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Original article

Nutritional Status of Celiac Disease Patients in Tripoli and Zawiya Hospitals: A Cross-Sectional Study

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Abstract
This study aims to assess the nutritional status of patients with celiac disease, investigate the prevalence of nutrient deficiencies, and analyze the impact of the disease on weight, body mass index (BMI), and vitamin and mineral levels. A cross-sectional study was conducted involving 70 patients diagnosed with celiac disease. Data were collected through questionnaires that included information on medical history, anthropometric measurements, and nutritional factors. The results were analyzed using SPSS software. The study revealed that the proportion of females was higher than that of males (58.6% vs. 41.4%). The most represented age group was between 26 and 35 years. Deficiencies in iron, calcium, and several vitamins were identified among the patients. These findings indicate a significant prevalence of nutrient deficiencies in individuals with celiac disease, underscoring the need for tailored dietary treatment plans and improved nutritional education.

Keywords. *Celiac Disease, Nutritional Status, Nutrient Deficiencies, Body Mass Index, Dietary Treatment*

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Introduction

Health care providers assess nutritional status to detect medical complications that may affect the body's ability to digest food and absorb nutrients effectively. Furthermore, this assessment helps uncover practices that could increase the risk of malnutrition and infection. It also serves as a foundation for providing nutrition education and counseling and establishing appropriate nutrition care plans tailored to the client's specific needs [1]. The first step in the nutritional care process is nutritional assessment. During the assessment, pertinent data are gathered and compared with normal values. A nutrition diagnosis is determined, and a nutrition care plan is developed and prescribed. The nutrition intervention should include goals that are quantifiable, achievable, time-defined, and negotiated with the patient so as to improve dietary intake and reduce risk factors. The assessment continues at each patient visit. A complete nutrition assessment includes a review of dietary intake, anthropometric measures, biochemical data, medical tests, and procedures [2].

Celiac disease is a lifelong systemic disease with a burdensome treatment that requires regular follow-up visits with the expert dietitian and gastroenterologist; patients must be monitored for compliance, symptoms, well-being, and medical issues [2]. The first to provide an accurate clinical description of celiac disease was Samuel G. in 1888, who indicated that following a suitable diet was a crucial factor in improving the patients' condition, thus laying the foundation for understanding the relationship between nutrition and autoimmune bowel diseases. [3]. Celiac disease is an autoimmune disorder caused by the consumption of gluten, a protein found in wheat, barley, rye, and oats. It causes damage to the lining of the small intestine in individuals with a genetic predisposition to the condition [4]. Celiac disease is one of the most common chronic disorders, affecting individuals of all ages worldwide, while the exact reason for its prevalence is still not fully understood. [5]. Therefore, the mechanism of celiac disease development is based on a complex interaction between genetic and environmental factors; gluten consumption is the primary environmental factor, while a group of genes plays a key role in determining the genetic predisposition to the disease. [6].

Although the symptoms and signs of celiac disease have been known for over a century, the link between the disease and gluten consumption was not confirmed until the 1940s, when the Dutch pediatrician Willem Dijk proved a direct correlation between exposure to wheat protein (gluten) and the onset of the disease [7]. When a person with celiac disease consumes gluten, a protein found in wheat, barley, and rye, their immune system launches a response that attacks the small intestine. This immune response damages the villi, tiny finger-like structures that line the small

