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Research Article

Assessment of Nutritional Deficiencies Among Hospitalized Patients in Makkah: A Cross-sectional Analysis

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ABSTRACT

Background/ Purpose of the research: Malnutrition is a prevalent issue among hospitalized patients, contributing to adverse outcomes such as anemia, hypoalbuminemia, prolonged recov-ery times, and increased healthcare burdens. This study aimed to evaluate the nutritional status of 200 hospitalized patients with chronic conditions in Makkah, Saudi Arabia, to identify defi-ciencies and guide intervention strategies.
Methods: A cross-sectional analysis was conducted at three major hospitals, assessing body mass index (BMI), hemoglobin (Hb), albumin (ALB), and total protein (TP) levels five days post-admission. The study included patients diagnosed with diabetes mellitus, renal disease, liver disease, cardiovascular disease, and those in post-surgical recovery. Nutritional and bio-chemical data were collected and analyzed to identify patterns and prevalence of deficiencies.

Results: Significant nutritional deficiencies were observed, particularly in patients with liver and renal diseases. Hemoglobin levels ranged from 10.33 to 11.22 g/dL, while albumin levels were between 2.77 and 3.42 g/dL, indicating widespread hypoalbuminemia. Despite normal total protein levels, deficiencies in albumin were common, with patients consuming low-residue diets exhibiting exacerbated deficiencies in Hb and albumin. These findings highlight the critical role of dietary habits in influencing nutritional outcomes.

Conclusion: Targeted nutritional interventions, including iron supplementation and tailored dietary plans, are essential to address albumin deficiencies, particularly among elderly patients and those with chronic illnesses. Routine nutritional assessments and monitoring are crucial for early detection and improved patient outcomes. Future research should explore the broader impact of malnutrition and refine care strategies to mitigate its effects on hospitalized popula-tions.

INTRODUCTION

Malnutrition remains a significant concern among hos-pitalized patients, contributing to anemia, hypoalbu-minemia, and other complications that exacerbate morbidity and mortality. Anemia, defined by the World Health Organization (WHO) as a hemoglobin (Hb) level below 12–15 g/dL in women and girls and 13–17 g/dL in men and boys, occurs when red blood cells (RBCs) or their oxygen-carrying capacity are insufficient to meet the body's physiological needs, influenced by factors such as age, sex, altitude, and pregnancy (Safiri, et al., 2021). Chronic illnesses, including renal and liver dis-eases, heart failure, and systemic inflammation, are major contributors to anemia in hospitalized patients (Madu and Ughasoro,2017).

Hospital-acquired anemia (HAA), a condition that de-velops during hospitalization, has been linked to diag-nostic blood loss and inflammation. Studies have shown that the cumulative volume of blood drawn for laboratory testing significantly contributes to anemia among inpa-tients. For instance, Shander and Corwin (2020) demon-strated a proportional decrease in hematocrit levels with increased blood collection. Similarly, Lin et al. (2023) emphasized that anemia exacerbates hospital stay du-ration and increases readmission rates, particularly in critically ill populations.

Hypoalbuminemia, another common issue in hospital-ized patients, is strongly associated with poor outcomes, including prolonged recovery times, increased infection rates, and higher mortality (Graterol Torres et al.,2022). Albumin levels, often used as indicators of nutritional and inflammatory status, tend to decrease in critically ill patients with conditions such as liver disease and chron-ic kidney disease (CKD). Studies highlight that serum albumin levels below 2 g/dL are

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predictive of adverse outcomes (Armentaro et al., 2024). Furthermore, recent findings emphasize the strong link between hypoalbu-minemia and frailty, particularly among elderly individ-uals, where it contributes to greater vulnerability and worsened prognosis (Alshammari et al., 2022).

In Saudi Arabia, particularly in Makkah City, the prevalence of chronic conditions such as diabetes melli-tus (DM), cardiovascular disease (CVD), and renal and liver disorders is high, necessitating a comprehensive assessment of nutritional status among hospitalized patients. Previous research underscores the importance of monitoring BMI, hemoglobin, albumin, and total protein levels to evaluate health and dietary interventions (Al-Mutairi et al., 2021; Alharbi et al., 2022).

