

Celiac Disease and Gluten-free Diet in Portuguese Children – An Anthropometric Marker Contribution Assessment

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Abstract Celiac disease is an autoimmune disease that is expressed by chronic food sensitivity to gluten, having as typical symptoms diarrhea and weight loss. The present study has evaluated anthropometric marker progressions in 61 Portuguese children with celiac disease, at diagnosis time and at the study time, comparing these variations with the intake of gluten free products. Data from 61 children (59.0 % girls) with celiac disease were evaluated, following a gluten free diet for 5.0 ± 4.6 years. Statistical *t*-test analysis of pBMI at diagnosis and at study time, revealed a positive increase with statistical significance for both girls and boys ($p = 0.008$). The differences between ingested and recommended values were quantified and confirming the increase in total energy consumption and carbohydrates. Following a gluten free diet allows the recovery of the nutritional status in most children; however, nutritional counseling seems mandatory to avoid nutrient imbalances and further health issues.

Keywords: celiac disease, gluten free diet, children, natural gluten free products, processed gluten free products

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1. Introduction

Celiac disease (CD) is an autoimmune disease characterized by chronic food gluten sensitivity in genetically susceptible individuals [1]. Comparing it with various autoimmune diseases, CD presents the highest number of new cases [2].

Despite the incidence of CD have increased significantly over the last 60 years [3], doesn't display a common pattern around the world for multiple reasons. In Europe it occurs in approximately 1.0% of the population [4,5,6] with incidence in Finland and Sweden as high as 2.0% to 3.0% [7] and in Portugal mainland about 0.7% [8,9]. However, only 0.07% were found for under 18 in Madeira Island [10]. Yet, those Portuguese values can be higher due to atypical and asymptomatic forms that are underdiagnosed and absence of more recent data, that include information on diagnosis based in heterogeneous clinical presentation of the disease. [11].

The epidemiology and phenotype of CD are constantly changing, whereas the symptoms exhibited by children with CD are variable and influenced by age. Despite being associated with children with reduced nutrient absorption, recent studies have shown that obese children have been diagnosed with gluten sensitive enteropathy [12]. Very young children, have mostly classic symptoms such as: diarrhea, abdominal distension and growth retardation

[13], while school-aged children and adolescents present mostly atypical gastrointestinal symptoms: cramping, vomiting and constipation [14]. Other extra-intestinal conditions that can be associated with the diagnosis include arthritis, neurological disorders and anemia [15,16,17].

Gluten-free diet (GFD) is the only current treatment for this condition that allows the recovery of the intestine and the gradual decrease of digestive symptoms, signs and systemic manifestations [18,19,20]. Several authors described difficulties to follow a strict GFD and indicate factors as taste, scarcity, cost and insufficient labeling of products. Also, the difficulty in eating out and limited knowledge of general community contribute to a negative impact on quality of life patients leading to low compliance, particularly in adolescence [21-27].

Gluten-free foods can be categorized as natural (rice, maize, potato), and processed gluten free foods (wheat, barley). For rye and oat, immunotoxicity is not totally excluded since their storage proteins, secalin and avenin respectively, have also multiple proline and glutamine residues making them resistant to gastrointestinal digestion and increase tissue transglutaminase activity [28,29].

Gluten removal process can also lead to a change in the overall composition of nutrients. In the last decade, the industry has placed in the market a large diversity of foods specifically designed for gluten-free diets, providing greater choice and also an increased intake of these foods

(nutritionally altered). On the other hand, the increased intestinal permeability induced by the industrial food additives, explains the observed surge in general autoimmune diseases, CD included [30]. However, and parallel to the beneficial effect already described, the nutritional adequacy of GFD and the impact on anthropometric parameters of children with CD, has been questioned [31], since it may lead to nutritional imbalances, increasing the shortcomings caused by the intestinal malabsorption [32].

Evaluations of children's anthropometric data evolution with CD has been studied and in some cases, children with normal weight at the time of diagnosis evolve to a state of pre-obesity or obesity during follow-up of GFD [11,12,33,34,35,36]. Despite the relevance of this subject, there is insufficient monitoring and scarce published data for the anthropometric evolution of CD Portuguese children, reinforcing the adequacy and necessity of the present study. For this purpose an evaluation of anthropometric marker progressions in Portuguese CD children was performed, followed by a comparative study between their food nutrient intake and the recommendations from the Portuguese National Health Institute. The proportion of specially designed gluten free products versus naturally gluten free foods in the food intake of these children was also evaluated.