intestine and help to absorb nutrients. Damage to these villi impairs the effective absorption of essential nutrients. [8]. Gastrointestinal symptoms of celiac disease include bloating, abdominal cramps, diarrhea, nausea, and other intestinal disturbances. In addition, patients may experience extragastrointestinal symptoms such as osteoporosis, anemia, chronic fatigue, headaches, cognitive impairment, joint pain, and skin rashes [9]. A delay in diagnosis can rarely lead to a life-threatening coeliac crisis, which is characterized by watery diarrhea, marked abdominal distension, dehydration, electrolyte imbalance, hypoalbuminemia, hypotension, and lethargy. Acute or recurrent intestinal intussusception is another possible manifestation [10].
Nonclassical coeliac disease is the most common presentation and is characterized by non-specific intestinal complaints (eg, recurrent abdominal pain, bloating, and diarrhea or constipation). Extra-intestinal subclinical (clinically silent) coeliac disease is identified through either screening programs in the general population or case finding in at-risk groups, such as relatives of individuals with coeliac disease [10]. Gender affects the incidence of the disease, with women being 1.5 times more likely to be affected than men. Age also influences the spread of the disease, as children are up to twice as likely to be affected as adults. However, there is a second peak in the incidence of Crohn's disease in people aged between 50 and 69 years [11]. Low concentrations of blood hemoglobin and serum albumin, calcium, potassium, magnesium, and iron are frequently encountered in adult celiac disease patients with untreated celiac sprue, and even those with subclinical disease have been frequently reported to suffer from anemia because of deficiencies of iron and folate [12]. Celiac diagnosis is based on specific serological tests, including antibodies against endomysium and anti-transglutaminase tissue. Serological tests are not only used for diagnosis, but are also used to monitor adherence to a gluten-free diet afterward.
The golden standard in the diagnosis of celiac disease is the biopsy. During the biopsy, 4-5samples are collected from several areas of the small intestine, thus determining the size of changes that have occurred in the mucosa. The severity of the symptoms will be greater the larger the intestinal area affected [13]. Made by the presence of characteristic histopathological changes in duodenal biopsies in the form of crypt hyperplasia and villous atrophy, as well as by the remission of clinical symptoms, improvements in tissue examination results have been observed in patients who adhere to a gluten-free diet. The presence of CD antibodies and specific HLA (human leukocyte antigen) haplotypes may aid the clinical evaluation. This study aims to assess the nutritional status of patients with celiac disease, investigate the prevalence of nutrient deficiencies, and analyze the impact of the disease on weight, BMI, and vitamin and mineral levels.

Methods

Study Design and Setting

This is a descriptive, analytical study with a convenience sample including celiac disease patients. Participants were individuals diagnosed with celiac disease, aged 5 to over 46 years, who voluntarily consented to participate in the study. Celiac disease diagnosis was determined through patient reports of serological tests, intestinal biopsies, genetic testing, and medical diagnostic reports. The study was conducted in the Gastroenterology Department at Tripoli University Hospital and Zawiya Street Hospital. The medical records of patients in the treatment departments at the aforementioned hospitals were reviewed. A questionnaire was prepared to collect information about the health and nutritional status of the patients. Some patients' data were collected through personal interviews, while others were collected from the medical records of patients attending the Therapeutic Nutrition Department and the Gastroenterology Department at Tripoli University Hospital and Zawiya Street Hospital. The questionnaire included information about gender, age, height, weight, body mass index, hemoglobin levels, calcium, vitamin D, vitamin B12, years of diagnosis, diagnosis of nutrient deficiency, comorbidities, and the type of test that diagnosed celiac disease.

Subjects and Sample Size

The study group consisted of 70 patients attending the Therapeutic Nutrition Department and the Gastroenterology Department at Tripoli University Hospital and Zawiya Street Hospital.

Data Collection

The study duration was four consecutive months. Patient data were collected through the distribution of a questionnaire designed for this purpose. Patients who could not be reached had their medical data collected after obtaining approval from the hospital administration and the hospital's treatment departments.

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Data analysis

After completing the questionnaire, the data were entered into an Excel spreadsheet. Data were analyzed using the Statistical Package for the Social Sciences, version 25 (SPSS). Normally distributed variables were presented as the mean ± standard deviation, and the accepted significance level was P<0.05. Demographic data (sex, age) were collected to assess nutritional status. Anthropometric data (weight and height) were collected and reported by the patients themselves. Body mass index (BMI) (kg/m²) was calculated from the weight and height data, and values were classified according to the World Health Organization (WHO) criteria. Regarding the history of celiac disease, questions about the diagnosis were applied.

Results

The study population consisted of 70 patients diagnosed with celiac disease, with a female predominance (58.6% females vs. 41.4% males). The mean age of participants was 29.5 ± 11.5 years. Regarding disease duration, nearly half of the patients (47.1%) had been diagnosed for less than 5 years, while only 4.3% had a disease duration of 15–20 years. Anthropometric measurements showed a mean BMI of 23.9 ± 4.2 kg/m ². In terms of biochemical markers, the mean hemoglobin level was 11.17 ± 2.0 g/dL, and the mean iron level was 41.25 ± 2.7 µg/dL. The results of this study showed that the percentage of females is 58.6%, while the percentage of males is 41.4%. As shown in (Table 1).

