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RESEARCH ARTICLE **OPEN ACCESS**

Frequency of Low Birth Weight and Assessment of Anthropometric Parameters in Pediatric Celiac Disease

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Abstract:

Introduction: Celiac disease, an autoimmune disorder triggered by gluten ingestion, leads to intestinal damage and malabsorption, significantly affecting growth and development in genetically predisposed individuals. This study aims to determine the frequency of low birth weight and anthropometric indices in children with celiac disease referred to clinics in Jiroft city, Iran, during 2023.

Methods: A cross-sectional (descriptive-analytical) study was conducted involving 39 pediatric patients diagnosed with celiac disease. Data were collected using a structured checklist that included demographic variables, birth weight, and growth measurements. The study employed a census sampling method, and ethical approvals were secured. Data analysis was performed using SPSS version 22, utilizing descriptive and inferential statistics.

Results: The mean age of the participants was 8.1 ± 1.4 years, with 84.6% of the participants being girls. The findings revealed that 58.9% of children experienced weight growth disorders below the 5th percentile, while 41% exhibited height growth disorders. Notably, 38.4% of the children had a birth weight of less than 2500 grams, all of whom were girls.

Discussion: The results indicated a concerning prevalence of growth disorders among children with celiac disease, emphasizing the need for increased awareness and early diagnosis. The association between celiac disease and low birth weight suggests potential complications during pregnancy for affected mothers.

Conclusion: These findings highlight the importance of managing the nutritional status of affected children to prevent developmental issues.

Keywords: Celiac disease, Low birth weight, Growth disorders, Children, Autoimmune disorder, Gluten sensitivity.

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1. INTRODUCTION

Celiac disease, also known as sprue or gluten-sensitive enteropathy, is an autoimmune disorder characterized by an inappropriate immune response to gluten, a protein found in many cereals [1]. In genetically predisposed individuals, the ingestion of gluten leads to damage to the intestinal mucosa, resulting in the destruction of intestinal villi and reduced absorption capacity [2]. This condition can manifest at any age and is particularly prevalent during childhood, adolescence, and adulthood; approximately 20% of patients are diagnosed after the age of 60 [1, 3]. The primary causative agent of celiac disease is gluten, which comprises a group of insoluble proteins found in various cereals [3]. For instance, gliadin is the specific gluten protein present in wheat. Individuals at risk for celiac disease typically possess human leukocyte antigen (HLA) types DQ2 and, to a lesser extent, DQ8 [4]. In these individuals, gluten consumption triggers an immune response and antibody production. Historically, celiac disease was considered rare; however, recent studies have indicated that it is common across various populations and is one of the most prevalent genetic disorders, affecting approximately 1-2% of the general population [5]. Individuals with HLA-DQ2 or, less commonly, HLA-DQ8 genotypes are genetically predisposed to celiac disease, a necessary but not sufficient condition for its development. While about 90-95% of patients carry HLA-DQ2, the presence of these alleles alone does not guarantee disease onset, as other factors also play a role. This distinction is crucial for understanding the risk and diagnosis of celiac disease [6]. Studies indicate that the prevalence of celiac disease in the United States aligns closely with that of Western European countries, both around 1%. Data from Asia reveal regional variability, with higher prevalence in South Asia, notably India, where 26-49% of children with chronic diarrhea in tertiary hospitals have CD. In contrast, prevalence is lower in East Asian countries, such as China and Japan, possibly due to distinct dietary patterns and lower genetic susceptibility. Screening methodology differences also influence prevalence estimates across Asia [7]. In Central Asia and Iran, the prevalence of celiac disease among individuals not at risk mirrors that in Western countries [8-10]. Among at-risk populations in these regions, prevalence rates range from 3% to 20% [11, 12]. In Iran specifically, various studies estimate that about 1% of the general population is affected [9, 13, 14].

