Volume 3, Issue 3, 2025

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

ASSESSMENT OF NUTRITIONAL STATUS AND DIETARY INTAKE PATTERNS OF CELIAC DISEASE PATIENTS (UNDER 5 YEARS): A CROSS-SECTIONAL STUDY AT TERTIARY CARE UNITS OF DISTRICT PESHAWAR

Dr. Fazia Ghaffar[*1], Asma Waheed[2], Sabahat Shoukat[3]

[*1]*Assistant Professor, Department of Food & Nutrition Sciences, College of Home Economics, University of Peshawar*
[2]*Senior Nutritionist, Khyber Teaching Hospital, Peshawar*
[3]*Department of Food & Nutrition Sciences, College of Home Economics, University of Peshawar*

[*1]faziaghaffar@uop.edu.pk

DOI: https://doi.org/10.5281/zenodo.15394407

Keywords
Celiac Disease, Anthropometry, Dietary Gluten, Sociodemographic factors, Dietary Patterns.

Article History
Received on 03 April 2025
Accepted on 03 May 2025
Published on 13 May 2025

Corresponding Author: *
Dr. Fazia Ghaffar

ABSTRACT

Introduction: *Celiac disease (CD), caused by genetic predisposition and gluten exposure, is increasing globally and has a significant economic burden. Adherence to a gluten-free diet can improve anthropometric measurements, but may not reach healthy levels. Limited studies on Pakistani young patients' dietary patterns or nutritional adequacy exist. The current study aimed at analyzing the nutritional status and dietary intake patterns of children under five children present with CD in a tertiary care Unit at Peshawar*

Results: *Most of the respondents (52.5%) belonged to rural areas. Females (62.5%) were more affected from the disease as compared to males (37.5%). Most samples belonged to low socio-economic status (65.5%) having low parental income. The majority of samples had illiterate mothers (80.0%). Due to a high illiteracy rate most mothers (90.0%) did not know about the disease. 22.5% samples had a family history of disease. 67.5% did not known gluten-free foods. The majority (57.5%) of samples belonged to the 1-2-year age group. The mean weight of 1-2 years male (6.962±1.0609), female (6.787±1.0690), 2-3 years male (8.975±1.3769), female (7.380±0.6099), 3-4 years male (10.500±0) and 4-5 years female (9.125±1.5478) did not fall within the normal reference range of WHO. Z-score values (<-3) showed that the samples were stunted. Biochemical parameters like tissue transglutaminase IgA, IgG, haemoglobin and random blood sugar levels were not in agreement with the reference values. About 87.5% samples were presented with diarrhoea, followed by 97.5% showing weight loss. 92.5% had dehydration, 97.5% had overall weakness, 97.5% had general fatigue. All samples (100%) had abdominal pain and irritable behaviour. 95% samples had delayed growth. The majority of the samples suffered from diabetes (32.5%), anaemia (32.5%) and hepatitis (27.5%). Consumption of gluten-rich sources such as roti, biscuits, cakes and starting complementary feeding with roti was highest. The intake of fruits and vegetables was less. Intake of tea and green tea was high. Overall, the children had clinical symptoms of micronutrient deficiencies along with being severely wasted and stunted.*

Conclusions: The current study concludes that children under five years were severely malnourished. Patients with lower incomes have worse CD-related health

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

and greater symptoms. The mass illiteracy among mothers and lack of knowledge about the disease and gluten-free foods emphasize the serious need for Maternal education that influences various factors such as access to healthcare, knowledge of dietary needs, and overall family health practices

1. INTRODUCTION

In genetically predisposed individuals, gluten and related protamine's can cause celiac disease, an immune mediated systemic illness marked by a variety of small intestinal damage combinations, celiac-specific antibodies, human leukocyte antigen, and gluten dependent clinical manifestations [1]. The etiology of celiac disease, an autoimmune disease, is known to be significantly influenced by environmental variables (gluten intake), autoantigen to tissue transglutaminase (tTG), and genetics (HLA-DQ2 and HLA-DQ8 genotypes) [3]. Celiac disease autoimmunity appears to be caused by a combination of genetic predisposition, gluten intake, loss of intestinal barrier function, gluten-induced pro-inflammatory innate immune response, incorrect adaptive immunological response, and an imbalanced gut flora [3]. HLA-DQ2 or HLA-DQ8 is present in over 99% of celiac patients, compared to 40% Celiac disease autoimmunity appears to be caused by a combination of genetic predisposition, gluten intake, loss of intestinal barrier function, gluten-induced pro-inflammatory innate immune response, incorrect adaptive immunological response, and an imbalanced gut flora [3]. Compared to 40% of the normal population, over 99% of celiac patients have HLA-DQ2 or HLA-DQ8 [4].

It has been proposed that the age at which newborns begin consuming gluten, the type of delivery, and breast milk may all influence the incidence of celiac disease. Retrospective studies, however, provide no evidence that those characteristics influence the likelihood of acquiring celiac disease [5-7]. It is estimated that one percent of people worldwide suffer with celiac disease [9]. The prevalence of celiac disease. In the world, the sero-prevalence of celiac disease is 1.4%, while the biopsy-proven prevalence is 0.7% [10]. Geographical and ethnic differences affect its prevalence. From early childhood to old age, celiac disease can strike at any time. It has two peaks, the first of which follows gluten consumption during the first two years of life and the second of which appears in the second or third decade. Because celiac disease symptoms differ from person to person, diagnosis is challenging [11].

