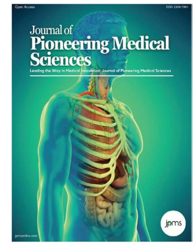

Journal of Pioneering Medical Sciences
Received: July 20, 2025 | Accepted: August 22, 2025 | Published: September 05, 2025
Volume 14, Issue 08, Pages 151-158

DOI https://doi.org/10.47310/jpms2025140819

Prevalence and Predictors of Malnutrition Risk among Saudi Adults on Home Enteral Nutrition: A Cross-Sectional MUST-Based Study

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Abstract: **Background:** Home Enteral Nutrition (HEN) is an essential therapeutic option for patients unable to meet their nutritional needs orally. While it supports long-term care, malnutrition remains a common complication in community and home-based settings. **Objective:** To determine the prevalence of malnutrition risk and its predictors among Saudi adults receiving HEN using the Malnutrition Universal Screening Tool (MUST). **Methods:** A cross-sectional study of 210 Saudi adults (≥18 years) on HEN was conducted across three cities. Data collection included structured interviews, home visits, and medical records. Nutritional risk was assessed using MUST. Group comparisons used chi-square/Fisher's exact tests for categorical data and Kruskal-Wallis tests for non-normal continuous variables. Multinomial logistic regression (low-risk reference) identified independent predictors of malnutrition risk. **Results:** Malnutrition risk was high, with 65.7% (95% CI: 59.3–72.1) classified as high risk, 27.1% (95% CI: 21.1–33.2) as low risk, and 7.1% (95% CI: 3.7–10.6) as medium risk. Lower BMI and greater unintentional weight loss were the strongest predictors of higher MUST risk ($p<0.001$). Acute illness (>5 days no intake) was exclusively observed in the high-risk group. Age and gender were not significant predictors in multivariable models. **Conclusion:** Malnutrition is highly prevalent among Saudi adults on long-term HEN, with BMI, weight loss, and acute illness emerging as the most important predictors. These findings highlight the importance of routine nutritional screening, individualized feeding strategies, and consistent dietitian follow-up to reduce malnutrition risk in this population.

Key Words Home Enteral Nutrition, Malnutrition, Must, Nutritional Screening, Saudi Arabia, Risk Factors, Cross-Sectional Study, Dietitian Follow-Up

INTRODUCTION

Home Enteral Nutrition (HEN) refers to the administration of nutrition through a feeding tube directly into the gastrointestinal tract and is reserved for patients unable to maintain nutrition orally [1-2]. Over recent decades, HEN has become an essential component of chronic care, allowing patients to receive long-term nutritional support outside hospital settings. It has been particularly valuable for individuals with chronic illness or disability, helping to maintain nutritional status, body composition, and quality of life [3-4]. HEN is commonly prescribed for patients with stroke, cancer, and neurological disorders where swallowing impairment or gastrointestinal dysfunction prevents adequate oral intake [5]. Evidence suggests that HEN may prolong survival, facilitate earlier hospital discharge, and support continuity of care at home [6].

Despite these advantages, HEN use is not without challenges. Patients remain at risk of nutrient deficiencies due to inadequate intake, intolerance to formulas, or tube-related complications. Clinical issues such as aspiration, diarrhoea, or tube obstruction can compromise nutrient absorption and contribute to weight loss [7]. These risks underscore the importance of reliable nutritional screening and monitoring in community settings.

The World Health Organization (WHO) defines malnutrition as an imbalance between nutrient supply and bodily requirements, driven by deficiency, excess, or metabolic alterations [8-9]. Traditionally, Body Mass

Index (BMI) has been the most widely used screening tool. However, BMI alone is insufficient for accurately detecting malnutrition, especially in patients with chronic disease, highlighting the need for more comprehensive assessment approaches [10].

The Malnutrition Universal Screening Tool (MUST) is a widely validated instrument designed to identify adults at risk of malnutrition. It incorporates three simple criteria: BMI, unintentional weight loss, and the impact of acute illness on dietary intake, which together classify patients into low, medium, or high risk categories [11]. While the Mini Nutritional Assessment-Long Form (MNA-LF) has often been considered a gold standard in certain clinical and community contexts due to its predictive validity [2,11], the practicality of MUST makes it more feasible for HEN patients, particularly in home or outpatient environments. Its ease of application, reliance only on basic anthropometric data, and suitability for use by both professionals and trained caregivers make it especially advantageous in resource-limited or home-based care settings [2,12].

