.47%)	0 (0.00%)	0 (0.00%)	2 (1.71%)	0.90	1.000
Stroke	0 (0.00%)	1 (2.94%)	0 (0.00%)	1 (0.85%)	2.46	0.308
Smoking History (*f*, %)	16 (19.75%)	8 (23.53%)	1 (50.00%)	25 (21.37%)	1.20	0.392
Alcohol History (*f*, %)	6 (7.41%)	4 (11.76%)	0 (0.00%)	10 (8.55%)	0.77	0.564
Exercise History (*f*, %)	23 (28.40%)	7 (20.59%)	0 (0.00%)	30 (25.64%)	1.47	0.717

Note: high socioeconomic status pertains to income above minimum monthly wage mandated by the Department of Labor and Employment
*Significant at $p < 0.05$

Table II. Anthropometric and Biochemical Parameters according to Nutrition Status (N = 117)

Anthropometric and Biochemical Parameters	Nutrition Status (N = 117) Normal (n = 81)	At Risk (n = 34)	Malnourished (n = 2)	Total (N = 117)	Test Statistic	*p*-value (Two-Tailed)
Vital Signs and Anthropometric Measurements						
SBP (mmHg; $\bar{x}$, SD)	124.20 (14.48)	122.35 (14.72)	120.00 (14.14)	123.59 (14.45)	0.25	0.776
DBP (mmHg; $\bar{x}$, SD)	78.02 (7.44)	74.71 (0.51)	80.00 (0.00)	77.09 (8.49)	1.98	0.143
Heart Rate (bpm; Md, IQR)	78.00 (70.00 – 84.00)	73.50 (68.00 – 83.00)	92.00 (84.00–100.00)	78.00 (70.00 – 84.00)	3.63	0.163
Height (Meters; $\bar{x}$, SD)	1.60 (0.07)	1.60 (0.07)	1.72 (0.12)	1.60 (0.07)	2.79	0.066
Weight (Kilograms; $\bar{x}$, SD)	64.40 (11.18)	61.45 (12.00)	71.35 (1.91)	63.66 (11.40)	1.27	0.285
BMI (kg/m^2; $\bar{x}$, SD)	25.22 (3.71)	23.86 (4.25)	24.40 (2.76)	24.81 (3.88)	1.49	0.230
Underweight	0 (0.00%)	2 (5.88%)	0 (0.00%)	2 (1.71%)	7.34	0.225
Normal	27 (33.33%)	15 (44.12%)	1 (50.00%)	43 (36.75%)		
Overweight	18 (22.22%)	5 (14.71%)	0 (0.00%)	23 (19.66%)		
Obese	36 (44.44%)	12 (35.29%)	1 (50.00%)	49 (41.88%)		
WC (Centimeters; $\bar{x}$, SD)	90.76 (10.20)	92.00 (11.86)	104.15 (14.35)	91.35 (10.80)	1.60	0.206
HC (Centimeters; $\bar{x}$, SD)	99.64 (8.62)	100.36 (11.54)	113.04 (8.97)	100.07 (9.63)	1.94	0.148
WHR ($\bar{x}$, SD)	0.91 (0.07)	0.92 (0.07)	0.92 (0.06)	0.91 (0.07)	0.11	0.898
WHtR ($\bar{x}$, SD)	0.57 (0.07)	0.57 (0.07)	0.61 (0.13)	0.57 (0.07)	0.45	0.640
Laboratory Test Results						
FBG (mg/dL; $\bar{x}$, SD)	140.92 (56.29)	148.04 (67.29)	194.74 (93.71)	143.91 (60.04)	0.90	0.411
Triglycerides (mg/dL; $\bar{x}$, SD)	142.18 (97.23)	144.74 (101.94)	118.00 (41.01)	142.51 (97.48)	0.07	0.931

SBP - systolic blood pressure; DBP - diastolic blood pressure; BMI - body mass index; WC - waist circumference; HC - hip circumference; WHR - waist to hip ratio; WHtR - waist to height ratio; FBG - fasting blood glucose
*Significant at $p < 0.05$

Table III. Other risk factors according to nutrition status N = 117)