Due to the widespread use of extremely sensitive and specific diagnostic tests for celiac disease, as well as greater physician understanding and awareness of the condition, the prevalence of celiac disease has increased dramatically over the past 30 years [12,13]. Up to 95% of celiac patients are still undiagnosed, despite greater awareness and understanding of the condition [14–16]. According to some research, it can take four to ten years to diagnose celiac disease [20,21]. Even in industrialized nations, a large number of cases go untreated. The dearth of skilled experts in this sector and the restricted availability of serological diagnostic tests in developing nations may be the cause of missed or delayed diagnoses [17]. Celiac disease is more common in people with Down syndrome, type 1 diabetes mellitus (DM), autoimmune thyroiditis, Turner syndrome, Williams syndrome, specific immunoglobulin (Ig)A deficiency, and first- and second-degree relatives of celiac patients [18–20]. The frequency of celiac disease has increased as a result of screening tests for the condition in at-risk groups, including those with autoimmune thyroid disorders, type 1 diabetes, and first-degree relatives of celiac patients [20,21,32].

A lifetime gluten-free diet is currently the only effective treatment. Strictly following a gluten-free

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

diet has been shown to significantly enhance quality of life, normalize biochemical testing, and alleviate symptoms [23]. Children with CD who receive an early diagnosis and who continue to receive regular follow-up are more likely to adhere to the gluten-free diet. Adolescents have less of it than adults [24]. The length of time spent following a gluten-free diet has been linked to an increase in autoimmune illnesses, according to certain reports [25]. The only effective treatment available at the moment is lifelong gluten avoidance. Following a gluten-free diet has several drawbacks, including a detrimental effect on life quality, psychological issues, unintentional gluten exposure, potential vitamin and mineral shortages, metabolic. The adherence to the gluten-free diet has some disadvantages; negative impact on quality of life, psychological problems, involuntary gluten contamination, possible vitamin and mineral deficiencies, metabolic syndrome, increased cardiovascular risk, and severe constipation [26-28]. With an incidence ranging from 12 to 69%, iron deficiency—regardless of anemia—is a prevalent clinical characteristic in untreated CD [29, 30]. It's interesting to note that incidence does not clearly differ by age or gender [29]. Reduced iron absorption in the duodenum as a result of the cranio-caudal progression of intestinal lesions is the primary pathogenic mechanism behind anemia. Additional factors include mutations in iron transporter genes, inflammation-related hepcidin overexpression, and reduced erythropoietin synthesis [25 ,30]. When iron insufficiency is present at any age, CD screening is required [31].

Although less common, anemia in CD patients can also result from folic acid and vitamin B12 deficits in addition to iron deficiency. According to recent data, vitamin B12 deficiency affects 8–41% of adults and 4–8% of children, whereas folic acid deficiency affects 20– 30% of newly diagnosed adult CD patients and 15–18% of children [32-34]. Global malabsorption is not the only factor contributing to these inadequacies; other factors also play a contribute. Untreated CD increases the incidence of fractures relative to the general population [51] and is linked to decreased bone mineral density (BMD) in both adults and adolescents, affecting 7–16% of patients [50]. and is more susceptible to fractures than the overall population [35]. The impairment of bone metabolism in CD is caused by more than just malabsorption of calcium and vitamin D. Although the precise causes are yet unclear, autoimmune processes and inflammatory mediators are also linked. Even in patients with small intestinal lesions, these variables may lead to a reduction in BMD [35].CD is connected to a variety of neurological disorders. Encephalopathy, myelopathy, tetraplegia/paraplegia, ataxia, psychosis, and seizures are examples of central nervous system involvement [36,37]. Patients with CD also frequently have peripheral neuropathy, which usually manifests as symmetric acral polyneuropathy [38]. A prominent cause of malabsorption-related ocular symptoms in CD, vitamin A insufficiency can result in corneal ulcers, xeropthalmia, keratomalacia, and night blindness [39]. Untreated CD frequently has low levels of several vitamins, such as vitamin E (88%), B1 (71%), K (21%), and B6 (12%).

2. METHODOLOGY

2.1: Study Design and Sample

This prospective cross-sectional study was carried out at the Nutritional Rehabilitation Unit (NRU) of Khyber Teaching Hospital, Peshawar. The purposive sample consisted of 74 children under five years old hospitalized children suffering from celiac disease. Data was collected on a pre standardized questionnaire after procuring written consents from the parents. The study was approved by the Institutional Ethical Approval Committee of the College of Home Economics, University of Peshawar.

2.2: Collection of data

The following methods were used to assess the nutritional status of the respondents

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

2.2.1Anthropometric assessment

2.2.1.1: Weight

Weight of a child reflects the current nutritional status. Weight was measured using Pediatric scale for Infants and beam scale for children. Scale was calibrated to zero and weight was recorded in kilograms after removing the heavy clothes of the child. The child was placed on the centre of the scale and reading was noted. Weight of children according to age and sex were then compared with WHO reference value.

2.2.1.2: Height/Length

Length board was used for measuring child length in centimeters after removing heavy dress and shoes of the child. The child was placed on the board with crown against the fixed end of the board. The child was positioned so that his/her shoulders and back were flat along the center of board and feet were straight and perpendicular to the movable end. After taking length and weight the values were compared with those of WHO reference values according to which the child's nutritional status assessed.

2.2.1.3: Weight for Height/Length Z-score

The Z-score was determined by using a table in hospital manually, where the weight for height would be checked. If a child has <-3SD Z-score then he/she was taken as severely malnourished. If a child has <-2SD Z-score and >-3SD then he/she was taken as moderately malnourished.