Globally, HEN is increasingly used, but there remains a lack of evidence on its outcomes in Saudi Arabia [13-14]. Local studies have explored general nutritional support practices but provide limited data on prevalence rates or predictors of malnutrition among adults on long-term HEN. This knowledge gap impedes the development of culturally relevant policies and tailored nutritional interventions.

Therefore, the present study aims to assess malnutrition risk among Saudi adults on HEN using the MUST tool. Specifically, the study seeks to:

- Estimate the proportion of patients classified as low, medium, or high nutritional risk
- Identify demographic, clinical, and care-related predictors of malnutrition risk

MATERIALS AND METHODS

Study Design and Setting

This study employed a cross-sectional descriptive design and was conducted across home care units and outpatient services in three major Saudi Arabian cities: Arar, Riyadh, and Dammam. These sites were selected in collaboration with local healthcare authorities to capture regional diversity and enhance generalizability. The study focused on adult patients receiving long-term Home Enteral Nutrition (HEN).

The sample size was calculated using an assumed malnutrition prevalence of 60% among HEN patients, with a 95% confidence level and 7% margin of error, yielding a minimum requirement of 185 participants. To account for missing data and exclusions, the sample was increased by 15%, resulting in a final recruitment target of 210 participants. This sample was sufficient to provide adequate statistical power for subgroup comparisons and multivariable regression modeling.

Sampling, Inclusion, and Exclusion Criteria

Participants were recruited through a multi-center convenience sampling approach coordinated by treating clinicians in the selected cities. While this ensured feasibility and access to patients across diverse diagnoses, it may have introduced a risk of selection bias.

Inclusion criteria

- Adults aged ≥18 years
- Receiving enteral nutrition through nasogastric, gastrostomy, or jejunostomy tubes
- On HEN for at least one month prior to enrollment

Exclusion Criteria

- Terminal illness with life expectancy <1 month (to avoid confounding by rapid end-of-life decline).
- Missing critical data (e.g., baseline weight, MUST components, or diagnosis).
- Patients on exclusive oral or parenteral nutrition.
- Severe cognitive impairment without a proxy caregiver able to provide informed consent or reliable medical history

Data Collection Procedures

Data collection combined structured caregiver interviews, direct patient assessments (where possible), and review of medical records. Trained health personnel performed home visits, ensuring completeness of data capture. To minimize recall bias, caregivers' reports were cross-verified with available records whenever possible.

Variables and Measures

Demographic and Clinical Variables

- **Age:** Recorded in years (continuous).
- **Gender:** Male or female (binary nominal).
- **Primary Diagnosis:** Underlying medical condition requiring HEN (categorical: neurological disorder, cancer, gastrointestinal dysfunction, others).
- **Duration of HEN:** Recorded in months since initiation (continuous).

Feeding Care, Regimen, and Formula Type

- **Feeding Regimen:** Mode of administration (bolus, continuous, intermittent) (categorical).
- **Formula Type:** Enteral nutrition classification (standard, high-protein, disease-specific) (categorical).
- **Dietitian Follow-Up Frequency:** Categorized as none, irregular (≤1/month, non-scheduled), or regular (≥2/month, scheduled).
- **Caregiver Training:** Whether the primary caregiver received structured HEN management training (yes/no).

Feeding Complications

- **Aspiration:** Documented aspiration pneumonia (yes/no)
- **Diarrhoea:** ≥3 loose stools/day attributed to enteral feeding (yes/no)
- **Tube Blockage:** Any obstruction requiring intervention (yes/no)
- 2.4.4 Anthropometric Measurements
- **Height (cm):** Measured to the nearest 0.5 cm using a stadiometer. For bedridden patients, height was estimated via ulna length or knee height using validated prediction equations
- **Current Weight (kg):** Measured to the nearest 0.1 kg using calibrated portable scales
- **Previous Weight (kg):** Obtained from medical records 3–6 months prior
- **Body Mass Index (BMI, kg/m^2):** Calculated as weight (kg)/height (m^2)

Nutritional Risk Assessment (MUST Components)

Malnutrition risk was assessed using the Malnutrition Universal Screening Tool (MUST) [2]

BMI

- 0: ≥20.0
- 1: 18.5–19.9
- 2: <18.5

Unintentional Weight Loss (3–6 months):

- 0: <5%
- 1: 5–10%
- 2: >10%
- Formula: % Change: [(Previous Weight – Current Weight)/Previous Weight] × 100