Risk Factors	Malnutrition Status (N = 117)				Test Statistic	*p*-value (Two-Tailed)
	Normal (n = 81)	At Risk (n = 34)	Malnourished (n = 2)	Total (N = 117)		
Frailty Score ($\bar{x}$, SD)	0.54 (0.78)	1.24 (0.96)	2.50 (0.71)	0.78 (0.91)	12.68*	0.001
Frailty Status (*f*, %)					10.41*	0.025
Non-Frail	79 (97.53%)	31 (91.18%)	1 (50.00%)	111 (94.87%)		
Frail	2 (2.47%)	3 (8.82%)	1 (50.00%)	6 (5.13%)		
Mini-Cog Assessment ($\bar{x}$, SD)	3.27 (1.52)	2.97 (1.73)	4.50 (0.71)	3.21 (1.58)	1.12	0.329
Dementia Screening Status (*f*, %)					1.17	0.778
Negative for Dementia	51 (62.96%)	22 (64.71%)	2 (100.00%)	75 (64.10%)		
Positive for Dementia	30 (37.04%)	12 (35.29%)	0 (0.00%)	42 (35.90%)		

*Significant at $p < 0.05$

Table IV. Diabetes status according to Nutrition Status (N = 117)

Parameter	Malnutrition Status (N = 117)				Test Statistic	*p*-value (Two-Tailed)
	Normal (n = 81)	At Risk (n = 34)	Malnourished (n = 2)	Total (N = 117)		
Duration of Diabetes (Years; $\bar{x}$, SD)	12.35 (8.57)	13.50 (7.80)	15.00 (7.07)	12.73 (8.29)	0.30	0.738
Diabetes Medications (*f*, %)					4.46	0.226
Insulin	3 (3.75%)	1 (2.94%)	0 (0.00%)	4 (3.45%)		
OHA	57 (1.25%)	18 (52.94%)	1 (50.00%)	76 (65.52%)		
Combined Insulin and OHA	20 (25.00%)	15 (44.12%)	1 (50.00%)	36 (31.03%)		
TyG Index ($\bar{x}$, SD)	4.87 (0.28)	4.86 (0.39)	4.97 (0.43)	4.87 (0.32)	0.13	0.879
Insulin Resistance Status (*f*, %)					1.55	0.343
Without Insulin Resistance	19 (23.46%)	11 (32.35%)	1 (50.00%)	31 (26.50%)		
With Insulin Resistance	62 (76.54%)	23 (67.65%)	1 (50.00%)	86 (73.50%)		
HbA1c (%; $\bar{x}$, SD)	7.32 (1.69)	7.72 (1.68)	8.60 (3.96)	7.46 (1.72)	1.09	0.340
Glycemic Control Status (*f*, %)					3.93	0.093
Poor Glycemic Control	23 (28.40%)	16 (47.06%)	1 (50.00%)	40 (34.19%)		
Good Glycemic Control	58 (71.60%)	18 (52.94%)	1 (50.00%)	77 (65.81%)		

OHA - oral hypoglycemic agent; HbA1c - glycated hemoglobin
*Significant at $p < 0.05$

was considered statistically significant. Descriptive statistics included frequency and percentage for nominal data; median and interquartile range for ordinal and non-normal, continuous data, and mean and standard deviation for normally-distributed, continuous-level variables. The testing for prevalence of malnutrition was also determined alongside its 95% confidence interval.[15]

Comparative analyses of the demographic and clinical characteristics and clinical outcomes according to the nutrition status (normal, at-risk, and malnourished) were conducted using One-Way Analysis of Variance (for continuous data with normal distribution), Kruskall-Wallis H Test (for continuous data with non-normal distribution and ordinal data), and Chi-Square Test of Homogeneity or Fisher's Exact Test (for nominal data), if the assumption of more than 80% of the cells had an expected frequency of < 5 was not met.[15] Polynomial and binary logistic regression analysis were conducted to determine the association between malnutrition defined by the MNA-SF and the risk factors, insulin resistance and glycemic control.[15]

Ethical Considerations. This study adhered to the ethical considerations and ethical principles set out in relevant guidelines, including the Declaration of Helsinki, WHO guidelines, International Conference on Harmonization-Good Clinical Practice, Data Privacy Act of 2012, and National Ethics Guidelines for Health Research 2017. The study only commenced upon the approval of the Chinese General Hospital and Medical Center Research Ethics Review Board (CGHMC RERB2021-F-72). Results and patient information were maintained confidential by the primary investigator. Data were encoded and kept in a password-protected spreadsheet.

Results

The prevalence of malnutrition in this study defined by the MNA-SF was 1.71%, with 29.06% at-risk for malnutrition and 69.23% with normal nutritional status.