This study seeks to assess the nutritional status of hospi-talized patients in Makkah City, focusing on BMI, CBC, albumin, and total protein levels, to provide in-sights for improving nutritional care and patient out-comes.

2. MATERIALS AND METHODS

2.1 Study Design and Population

A cross-sectional study was conducted on 200 hospital-ized patients diagnosed primarily with diabetes mellitus (DM), renal diseases, liver diseases, cardiovascular dis-eases (CVD), or undergoing surgery. Participants were recruited from three hospitals in Makkah City, Saudi Arabia: Alnoor Specialist Hospital, King Faisal Hospital, and Hera'a General Hospital, after 5 days of admission to ensure sufficient clinical and biochemical data avail-ability.

2.2 Data Collection and Measurements

Data collection was conducted using a comprehensive questionnaire divided into three sections:

2.2.1 Socio-demographic Data

Information on family structure, education level, in-come level, and smoking habits was collected through direct interviews with participants.

2.2.2 Clinical and Biochemical Data

Clinical information, including disease type, primary diagnosis, cause of admission, disease duration, diet type, and medical therapy, was extracted from patients' files. Biochemical data included total white blood cells, red blood cells, hemoglobin (Hb), hematocrit (HCT), mean corpuscular volume (MCV), mean corpus-cular hemoglobin (MCH), mean corpuscular hemoglo-bin concentration (MCHC), albumin, and total protein (Badura et al., 2024).

2.2.3. Anthropometric Measurements

Anthropometric data, including height and weight, were collected from patient records. Body mass index (BMI) was calculated using the formula: BMI (kg/m²) = Weight (kg) / Height (m)2. Body mass index categories were defined as Underweight: <18.5 kg/m², Normal weight: 18.5–24.9 kg/m², Overweight: 25–29.9 kg/m², Obese: ≥30 kg/m² (Chaparro and Suchdev,2019; Kharra-zi et al.,2018).

2.3 Statistical Analysis

All data were analyzed using the Statistical Package for the Social Sciences (SPSS) software, version 20. Descrip-tive statistics (mean ± standard deviation) were used to summarize quantitative variables. T-test and One-way analysis of variance (ANOVA) were employed to ana-lyze differences among patient groups. If significant differences were detected, Duncan's multiple range test was used as a post-hoc analysis (Graterol Torres et al., 2022). Categorical variables were analyzed using the chi-square test. A Significance was considered at $P \leq 0.05$ (Gremese et al., 2023).

3. RESULTS

3.1 Analysis of Socio-Demographic Data

Table 1 summarizes the socio-demographic data of the participants. The study population included 41% males and 59% females. The majority of participants (44%) were aged 60 years or above. Regarding family struc-ture, 45% lived in households with four or more mem-bers. University education was the most common level of education (36%), while most participants (49%) had an income between 2000–5000 SAR.

Table 1: Socio-Demographic Data

Socio-Demograph-ic Data	Frequency	%
Gender		
Male	82	41.0
Female	118	59.0
Age Group		
20–39 years	40	20.0
40–59 years	72	36.0
≥ 60 years	88	44.0
Family Structure		
Lives alone	14	7.0
With spouse	40	20.0
3 members	56	28.0
≥ 4 members	90	45.0
Education Level		
Illiterate	32	16.0
Primary	28	14.0
Intermediate	18	9.0
Secondary	50	25.0
University	72	36.0
Income (SAR/ month)		
< 2000	48	24.0
2000–5000	98	49.0
> 5000	54	27.0

(SAR), Saudi Riyal

3.2 Analysis of Disease Versus Lifestyle Data

Table 2 details the distribution of diseases, causes of admission, medication therapy, and smoking habits. Diabetes mellitus (DM) was the most common diagnosis (33%), with 71% admitted for a single disease and 29% for two or more conditions. Among participants, 69% were non-smokers, and 78% were on medication thera-py, while 21% required dialysis.