Acute Disease Effect

- 0 = no acute illness/normal intake
- 2 = acute illness with no intake for >5 days

Outcome Measures

- Primary Outcome: Prevalence of malnutrition risk by MUST category:
- Low (score = 0)
- Medium (score = 1)
- High (score ≥2)
- Secondary Outcomes: Associations between malnutrition risk and:
- Demographics (age, gender)
- Clinical factors (diagnosis, HEN duration, complications)
- Care-related factors (dietitian follow-up, caregiver training)

Data Quality and Validation

To ensure reliability, all field assessors were trained in standardized anthropometric protocols and MUST scoring. Data entry was double-checked, and discrepancies resolved by secondary verification.

Ethical Considerations

Ethical approval was obtained from the Northern Border University Ethics Committee. Written informed consent was obtained from participants or legal guardians prior to participation. Confidentiality was maintained throughout, in line with international research standards.

Statistical Analysis

Analyses were performed using Stata v19 (StataCorp LLC, College Station, TX). Descriptive statistics summarized participant characteristics. Categorical variables were reported as n (%) and compared using Chi-square or Fisher's exact test. Continuous non-normally distributed variables were expressed as medians (IQR) and compared using the Kruskal-Wallis test.

Prevalence of malnutrition risk categories was estimated with 95% confidence intervals (CIs) and displayed graphically.

To identify predictors of malnutrition risk, multinomial logistic regression was applied, with "low risk" as the reference category. Model building followed a two-step approach:

- **Bivariate Screening:** Variables associated with malnutrition risk at p<0.20 were considered for multivariable modeling. This liberal threshold was intentionally selected to avoid excluding potential confounders [2].
- **Multivariable Model:** Candidate variables were entered and refined. Multicollinearity among anthropometric predictors (BMI, weight, % weight change) was assessed; BMI was retained due to high correlation and clinical interpretability. Age and gender were included irrespective of significance to control for demographic effects.

Results are reported as Relative Risk Ratios (RRRs) with 95% CIs. A p-value <0.05 was considered statistically significant.

RESULTS

Participant Characteristics

Ourstudy included a total of 210 participants receiving HEN, the majority of whom were female (56.2%) with a median age of 54 years (IQR: 34–72 years). The primary clinical diagnoses varied, with stroke being the most common (30.5%), followed by cancer (24.8%) and neurodegenerative diseases (22.9%). A significant

Table 1: Participants' Characteristics by MUST* Nutritional Categories

Parameters	MUST Risk Category				
	Low	Medium	High	Total	P#
N	57 (27.1%)	15 (7.1%)	138 (65.7%)	210 (100.0%)	-
Gender					
Female	32 (56.1%)	9 (60.0%)	77 (55.8%)	118(56.2%)	0.953
Male	25 (43.9%)	6 (40.0%)	61 (44.2%)	92 (43.8%)	-
Age	52 (33, 71)	75 (47, 81)	54 (34, 72)	54 (34, 72)	0.170
Primary Diagnosis					
Cancer	13 (22.8%)	6 (40.0%)	33 (23.9%)	52 (24.8%)	0.459
Head injury	5 (8.8%)	1 (6.7%)	14 (10.1%)	20 (9.5%)	-
Neurodegenerative disease	16 (28.1%)	5 (33.3%)	27 (19.6%)	48 (22.9%)	-
Other	5 (8.8%)	0 (0.0%)	21 (15.2%)	26 (12.4%)	-
Stroke	18 (31.6%)	3 (20.0%)	43 (31.2%)	64 (30.5%)	-
Acute Illness Effect (>5 days no intake)					
No	57 (100.0%)	15 (100.0%)	76 (55.1%)	148 (70.5%)	<0.001
Yes	0 (0.0%)	0 (0.0%)	62 (44.9%)	62 (29.5%)	-
BMI	25 [23, 28]	21 [20, 22]	19 [17, 22]	21 [18, 24]	<0.001

*MUST: Malnutrition Universal Screening Tool. #Categorical variables compared using Pearson X2 (exact test if expected cell count<5). #Continuous variables reported as median (IQR) and compared using the Kruskal-Wallis test

Table 2: Prevalence of Malnutrition Risk (Based on MUST Categories)

MUST Risk Category	Count	Percentage (%)	95% CI (Lower–Upper)
High	138	65.71%	59.29–72.13%
Low	57	27.14%	21.13–33.16%
Moderate	15	7.14%	3.66–10.63%