Table1. The distribution of the sample by gender

Gender	Frequency	%
Female	41	58.6%
Male	29	41.4%
Total	70	100.0%

(Fig 1) shows the highest percentage of the sample distribution is within the age group of (25–35) years, accounting for (35.7%) of the sample size. Following this, those in the age group of (15–25) years represent (24.3%) of the sample. The lowest percentage is found in the age group of (5–15) years, with a representation of (10%). The mean age is 29.5 years, with a standard deviation of 11.53.

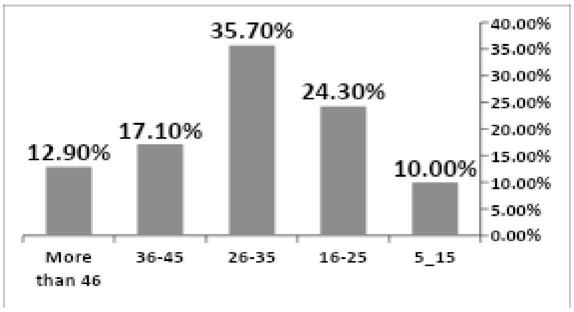

Fig 1. The distribution of the sample by age

Table 2. The distribution of the sample by height

Height	Frequency	%
133-146	14	20.0%
146-159	15	21.4%
159-172	19	27.1%
172-185	15	21.4%
185-198	7	10.0%
Mean	163.7	
Standard deviation	0.108	

Table 3. The distribution of the sample by weight

Weight	Frequency	%
42-52	14	20.0%
52-62	15	21.4%

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62-72	19	27.1%
72-82	15	21.4%
82-92	7	10.0%
Total	70	100.0%
Mean	64.14	
Standard deviation	13.02	

Table 3 shows that the highest percentage of the sample distribution consists of patients with weights ranging between 62 and 72 kg, accounting for 27.1% of the sample size. Following this, patients with weights ranging between 52 and 62 kg and those between 72 and 82 kg each represent 21.4% of the sample. The lowest percentage is found among patients with weights ranging from 82 to 92 kg, comprising 10%. The mean weight is 64.14 kg, with a standard deviation of 13.02.

Table 4. The distribution of the sample according to body mass index

Body mass index	Frequency	%
16.5-19.7	14	20.0%
19.7-22.9	21	30.0%
22.9-26.1	20	28.6%
26.1-29.3	15	21.4%
Total	70	100.0%
Mean	23.92	
Standard deviation	4.2	

In (Table 4) we note that the highest percentage of the sample distribution consists of patients with a body mass index (BMI) ranging from 19.7 to 22.9, accounting for 30% of the sample size. Following this, patients with a BMI between 22.9 and 26.1 represent 28.6% of the sample. The lowest percentage is found among patients with a BMI ranging from 16.5 to 19.7, comprising 20%. The mean BMI is 23.92, with a standard deviation of 4.2.

Table 5. The distribution of the sample according to the hemoglobin levels

Hemoglobin levels	Frequency	%
5-8	3	4.3%
8-11	23	32.9%
11-14	25	35.7%
14-17	19	27.1%
Total	70	100.0%
Mean	11.17	
Standard deviation	2.016	

(Table 5) shows that the highest percentage of the sample distribution is patients with hemoglobin levels ranging from 11 to 14 g/L, accounting for 35.7% of the sample. Following this, patients with hemoglobin levels between 8 and 11 g/L represent 32.9% of the sample. The lowest percentage is found among patients with hemoglobin levels ranging from 5 to 8 g/L, comprising 4.3%. The mean hemoglobin level is 11.17 g/L, with a standard deviation of 2.016 g/L.

