

Assessment of Malnutrition and its Determinants among Patients with Type 2 Diabetes seen in Primary Care Settings of Eastern Uttar Pradesh, India

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Abstract

Background

Malnutrition is an under-recognized yet clinically significant problem among patients with Type 2 Diabetes Mellitus (T2DM), particularly in low-resource settings.

Objective

To assess malnutrition among patients with Type 2 Diabetes Mellitus attending primary health care facilities in Gorakhpur, Eastern Uttar Pradesh, and to identify associated determinants.

Methods

A cross-sectional observational study was conducted among patients with Type 2 Diabetes Mellitus(T2DM) attending three primary health care centres from April, 2024 to December 2024. Data on socio-demographic characteristics, clinical profile, and anthropometric measurements were collected. Patients were evaluated for malnutrition using Malnutrition Universal Screening Tool(MUST), a screening tool to identify adults at risk of malnutrition. Associations between malnutrition risk and explanatory variables were examined using chi-square or Fisher's exact test, with a p-value < 0.05 considered statistically significant.

Results

A total of 152 patients with T2DM were included with a near equal ratio of males and females (1.1:1). The mean age of the participants was 53.92 ± 15.02 years with half (50.0%) belonging to lower or lower middle class and majority (80.0%) belonging to rural background. Using the MUST score, 29.6% of the participants were having malnutrition risk with 13.8% having high risk. Rural residence ($p = 0.04$), lower income ($p = 0.01$), lower socioeconomic status ($p = 0.02$), presence of comorbidities ($p = 0.003$), lower BMI ($p < 0.001$), absence of abdominal obesity ($p = 0.04$), and lower mid-upper arm circumference ($p = 0.01$) were significantly associated with higher malnutrition risk.

Conclusion

One in every three individuals with type 2 diabetes seen in primary care is at risk of malnutrition. Routine nutritional screening using simple tools such as MUST should be integrated into primary care and outpatient diabetes care, particularly for socioeconomically vulnerable and high-risk groups in order to address this problem.

Introduction

Malnutrition refers to a state in which the body's nutritional needs are not adequately met due to insufficient dietary intake, impaired absorption, or altered utilization of nutrients [1]. It remains a major public health concern worldwide. The World Health Organization (WHO) describes malnutrition as a cellular imbalance between nutrient and energy supply and the body's requirements for growth, maintenance, and specific physiological functions, encompassing both undernutrition and excess nutrition, including overweight and obesity [2]. The American Society for Parenteral and Enteral Nutrition (ASPEN) characterizes malnutrition as the presence of at least two clinical features such as inadequate energy intake, unintended weight loss, loss of muscle mass, depletion of subcutaneous fat, fluid accumulation, or reduced handgrip strength [3]. The Global Nutrition Report 2020 highlights that India is among 88 countries projected to fall short of achieving the global nutrition targets established by the World Health Assembly for 2025 [4].

Diabetes Mellitus, particularly type 2 diabetes (T2DM), represents a substantial and growing burden on health systems globally. According to the International Diabetes Federation (IDF) Diabetes Atlas 2025, approximately 589 million adults are currently living with diabetes worldwide, and this number is expected to rise to 853 million by 2050, with India accounting for a significant proportion of this increase [5, 6]. The financial implications are considerable, including direct medical costs related to treatment and complications, as well as indirect costs arising from disability, premature mortality, and diminished quality of life.

Nutritional status plays a critical role in the overall well-being and clinical outcomes of individuals with T2DM. Appropriate nutrition influences glycaemic control, risk of complications, and disease progression. However, dietary restrictions aimed at improving glycaemic parameters or reducing body weight may unintentionally result in inadequate intake of essential nutrients if not carefully individualized. Furthermore, persistent hyperglycaemia, recurrent infections, gastrointestinal symptoms, unintended weight loss, and coexisting chronic conditions may further compromise nutritional status in patients with T2DM [7]. Emerging research indicates that malnutrition among individuals with diabetes is not uncommon and is associated with poorer glycaemic control, reduced functional capacity, increased complication rates, and lower quality of life [8].

Despite its clinical importance, malnutrition in people with diabetes often goes unrecognized, particularly in outpatient and primary care settings where attention is frequently focused on overweight and obesity. Evidence suggests that nutritional risk can exist even among individuals with normal or elevated body mass index, a condition sometimes referred to as "hidden malnutrition" or sarcopenic obesity [9, 10]. Sole reliance on anthropometric measures such as BMI may therefore overlook individuals at nutritional risk, emphasizing the need for comprehensive and validated screening approaches.