Table 3: Enteral Feeding Practices and Nutrition by MUST* Nutritional Categories

Parameters	MUST Risk Category				
	Low	Medium	High	Total	p#
N	57 (27.1%)	15 (7.1%)	138 (65.7%)	210 (100.0%)	
Months on Tube Feeding	17 [10, 26]	6 [4, 20]	20 [9, 26]	18 [8, 26]	0.033
Dietitian Follow-Up					
Irregular	24 (42.1%)	10 (66.7%)	61 (44.2%)	95 (45.2%)	0.468
None	10 (17.5%)	1 (6.7%)	27 (19.6%)	38 (18.1%)	
Regular	23 (40.4%)	4 (26.7%)	50 (36.2%)	77 (36.7%)	
Caregiver Trained					
No	24 (42.1%)	7 (46.7%)	41 (29.7%)	72 (34.3%)	0.146
Yes	33 (57.9%)	8 (53.3%)	97 (70.3%)	138 (65.7%)	
Feeding Method					
Bolus	17 (29.8%)	7 (46.7%)	45 (32.6%)	69 (32.9%)	0.713
Continuous	20 (35.1%)	3 (20.0%)	49 (35.5%)	72 (34.3%)	
Intermittent	20 (35.1%)	5 (33.3%)	44 (31.9%)	69 (32.9%)	
Formula Type					
Diabetic-specific	13 (22.8%)	2 (13.3%)	37 (26.8%)	52 (24.8%)	0.067
Fiber-enriched	15 (26.3%)	2 (13.3%)	36 (26.1%)	53 (25.2%)	
High protein	14 (24.6%)	9 (60.0%)	28 (20.3%)	51 (24.3%)	
Standard	15 (26.3%)	2 (13.3%)	37 (26.8%)	54 (25.7%)	
Weight (kg)	67 (62, 75)	57 (55, 60)	51 (46, 58)	55 (50, 65)	<0.001
Past (3–6 months) Weight	68 (64, 78)	61 (57, 64)	56 (51, 63)	61 (54, 68)	<0.001
Weight % Change (3–6 months)	−3 (−4,−1)	−7 (−8, −5)	−8 (−11, −5)	−6 (−10, −3)	<0.001
Energy Adequacy (%)	89 (77,100)	80 (77, 85)	88 (76, 95)	88 (77, 96)	0.262
Malnutrition Status					
Malnourished	2 (3.5%)	11 (73.3%)	106 (76.8%)	119 (56.7%)	<0.001
Well-nourished	55 (96.5%)	4 (26.7%)	32 (23.2%)	91 (43.3%)	

*MUST: Malnutrition Universal Screening Tool.#Categorical variables compared using Pearson X2 (exact test if expected cell count<5). #Continuous variables reported as median (IQR)and compared using the Kruskal-Wallis test. Past weight: Last recorded weight in the past 3–6 months

portion of the sample was nutritionally compromised; according to the MUST screening, 65.7% were at high risk for malnutrition. This was reflected in a median BMI of 21 kg/m² (IQR: 18–24). (Table 1). BMI differed significantly (p<0.001), with median values decreasing from the low-risk group (25 (IQR: 23–28)) to the high-risk group (19 (IQR: 17–22)). Acute illness effects (>5 days no intake) were exclusive to the high-risk group (44.9% vs. 0% in the low/medium group, p<0.001). No significant associations were found for gender, primary diagnosis.

Prevalence of Malnutrition

The prevalence of malnutrition risk based on MUST categories was high (65.71%, 95% CI: 59.29–72.13%), followed by low (27.14%, 95% CI: 21.13–33.16%) and moderate (7.14%, 95% CI: 3.66–10.63%) risk levels (Table 2, Figure 1).

Table 4: Enteral Feeding Complications by MUST* Nutritional Categories

Parameters	MUST Risk Category				
	Low	Medium	High	Total	P#
N	57 (27.1%)	15 (7.1%)	138 (65.7%)	210 (100.0%)	-
Aspiration					
No	44 (77.2%)	11 (73.3%)	107 (77.5%)	162 (77.1%)	0.934
Yes	13 (22.8%)	4 (26.7%)	31 (22.5%)	48 (22.9%)	
Diarrhea					
No	42 (73.7%)	10 (66.7%)	107 (77.5%)	159 (75.7%)	0.593
Yes	15 (26.3%)	5 (33.3%)	31 (22.5%)	51 (24.3%)	
Tube Blockage					
No	46 (80.7%)	13 (86.7%)	111 (80.4%)	170 (81.0%)	0.842
Yes	11 (19.3%)	2 (13.3%)	27 (19.6%)	40 (19.0%)	