Table 2: Disease and Lifestyle Data

Disease and Lifestyle Data	Frequency	%	P-value
Primary Diagnosis			
DM	66	33.0	0.047
Renal Disease	46	23.0	
Liver Disease	40	20.0	
Cardiovascular Disease	24	12.0	
Surgery	24	12.0	
Cause of Admission			
One disease	142	71.0	0.034
Two or more diseases	58	29.0	
Smoking Habits			
Smoker	62	31.0	0.044
Non-smoker	138	69.0	
Medication Therapy			
Dialysis	42	21.0	0.036
Medication Therapy	156	78.0	

(DM), **Diabetes Mellitus**

3.3 Analysis of Nutritional Versus Hematological Data

The distribution of diet types, BMI categories, and he-moglobin (Hb) levels are shown in Table 3. DM and HTN diets were the most common (30%). BMI data revealed that 33% of participants were obese, while 13% were underweight. Additionally, 76% had low he-moglobin levels, with only 24% having normal Hb.

Table 3: Nutritional and Hematological Data

Nutritional /Hematological Data	Frequency	%	P-value
Diet Type			
DM and HTN Diet	60	30.0	0.048
Low Sodium, Protein Diet	50	25.0	
Low-Fat Diet	48	24.0	
Cardiac Dash Diet	26	13.0	
Low Residue Diet	16	8.0	
BMI Category			
Underweight	26	13.0	0.063
Normal Weight	52	26.0	
Overweight	56	28.0	
Obese	66	33.0	
Hb Status			
Low Hb	152	76.0	0.038
Normal Hb	48	24.0	

DM: Diabetes Mellitus, HTN Diet: Hypertension Diet, Hb: Hemoglobin, BMI: Body Mass Index.

3.4 Analysis of BMI Versus Disease Type

Table 4 presents the statistical analysis of BMI distribu-tion across various disease types, revealing significant differences (P < 0.05) in BMI categories. Overweight and obesity were predominantly observed in diabetic and cardiovascular di-sease patients. Among diabetic patients, 24 were overweight and 32 were obese, with no cases of underweight individuals, indicating a strong association between elevated BMI and di-abetes melli-tus (P < 0.001). Similarly, cardiovascular disease pa-tients showed higher BMI levels, with 8 overweight and 10 obese individuals, while no cases of underweight were re-corded.

In contrast, renal and liver disease patients exhibited a different BMI distribution. Among renal disease pa-tients, underweight individuals were most common (20), followed by normal weight (10), while overweight and obese categories had only 8 individuals each. Liver dis-ease patients also had a higher proportion of normal-weight individuals (16), with fewer in the underweight (6), overweight (6), and obese (12) categories.

Patients undergoing surgery displayed a balanced distri-bution, with 10 individuals each in the normal weight and overweight categories, while no underweight cases and only 4 obese cases were recorded. These findings emphasize the varying BMI patterns across disease types, highlighting the prevalence of obesity in metabol-ic conditions such as diabetes and cardiovascular dis-ease, and underweight status in renal disease patients.

Table 4: Statistical Analysis of BMI and Disease Type

BMI / Disease Type	Under weight	Normal Weight	Over weight	Obese	P-value
DM	0	10	24	32	0.001 >
Renal Disease	20	10	8	8	
Liver Disease	6	16	6	12	
Cardiovascular Disease	0	6	8	10	
Surgery	0	10	10	4	

DM: Diabetes Mellitus, BMI: Body Mass Index.

3.5 Gender-Based Analysis of Age, BMI, Albumin, Hemoglobin and Total Protein

The data in Table 5 highlight gender-based differences in age, BMI, hemoglobin (Hb), albumin (ALB), and total protein (TP) among male and female participants. Male participants had a mean age of 56.21 ± 14.1 years, while females were slightly older at 61.8 ± 7.8 years. BMI values were higher in males, averaging 28.73 ± 6.01 kg/m² compared to 25.3 ± 7.75 kg/m² in females, indicating a tendency toward overweight in males. Hemoglobin levels were below the reference ranges for both sexes, with males at 11.8 ± 2.65 g/dL (normal range: 13–17 g/dL) and females at 10.7 ± 1.94 g/dL (normal range: 12–15 g/dL), suggesting mild to moderate anemia, more pronounced in females. Simi-larly, albumin levels were below the reference range of 3.4–4.8 g/dL for both sexes, with males at 3.3 ± 1.1 g/dL and females at 2.95 ± 2.7 g/dL, indicating hypoal-buminemia that was more severe in females. Total pro-tein levels were also below the reference range (6.4–8.3 g/dL), with males at 6.05 ± 10.49 g/dL and females at 5.72 ± 8.23 g/dL, pointing to potential nutritional defi-ciencies or chronic health conditions. These findings underscore the need for further investigation into the underlying causes of these abnormalities in both male and female participants.