Celiac disease appears to be more common in women, with a female-to-male ratio reported between 1:2 and 1.3:1. Genetic factors play a significant role in this condition; monozygotic twins show a simultaneous occurrence rate of up to 75%. First-degree relatives of patients with confirmed celiac disease have a prevalence rate ranging from 4% to 12%, while second-degree relatives are also at increased risk. The prevalence among individuals with type 1 diabetes is reported to be between 3% and 8%, and in those with Down syndrome, between 5% and 12%. Celiac disease has also been associated with Turner syndrome, Williams syndrome, immunoglobulin A deficiency, and other autoimmune disorders [15-17]. Thus, gluten intolerance presents as a significant global health issue. Awareness and clinical suspicion are critical for timely diagnosis. Celiac disease results from interactions among genetic predisposition, immunological factors, and environmental triggers, primarily gluten proteins found in wheat, rye, and barley. In affected individuals, these peptides resist digestion by gastric acid and pancreatic enzymes. Gluten proteins bound to HLA are recognized by T lymphocytes, which leads to the activation of B lymphocytes and the production of antibodies. Cytokines released by activated T lymphocytes further stimulate inflammatory mechanisms that cause intestinal damage [18, 19].

Tissue transglutaminase plays a crucial role in this immune response by deaminating glutamine residues in gluten peptides. This process enhances the binding affinity of deaminated peptides for HLA-DQ2 and HLA-DQ8 molecules, which are presented to the immune system [18, 20]. Celiac disease manifests diversely, from asymptomatic cases to severe malnutrition, across several forms: Typical celiac disease: It is characterized by classic malabsorption symptoms, such as diarrhea, fatty stools, severe weight loss, and abdominal distension. Atypical celiac disease: Symptoms may include short stature, anemia, infertility issues, neurological symptoms, metabolic bone diseases, or liver involvement. Silent celiac disease: Patients exhibit no clinical symptoms but show morphological changes consistent with celiac disease upon small intestinal biopsy. Latent celiac disease: Individuals may initially have normal biopsy results on a gluten-containing diet but later show villous atrophy upon re-evaluation. Celiac disease potential: These patients do not display histological evidence of celiac disease but possess immunological markers, such as anti-endomysial antibodies or increased

intraepithelial lymphocytes [21, 22]. The presentation can differ significantly between children and adults. In children, symptoms often include diarrhea, steatorrhea (fatty stools), abdominal pain, vomiting, and growth retardation; some may only experience short stature or growth failure [21]. In adults, gastrointestinal symptoms, such as diarrhea and bloating, are common, often accompanied by weight loss, depending on the severity of intestinal damage. Fatigue and weakness are prevalent due to anemia caused by nutrient malabsorption. Additionally, recurrent mouth ulcers may be the sole symptom experienced by some adults [23]. Celiac disease remains a common autoimmune disorder triggered by gluten ingestion among genetically susceptible individuals. Screening studies worldwide reveal that many cases remain undiagnosed; an analogy often made is that knowledge of celiac disease prevalence resembles an iceberg where most patients remain hidden beneath the surface [4]. This chronic condition is diagnosed primarily in children presenting with growth failure or malabsorption issues [9]. The present study aims to determine the frequency of low birth weight among individuals with celiac disease referred to clinics in Jiroft city during 2014.

2. METHODS

2.1. Study Design and Population

This study employed a cross-sectional descriptive-analytical design conducted in 2023. The study population comprised all children diagnosed with celiac disease who were referred to clinics in Jiroft city during this period and confirmed based on positive serological tests, including tissue transglutaminase IgA (tTG-IgA) antibodies (with total serum IgA assessment to exclude IgA deficiency). Inclusion criteria required a documented diagnosis of celiac disease along with available information on birth weight and growth curves. Patients missing these data were excluded. Census sampling was used to include all eligible patients. A total of 39 children with complete data participated in the study.

2.2. Data Collection

Data were collected by the researcher, obtained from medical records documented at delivery, and measured by clinical staff using calibrated digital scales immediately after birth, ensuring accuracy and standardization through a structured checklist. The checklist included demographic variables, birth weight, and anthropometric measurements (weight and height) obtained at clinic visits. Growth status was assessed using standard height-for-age and weight-for-age percentiles to identify deviations in growth. Inclusion criteria were children diagnosed with celiac disease having documented birth weight and growth data, while exclusion criteria included patients lacking these data or without a confirmed diagnosis and consent.