The Malnutrition Universal Screening Tool (MUST), developed by the British Association for Parenteral and Enteral Nutrition (BAPEN), is a practical and validated instrument intended for use in both community and clinical settings. It evaluates malnutrition risk based on three components: body mass

index, unintentional weight loss, and the impact of acute disease, allowing individuals to be classified as low, medium, or high risk [11]. MUST has been validated across various populations and healthcare contexts and is recommended for routine nutritional assessment in adults [12]. Its simplicity and ease of use make it especially appropriate for primary healthcare and resource-constrained environments.

In the Indian context, data regarding malnutrition among patients with T2DM remain limited, particularly at the primary care level. Most existing studies have been conducted in tertiary care or hospital-based settings, which may not adequately represent patients receiving care at frontline health facilities. Assessing the magnitude and determinants of malnutrition among individuals with T2DM in primary healthcare settings is crucial for informing targeted interventions and strengthening integrated non-communicable disease management. Against this backdrop, the present study was undertaken to evaluate the risk of malnutrition among patients with T2DM attending primary healthcare facilities in district Gorakhpur, Uttar Pradesh, and to identify associated socio-demographic and clinical factors.

Material & Methods

Study Design and Setting

A facility-based cross-sectional observational study was conducted out at three primary health care facilities under the Department of Community and Family Medicine, AIIMS Gorakhpur, Uttar Pradesh, India. These included two Rural and one Urban Primary Health Centres. These centres cater predominantly to populations from **lower and middle socioeconomic strata**, with a large proportion residing in rural areas. The facilities provide outpatient services for non-communicable diseases, including diabetes, under routine primary care services.

Study Duration

The study was conducted over a period of nine months from April, 2024 to December, 2024.

Study Population

The study population comprised adult patients diagnosed with Type 2 Diabetes Mellitus attending the selected primary health care facilities during the study period.

Eligibility Criteria

Inclusion Criteria

- Adults aged 18 years and above
- Diagnosed cases of Type 2 Diabetes Mellitus for at least six months

- Patients attending the selected primary health care facilities during the study period
- Patients who provided written informed consent

Exclusion Criteria

- Patients with cognitive impairment or psychiatric illness affecting comprehension or response
- Pregnant women
- Severely ill patients requiring emergency or inpatient care
- Patients unwilling to participate in the study

Sample Size and Sampling Technique

The sample size was calculated using prevalence data from a previous Indian study from Mumbai that assessed malnutrition risk among patients with T2DM using the MUST, which reported a prevalence of 10.1% [13]. Assuming a confidence level of 95%, power of 80%, and allowable error of 5%, the minimum sample size was estimated to be 138 using OpenEpi software (version 2.3). To account for non-response by taking non-response rate as 10%, a total of **152 participants** were included in the study.

A **consecutive sampling technique** was employed, wherein all eligible patients attending the selected facilities during the study period were approached and enrolled until the desired sample size was achieved. Efforts were made to ensure representation from both rural and urban settings.

Study Tools and Data Collection

Data were collected using a **pre-tested, structured questionnaire**, administered through face-to-face interviews by the study investigators (Supplementary file 1). The questionnaire consisted of three sections:

1. Socio-demographic Characteristics

Information was collected on age, gender, religion, place of residence (rural/urban), marital status, level of education, occupation, type of family, and total monthly household income. Socioeconomic status was assessed using the **Modified BG Prasad Scale**, updated for the year 2024 [14].

2. Clinical and Anthropometric Details

Clinical information included duration of diabetes, treatment details, and presence of comorbidities such as hypertension, coronary artery disease, thyroid disorders, and other chronic conditions (multiple responses allowed).

Anthropometric measurements were recorded following standard procedures:

- Weight was measured using a calibrated digital weighing scale to the nearest 0.1 kg, with participants wearing light clothing and no footwear.
- Height was measured using a Stedimeter to the nearest 0.1 cm.
- Body Mass Index (BMI) was calculated as weight (kg) divided by height squared (m^2) and categorized using Asian BMI cut-offs [15].
- Waist circumference was measured using a non-stretchable measuring tape at the midpoint between the lowest rib and the iliac crest. Abdominal obesity was defined as waist circumference > 90 cm for males and > 80 cm for females [15].
- Mid-Upper Arm Circumference (MUAC) was measured at the midpoint between the acromion and olecranon process of the non-dominant arm using a flexible measuring tape.