Table 5: Means of Age, BMI, Albumin, Hemoglobin, and Total Protein

Parameter	Male	Female	Reference Range
Age (years)	56.21 ±14.1	61.8±7.8*	-
Hemoglobin(g/dL)	11.8±2.65	10.7± 1.94*	Male: 13–17 Female: 12–15
BMI (kg/m²)	28.73 ± 6.01	25.3± 7.75*	18.5–24.9
Albumin(g/dL)	3.3± 1.1*	2.95± 2.7*	3.4–4.8
Total Protein(g/dL)	6.05 ± 10.49	5.72± 8.23	6.4–8.3

Values are means ± SE, ***p < 0.01** indicates highly significant differences. BMI, body mass index.

3.6 Analysis of Hematological Parameters Versus Disease Type

The laboratory results for hemoglobin (Hb), albumin (ALB), and total protein (TP) were analyzed across dif-ferent disease types, with hemoglobin levels further bro-ken down by gender (Table 6). The findings reveal dis-tinct patterns in these parameters, highlighting varia-tions by disease type and between males and females.

Male patients generally exhibited higher hemoglobin levels than females across all disease types. Renal dis-ease patients had the lowest overall hemoglobin levels, with males at 10.8 ± 0.72 g/dL and females at 9.9 ± 0.68 g/dL. In contrast, diabetes mellitus patients had the highest hemoglobin levels, with males at 12.3 ± 1.12 g/dL and females at 11.4 ± 1.05 g/dL. Although the gender differences were consistent, the overall hemo-globin levels remained below normal ranges for many patients, particularly in females with renal and liver dis-ease.

Albumin (ALB) levels showed significant differences (P < 0.05) across disease types. Patients with liver disease (2.77 ± 0.91 g/dL) and those undergoing surgery (2.86 ± 0.78 g/dL) had the lowest levels, indicating hypoalbu-minemia regardless of gender. In contrast, patients with renal disease (3.42 ± 0.56 g/dL), cardiovascular disease (3.17 ± 0.67 g/dL), and diabetes mellitus (3.62 ± 0.72 g/dL) had higher albumin levels, often within the normal range, with males typically exhibiting slightly higher levels than females.

Total protein (TP) levels also showed significant differ-ences (P < 0.05). Cardiovascular disease patients had the highest total protein levels (7.28 ± 0.92 g/dL), with males having higher values than females. Renal disease (6.95 ± 1.04 g/dL) and diabetes mellitus (6.94 ± 0.78 g/dL) patients exhibited similar levels. However, pa-tients with liver disease (6.34 ± 0.88 g/dL) and those undergoing surgery (6.46 ± 0.89 g/dL) had the lowest levels, suggesting potential protein deficiencies, particu-larly among females.

These results underscore the influence of disease type and gender on hematological and biochemical parame-ters. Hemoglobin levels reflect gender-specific varia-tions, while albumin and total protein levels highlight the impact of underlying disease and nutritional status.

Table 6: Analysis of Hematological Parameters Versus Disease Type

Disease Type	Hemoglobin (g/dL)	Albumin (g/dL)	Total Protein (g/dL)
Renal Disease	Male: 10.8 ± 0.72	3.42 ± 0.56**	6.95 ± 1.04**
	Female: 9.9 ± 0.68		
Surgery	Male: 11.5 ± 0.89	2.86 ± 0.78	6.46 ± 0.89
	Female: 10.9 ± 0.77		
Liver Disease	Male: 11.3 ± 1.02	2.77 ± 0.91	6.34 ± 0.88
	Female: 10.6 ± 1.08		
Cardiovascular Disease	Male: 11.9 ± 0.98	3.17 ± 0.67**	7.28 ± 0.92**
	Female: 10.8 ± 0.84		
Diabetes Mellitus (DM)	Male: 12.3 ± 1.12	3.62 ± 0.72**	6.94 ± 0.78
	Female: 11.4 ± 1.05		

Values are means ± SE, Reference ranges Hemoglobin (male: 13–17 g/dL, female: 12–15 g/dL), Albumin (3.4–4.8 g/dL), Total Protein (6.4–8.3 g/dL).