*MUST: Malnutrition Universal Screening Tool. #Categorical variables compared using Pearson X2 (exact test if expected cell count<5)

Table 5: Multinomial Logistic Regression Predicting MUST Risk Category

MUST Categories/ Predictors	RRR vs. Low Risk	95% CI
Low		
Months on tube feeding	1.00	(1.00,1.00)
Diabetic-specific formula	1.00	(1.00,1.00)
Fiber-enriched formula	1.00	(1.00,1.00)
High protein formula	1.00	(1.00,1.00)
Standard formula	1.00	(1.00,1.00)
BMI	1.00	(1.00,1.00)
Age	1.00	(1.00,1.00)
Female	1.00	(1.00,1.00)
Male	1.00	(1.00,1.00)
Medium (vs. Low)		
Months on tube feeding	0.96	(0.90,1.03)
Diabetic-specific formula	1.00	(1.00,1.00)
Fiber-enriched formula	0.68	(0.08,6.02)
High protein formula	3.29	(0.54,20.01)
Standard formula	0.87	(0.10,7.74)
BMI	0.81**	(0.68,0.95)
Age	1.02	(0.99,1.05)
Female	1.00	(1.00,1.00)
Male	0.76	(0.21,2.72)
High (vs. Low)		
Months on tube feeding	1.04*	(1.00,1.08)
Diabetic-specific formula	1.00	(1.00,1.00)
Fiber-enriched formula	0.73	(0.24,2.24)
High protein formula	0.47	(0.14,1.56)
Standard formula	0.79	(0.25,2.49)
BMI	0.65***	(0.58,0.74)
Age	1.00	(0.98,1.02)
Female	1.00	(1.00,1.00)
Male	1.06	(0.47,2.39)
Observations	210	
Pseudo R^2	0.313	

Exponentiated coefficients; 95% confidence intervals in brackets. *p< 0.10, **p< 0.05, ***p< 0.001

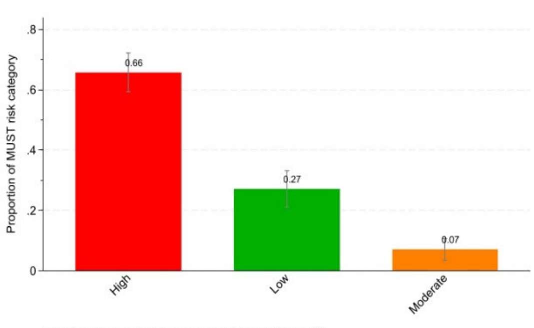

Figure 1*:* Proportion of MUST Risk Categories Among Participants

Enteral Feeding Practices

The median duration of tube feeding was 18 months (IQR: 8–26 months), and approximately two-thirds of caregivers (65.7%) received training in feeding administration. Dietitian follow-up was irregular for most patients (45.2%), and various feeding methods were used, including continuous (34.3%), bolus (32.9%), and intermittent (32.9%). We found that current weight (p<0.001) and past weight (p<0.001) were lower in high-risk participants (51 (46–58) kg and 56 (51–63) kg, respectively) compared to low-risk (67 (62–75) kg and 68 [64–78] kg, respectively). Weight changes over 3–6 months also varied significantly (p<0.001), with high-risk participants experiencing a greater median loss (–8%

(−11 to −5%)) than low-risk participants (−3% (−4 to −1%)). Months on tube feeding differed significantly (p = 0.033), butenergy adequacy did not (p = 0.262). Malnutrition status was strongly associated with MUST categories (p<0.001), with 76.8% of high-risk participants classified as malnourished versus 3.5% in the low-risk group. Dietitian follow-up, caregiver training, and formula type also showed no significant differences across MUST categories (all p>0.05) (Table 3).

Enteral Feeding Complications

The most common complications reported were diarrhoea(24.3%), aspiration (22.9%), and tube blockage (19.0%). No significant associations were found for feeding complications (aspiration, diarrhoea, tube blockage; all p>0.05) (Table 4). Of the feeding-related complications assessed, only aspiration showed a significant association with formula type (p = 0.045). Aspiration was more frequent among patients receiving diabetic-specific (32.7%) and high-protein (29.4%) formulas compared to those on fibre-enriched (13.2%) or standard (16.7%) formulas. No other significant associations were observed between complications and caregiver training or dietitian follow-up.