2.2: Biochemical tests

Biochemical assessment was done in which anibodies (IgA and IgG), hemoglobin level and random blood sugar was compared with normal levels.

2.3: Clinical Assessment & Medical History

The physical or mental conditions of which the patient, the major illnesses the patient, history of surgeries, information about any pain, discomfort or other medical issues the patient were recorded. Patients were also examined for nutritional status. It included complete physical examination special attention is given to hair, skin, eyes, fontanels, perennial rashes, etc.

2.4: Dietary Assessment

A pre-standardized semi-quantitative Food frequency Questionnaire (FFQ) divided into 7 food groups and 143 food items with a focus on gluten-containing and gluten-free food to collect data about the different foods and beverages, with responses being categorized to indicate usual frequency of consumption over the time queried. Also referred to as a diet history, the patient's mother or the attendant was asked to recall the kind of food consumed by the child over the previous week before hospitalization. The child's usual daily, weekly and monthly food intakes were recorded to ascertain the intake of nature of the diet.

2.5: Statistical Analysis

The data procured was statistically analyzed for percentage, mean, standard deviation and Z scores.

3. RESULTS & DISCUSSION

3.1: Socio-demographic Characteristics of the Sample

Table 1 shows that celiac disease was more prevalent among female children (62.5%) than in males (37.5%). Data regarding parents' educational background showed that 45.0% of fathers were illiterate, 42.5% had elementary education and only 12.5% were above matric, whereas 80.0% of mothers were illiterate, 12.5% had primary education and only 7.5% had secondary education. About 65.0% of families had low social status, 25.0% were of moderate financial background, and only 10.0% of families were of high status. About parental occupational background, 30.0% of fathers were labourers and 67.5% of mothers were homemakers. The data also showed that 30.0% of the children belonged to nuclear families, while 70.0% of the patients belonged to a joint family set up. The data showed that 47% samples belonged to urban areas of Peshawar, while 53% belonged to rural areas. Only 10.0% of mothers knew about the disease, while 90.0% had not heard about the disease. About 22.5% of the respondents had a family history of disease, while 77.5% had no history of celiac disease. About 32.5% of mothers know about CD, while 67.5% did not know about gluten-free foods. These findings align with other studies,

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

which showed the relationship between mothers' education and diagnosis of the disease [40,41]

Table 1: Demographic Distribution of the Sample

Parameters	Percentage	Parameters	Percentage
Gender of the Child		Father occupation	
Male	37.5	Labourer	30.0
Female	62.5	Mechanic	12.5
Father's Education		Shopkeeper	30.0
Illiterate	45.0	Drug addicted	5.0
Elementary	42.5	Teacher	7.5
Above matric	12.5	OTHERS	15
Mother Education		Mother Occupation	
Illiterate	80.0	House wife	67.5
Elementary	12.5	Maid	22.5
Above matric	7.5	Teacher	7.5
Socio-Economic status		Lunch Lady	2.5
Low (upto 20,000)	65.0	Residence	
Moderate (20,000-35,000)	25.0	Rural	53
High (> 35,000)	10.0	Urban	47
Family type		Mother's Knowledge of CD	
Nuclear	30.0	Yes	10.0
Joint	70.0	No	90.0
Knowledge of gluten-free foods		Family History of CD	
Yes	12.5	Yes	22.5
No	87.5	No	77.5

3.2: Clinical Symptoms and Complications among the Patients

Graph 1 shows that 57.5% of children were within the age group 1-2 years, 30% were within 2-3 years age group, while 2.5% of children belonged to the 3-4 years age group, and 10% belonged to the 4-5 years age group. About 87.5% of the children were presented with diarrhea, 30.0% with constipation, 97.5% were presented with weight loss, 77.5% were presented with vomiting, 92.5% were presented with dehydration, 77.5% were presented with eyes yellowish, 97.5 were presented with weakness, 75.0% were presented with pale skin, 97.5% were presented with general fatigue, 100% with abdominal pain and 100% were presented with irritable behavior, 95.0% with delayed growth. The findings also showed that 5.0% were diagnosed with liver disease, 32.5% were diagnosed with diabetes mellitus, 27.5% were diagnosed with hepatitis, 2.5% with tuberculosis, and 32.5% had a severe form of anaemia. The feeding practices of the respondents, 47.5% were given prelacteal, out of which 87.5% of babies were given green tea and 12.5% water with added sugar & local herbs. The study is in line with the previous study, which identifies that low family income is one of the leading causes of celiac disease, due to which parents cannot afford gluten gluten-free diet for their children [40,42].