(**) Significant differences at (P < 0.05)

3.7 Analysis of Hematological Parameters Versus Diet Type

Table 7 presents the mean ± SE values for hemoglobin (Hb), albumin (ALB), and total protein (TP) across dif-ferent diet types, including gender-specific analysis for hemoglobin. The findings highlight distinct variations in these parameters influenced by diet and gender. Hemo-globin levels varied among diet types, with males con-sistently exhibiting higher levels than females. The low-est Hb levels were recorded in individuals on a low-sodium, low-protein diet, where males averaged 10.8 ± 1.22 g/dL and females 10.1 ± 1.08 g/dL. Conversely, the highest Hb levels were seen in patients adhering to the DM and HTN diet, with males averaging 12.5 ± 1.32 g/dL and females 11.7 ± 1.12 g/dL. Despite these differ-ences, no statistically significant variations in hemoglo-bin levels were observed across diet types or genders.

Albumin levels demonstrated significant differences across diet types (P < 0.05). The lowest albumin levels were observed in patients on low-residue (2.86 ± 0.78 g/dL) and low-fat diets (2.77 ± 0.79 g/dL), indicating hypoalbuminemia in these groups. Patients following the DM and HTN diet had the highest albumin levels at 3.69 ± 0.72 g/dL, followed by those on a low-sodium, low-protein diet (3.36 ± 0.85 g/dL) and the cardiac DASH diet (3.23 ± 0.76 g/dL). These differences under-line the role of diet in maintaining or improving nutri-tional status.

Total protein levels remained within the normal range across all diet types, though significant differences were observed (P < 0.05). The cardiac DASH diet was associ-ated with the highest total protein levels (7.08 ± 0.88 g/dL), closely followed by the DM and HTN diet (7.01 ± 0.77 g/dL). In contrast, the lowest levels were reported in individuals on low-fat (6.42 ± 0.89 g/dL) and low-residue diets (6.55 ± 0.91 g/dL). These findings suggest potential protein deficiencies in individuals following these restrictive diets.

Table 7: Analysis of Hematological Parameters Versus Diet Type

Diet Type	Hb (g/dL)	ALB (g/dL)	TP (g/dL)
Low Sodium, Low Protein	Male: 10.8 ± 1.22	3.36 ± 0.85**	6.87 ± 0.98
	Female: 10.1 ± 1.08		
Low Residue Diet	Male: 11.3 ± 1.34	2.86 ± 0.78	6.55 ± 0.91
	Female: 10.7 ± 1.18		
Cardiac DASH Diet	Male: 11.5 ± 1.18	3.23 ± 0.76**	7.08 ± 0.88**
	Female: 10.9 ± 1.14		
Low-Fat Diet	Male: 12.0 ± 1.28	2.77 ± 0.79	6.42 ± 0.89
	Female: 11.0 ± 1.22		
DM and HTN Diet	Male: 12.5 ± 1.32	3.69 ± 0.72**	7.01 ± 0.77
	Female: 11.7 ± 1.12		

Values are means ± SE, Reference ranges: Hemoglobin (Hb)

(male: 13–17 g/dL, female: 12–15 g/dL), Albumin (ALB) (3.4–4.8 g/dL), Total Protein (TP) (6.4–8.3 g/dL).

(**) Significant differences at ($P < 0.05$).

4. DISCUSSION

Obesity and overweight are significant contributors to the development of cardiometabolic disorders, including type 2 diabetes mellitus (T2DM), hypertension, hyper-lipidemia, metabolic syndrome, cardiovascular disease (CVD), and certain cancers, which collectively increase global mortality rates (Ali et al., 2024). As shown in Ta-ble 4, most diabetic and CVD patients were overweight or obese, aligning with evidence linking excess body fat to an elevated risk of metabolic diseases (Ali et al., 2024). Similarly, Workeneh and Mitch (2010) found that over 75% of hospitalized patients, especially those with chronic kidney disease (CKD), had a BMI exceed-ing 25 kg/m², highlighting the complex interplay between obesity, muscle wasting, and adverse clinical out-comes in CKD patients.