2. Methods

The present study is a descriptive, observational, cross-sectional evaluation of anthropometric marker progressions in Portuguese children with CD, based on survey research methodology. The development and implementation of a survey questionnaire followed guidelines for this research methodology [37,38,39]. The questions were ordered to establish both the survey's logic and inner flow. A widespread dissemination was done by the Portuguese Celiac Association webpage ensuring answers from parents or caregivers of children with CD. Data collection took place between February and April 2015.

Inclusion criteria were being older than five years old, compliance with GFD after a comproved diagnosis by one or more of the following methods: serological tests, human leukocyte antigen typing, video capsule endoscopy and small intestinal biopsy. Sixty-three completed questionnaires were obtained, of which two were excluded, because they did not meet the inclusion criteria.

Body Mass Index (BMI) was calculated as weight (kg) / [height (m)]² and used self-reported weight and height. Body mass index percentiles (pBMI) were

estimated using growth curves adopted by the Health General Directorate [40] as recommended by National Centre for Health and Statistics.

For processed free gluten food, energy and macronutrients values were estimated from their labels, while for natural free gluten food the Portuguese Food Composition Table was used [41]. Energy and macronutrient recommendations were available at the Portuguese Platform Against Obesity [42,43,44]. The relative difference between the recommended and the ingested value was given in percentage.

Respecting the principles of the Helsinki Declaration, this study was approved by the Ethics Committee of the Atlântica University and informed consent obtained from participants at the time of completing the questionnaire.

Statistical analysis was performed using Excel, Microsoft Office 2010 (Microsoft, USA). The numerical variables were presented as mean and standard deviation. Categorical variables were expressed as a percentage. The parametric Student t-tailed test was used to analyze the difference between the average pBMI paired data at diagnosis and study time as well as for the intake differences between boys and girls. The non-parametric sign test [45] was used to counts signs, positive (if above) and negative (if below), of the determined values for energy intake and macronutrient compared with the recommendations from the Portuguese National Health Institute for children of the same age in the 50th percentile of the body mass index (hypothesized value). The null hypothesis will be rejected when the numbers of positive and negative signs differ significantly from equality. The critical *p* value was set at 0.05 according to the confidence interval of 95%.

3. Results

Children were positively diagnosed for CD mainly through intestinal biopsy (80.3%) and the remaining through serological tests according to ESPGHAN guidelines from 2012; antitransglutaminase antibodies (>10 times upper limit) and antiendomysial antibodies positive [46]. Coexisting immunological conditions were also reported for about 28% of children (25% girls and 32% boys), such as dermatitis (5%), lactose intolerance (7%) and respiratory problems (13%).

Descriptive statistics for demographic variables showed participants being 5.1 ± 3.8 years at CD diagnosis and 10.0 ± 3.7 years at study time, where 59.0% were girls and 41.0% boys. In average participants showed 5.0 ± 4.6 years of GFD (Table 1).

Table 1. Characteristics of gluten-free diet survey participants (n=61)

	Girls (n=36; 59.0%)		Boys (n=25; 41.0%)		Total (n=61)	
	Mean \pm sd	Range	Mean \pm sd	Range	Mean \pm sd	Range
Age at diagnosis	5.7 \pm 4.4	2-16	4.2 \pm 2.5	2-10	5.1 \pm 3.8	2-16
Age at study time	10.3 \pm 3.8	2-18	9.6 \pm 3.6	4-16	10.0 \pm 3.7	2-18
Years of gluten-free diet	4.8 \pm 4.4	0-10	5.4 \pm 4.8	1-14	5.0 \pm 4.6	0-14