All measurements were taken twice, and the average was recorded to minimize measurement error.

3. Assessment of Malnutrition Risk

Nutritional risk was assessed using the **Malnutrition Universal Screening Tool (MUST)**, a validated screening tool developed by the British Association for Parenteral and Enteral Nutrition (BAPEN)(11).

The MUST assesses three core areas namely: body mass index (BMI), unintentional weight loss in the past 3–6 months and acute illness or likelihood of no nutritional intake for 5 or more days. The scores for these three categories are calculated as:

1. BMI score:-

BMI(in kg/m^2) - score

>20 = 0

18.5 -20 = 1

<18.5 = 2

2. Weight loss score:-

Weight loss in past 3-6 months

% - score

<5 = 0

5-10 = 1

>10 = 2

3. Acute disease effect score:-

and the socioeconomic distribution, as per BG Prasad scale, indicated that 29.28% were middle class, while 20% each were in the upper-middle and lower-middle classes(Table 1).

Table 1
Socio-demographic, Clinical, and Anthropometric characteristics of the study population (n = 152) * Multiple responses possible **Waist circumference: Male > 90 cm, Female > 80 cm

Variables	Frequency (n)	Percentage (%)
<i>Age-groups (in years)</i>		
18–40	20	15.00
41–59	65	47.14
≥ 60	67	37.85
<i>Gender</i>		
Male	81	53.57
Female	71	46.42
<i>Religion</i>		
Hinduism	129	90.71
Islam	23	16.42
Others	00	0.0
<i>Place of residence</i>		
Rural	104	65.00
Urban	48	35.00
<i>Marital status</i>		
Unmarried	02	1.42
Currently married	138	93.57
Widowed/separated/divorced	12	5.00
<i>Level of education</i>		
Illiterate/no formal education	54	35.5
Primary school	22	14.5
High school	45	29.6
Intermediate/Diploma	11	7.2
Graduate and above	20	13.2
<i>Occupation</i>		
Unemployed/housewife	82	53.9
Unskilled labour	03	02.0

Variables	Frequency (n)	Percentage (%)
Semiskilled/skilled labour	19	12.5
Shopkeeper/farmer/businessman	39	25.7
Professional	09	05.9
<i>Type of Family</i>		
Nuclear	41	25.71
Joint	71	47.14
Three-generation	40	27.14
<i>Total monthly income (in INR)</i>		
< 10,000	101	79.28
10,000- 20000	32	17.85
> 20000	19	02.85
<i>Socio-economic status(as per BG Prashad scale)</i>		
Upper class	29	20.71
Upper middle class	39	27.85
Middle class	48	29.28
Lower middle class	28	20.00
Lower class	8	02.14
<i>Duration of illness (in years)</i>		
< 1	6	07.85
1–5	99	62.85
> 5	47	20.00
<i>Co-morbidities*</i>		
Hypertension	73	47.85
Coronary artery disease	05	03.57
Thyroid disorders	05	03.57
Others	20	10.71
Nil	50	34.28
<i>BMI categories</i>		

Variables	Frequency (n)	Percentage (%)
Underweight (< 18.5 Kg/m ²)	13	09.28
Normal (18.5–22.9 Kg/m ²)	39	20.71
Overweight (23.0-24.9 Kg/m ²)	38	28.57
Obese (≥ 25 Kg/m ²)	62	41.42
<i>Abdominal obesity**</i>		
Present	87	59.28
Absent	65	40.72
<i>Mid upper arm circumference (in cm)</i>		
< 20	05	4.28
20–29	114	72.14
> 30	33	23.57

The mean duration of diabetes was 5.02 ± 4.64 years ranging from 6 months to 22 years. Nearly 63% had diabetes for five years or less. Hypertension (47.85%) was the most common comorbidity, followed by thyroid disorders and coronary artery disease (3.57% each).

Anthropometric assessment showed that 41.42% were obese, and 59.28% had abdominal obesity. Using MUAC, 72.14% fell in the 20–29 cm category (Table 1).