The demographic and clinical characteristics of the participants according to nutrition status is shown in *Table I*. The mean age of the participants was 67.65 years (SD=5.92). Majority were females (64.96%), completed tertiary level education (46.15%), and belonged to a low socio-economic class (59.83%). The most common comorbidities were hypertension (70.94%), heart disease (23.08%), and chronic kidney disease (15.38%). Comparative analyses of demographic and clinical

Table V. Univariate Polynomial Logistic Regression Analyses of Risk Factors Associated with Malnutrition (N = 117)

Characteristics	Malnutrition Status (At-Risk to Malnourished)	
	Odds Ratio (OR)	*p*-value (Two-Tailed)
Age (Years)	1.03	0.351
Sex (Female)	1.34	0.498
Educational Attainment		
Primary Education	Reference	–
Secondary Education	1.37	0.572
Tertiary Education	0.80	0.685
High socio-economic status	1.29	0.530
Duration of Diabetes (Years)	1.02	0.456
Comorbidities (*f*, %)		
Hypertension	0.90	0.812
Heart Disease	1.79	0.204
Chronic Kidney Disease	2.03	0.177
Breast Cancer	0.74	0.800
Diabetes Medications		
Insulin	Referent	–
OHA	1.00	1.000
Combined Insulin and OHA	2.40	0.467
Smoking History	1.35	0.524
Alcohol History	1.56	0.511
Exercise History	0.61	0.309
Vital Signs and Anthropometric Measurements		
SBP	0.99	0.494
DBP	0.96	0.079
Heart Rate	0.99	0.623
Height	13.13	0.359
Weight	0.98	0.294
BMI	0.91	0.091
WC	1.02	0.376
HC	1.02	0.460
WHR	3.58	0.614
WHtR	5.70	0.568
Laboratory Test Results		
FBG	1.01	0.422
Triglycerides	1.01	0.956
Frailty Score	2.57*	0.001
Frailty Status (Frail)	4.94*	0.043
Mini-Cog Assessment	0.92	0.493
Dementia Screening Status (*Positive*)	0.85	0.700

OHA - oral hypoglycemic agent; SBP - systolic blood pressure; DBP - diastolic blood pressure; BMI - body mass index; WC - waist circumference; HC - hip circumference; WHR - waist to hip ratio; WHtR - waist to height ratio; FBG - fasting blood glucose

*Significant at $p < 0.05$

Table VI. Univariate Polynomial Logistic Regression Analyses of the Associations of Glycemic Control and Insulin Resistance with Malnutrition (N = 117)

Characteristics	Malnutrition Status (At-Risk to Malnourished)	
	Odds Ratio (OR)	*p*-value (Two-Tailed)
TyG Index	0.96	0.951
Insulin Resistance Status (*With Resistance*)	0.61	0.266
Glycosylated Hemoglobin (HbA1c)	1.16	0.198
Glycemic Control Status (*Good Control*)	0.44*	0.050

*Significant at $p<0.05$

characteristics showed no significant difference between the different nutrition status ($p > 0.05$).

Anthropometric data presented in *Table II* showed a mean BMI 24.81 kg/m^2 (SD=3.88), with almost half of the participants being obese (41.88%). The mean waist and hip circumference were 91.35 centimeters (SD=10.80) and 100.07 centimeters (SD=9.63) with the mean computed waist-hip ratio and waist-height ratio were 0.91 (SD=0.07) and 0.57 (SD=0.07), denoting a high proportion of central obesity. No significant difference between the different nutrition groups was observed ($p > 0.05$).

The evaluation of other risk factors is depicted in *Table III* where frailty was observed in 5.13% of the participants and dementia screening was positive for 35.90%. Post-hoc analyses, using Bonferroni adjustment, indicated that the mean frailty score of those at-risk for malnutrition ($\bar{x}$=1.24, SD=0.96; t=4.08, $p=0.001$) and malnourished ($\bar{x}$=4.50, SD=0.71; t=3.29, $p=0.004$) were significantly higher than those with normal nutritional status ($\bar{x}$=0.54, SD=0.78). Furthermore, the proportion of participants classified as frail was significantly higher among those who were malnourished (50.00%, $p=0.001$).

The diabetes status of participants is depicted in *Table IV*. The mean duration of diabetes mellitus among the participants was 12.73 years (SD=8.29), and most were on oral hypoglycemic agents alone (65.52%). The mean TyG index was 4.87 (SD=0.32) with 73.50% of the participants having insulin resistance. The mean HbA1c was 7.46 (SD=1.72), with 34.19% of participants classified to have poor glycemic control. No significant difference was seen across the different nutrition status ($p>0.05$).