Volume 3, Issue 3, 2025

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

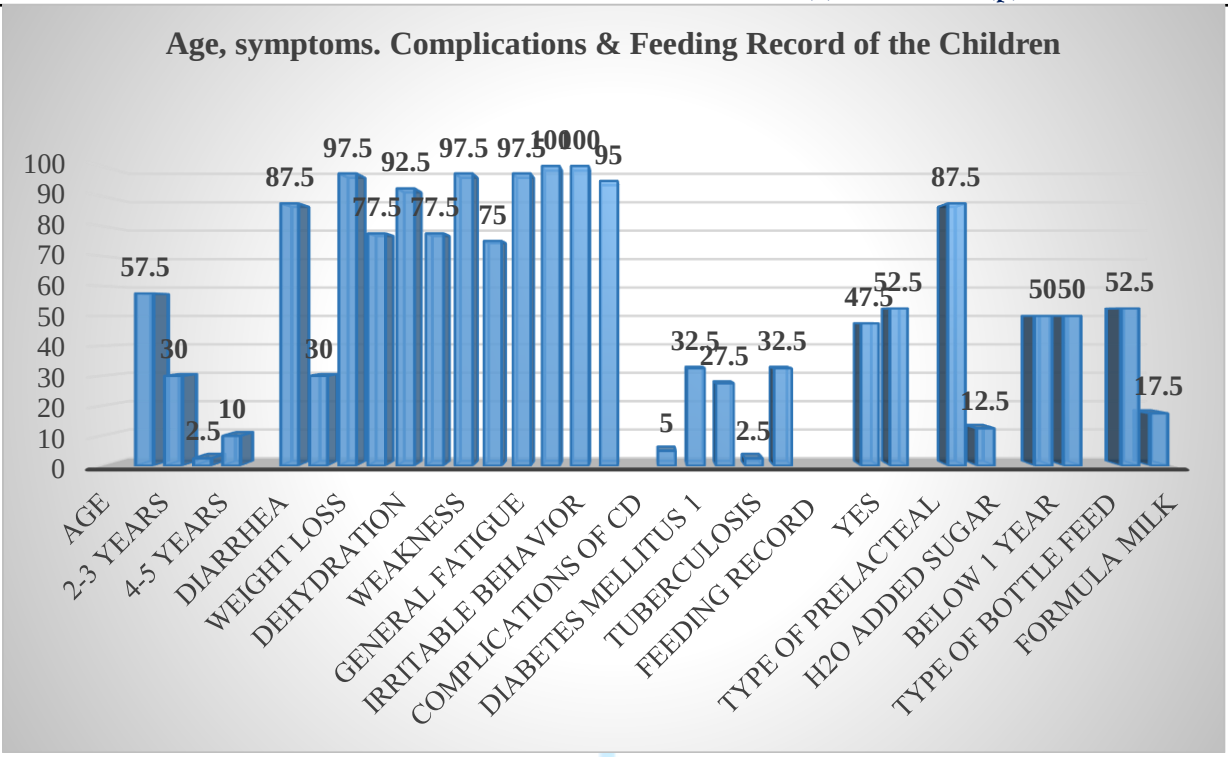

Figure 1: Age, Symptoms of CD, & Feeding Record of the Children

3.3: Anthropometric Profiles of the Patients

Table 2 shows the anthropometric measurements of the samples. According to data, male children of 1-2 years had a mean height of 75.250±9.9535, and the difference was -1.11% less than the reference value for this age. Female children of 1-2 years had a mean height of 73.433±5.0031, and the difference was -2.076% less than the reference value. The mean height of 2-3 years male children was 85.125±7.0755, and the difference was -0.55% less than the reference value for this age. The mean height of 2-3-year-old female children was 78.400±5.7271, and the difference was -7.21% less than the reference value. The mean height of 3- 4-year-old male children was 95.000±0, and the difference was 0.1%, which was less than the reference value for this age. The mean height of 4-5-year-old female children was 88.250±9.0692, and the difference was -13.1% less than the reference. The height difference showed that the children were stunted. Regarding the weight of the samples, the above table shows that the mean weight of 1-2 years old male children was 6.962±1.0609, and the difference value was -31.7% less than the reference value for this age. The mean weight of 1-2 female children was 6.787±1.0690, and the difference was -28.5% less than the reference value. The mean weight of 2-3-year-old male children was 8.975±1.3769, and the difference value was -27.0% less than the reference value. The mean weight of 2-3-year-old female children was 7.380±0.6099, and the difference was -37.4% less than the reference value. The mean weight of 3-4-year-old male children was 10.500±0, and the difference was -28.1% less than the reference value for this age. The mean weight of 4-5-year-old female children was 9.125±1.5478, and the difference was -42.9% less than the reference value. The difference in weight of the samples shows that celiac patients were wasting. The data showed that the samples were more wasted, and though not much stunted. The findings of the current study are in line with the previous studies, which showed that celiac disease can cause muscle wasting due to malabsorption of protein and other nutrients [42-44]

Volume 3, Issue 3, 2025

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Table 2: Anthropometric profile of the samples

Parameters	Mean± Standard Deviation	minimum	maximum	Reference* Values (WHO)	Percent difference from the Reference
1) Height (cm)					
1-2 years					
i. Males	75.250±9.9535	64.0	98.0	76.1	(-1.11%)
ii. Females	73.433±5.0031	60.5	80.0	75	(-2.076%)
2-3 years					
i. Males	85.125±7.0755	77.0	92.0	85.6	(-0.55%)
ii. Females	78.400±5.7271	70.0	86.0	84.5	(-7.21%)
3-4 years					
i. Male	95.000±0	95.0	95.0	94.9	(0.1%)
4-5 years					
ii. Females	88.250±9.0692	77.0	99.0	101.6	(-13.1%)
2) Weight (kg)					
1-2 years					
i. Males	6.962±1.0609	5.0	8.7	10.2	(-31.7%)
2-3 Years					
i. Males	8.975±1.3769	7.3	10.2	12.3	(-27.0%)
ii. Females	7.380±0.6099	6.6	8.2	11.8	(-37.4%)
3-4 years					
i. Male	10.500±0	10.5	10.5	14.6	(-28.1%)
4-5 years					
i. Females	9.125±1.5478	7.0	10.5	16.0	(-42.9%)
3) Z-score (SD)					
1-2 years				1. Stunted :Height for age <-2SD to -3SD	
i. Males	3.00±0.000	<-3	<-3		
ii. Females	2.73±0.458	<-2	<-3	2. Severly stunted: Height for age <-3SD	
2-3 years					
i. Males	3.00±0.000	<-3	<-3	1. Wasted: Weight for height <-2SD to -3SD	
ii. Females	3.00±0.000	<-3	<-3	2. Severly wasted: Weight for height <-3SD	
3-4 years					
i. Male	3.00±0	<-3	<-3		
4-5 years					
i. Females	2.67±0.577	<-2	<-3		