Nutritional Status Based on MUST Component and scores

Based on Individual Malnutrition Universal Screening Tool (MUST) components:

BMI score

83.57% scored 0 (low risk), while 10% scored 2 (high risk)

Weight loss score

84.28% scored 0, while remaining 13.57% scored 1.

Acute disease effect

94.28% had a score of 0; only 5.71% scored 2 (Table 2).

Table 2
MUST scores of the study participants under the individual categories(n = 140)

MUST categories score	Frequency	Percentages
BMI score		
0	117	83.57
1	9	06.42
2	14	10.00
Weight loss score		
0	118	84.28
1	19	13.57
2	03	02.14
Acute disease score		
0	132	94.28
2	08	05.71

Based on the total MUST score, 70.4% were at low risk, 15.8% at medium risk, and 13.8% were at high risk of malnutrition (Fig. 1)

Factors Associated with Malnutrition Risk

Socio-demographic Factors

Place of residence showed a significant association($p = 0.04$), with a higher proportion of medium/high-risk individuals residing in rural areas. Income was significantly associated with malnutrition risk ($p = 0.01$), with lower income groups demonstrating higher risk. Similarly, socioeconomic status also showed significant association ($p = 0.02$); lower classes had higher malnutrition risk(Table 3).

Table 3

Association of risk of Malnutrition with Socio-demographic and clinical characteristics (N = 152)

Variables	Risk category			p-value
	Low risk (n = 107)	Medium/ High risk(n = 45)	Total	
	N(%)	N(%)	N(%)	
Age-groups (in years)				
18–40	13(61.9)	07(38.1)	20(100.0)	0.38
41–59	50(77.3)	15(22.7)	65(100.0)	
≥ 60	44(73.6)	23(26.4)	67(100.0)	
Gender				
Male	59(77.34)	22(22.66)	81(100.0)	0.48
Female	48(69.23)	23(30.76)	71(100.0)	
Education level				
Illiterate/no formal education	35(68.08)	19(31.91)	54(100.0)	0.82
Upto primary	17(75)	05(25)	22(100.0)	
High school	32(91.66)	13(08.33)	45(100.0)	
Intermediate/diploma	08(80)	03(20)	11(100.0)	
Graduate & above	15(78.94)	05(21.05)	20(100.0)	
Occupation				
Unemployed/housewife	55(56.75)	27(43.24)	82(100.0)	0.92
Unskilled labour	02(66.66)	01(33.33)	03(100.0)	
Semiskilled/skilled labour	14(57.89)	05(42.10)	19(100.0)	
Shopkeeper/farmer/businessman	29(65.71)	10(34.28)	39(100.0)	
Professional	07(55.55)	02(44.44)	09(100.0)	
Type of Family				
Nuclear	33(83.33)	08(16.66)	41(100.0)	0.21
Joint	46(69.69)	25(30.30)	71(100.0)	
Three-generation	28(71.05)	12(28.94)	40(100.0)	
Religion				
<i>*Statistically significant</i>				

Hinduism	95(71.65)	44(28.34)	139(100.0)	0.11
Islam	12(92.30)	1(7.69)	13(100.0)	
Place of residence				
Rural	68(69.23)	36(30.76)	104(100.0)	0.04*
Urban	39(81.63)	09(18.36)	48(100.0)	
Marital status				
Unmarried/divorced/widowed	09(55.55)	05(44.44)	14(100.0)	0.42
Currently married	98(74.80)	40(25.20)	138(100.0)	
Duration of illness(in years)				
≤ 5	73(73.5)	32(26.5)	105(100.0)	0.72
> 5	34(82.9)	13(17.1)	47(100.0)	
Comorbidity				
Present	64(65.21)	38(34.78)	102(100.0)	0.003*
Absent	43(89.58)	7(10.41)	50(100.0)	
Income (in INR)				
< 10,000	70(68.00)	31(32.00)	101(100.0)	0.01*
10000–19999	19(82.60)	04(17.39)	32(100.0)	
≥ 20000	18(94.11)	01(05.88)	19(100.0)	
Socioeconomic status				
Upper class(I)	27(93.10)	02(06.89)	29(100.0)	0.02*
Upper middle class(II)	26(66.66)	13(33.33)	39(100.0)	
Middle class(III)	31(75.60)	10(24.39)	41(100.0)	
Lower middle class(IV)	18(64.28)	10(35.71)	28(100.0)	
Lower class(V)	1(33.33)	2(66.66)	03(100.0)	
BMI Category				
Underweight /Normal	24(47.61)	28(52.38)	52(100.0)	< 0.001*
Overweight/Obese	83(84.46)	17(15.30)	100(100.0)	
Abdominal Obesity				
Present	67(77.0)	20(23.0)	87(100.0)	0.04*
<i>*Statistically significant</i>				