Hemoglobin (Hb) levels were below normal in both male and female patients (Table 5), a finding that aligns with Randi et al. (2020), who identified anemia as a key predictor of poor outcomes in hospitalized individuals. Addressing anemia during hospitalization is critical to reducing mortality risks. Badura et al. (2024) further noted that anemia in CKD is primarily due to dimin-ished erythropoietin production resulting from kidney dysfunction, compounding the severity of clinical out-comes.

The lowest Hb levels were recorded in patients with re-nal disease (Table 6), consistent with findings by Koppe et al. (2019), which demonstrated that progressive renal failure is often accompanied by reductions in serum albumin, lean body mass, and increased systemic in-flammation. These factors collectively exacerbate pro-tein-energy malnutrition and anemia in patients with renal disease (Koppe et al., 2019).

Hematological abnormalities, particularly iron-deficiency anemia, are frequently observed in patients with chronic liver disease. These abnormalities are pri-marily caused by gastrointestinal bleeding and inade-quate dietary intake. Management strategies such as oral iron supplementation, parenteral therapy, and blood transfusions are often employed to address these issues (Gkamprela et al., 2017). Notably, diabetic nephropathy accelerates and exacerbates anemia com-pared to non-diabetic renal diseases, underscoring the importance of routine anemia screening in diabetic pa-tients to improve clinical outcomes (Gkamprela et al., 2017).

Anemia is also prevalent in patients with heart failure due to multiple factors, including reduced erythropoietin production, bone marrow suppression, side effects of medications, and nutritional deficiencies. These interre-lated causes necessitate comprehensive management approaches to reduce hospitalization rates and mortali-ty among this patient population (Siddiqui et al., 2022).

Recent advancements in anemia management empha-size the importance of integrated strategies. Kuragano (2022) stressed the value of early detection of anemia and the use of interventions such as iron supplementa-tion and erythropoiesis-stimulating agents (ESAs) in CKD patients to improve their quality of life. Addition-ally, Mouliou (2023) demonstrated that obesity-associated inflammation worsens anemia in CKD, highlighting the need for approaches that address both met-abolic and hematological issues simultaneously (Ku-ragano, 2022; Mouliou, 2023).

Holistic management of obesity and anemia across various chronic medical conditions is essential for en-hancing patient outcomes and minimizing the burden of associated complications. This integrative approach could significantly improve health and quality of life for patients facing these interconnected challenges.

5. CONCLUSION AND RECOMMENDATION

This study underscores significant reductions in hemo-globin (Hb) and serum albumin (ALB) levels among hospitalized patients with chronic diseases, particularly those with liver and renal conditions. While total protein levels were generally within normal ranges, iron, and albumin deficiencies were prevalent, often linked to inadequate dietary intake and low-residue diets. These findings highlight the critical role of clinical dietitians in addressing these deficiencies through targeted interven-tions, including iron supplementation and tailored die-tary plans, with a particular focus on elderly patients more vulnerable to malnutrition. Regular monitoring of nutritional status is essential for early identification and management of deficiencies, ultimately improving pa-tient outcomes. Future research should further explore the prevalence of malnutrition in hospitalized patients and develop effective, disease-specific nutritional strat-egies to enhance care.

AUTHOR CONTRIBUTION

The author was solely responsible for the conceptualiza-tion, design, and execution of this research. The author conducted data collection, analysis, and interpretation of results, as well as the drafting and critical revision of the manuscript for intellectual content. The author ap-proved the final version of the manuscript and agrees to be accountable for all aspects of the work, ensuring the accuracy and integrity of the research.

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DECLARATION

Statement of Ethics

Ethical approval for this study was obtained from the University Ethical Committee (approval number: AM-SEC-3-20-9-2018).

Participants Consent

Written informed consent was obtained from all partici-pants before data collection, ensuring their voluntary participation and understanding of the study's purpose, procedures, risks, and benefits.

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Conflict of Interest

The author declares no potential conflicts of interest related to this article's research, authorship, or publica-tion.

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