Predictors of MUST Risk Categories

The multinomial logistic regression model was statistically significant, explaining approximately 31.3% of the variance in risk status (LR) = 107.67, p<0.001, Pseudo R2 0.313. For the high-risk category, BMI was the most significant predictor. For each one-unit increase in BMI, the relative probabilityof being in the high-risk group decreased by 35% (RRR = 0.65, 95% CI [0.58, 0.74), p<0.001). Alonger duration of tube feeding showed a borderline significant association with increased risk (RRR = 1.04, p = 0.072). Formula type, age, and gender were not significant predictors for this group.

When comparing the medium-risk category to the low-risk reference, lower BMI was the only statistically significant predictor. A one-unit increase in BMI was associated with a 19% decrease in the relative chanceof being in the medium-risk category (RRR = 0.81, 95% CI (0.68, 0.95), P = 0.012). None of the other variables – including months on tube feeding, formula type, age, andgender –had a significant impact on the probabilityof being classified as medium-risk versus low-risk.

DISCUSSION

This multicenter study provides new insights into the nutritional vulnerabilities of Saudi adults receiving Home Enteral Nutrition (HEN). Using the MUST tool, we found that nearly two-thirds (65.7%) of participants were classified as high risk for malnutrition. This prevalence mirrors international findings, underscoring that malnutrition remains a persistent and widespread complication in long-term care despite the therapeutic intent of HEN.

Key Predictors of Malnutrition Risk

Among evaluated predictors, BMI emerged as the most robust determinant of MUST category classification. Each unit increase in BMI was associated with significantly lower odds of being categorized as medium or high risk, consistent with Poulia *et al.* [11] who emphasized BMI's value in malnutrition screening among chronically ill patients. Elia [2] and Corbelli *et al*. [11] likewise highlighted the importance of BMI and weight change as practical markers in community-based assessments. In line with this, recent weight loss was also a strong correlate of malnutrition risk, validating MUST's original conceptual framework [2-9]. Together, these findings reinforce the utility of simple anthropometric indicators in contexts where laboratory-based markers may not be readily available.

Comparison with International Literature

Our prevalence estimates align with global studies of HEN patients. Mundi *et al.* [5] reported malnutrition rates above 60%, and Madrid-Paredes *et al*. similarly documented undernutrition in 64% of HEN users. Soljan *et al.* [15] found comparable protein–energy malnutrition rates among long-term HEN patients in Croatia, further highlighting the challenges of sustaining nutritional adequacy despite tube feeding. Collectively, these findings confirm that malnutrition risk is not unique to Saudi Arabia but rather reflects a global challenge in HEN populations.

Duration of HEN and Nutritional Decline

We observed a borderline association between longer HEN duration and malnutrition risk, with high-risk patients having a median feeding duration of 20 months (p = 0.072). Although this trend did not reach statistical significance, it may suggest progressive nutritional deterioration during prolonged dependence on enteral feeding. Similar patterns have been described by Silver *et al*. [16], who noted frequent gastrointestinal complications interrupting feeding in older adults, and by Sabbouh and Torbey [17], who emphasized that inadequate protein and calorie delivery can perpetuate malnutrition despite access to tube feeding. These findings underline the importance of periodic MUST re-screening, individualized regimen adjustments, and proactive multidisciplinary oversight (dietetic, nursing, and medical). Without such measures, nutritional adequacy may deteriorate over time even in patients maintained on HEN.

Feeding Complications and Care-Related Factors

Feeding complications were common in our cohort, with aspiration (22.9%), diarrhea (24.3%), and tube blockage (19%) frequently observed. Although these were not statistically associated with MUST categories, their clinical impact cannot be overlooked. Mundi *et al*. [5] and Wiekmeijer *et al*. similarly reported these complications as recurring challenges in enteral nutrition. Importantly, the lack of statistical association in our regression may reflect limited power, potential under-reporting, or the complex interplay of multiple care variables. Likewise, caregiver training and frequency of dietitian follow-up were not significant predictors of malnutrition risk. While unexpected, this may be explained by variability in training quality, inconsistent follow-up protocols, or caregiver burden—factors not fully captured in our study. Future research should investigate these dimensions more deeply to clarify their role.