Absent	40(61.5)	25(38.5)	65(100.0)	
MUAC (in cm)				
< 30 cm	78(69.15)	41(30.84)	119(100.0)	0.01*
≥ 30 cm	29(87.87)	4(12.12)	33(100.0)	
<i>*Statistically significant</i>				

Variables such as age, gender, education, occupation, family type, religion, marital status, and duration of illness were not significantly associated ($p > 0.05$).

Clinical and Anthropometric Factors

Significant associations were found for **presence of comorbidities** ($p = 0.003$), with those having co-morbid conditions more likely to fall in the medium/high-risk group, **BMI category** ($p < 0.001$), where underweight/normal individuals had substantially higher malnutrition risk compared to overweight/obese, **Abdominal obesity** ($p = 0.04$), with lower risk of malnutrition among participants with abdominal obesity and **MUAC** ($p = 0.01$), where MUAC < 30 cm was significantly associated with higher malnutrition risk (Table 3).

Discussion

The present study assessed the malnutrition risk of and its determinants among patients with Type 2 Diabetes Mellitus (T2DM) attending primary health care facilities in Gorakhpur, Uttar Pradesh, North India using the Malnutrition Universal Screening Tool (MUST). The findings reveal that malnutrition risk is a significant yet under-recognized problem in this population, coexisting with a high prevalence of overweight, obesity, and abdominal adiposity. This dual burden reflects the evolving nutritional and epidemiological transition occurring in low- and middle-income settings, particularly among individuals living with chronic non-communicable diseases.

In the current study, nearly 30% of participants were categorized as being at medium or high risk of malnutrition, with **13.8% identified as high risk**. This proportion is clinically meaningful and comparable with earlier studies from India and other south Asian countries that have reported malnutrition risk ranging from one-fifth to one-third of patients with T2DM when screened using MUST or similar tools [12, 16]. International evidence also supports these findings, demonstrating that malnutrition is prevalent among people with diabetes both in outpatient and inpatient settings [8, 17–19]. A study by Rashid et al. [20] from Pakistan assessing malnutrition among elderly with T2DM using mini nutritional scale(MNA) found that 69.5% were at risk of malnutrition which is much higher than found in our study. This difference is mainly due to difference in the age structure and use of a different tool for assessing malnutrition.

Traditionally, nutritional assessment in diabetes care has focused largely on overnutrition, obesity, and excess caloric intake. However, the present findings highlight that malnutrition and nutritional risk

remain substantial concerns, even among individuals who appear adequately nourished or overweight based on BMI alone. Chronic hyperglycaemia, catabolic metabolic states, dietary restrictions, unintentional weight loss, and recurrent illness episodes can all contribute to declining nutritional reserves in patients with diabetes [8]. The MUST tool, by incorporating BMI, recent weight loss, and acute disease effect, is particularly useful in capturing these dimensions of nutritional vulnerability.

The socio-demographic profile of the study population reflects the typical catchment of primary health centres in eastern Uttar Pradesh, characterized by a predominance of rural residents, low income, and lower educational attainment. In this context, **rural residence emerged as a significant determinant of malnutrition risk**, with rural participants being more likely to fall into the medium or high-risk category. This rural disadvantage may be explained by multiple interrelated factors, including food insecurity, limited dietary diversity, inadequate access to nutrition education, and reduced availability of specialized health services.

Income and socioeconomic status showed strong and statistically significant associations with malnutrition risk. Participants from lower income groups and lower socioeconomic classes were disproportionately affected. This finding aligns with the broader literature linking poverty with poor nutritional outcomes, particularly among individuals with chronic diseases [21, 22]. The financial burden of diabetes management—including costs related to medications, investigations, and transportation—may further constrain household food budgets, leading to compromised dietary quality and quantity.