3.4: Biochemical Profiles of the Children

Table 3 shows the biochemical assessment of the parameters suffering from celiac disease. Tissue transglutaminase IgA (mg/dl) was recorded as 102, while a maximum was 250. The normal reference range of IgA level was 20-100. All samples had a high level of IgA level which identifies their disease. Tissue transglutaminase IgG level minimum recorded was 120 while the maximum was 980. The normal reference range was 435-916. The minimum recorded haemoglobin was 6.1 while the maximum was 9.0, and the mean was 7.532±0.8695. The normal reference value of haemoglobin was 11. This showed that the samples were anaemic. The random blood sugar minimum recorded was 66 while the maximum recorded was 215, and the mean was 109.90±28.741. The normal reference range of random blood sugar was 80-120.These findings align with other such study [44].

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Table 3: Biochemical Profiles of the Patients

Parameters	Mean±SD	Minimum	Maximum	WHO*
Tissue transglutaminase IgA (mg/dl)	142.35±41.582	102	250	20-100
Tissue transglutaminase IgG (mg/dl)	907.13±128.145	120	980	435-916
Hemoglobin (mg/dl)	7.532±0.8695	6.1	9.0	11
Random blood sugar (gm/dl)	109.90±28.741	66	215	80-120

3.5: Complementary Feeding and Food Intake Patterns of the Children with CD

Graph 2 shows that 62.5% of respondents with started complementary foods at the age of 2-6 months, 25.0% started at the age of 6-12 months, 7.5% started complementary foods after 1 year, 2.5% of mothers do not remember and 2.5% respondents had not started complementary foods yet. Regarding the type of complementary foods taken, 60.0% intake was of roti, 2.5% intake of custard, 15.0% intake was of banana, 5.0% intake was of potato, 10.0% intake was of bakery items, and 7.5% intake was of boiled rice. The intake of biscuits, cakes, and wheat bread among the respondents was highest daily, 67.5% of children consumed roti daily, while only 15.0% consumed it once a month. Most of the respondents (92.5%) rarely consumed maize bread. 25.0% of respondents consumed tandoori roti while only 7.5% consumed it rarely. The most common form of milk was buffalo milk being consumed bt 15% on daily, while 82.5% consumed it rarely. Goat milk, dried milk was also taken but on rarely basis except in children whose familes owned goats at home. the data of the respondents about meat and meat products. 7.5% consumed boiled egg daily while 52.5% consumed it once a week. 2.5% children consumed beaf once in a month while 97.5% consumed it rarely. khichri consumption was 25.0% daily and 42.5% consumed once a week. 90.0% of the respondents rarely consumed. Intake of rice was less in samples which are gluten-free. About 60.0% respondents consumed banana daily while 32.5% respondents consumed it once a week. While the intake of seasonal vegetables varied considerably with 1 per day (37.5), 2-3 per day (15.0), 4-6 per day (5.0), 1 per week (22.5), 1 or 2 per month (2.5), and rarely or none was about 17.5%. On the whole intake of vegetables was less due to which samples lack essential micronutrients. About 35.0 % children were given green tea with added sugar (80%) or jaggery (20%) daily. Plain custard (15%) was also given on daily basis. The most common source of fats in the diet was hydrogenated ghee (97.5%). The findings of the recent study is in accordance with the study which shows that the intake of gluten in the early age increases the risk of the disease and poor dietary patterns can lead severe complications among patients with CD [45]