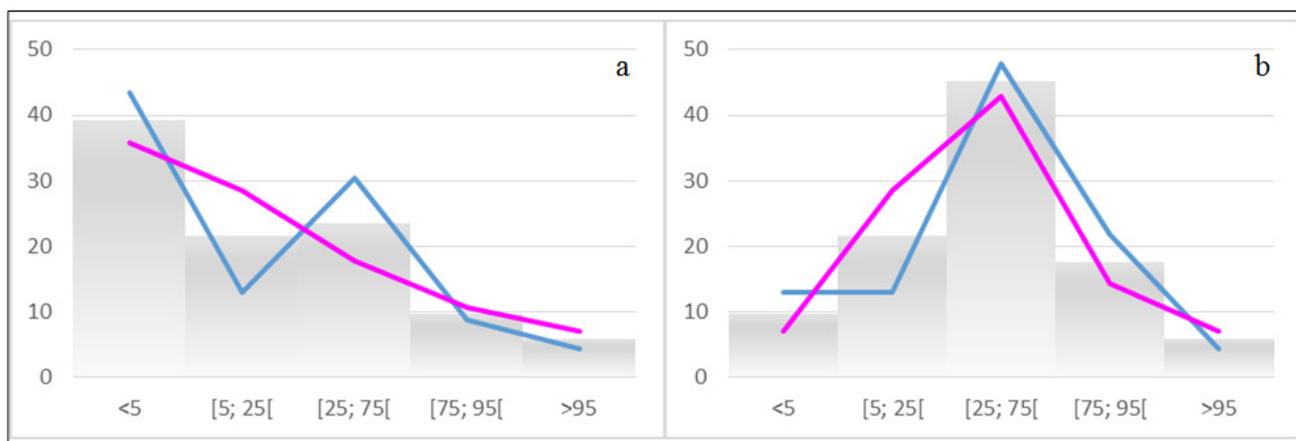


Figure 1. Pattern of pBMI classes for evaluated children at diagnosis (a) and at study time (b) █ all █ girls █ boys

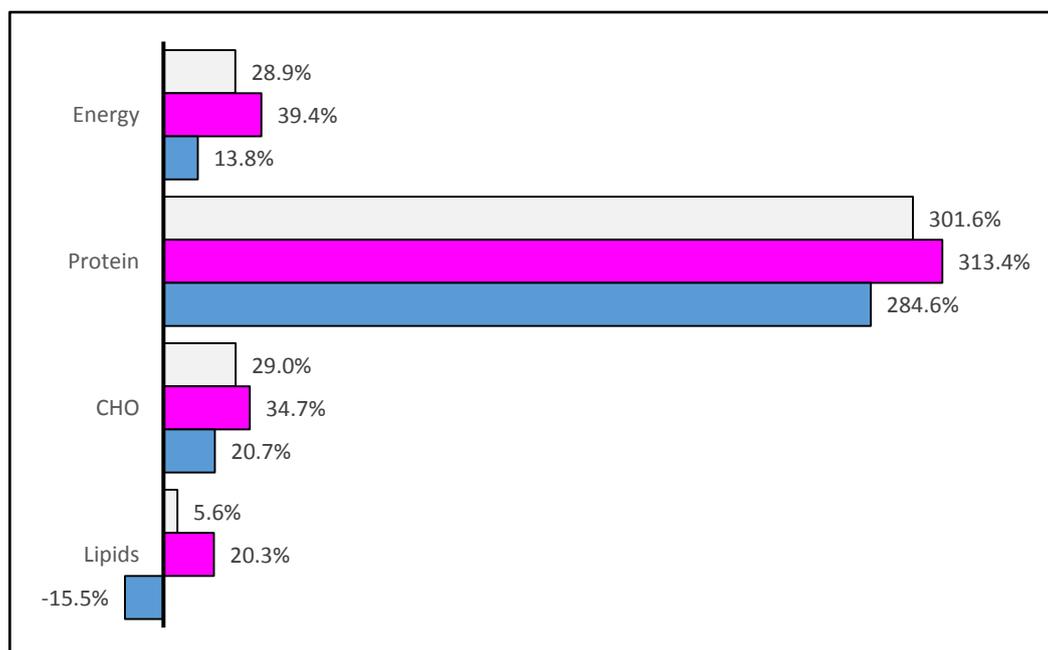


Figure 2. Deflect percentage from the recommended values of macronutrients intake for all children, boys and girls, █ all █ girls █ boys

As showed in Figure 1, almost 40% of children were underweight at diagnosis (pBMI <5), 10% overweight and 6.0% were obese; whereas at study time only 10% of children exhibit a pBMI <5. The analysis of the figure showed a clear recover of the pBMI pattern after following a GFD, for both boys and girls. The constant percentage of obese cases together with a considerable increase in overweight values, contributes to an increase of total number of children with pBMI above normal.

Statistical *t*-test analysis of pBMI at diagnosis and at study time, revealed a statistical significant increase for girls and boys ($p = 0.008$). Although a positive trend was revealed for both genders when analyzed separately, the statistical significance was only observed for girl's data ($p = 0.049$).

The sign test allocated either positive or negative sign to each observation, according to whether is it higher or lower than those recommended for children of the same age (pBMI of 50%). Sampled children revealed values above those recommended for energy intake ($p = 0.007$) and carbohydrates ($p = 0.007$). Regarding proteins ingested, all children showed values much higher than those recommended ($p = 0.000$). The fat intake results

were not statistically significant ($p=1.101$), as a matter of fact boys presented a lipids consume below the recommended.

The differences between ingested and recommended values were quantified and are showed in Figure 2. Despite confirming the increase in total energy consumption and carbohydrates, these values are not so surprising as those observed for protein consumption and for the unexpected negative value for lipid intake observed in boys.