Value of the MUST Tool

The current findings reinforce MUST's utility in HEN contexts. Poulia *et al.* [11] highlighted its reliability across clinical and community settings, and Cortés-Aguilar *et al*. [12] affirmed its predictive value in resource-limited environments. Almasaudi *et al*. [18] further showed that higher MUST scores predict poor clinical outcomes in colorectal cancer, demonstrating the tool's broad applicability across disease contexts. For Saudi Arabia, where community-based nutritional services are still developing, MUST offers a practical, cost-effective, and evidence-based screening approach.

Strengths and Limitations

This study's strengths include its multicenter design across three cities, rigorous statistical methods (including multinomial logistic regression), and the use of standardized data collection protocols. These features enhance both the generalizability and internal validity of findings.

However, several limitations should be acknowledged. The cross-sectional design precludes causal inference. Reliance on caregiver recall for past weights introduces potential recall bias, although triangulation with medical records mitigated this to some degree. The absence of biochemical markers (e.g., albumin, prealbumin) limited the ability to capture metabolic aspects of malnutrition [19]. Additionally, small subgroup sizes within specific diagnoses restricted statistical power for subgroup comparisons. Finally, the use of a convenience sampling method, while pragmatic, raises the possibility of selection bias.

Implications and Future Directions

Our findings reinforce the urgent need for structured, routine nutritional screening among long-term HEN patients. Regular reassessment using simple tools like MUST, combined with individualized dietetic input and caregiver education, can substantially reduce malnutrition risk. Emerging strategies such as tele-nutrition and digital monitoring platforms may provide innovative ways to support continuity of care, particularly in geographically dispersed populations.

Future research should include prospective and interventional studies to test whether structured follow-up, improved training programs, or digital monitoring can mitigate malnutrition risk. Further exploration of socioeconomic disparities and regional variations in access to HEN services would also inform national policy and resource allocation. By addressing these gaps, healthcare systems can strengthen patient outcomes and reduce the burden of malnutrition in this vulnerable population.

CONCLUSION

This study demonstrates a high prevalence of malnutrition among Saudi adults receiving long-term Home Enteral Nutrition (HEN), with 65.7% classified as high risk according to MUST. BMI and unintentional weight loss were the most consistent predictors of nutritional risk, confirming the value of simple anthropometric indicators for screening in community-based care. Although feeding complications and care-related factors (dietitian follow-up frequency, caregiver training) were not statistically significant predictors, their clinical importance remains noteworthy and warrants further exploration.

Overall, these findings underscore the need for routine nutritional screening using validated tools such as MUST, coupled with individualized feeding plans, structured follow-up, and active caregiver and dietitian involvement. Integrating these practices into HEN services can facilitate earlier detection of malnutrition risk, guide timely interventions, and improve long-term outcomes.

Back Matter

Author Contributions

All authors contributed equally to the conceptualization, data collection, statistical analysis, interpretation, and manuscript drafting. Both authors reviewed and approved the final version of the manuscript.

Funding

This research was funded by the Deanship of Scientific Research at Northern Border University, Arar, KSA, under project number NBU-FFR-2025-2975-16.

Ethical Approval and Informed Consent

The study protocol received prior approval from the Ethics Committee of Northern Border University, Saudi Arabia, and was conducted in accordance with the Declaration of Helsinki and all applicable ethical standards. Written informed consent was obtained from all participants or their legal guardians prior to data collection. Consent for publication of anonymized clinical data was also obtained and documented. The corresponding author retains the original signed consent forms, which can be made available to the journal's editorial board upon request.

Data Availability Statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. Due to privacy and ethical restrictions, the raw dataset is not publicly accessible but can be provided in anonymized form for academic and research purposes.

Acknowledgements

The authors express their sincere gratitude to the home care teams and medical records departments in Arar, Riyadh, and Dammam for their invaluable assistance in data collection. Special thanks are extended to the caregivers and patients whose participation made this research possible. The authors also acknowledge the significant contributions of clinical dietitians Ms. Hanan Alanazi, Ms. Yasmin Flimpan, Ms. Arwa Barakat, Ms. Jinan Alrashid, and Ms. Samiah Alshehri, whose expertise and support were instrumental to the study's success.

Conflicts of Interest

The authors declare no conflicts of interest related to the conduct or publication of this research.

REFERENCES

[1] Stratton, R.J. *et al.* "Enteral nutritional support in prevention and treatment of disease-related malnutrition in adults." *Clinical Nutrition*, vol. 22, no. 5, 2003, pp. 527–547.