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

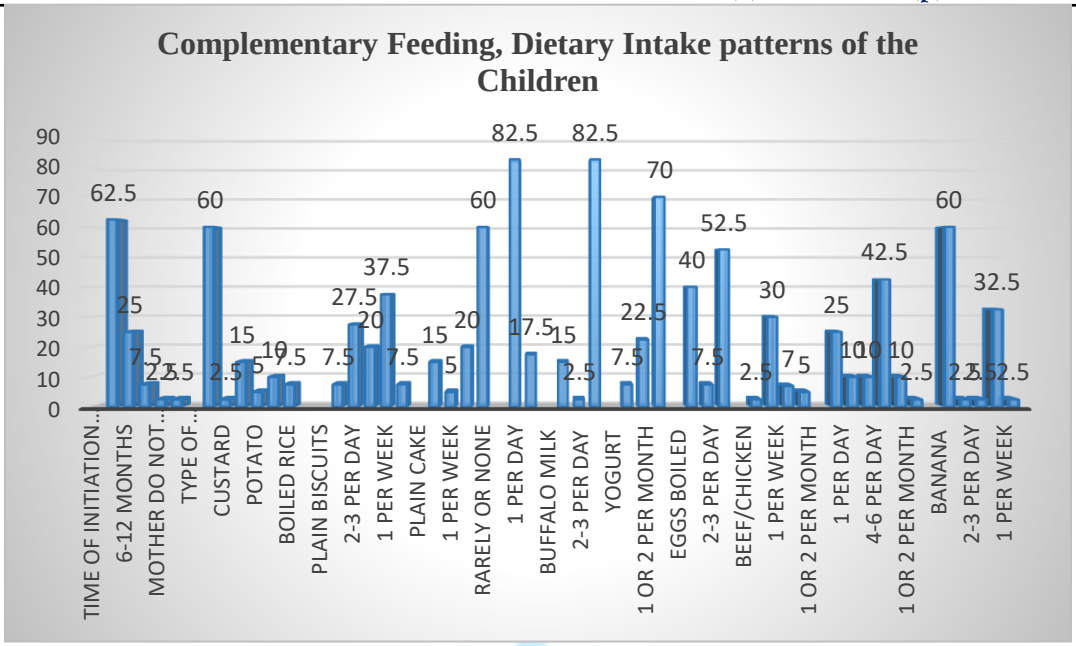

Figure 2: Complementary Feeding, and Dietary Intake Patterns of the CD Children

4.CONCLUCIONS

The study concludes that the intake of gluten, delayed breastfeeding and certain demographic parameters became the cause of celiac disease. Celiac disease was more prevalent among females than in males. Most of them belonged to rural areas. We found mass illiteracy among the mothers with no knowledge of the disease and gluten-free diets. The majority of them had low family income and larger family sizes. Children were suffering from wasting. stunting, severe symptoms of the disease and anaemia indicating poorly managed CD. All samples had muscle wasting, which leads to malnourishment. Consumption of a protein-rich diet, caloric insufficiency, poor intake of fruits and vegetables and high intake of tea and green tea were contributing to the poor nutritional status of these children. This study provides a clear picture of deficiencies and common malnutrition among the CD children and provides a basis for improving education and the quality of diets.

REFERENCES

1. Husby S, Koletzko S, Korponay-Szabó IR, Mearin ML, Phillips A, Shamir R, Troncone R, Giersiepen K, Branski D, Catassi C, Lelgeman M, Mäki M, Ribes-Koninckx C, Ventura A, Zimmer KP ESPGHAN Working Group on Coeliac Disease Diagnosis; ESPGHAN Gastroenterology Committee; European Society for Pediatric Gastroenterology. Hepatology , and Nutrition. European Society for Pediatric Gastroenterology, Hepatology, and Nutrition guidelines for the diagnosis of coeliac disease. J Pediatr Gastroenterol Nutr. 2012;54:136–160. doi: 10.1097/MPG.0b013e31821a23d0.
2. Caio G, Volta U, Sapone A, Leffler DA, De Giorgio R, Catassi C, Fasano A. Celiac disease: a comprehensive current review. BMC Med. 2019;17:142. doi: 10.1186/s12916-019-1380-z.
3. Hadithi M, von Blomberg BM, Crusius JB, Bloemena E, Kostense PJ, Meijer JW, Mulder CJ, Stehouwer CD, Peña AS. Accuracy of serologic tests and HLA-DQ typing for diagnosing celiac disease. Ann Intern Med. 2007;147:294–302. doi: 10.7326/0003-4819-147-5-200709040-00003.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

4. Lionetti E, Castellaneta S, Francavilla R, Pulvirenti A, Catassi C SIGENP Working Group of Weaning and CD Risk. Mode of Delivery and Risk of Celiac Disease: Risk of Celiac Disease and Age at Gluten Introduction Cohort Study. J Pediatr. 2017;184:81–86.e2. doi: 10.1016/j.jpeds.2017.01.023.
5. Koletzko S, Lee HS, Beyerlein A, Aronsson CA, Hummel M, Liu E, Simell V, Kurppa K, Lernmark Å, Hagopian W, Rewers M, She JX, Simell O, Toppari J, Ziegler AG, Krischer J, Agardh D TEDDY Study Group. Cesarean Section on the Risk of Celiac Disease in the Offspring: The Teddy Study. J Pediatr Gastroenterol Nutr. 2018;66:417–424. doi: 10.1097/MPG.0000000000001682.
6. Dydensborg Sander S, Hansen AV, Størdal K, Andersen AN, Murray JA, Husby S. Mode of delivery is not associated with celiac disease. Clin Epidemiol. 2018;10:323–332. doi: 10.2147/CLEP.S152168
7. Lindfors K, Ciacci C, Kurppa K, Lundin KEA, Makharia GK, Mearin ML, Murray JA, Verdu EF, Kaukinen K. Coeliac disease. Nat Rev Dis Primers. 2019;5:3. doi: 10.1038/s41572-018-0054-z.
8. Singh P, Arora A, Strand TA, Leffler DA, Catassi C, Green PH, Kelly CP, Ahuja V, Makharia GK. Global Prevalence of Celiac Disease: Systematic Review and Meta-analysis. Clin Gastroenterol Hepatol. 2018;16:823–836.e2. doi: 10.1016/j.cgh.2017.06.037.
9. Fasano A. Celiac disease--how to handle a clinical chameleon. N Engl J Med. 2003;348:2568–2570. doi: 10.1056/NEJMe030050.
10. Liu E, Dong F, Barón AE, Taki I, Norris JM, Frohnert BI, Hoffenberg EJ, Rewers M. High Incidence of Celiac Disease in a Long-term Study of Adolescents With Susceptibility Genotypes. Gastroenterology. 2017;152:1329–1336.e1. doi: 10.1053/j.gastro.2017.02.002.
11. King JA, Jeong J, Underwood FE, Quan J, Panaccione N, Windsor JW, Coward S, deBruyn J, Ronksley PE, Shaheen AA, Quan H, Godley J, Veldhuyzen van Zanten S, Lebwohl B, Ng SC, Ludvigsson JF, Kaplan GG. Incidence of Celiac Disease Is Increasing Over Time: A Systematic Review and Meta-analysis. Am J Gastroenterol. 2020;115:507–525. doi: 10.14309/ajg.0000000000000523
12. Hujoel IA, Van Dyke CT, Brantner T, Larson J, King KS, Sharma A, Murray JA, Rubio-Tapia A. Natural history and clinical detection of undiagnosed coeliac disease in a North American community. Aliment Pharmacol Ther. 2018;47:1358–1366. doi: 10.1111/apt.14625
13. Murray JA, Van Dyke C, Plevak MF, Dierkhising RA, Zinsmeister AR, Melton LJ 3rd. Trends in the identification and clinical features of celiac disease in a North American community, 1950-2001. Clin Gastroenterol Hepatol. 2003;1:19–27. doi: 10.1053/jcgh.2003.50004.
14. Lebwohl B, Rubio-Tapia A, Assiri A, Newland C, Guandalini S. Diagnosis of celiac disease. Gastrointest Endosc Clin N Am. 2012;22:661–677. doi: 10.1016/j.giec.2012.07.004.
15. Sanders DS, Hurlstone DP, Stokes RO, Rashid F, Milford-Ward A, Hadjivassiliou M, Lobo AJ. Changing face of adult coeliac disease: experience of a single university hospital in South Yorkshire. Postgrad Med J. 2002;78:31–33. doi: 10.1136/pmj.78.915.31.
16. Lo W, Sano K, Lebwohl B, Diamond B, Green PH. Changing presentation of adult celiac disease. Dig Dis Sci. 2003;48:395–398. doi: 10.1023/a:1021956200382.
17. Nenna R, Tiberti C, Petrarca L, Lucantoni F, Mennini M, Luparia RP, Panimolle F, Mastrogiorgio G, Pietropaoli N, Magliocca FM, Bonamico M. The celiac iceberg: characterization of the disease in primary schoolchildren. J Pediatr Gastroenterol Nutr. 2013;56:416–421. doi: 10.1097/MPG.0b013e31827b7f64.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