2.3. Ethical Considerations

Ethical approval was obtained from the Research Council and Ethics Committee of Jiroft University of Medical Sciences (Ethics code: IR.JMU.REC.1403.047). Confidentiality and anonymity of participant information were strictly maintained. Informed consent was obtained from parents or legal guardians. The study adhered to ethical principles in data handling and publication.

2.4. Statistical Analysis

Data were coded and entered into SPSS version 22 for analysis. Descriptive statistics, such as frequency distribution tables, means, and standard deviations, summarized participants' characteristics and growth indicators. Inferential statistical analyses, including two-sample t-tests, chi-square tests, and Fisher's exact tests, were conducted to examine associations and differences relevant to research questions. The significance level was defined at $p < 0.05$.

3. RESULTS

This cross-sectional (descriptive-analytical) study examined 39 children with celiac disease who were referred to clinics in Jiroft city in 2023. The results indicated that the mean age and standard deviation of the children were 8.1±1.4 years (1 to 15 years), with the highest frequency in the 5- to 10-year-old age group, and 84.6% (33) of them were girls. The highest frequency of weight at first visit was observed in the weight range of 10 to 20 kg and height of 100 to 120 cm Table **1**.

Table 1. Determination of demographic variables of the studied children.

Variables		Frequency	Percent
Age (years)	1-5	13	33.3
	5-10	14	35.8
	10-15	12	30.9
Gender	Girl	33	84.6
	Boy	6	15.4
Weight at visit (kg)	<10	3	7.6
	10-20	18	46.2
	20-30	9	23.1
	30-40	9	23.1
Height at visit	<100	8	20.5
	100-120	13	33.3
	120-140	10	25.7
	140-160	8	20.7

Table **2** presents information on deviations in the height-for-age growth pattern among the children studied. The results indicated that out of the 39 children studied, 25 (64.1%) exhibited optimal height growth, while 14 (35.9%) showed slow height growth.

Table **3** presents information on deviations in the weight-for-age growth pattern among the children studied. The results indicated that out of the 39 children studied, 27 (69.2%) exhibited optimal height growth, 7 (17.9%) showed growth retardation, 2 (5.1%) experienced growth arrest, and 3 (7.8%) had weight stagnation.

Table 4 shows the information related to the weight-for-age percentile at the first visit of the children. The results indicated that out of 39, 23 (58.9%) were below the 5th percentile, 10 (25.6%) were in the 5th to 25th percentile, 5 (12.8%) were in the 25th to 50th percentile, and 1 (2.7%) was in the 50th to 70th percentile.

Table 2. Determination of deviations in the height-for-age growth pattern in the studied children.

Variable	Frequency	Percent
Desirable growth	25	64.1
Slow growth	14	35.9
Total	39	100

Table 3. Determination of deviations in the weight-for-age growth pattern in the studied children.

Variable	Frequency	Percent
Desirable growth	27	69.2
Slow growth	7	17.9
Decline in growth	2	5.1
Stopped growth	3	7.8
Total	39	100

Table 4. Determination of weight-for-age percentile at the first visit of the studied children.

Percentile	Frequency	Percent
<5	23	58.9
5-25	10	25.6
25-50	5	12.8
50-75	1	2.7
Total	39	100

Table 5 presents the information related to the height-for-age percentile at the children's first visit. The results indicated that out of 39 people, 16 people (41.1%) were below the 5th percentile, 13 people (33.3%) were in the 5th to 25th percentile, 7 people (17.9%) were in the 25th to 50th percentile, 2 people (4.8%) were in the 50th to 70th percentile, and 1 person (2.7%) was in the 75th to 90th percentile group.

Table 5. Determination of the height-for-age percentile at the first visit of the studied children.

Percentile	Frequency	Percent
< 5	16	41.1
5-25	13	33.3
25-50	7	17.9
50-75	2	4.8
75-90	1	2.7
Total	39	100

Table 6 presents the information related to the frequency distribution of birth weight among the studied children. Of the 39 children studied, 15 (38.4%) weighed less than 2500 grams at birth, and 24 (61.6%) weighed more than 2500 grams. The distribution of the frequency of low birth weight (weight less than 2500 grams) in the studied children by gender indicated that all children who weighed less than 2500 grams at birth were girls (15 people, 100%).