[2] Elia, M. "The 'MUST' report: nutritional screening for adults – a multidisciplinary responsibility. Development and use of the 'Malnutrition Universal Screening Tool' (MUST) for adults." *British Association for Parenteral and Enteral Nutrition*, 2003, available from: https://eprints.soton.ac.uk/362499/ (accessed 09 July 2025).

[3] He, L. *et al.* "Comparison of enteral formulas in HEN patients." *Nutrition Research and Practice*, vol. 14, no. 6, 2020, pp. 507–514.

[4] Gao, X. *et al.* "The application and mechanism analysis of enteral nutrition in clinical management of chronic diseases." *Nutrients*, vol. 17, no. –, 2025, pp. 450.

[5] Mundi, M.S. *et al.* "Home enteral nutrition: a descriptive study." *Journal of Parenteral and Enteral Nutrition*, vol. 47, no. 4, 2023, pp. 550–562.

[6] Zhang, C. *et al.* "Home enteral nutrition for patients with esophageal cancer undergoing esophagectomy: A systematic review and meta-analysis." *Frontiers in Nutrition*, vol. 9, 2022, pp. 895422.

[7] Wanden-Berghe, C. *et al.* "Complications associated with enteral nutrition: CAFANE study." *Nutrients*, vol. 11, no. 9, 2019, pp. 2041.

[8] World Health Organization. "Turning the tide of malnutrition: responding to the challenge of the 21st century." Geneva: World Health Organization, 2000.

[9] Kondrup, J. *et al.* "ESPEN guidelines for nutrition screening 2002." *Clinical Nutrition*, vol. 22, no. 4, 2003, pp. 415–421.

[10] Corbelli, G. *et al.* "Nutritional evaluation of patients candidates for home enteral nutrition (HEN)." *Nutrition*, vol. 65, 2019, pp. 7.

[11] Poulia, K.A. *et al.* "The two most popular malnutrition screening tools in the light of the new ESPEN consensus definition of the diagnostic criteria for malnutrition." *Clinical Nutrition*, vol. 36, no. 4, 2017, pp. 1130–1135.

[12] Cortés-Aguilar, R. *et al.* "Validity of nutrition screening tools for risk of malnutrition among hospitalized adult patients: A systematic review and meta-analysis." *Clinical Nutrition*, vol. 43, no. 5, 2024, pp. 1094–1116.

[13] Ajabnoor, S.M. *et al.* "Exploring the practice of nutritional support during hospitalization across physicians, dietitians, and pharmacists based in Saudi Arabia." *Frontiers in Nutrition*, vol. 10, 2023, pp. 1149727.

[14] Bakr, E.S.H. *et al.* "Assessment of nutritional status for intensive care patients." *Current Research in Nutrition and Food Science*, vol. 12, no. 3, 2024, pp. 1220–1231.

[15] Soljan, E. *et al.* "Nutrition status and incidence of malnutrition in home enteral nutrition patients: A cross-sectional study." *Proceedings of the Nutrition Society*, vol. 83, no. OCE1, 2024, pp. E169.

[16] Silver, H.J. *et al.* "Older adults receiving home enteral nutrition: Enteral regimen, provider involvement, and health care outcomes." *Journal of Parenteral and Enteral Nutrition*, vol. 28, no. 2, 2004, pp. 92–98.

[17] Sabbouh, T., and M.T. Torbey. "Malnutrition in stroke patients: Risk factors, assessment, and management." *Neurocritical Care*, vol. 29, no. 3, 2018, pp. 374–384.

[18] Almasaudi, A.S. *et al.* "The relation between Malnutrition Universal Screening Tool (MUST), computed tomography-derived body composition, systemic inflammation, and clinical outcomes in patients undergoing surgery for colorectal cancer." *The American Journal of Clinical Nutrition*, vol. 110, no. 6, 2019, pp. 1327–1334.

[19] Przekop, Z. *et al.* "Efficacy of the Nutritional Risk Index, Geriatric Nutritional Risk Index, BMI, and GLIM-defined malnutrition in predicting survival of patients with head and neck cancer qualified for home enteral nutrition." *Nutrients*, vol. 14, no. 6, 2022, pp. 1268.

[20] Poulia, K.A. *et al.* "Evaluation of the efficacy of six nutritional screening tools to predict malnutrition in the elderly." *Clinical Nutrition*, vol. 31, no. 3, 2012, pp. 378–385.