Interestingly, variables such as age, gender, education level, occupation, marital status, and duration of diabetes were not significantly associated with malnutrition risk. While older age and longer disease duration have been associated with malnutrition in some studies, the absence of such associations here suggests that **economic and contextual vulnerabilities may outweigh demographic factors** in determining nutritional risk in primary care populations. Similar observations have been reported by Stratton et al., who emphasized the importance of social and clinical context over demographic characteristics alone [12].

The presence of co morbid conditions was a strong predictor of malnutrition risk in the present study. Patients with one or more comorbidities were significantly more likely to be categorized as medium or high risk. Hypertension was the most common comorbidity, followed by coronary artery disease and thyroid disorders. Multimorbidity can increase metabolic demands, complicate dietary recommendations, reduce appetite, and lead to polypharmacy-related side effects, all of which may contribute to nutritional deterioration [23, 24, 25].

These findings underscore the importance of **integrated care approaches** in diabetes management. Nutritional assessment should be prioritized for patients with coexisting chronic conditions, as malnutrition in this group may adversely affect disease control, functional status, and quality of life. Evidence suggests that timely nutritional support can reduce complications, improve treatment adherence, and enhance overall outcomes in patients with chronic diseases [8].

Anthropometric assessment revealed a high prevalence of overweight, obesity, and abdominal obesity among participants. Despite this, malnutrition risk remained substantial, highlighting the phenomenon of “**hidden malnutrition**” or qualitative nutritional deficiency. Participants who were underweight or had normal BMI were at significantly higher risk of malnutrition compared to those who were overweight or obese, which is consistent with the scoring logic of the MUST tool [11].

However, it is noteworthy that a proportion of overweight and obese individuals also fell into the medium or high-risk category. This finding supports emerging evidence that excess body weight does not preclude malnutrition, particularly in the presence of muscle loss, micronutrient deficiencies, or recent weight loss—a condition often described as sarcopenic obesity. Such individuals may be overlooked if nutritional assessment relies solely on BMI.

Abdominal obesity was found to be inversely associated with malnutrition risk, with participants having central adiposity showing lower risk. Similar findings have been reported in previous studies[13], possibly reflecting greater energy reserves among individuals with higher fat mass. Nonetheless, this should not be interpreted as a protective effect in a metabolic sense, as abdominal obesity remains a major risk factor for insulin resistance, cardiovascular disease, and adverse diabetes outcomes.

Mid-upper arm circumference (MUAC) emerged as a significant and practical anthropometric correlate of malnutrition risk. Participants with MUAC less than 30 cm were more likely to be malnourished. MUAC is a simple, low-cost, and feasible measure that can be easily incorporated into routine primary care practice, especially in resource-constrained settings [11]. Its strong association with malnutrition risk in this study reinforces its utility as a complementary screening tool alongside MUST.

The findings of this study have important implications for strengthening diabetes care at the primary health care level. The substantial prevalence of malnutrition risk indicates that **nutritional screening should not be optional but routine** in the management of patients with T2DM. Tools such as MUST are simple, validated, and feasible for use by frontline health workers with minimal training [26].

Early identification of malnutrition risk can enable timely interventions, including individualized dietary counselling, linkage with nutrition supplementation programmes, and referral to higher levels of care when required. Given the observed association with socioeconomic disadvantage, targeted interventions for vulnerable groups—particularly rural and low-income populations—are essential.

Strengths and Limitations

This study has several strengths. It employed a validated nutritional screening tool, included participants from both rural and urban primary care settings, and assessed a wide range of socio-demographic, clinical, and anthropometric variables. However, certain limitations should be acknowledged. The cross-sectional design precludes causal inference. Dietary intake, biochemical markers of nutritional status, and glycaemic control indicators such as HbA1c were not assessed. Additionally, the study was

conducted in a single district, which may limit generalizability. Future longitudinal and multicentric studies are needed to address these gaps.

Conclusion

This study demonstrates that malnutrition is a significant and underappreciated problem among patients with Type 2 Diabetes Mellitus attending primary health care facilities in northern India. Nearly one-third of participants were identified as being at medium or high risk of malnutrition, despite a high prevalence of overweight and obesity. Rural residence, low income, lower socioeconomic status, presence of comorbidities, and adverse anthropometric indicators—particularly low BMI and low MUAC—were key determinants of nutritional risk. These findings highlight the urgent need to integrate routine nutritional screening and targeted nutritional interventions into primary-level diabetes care.