Table 6. Determination of the frequency of birth weight in the studied children.

Birth weight	Frequency	Percent
Less than 2500	15	38.4
More than 2500	24	61.6
Total	39	100

4. DISCUSSION

Celiac disease is a common autoimmune disorder triggered by the ingestion of gluten proteins found in wheat, rye, and barley in genetically predisposed individuals. Screening studies from various countries suggest that the true prevalence of celiac disease resembles an iceberg, with a substantial number of cases remaining undiagnosed and unrecognized [4]. This chronic condition presents as gluten-induced enteropathy, commonly diagnosed in children who exhibit symptoms, such as growth failure, malabsorption, chronic diarrhea, abdominal pain, and nutrient deficiencies [9]. The present study aimed to determine the frequency of low birth weight among children with celiac disease referred to clinics in Jiroft city in 2023. The findings revealed that 58.9% of these children experienced weight growth disorders reflected by weight-for-age below the 5th percentile, while 41% had height-for-age below the 5th percentile, indicating linear growth impairment. Growth failure is often under-recognized as a symptom of celiac disease. However, it has been reported in approximately 36% of affected pediatric patients, underscoring the importance of growth monitoring in this population [24]. A similar study conducted at a pediatric medical center identified chronic diarrhea, underweight status, and anemia as the most common clinical findings among children diagnosed with celiac disease [25]. In Italy, a study reported a prevalence of celiac disease at 2.3% among children with growth disorders [26]. Short stature is one of the most common issues encountered in pediatric endocrine medicine. While genetic or congenital factors are often the primary causes of short stature, underlying conditions, such as celiac disease, can also play a contributing role [27]. Celiac disease can present with a range of symptoms, including short stature, anemia, delayed puberty, infertility, bone pain, frequent abdominal pain, and depression [28]. In a Turkish study involving 109 children with celiac disease, 60.6% had classic symptoms, while 37.6% exhibited atypical manifestations; only 1.7% were diagnosed with the silent form of the disease. Notably, short stature was observed in 31.2% of these patients [29]. Hashemi and colleagues from Jundishapur

University in Ahvaz reported that among 104 children with idiopathic short stature, 33.6% had celiac disease [30]. The prevalence of celiac disease in short children without gastrointestinal symptoms varies widely from 0% to 59%, depending on the study location [31]. Shahraki et al. found that children with celiac disease exhibited a range of symptoms, including diarrhea, weight loss, anemia, and short stature; those older than two years showed a higher incidence of non-classical symptoms, such as abdominal pain and short stature, alongside more severe small bowel pathology [32]. Some studies indicated that celiac disease can manifest without digestive complications and primarily present as short stature [33, 34]. In research by Dehghani et al., among 72 short children studied, celiac disease was identified in 2.8%, anemia in 5.6%, giardiasis in 6.9%, and growth hormone deficiency in another 6.9% [35]. Studies conducted on short children without gastrointestinal symptoms in Saudi Arabia and Egypt reported prevalence rates for celiac disease at 10.9% and 6.66%, respectively [36, 37]. Research from India indicated that malnutrition and diarrhea are prevalent clinical symptoms among affected children [4]. Gluten damages intestinal villi in individuals with celiac disease; when these villi are compromised, nutrient absorption becomes impaired, potentially affecting growth and leading to malnutrition. The differences observed between our study's results and those from other studies may be attributed to various racial, nutritional, and genetic factors present in different populations. In our study, we found that 38.4% of patients with celiac disease had a birth weight below 2500 grams. There is limited research on this topic; however, evidence suggests a correlation between celiac disease and various pregnancy complications. Women with celiac disease are six times more likely to have low birth weight babies compared to those without the condition [38]. Additionally, individuals living with untreated celiac disease often experience shorter pregnancies and may face premature births that contribute to low birth weight outcomes. Celiac disease is recognized as a risk factor for adverse pregnancy outcomes, including miscarriage and preterm birth [39]. In research by Bilge Ozgor et al., positive celiac serology was identified in six parents; five had premature babies, while one parent had a healthy infant [40]. Kemal Beksac et al. reported that mothers maintaining good control over their condition had an average birth weight of 2691 grams compared to just 2262 grams for those with poor control. Consequently, celiac disease is linked to increased risks for adverse pregnancy outcomes, such as preterm birth and low birth weight. Intrauterine growth restriction occurs in over 6% of women with celiac disease but is not observed in women from control groups [39]. Some researchers believe that breastfeeding may significantly reduce this risk; however, further studies are needed to confirm this claim [41]. Additionally, untreated women with celiac disease may experience shorter reproductive lifespans due to earlier menarche and menopause along with a higher prevalence of secondary amenorrhea [42]. Research indicates that infants born to parents with celiac disease tend to have lower birth weights, with intrauterine growth retardation being a common predictable outcome due to impaired maternal nutrient absorption; this condition is a significant contributor to perinatal morbidity and mortality, as well as increased risks of adverse health outcomes later in life compared to non-celiac controls [43]. Given the limited resources and data available on this topic within Iran, further studies are recommended across different cities to enable accurate comparison of results and a better understanding of the disease's regional variations.