Table V shows the univariate binary logistic regression analyses performed to identify risk factors for malnutrition in this study. Frailty score (OR=2.57, $p=0.001$) and frailty status (OR=4.94, $p=0.043$) were found to be significantly associated with the risk of malnutrition. Results demonstrated that every 1-unit increase in frailty score led to 2.57-times increase in the likelihood of being malnourished and indicated that frail patients were 4.94-times at greater odds of being malnourished.

Univariate binary logistic regression analyses were also performed to identify the association of glycemic control and insulin resistance with malnutrition as presented in Table 6. Results showed that glycemic control was

statistically associated with nutrition status, indicating that those with poor glycemic control had 2.27-times increased likelihood of being malnourished compared to those with poor glycemic control.

Discussion

The prevalence of malnutrition and at risk for malnutrition among elderly patients with diabetes in this study was 30.7%. This is like the prevalence reported by Nguyen et al among Vietnamese population (31%) but slightly higher than that reported by Praneetvatakul et al among Thai patients (23.1%).[12,17] The high proportion of older patients with diabetes found to be malnourished highlights the importance of screening for malnutrition despite commonly presenting with overweight or obese. These patients would often present with complications such as diabetic gastroparesis and take antidiabetic medication with side effects on the gastrointestinal system which may increase their risk for malnutrition.[18]

Across the different nutrition status, High BMI and central obesity were observed. This finding is consistent with the findings of Tyrovolas et al where diabetes was associated with central obesity in adults aged 50 years and older across nine countries included in their study.[19] The association of obesity with type 2 diabetes is due to the role of long duration and visceral type of obesity in the pathogenesis of diabetes and the diabetes treatment that may contribute to further weight gain.[20] A high proportion of participants was also found to be insulin resistant as reflected by a high TyG index and this can be attributed to skeletal muscle dysfunction that occur with aging, in addition to the contribution of abdominal obesity.[21,22]

Among the risk factors investigated in the study, frailty was found to be significantly associated with malnutrition. This finding is similar to Vietnamese study where those with frailty had 8.45 times increased odds of malnutrition risk.[12] Frailty had been identified by several studies as a risk factor for malnutrition in older adults and because diabetes is associated with an increased risk of frailty.[23,24] This implies that frailty plays a role in the development of malnutrition in older patients with diabetes. This study however did not find an association between cognitive impairment and malnutrition as opposed to the findings of Nguyen et al.[12] This may be due to the small number of malnourished participants and a predominance of participants with high BMI. A recent study found that obesity was associated with greater cognitive function among patients with diabetes and attributed this protective effect of higher BMI to a greater total brain volume among these patients.[25]

This study also failed to identify any association between demographic data and malnutrition. This is in contrast with the findings in Iraqi and Nigerian populations where increasing age was associated with higher risk for malnutrition.[18,26] This may be due to a small number of participants aged 70 years and older included in this study.

This study found that good glycemic control was associated with lower risk of malnutrition. This finding is similar to a local unpublished study that investigated the nutritional status of patients with diabetes and found severe malnutrition to be associated with poor glycemic control (personal communication). Similarly, Ayub et al and Junaid et al found that uncontrolled diabetes increased malnutrition risk.[18,26] Poor glycemic control is often associated with complications in diabetes such as gastroparesis which often lead to malnutrition.[27,28] However, a recent study in a Thai population investigated the association of glycemic control and malnutrition among older patients with diabetes and found no significant association and also reported no oral, digestive, chronic pain among patients with malnutrition.[29] This suggests further studies are needed to identify a clear association between glycemic status and malnutrition.

Insulin resistance was not associated with malnutrition in this study. This suggests that insulin resistance does not contribute to the mechanism of malnutrition in this population. Geng et al found that nutritional risk among elderly patients with diabetes was associated with worse islet function and not with insulin sensitivity.[30]

This study had several limitations including a cross-sectional design which precludes conclusions regarding any causal associations between the risk factors; a small sample size; and the use of convenience sampling which led to a small number of malnourished participants. This study also did not utilize objective measurements of malnutrition and frailty such as loss of muscle mass and hand grip strength which may improve detection of malnutrition and frailty among participants. Confounding factors, including specific oral hypoglycemic agents and other medications which patients may have been taking and may have affected some variables were overlooked.

Conclusion

Malnutrition is prevalent among elderly patients with diabetes. Frailty and poor glycemic control were associated with higher risk of malnutrition. These findings support the inclusion of nutritional assessment among elderly patients with diabetes to alleviate the complications of malnutrition. Evaluating for frailty and achieving good glycemic control are also underscored to reduce the risk of malnutrition.

Conflicts of Interest. The authors declared no conflicts of interest and assume full responsibility for the contents of this manuscript. No funding was received during and upon completion of the study.

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