18. Nellikkal SS, Hafed Y, Larson JJ, Murray JA, Absah I. High Prevalence of Celiac Disease Among Screened First-Degree Relatives. Mayo Clin Proc. 2019;94:1807–1813. doi: 10.1016/j.mayocp.2019.03.027. [
19. Fasano A, Berti I, Gerarduzzi T, Not T, Colletti RB, Drago S, Elitsur Y, Green PH, Guandalini S, Hill ID, Pietzak M, Ventura A, Thorpe M, Kryszak D, Fornaroli F, Wasserman SS, Murray JA, Horvath K. Prevalence of celiac disease in at-risk and not-at-risk groups in the United States: a large multicenter study. Arch Intern Med. 2003;163:286–292. doi: 10.1001/archinte.163.3.286.
20. Singh P, Arora S, Lal S, Strand TA, Makharia GK. Risk of Celiac Disease in the First- and Second-Degree Relatives of Patients With Celiac Disease: A Systematic Review and Meta-Analysis. Am J Gastroenterol. 2015;110:1539–1548. doi: 10.1038/ajg.2015.296
21. Hill ID, Dirks MH, Liptak GS, Colletti RB, Fasano A, Guandalini S, Hoffenberg EJ, Horvath K, Murray JA, Pivor M, Seidman EG North American Society for Pediatric Gastroenterology. Hepatology and Nutrition. Guideline for the diagnosis and treatment of celiac disease in children: recommendations of the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition. J Pediatr Gastroenterol Nutr. 2005;40:1–19. doi: 10.1097/00005176-200501000-00001
22. Singh P, Arora S, Lal S, Strand TA, Makharia GK. Risk of Celiac Disease in the First- and Second-Degree Relatives of Patients With Celiac Disease: A Systematic Review and Meta-Analysis. Am J Gastroenterol. 2015;110:1539–1548. doi: 10.1038/ajg.2015.296.
23. Pham-Short A, Donaghue KC, Ambler G, Phelan H, Twigg S, Craig ME. Screening for Celiac Disease in Type 1 Diabetes: A Systematic Review. Pediatrics. 2015;136:e170–e176. doi: 10.1542/peds.2014-2883.
24. Sahin Y, Evliyaoglu O, Erkan T, Cokugras FC, Ercan O, Kutlu T. The frequency of celiac disease in children with autoimmune thyroiditis. Acta Gastroenterol Belg. 2018;81:5–8
25. Husby S, Bai JC. Follow-up of Celiac Disease. Gastroenterol Clin North Am. 2019;48:127–136. doi: 10.1016/j.gtc.2018.09.009.
26. Ventura A, Magazzù G, Greco L. Duration of exposure to gluten and risk for autoimmune disorders in patients with celiac disease. SIGEP Study Group for Autoimmune Disorders in Celiac Disease. Gastroenterology. 1999;117:297–303. doi: 10.1053/gast.1999.0029900297.
27. Moreno ML, Cebolla Á, Muñoz-Suano A, Carrillo-Carrion C, Comino I, Pizarro Á, León F, Rodríguez-Herrera A, Sousa C. Detection of gluten immunogenic peptides in the urine of patients with coeliac disease reveals transgressions in the gluten-free diet and incomplete mucosal healing. Gut. 2017;66:250–257. doi: 10.1136/gutjnl-2015-310148
28. West J, Logan RF, Card TR, Smith C, Hubbard R. Risk of vascular disease in adults with diagnosed coeliac disease: a population-based study. Aliment Pharmacol Ther. 2004;20:73–79. doi: 10.1111/j.1365-2036.2004.02008.x.
29. Midhagen G, Hallert C. High rate of gastrointestinal symptoms in celiac patients living on a gluten-free diet: controlled study. Am J Gastroenterol. 2003;98:2023–2026. doi: 10.1111/j.1572-0241.2003.07632.x
30. Bergamaschi, G.; Di Sabatino, A.; Corazza, G.R. Pathogenesis, diagnosis and treatment of anaemia in immune-mediated gastrointestinal disorders. Br. J. Haematol. **2018**, 182, 319–329.
31. Mahadev, S.; Laszkowska, M.; Sundström, J.; Björkholm, M.; Lebwohl, B.; Green, P.H.; Ludvigsson, J.F. Prevalence of Celiac Disease in Patients with Iron Deficiency Anemia-A Systematic Review with Meta-analysis. Gastroenterology **2018**, 155, 374–382