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Declarations

Conflict of interests

None declared

Author Contribution

MAB and contributed to the study conception and design. Material preparation, data collection and analysis were performed by AI, MAB, and SG. The first draft of the manuscript was written by AI and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data Availability

All the data supporting the conclusions of this article are included within the article

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Figures

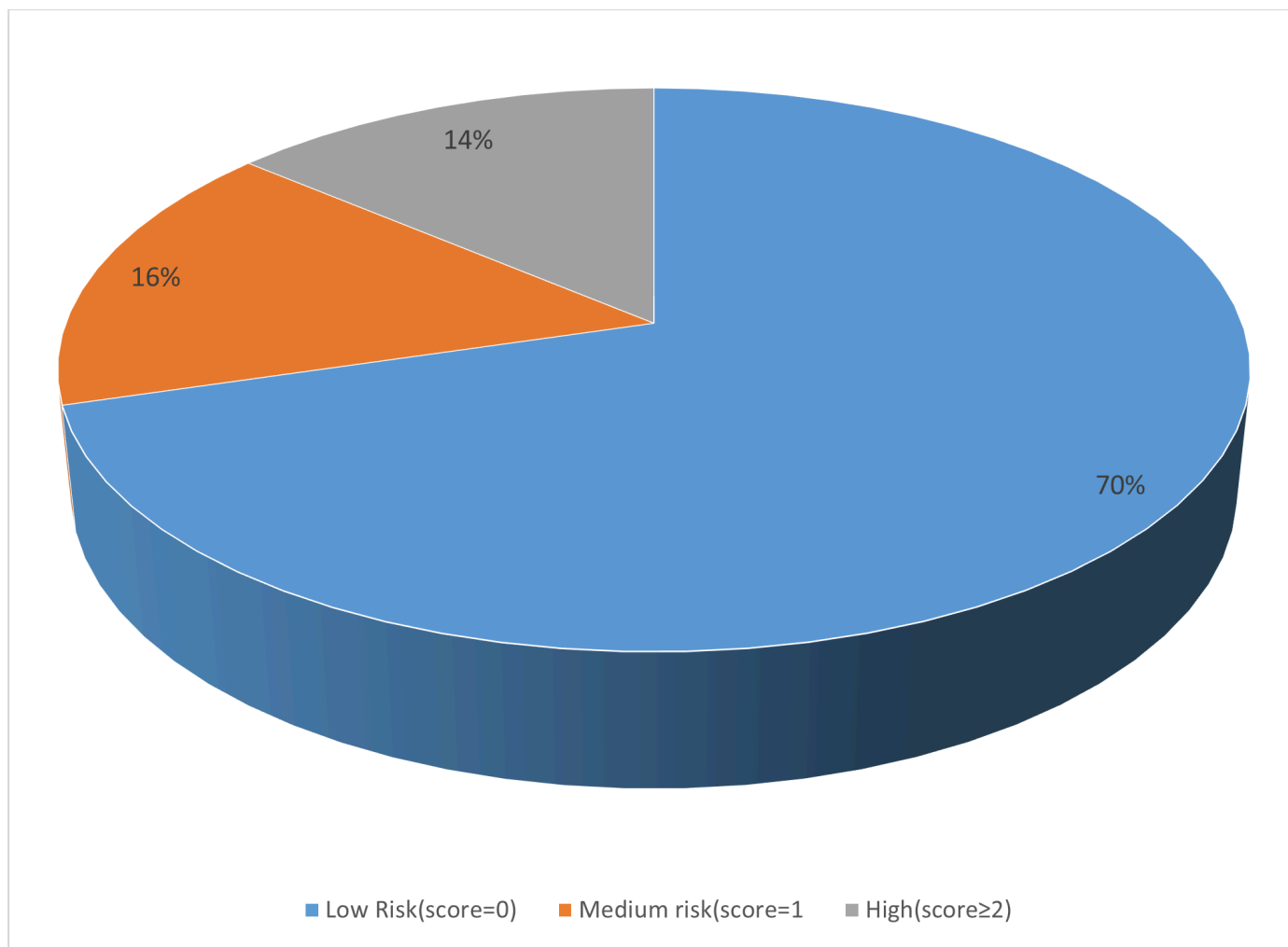


Figure 1

Classification of the study participants according to MUST risk score

Supplementary Files

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- [T2DMstudyquestionnaire.docx](#)