Table 6. The distribution of the sample according to the level of Iron

level of Iron	Frequency	%
Less than 40	47	67.1%
40-80	8	11.4%
80-120	8	11.4%
120-160	7	10.0%
Total	70	100.0%

Mean	41.25	
Standard deviation	2.7	

(Table 6) We note that the highest percentage of the sample distribution consists of patients with iron levels of less than 40 µg/dL, accounting for 67.1% of the sample size. The lowest percentage is found among patients with iron levels ranging from 120 to 160 µg/dL, comprising 10%. The mean iron level is 41.25 µg/dL, with a standard deviation of 2.7 µg/dL. (Fig 2) We note that the highest percentage of the sample distribution consists of patients with calcium levels of less than 10 mg/dL, accounting for 56% of the sample size. The lowest percentage is found among patients with calcium levels of 20 mg/dL or more, comprising 8.6%. The mean calcium level is 10.56 mg/dL, with a standard deviation of 7.9 mg/dL.

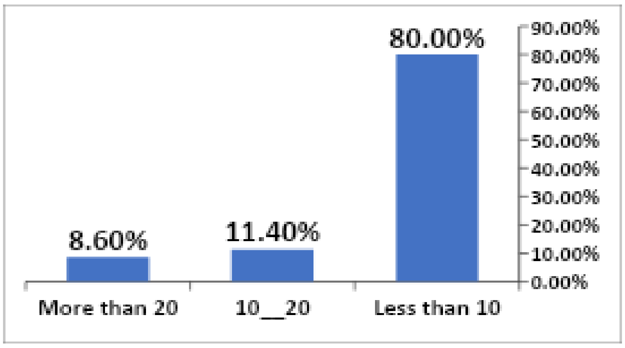

Fig 2. The distribution of the sample according to the level of calcium

Table 7. The distribution of the sample according to the level of Vitamin D

Level of Vitamin D	Frequency	%
Less than 12	20	28.6%
12-24	16	22.9%
24-36	18	25.7%
More than 36	16	22.9%
Total	70	100.0%
Mean	25.1	
Standard deviation	15.4	

In (Table 7) we note that the highest percentage of the sample distribution consists of patients with vitamin D levels of less than 12 ng/mL, accounting for 28.6% of the sample size. The lowest percentage is found among patients with vitamin D levels between 12 and 24 ng/mL and those with levels of 36 ng/mL or more, each comprising 22.9%. The mean vitamin D level is 25.1 ng/mL, with a standard deviation of 15.4 ng/mL.

Table 8. The distribution of the sample according to the level of Vitamin B12

Level of Vitamin B12	Frequency	%
Less than 100	10	14.3%
100-200	8	11.4%
200-300	12	17.1%
More than 300	40	57.1%
Total	70	100.0%
Mean	304.19	
Standard deviation	177.8	

(Table 8) We note that the highest percentage of the sample distribution consists of patients with vitamin B12 levels of 300 ng/mL or more, accounting for 57.1% of the sample size. The lowest percentage is found among patients with vitamin B12 levels ranging from 100 to 200 ng/mL, comprising 11.4%. The mean vitamin B12 level is 304.19 ng/mL, with a standard deviation of 177.8 ng/mL.

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Table 9. The distribution of the sample according to years of illness

Class	Frequency	%
Less than 5	33	47.1%
5-10	24	34.3%
10-15	10	14.3%
15-20	3	4.3%
Total	70	100.0%
Mean	6	
standard deviation	4.12	

From (Table 9), we observe that patients with a disease duration of "less than 5 years" represent the most common category, comprising 33 individuals (47.1%). This indicates that nearly half of the sample has experienced the condition for a short period, which may suggest recent cases or an emerging outbreak. Patients with a disease duration of "5-10 years" come second, with 24 individuals (34.3%), reflecting a significant number of individuals suffering from a medium-term condition. In contrast, patients who have been ill for "10-15 years" include 10 individuals (14.3%), indicating that fewer participants have experienced long-term illness in this timeframe. Similarly, those with a disease duration of "15-20 years" are the least represented, with only 3 individuals (4.3%). This data illustrates that the majority of participants have experienced illnesses for short to medium durations, potentially reflecting the nature of the condition or disease in question. It may be necessary to analyze the underlying causes for the high rates of short-term illnesses, such as environmental or behavioral factors. Additionally, the lower percentages in the longer duration categories may indicate that long-term conditions are less common, which could be a positive sign regarding the effectiveness of interventions or treatments used.

Table 10. Pearson Correlation Coefficients between Demographic/Anthropometric Variables and Biochemical Markers.