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

32. Stefanelli, G.; Viscido, A.; Longo, S.; Magistroni, M.; Latella, G. Persistent Iron Deficiency Anemia in Patients with Celiac Disease Despite a Gluten-Free Diet. Nutrients **2020**, 12, 2176.
33. Wierdsma, N.J.; van Bokhorst, M.A.; Berkenpas, M.; Mulder, C.J.; van Bodegraven, A.A. Vitamin and mineral deficiencies are highly prevalent in newly diagnosed celiac disease patients. Nutrients **2013**, 5, 3975–3992
34. Martín-Masot, R.; Nestares, M.T.; Diaz-Castro, J.; López-Aliaga, I.; Alférez, M.J.M.; Moreno-Fernandez, J.; Maldonado, J. Multifactorial Etiology of Anemia in Celiac Disease and Effect of Gluten-Free Diet: A Comprehensive Review. Nutrients **2019**, 11, 2557
35. Vici, G.; Belli, L.; Biondi, M.; Polzonetti, V. Gluten free diet and nutrient deficiencies: A review. Clin. Nutr. **2016**, 35, 1236–1241.
36. Heikkilä, K.; Pearce, K.; Mäki, M.; Kaukinen, K. Celiac disease and bone fractures: A systematic review and meta-analysis. J. Clin. Endocrinol. Metab. **2015**, 100, 25–34
37. Kurppa, K.; Collin, P.; Sievänen, H.; Huhtala, H.; Mäki, M.; Kaukinen, K. Gastrointestinal symptoms, quality of life and bone mineral density in mild enteropathic coeliac disease: A prospective clinical trial. Scand J. Gastroenterol. **2010**, 45, 305–314
38. Guarino, M.; Gambuti, E.; Alfano, F.; Strada, A.; Ciccocioppo, R.; Lungaro, L.; Zoli, G.; Volta, U.; De Giorgio, R.; Caio, G. Life-threatening onset of coeliac disease: A case report and literature review. BMJ Open Gastroenterol. **2020**, 7, e000406.
39. Mearns, E.S.; Taylor, A.; Thomas Craig, K.J.; Puglielli, S.; Cichewicz, A.B.; Leffler, D.A.; Sanders, D.S.; Lebwohl, B.; Hadjivassiliou, M. Neurological manifestation of neuropathy and ataxia in celiac disease: A systematic review. Nutrients **2019**, 11, 380
40. Ines Pinto-Sanchez M, Jedid-Jah Blom, Gibson P R, Armstrong D. Nutrition Assessment and Management in Celiac Disease. Gastroenterology. 2024; 167 (1): 16- 131 https://doi.org/10.1053/j.gastro.2024.02.049.
41. Mager DR, Liu A, Marcon M, Harms K, Brill H, Mileski H, et al. Diet patterns in an ethnically diverse pediatric population with celiac disease and chronic gastrointestinal complaints. Clin Nutr ESPEN. 2019;30:73–80.
42. Costa A, Brito GA. Anthropometric parameters in celiac disease: a review on the different evaluation methods and disease effects. Journal of nutrition and metabolism. 2019;2019.
43. Assa A, Frenkel-Nir Y, Leibovici-Weissman Ya, Tzur D, Afek A, Katz LH, et al. Anthropometric measures and prevalence trends in adolescents with coeliac disease: a population based study. Arch Dis Child. 2016. archdischild-2016-311376.
44. Nikniaz Z, Mahdavi R, Nikniaz L, Akbari Namvar Z, Shirmohammadi M, Akhavan Sabbagh M. Comparison of diet quality between celiac patients and non-celiac people in East Azerbaijan-Iran. Nutr J. 2020;19(1):1–6.
45. Kozioł-Kozakowska A, Salamon D, Grzenda-Adamek Z, Krawczyk A, Duplaga M, Gosiewski T, et al. Changes in diet and anthropometric parameters in children and adolescents with celiac disease—one year of Follow-Up. Nutrients. 2021;13(12):4306.
46. Morvaridi, M., Sadeghi, N., Alavinejad, P. et al. Assessment of dietary patterns in celiac disease patients using factor analysis method and their relationship with dietary intakes and body mass index. BMC Nutr **10**, 48 (2024). https://doi.org/10.1186/s40795-024-00849-7
47. Öhlund K, Olsson C, Hernell O, Öhlund I. Dietary shortcomings in children on a gluten-free diet. J Hum Nutr Dietetics. 2010;23(3):294–300.
48. Cena H, Calder PC. Defining a healthy diet: evidence for the role of contemporary dietary patterns in health and disease. Nutrients. 2020;12(2):334.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

49. Asghari G, Rezazadeh A, Hosseini-Esfahani F, Mehrabi Y, Mirmiran P, Azizi F. Reliability, comparative validity and stability of dietary patterns derived from an FFQ in the Tehran lipid and glucose study. Br J Nutr. 2012;108(6):1109–17.