5. LIMITATIONS OF THE STUDY

The study included only 39 children, limiting the generalizability and statistical power to detect significant differences. The use of census sampling may introduce selection bias, as the sample may not fully represent all children with celiac disease in Jiroft. Excluding patients without birth weight or growth data may result in information loss, affecting the study’s comprehensiveness. Being cross-sectional, the study captures data at a single time point, which restricts causal inferences between celiac disease and growth outcomes. Reliance on patient or caregiver recall for birth weight and growth data may introduce inaccuracies. The absence of a non-celiac control group limits comparison and assessment of CD’s specific impact on growth. Finally, the study focused on anthropometric measures and did not account for other influential factors, such as dietary adherence or socioeconomic status. For future research, we propose conducting a longitudinal study with a larger and more diverse cohort to better capture the progression and outcomes of celiac disease in children. Such a design would enable monitoring of growth trajectories, assessment of temporal relationships, and identification of the long-term impacts of the disease and its management, thereby enhancing applicability to the broader population.

CONCLUSION

This study found that 38.4% of children with celiac disease had a birth weight below 2500 grams, all of whom were girls. Additionally, the results indicated that while 69.2% of children exhibited optimal weight growth and 64.1% optimal height growth, significant proportions, 35.9% for height and 17.9% for weight, showed stunted growth patterns. These findings underscore the prevalence of weight and height growth disorders among children with celiac disease and highlight the need for increased attention to these issues. The association between celiac disease and low birth weight suggests potential complications during pregnancy for mothers affected by this condition. The results from this study could assist healthcare providers in early diagnosis of celiac disease and effective management of the nutritional status for affected children, ultimately preventing developmental issues.

AUTHORS' CONTRIBUTIONS

The authors confirm their contribution to the paper as follows: F.J.: Study conception and design; E.A and F.S.M.: Data collection; K.H.: Analysis and interpretation of

results; R.R.: Writing the Paper; M.N.: Conceptualization; R.M.: Methodology; S.D.: Writing the original draft preparation; All authors reviewed the results and approved the final version of the manuscript.

LIST OF ABBREVIATIONS

CD	=	Celiac Disease
HLA	=	Human Leukocyte Antigen
tTG-IgA	=	Tissue Transglutaminase Immunoglobulin A
EMA	=	Endomysial Antibody
DGP	=	Deamidated Gliadin Peptide
IgA	=	Immunoglobulin A
SPSS	=	Statistical Package for the Social Sciences
BMI	=	Body Mass Index
WHO	=	World Health Organization

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This project was approved by the ethics committee of Jiroft University of Medical Sciences with approval code IR.JMU.REC.1403.047.

HUMAN AND ANIMAL RIGHTS

All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committee and with the 1975 Declaration of Helsinki, as revised in 2013.

CONSENT FOR PUBLICATION

Informed consent was obtained from the parents or legal guardians of each participant. The principle of maintaining the confidentiality of information was strictly followed during the data collection process.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The data and supportive information are available within the article.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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