Variable	Hemoglobin (g/dL)	Iron (µg/dL)	Calcium (mg/dL)	Vitamin D (ng/mL)	Vitamin B12 (ng/mL)
BMI	r = -0.059	r = 0.067	r = 0.381**	r = -0.214	r = -0.165
	(P=0.72)	(P=0.99)	(P=0.008)	(P=0.15)	(P=0.23)
Weight (kg)	r = -0.049	r = -0.152	r = 0.277*	r = -0.079	r = -0.050
	(P=0.68)	(P=0.20)	(P=0.02)	(P=0.51)	(P=0.68)
Age (years)	r = 0.106	r = -0.025	r = 0.313**	r = -0.059	r = -0.169
	(P=0.38)	(P=0.83)	(P=0.008)	(P=0.62)	(P=0.16)
Disease Duration	r = -0.044	r = 0.325*	r = -0.137	r = -0.027	r = -0.114
	(P=0.72)	(P=0.006)	(P=0.25)	(P=0.82)	(P=0.34)

**Significant at $P < 0.05$*

The results revealed a statistically significant positive correlation between Serum Calcium levels and BMI (r=0.381, p=0.008), Weight (r=0.277, p=0.02), and Age (r=0.313, p=0.008). This indicates that higher body weight, BMI, and advanced age are associated with relatively higher calcium levels in this cohort. Furthermore, a significant positive correlation was found between Disease Duration and Serum Iron levels (r=0.325, p=0.006), suggesting that patients with a longer history of the disease tended to have higher iron levels.

Conversely, no statistically significant correlations were observed between Hemoglobin, Vitamin D, or Vitamin B12 levels and any of the studied anthropometric variables ($p > 0.05$). Additionally, BMI showed no significant association with Hemoglobin or Iron levels.

Discussion

The current study aimed to assess the nutritional status of patients diagnosed with celiac disease (CD) in Western Libya. Our findings indicate a higher prevalence of the disease among females (58.6%) compared to males. This aligns with global epidemiological data suggesting that autoimmune disorders, including celiac disease, are significantly more common in women. The mean age of our study population was 29.5 years, with the majority falling in the 26–35 age

group. This highlights that CD affects the economically active young adult population, emphasizing the need for effective long-term management strategies.
A key finding of this study is the presence of nutritional deficiencies, particularly in iron and calcium, among the participants. This can be attributed to the pathophysiology of celiac disease, where villous atrophy primarily affects the duodenum and proximal jejunum—the primary sites for iron and calcium absorption [Ref]. Even in patients adhering to a gluten-free diet (GFD), micronutrient deficiencies may persist due to incomplete mucosal recovery or poor dietary quality. Our results reinforce the importance of regular screening for anemia and bone density in CD patients, regardless of their symptom status.
Interestingly, our statistical analysis revealed a significant positive correlation between disease duration and serum iron levels (P=0.006). This suggests that patients who have lived with the disease for a longer period tend to have better iron stores compared to newly diagnosed patients. This could be explained by the gradual healing of the intestinal mucosa over years of adherence to a gluten-free diet, leading to improved absorption. Conversely, newly diagnosed patients likely suffer from active inflammation and severe villous atrophy, resulting in lower iron levels at the time of diagnosis.
The study also demonstrated a significant positive correlation between Body Mass Index (BMI) and serum calcium levels (P=0.008). Patients with lower BMI exhibited lower calcium levels, which may indicate a dual burden of malnutrition: caloric insufficiency combined with micronutrient malabsorption. On the other hand, the lack of significant correlation between BMI and other markers (Hemoglobin, Vitamin D, B12) suggests that a "normal" or "high" BMI does not guarantee adequate nutritional status. This phenomenon, often termed "Hidden Hunger," is common in CD patients consuming high-calorie, nutrient-poor gluten-free processed foods.

Conclusion
The results of this study showed that body mass index (BMI) had no effect on hemoglobin level, iron level, calcium level, vitamin D, or vitamin B12. The results also included that the highest BMI among patients was (19.7–22.9), representing 30%. Using Pearson's correlation coefficient, it was clear that age did not affect the blood parameters, including hemoglobin level, iron level, vitamin D, or vitamin B12, except for calcium level, at a significance level of 0.008.

Conflict of interest. Nil

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