The natural gluten free products as fruits, dairy products, soup and vegetables presented the higher frequency intake, once or twice a day. Regarding, specially designed gluten free products, bread is the most consumed while products also considered as harm food (pre-prepared meals, salty snacks, desserts...) were those that were consumed in less quantity (Figure 3). However, weighted analysis of nutrient proportion for specially designed gluten free products revealed that an important part of daily energy intake (40.9%) become from unnatural source (Table 2.). Also 50% of daily carbohydrate intake comes from processed products. This patten was common for girls and boys.

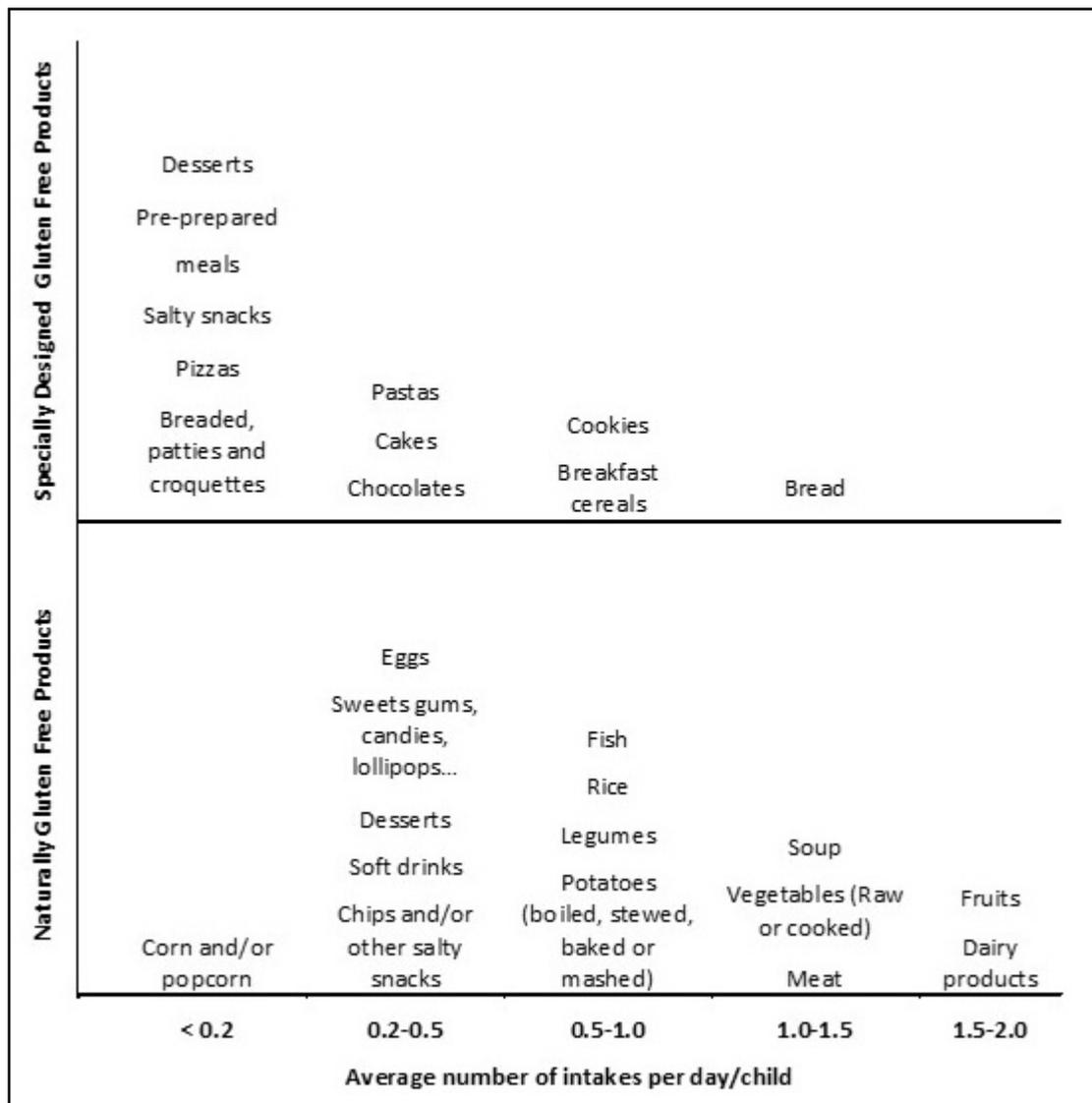


Figure 3. Intake frequency of naturally and specially designed gluten free products

Table 2. Percentage diet intake macronutrients for boys and girls of specially designed gluten free products

	Energy	Protein	CHO	Lipids
Girls	39.8%	30.7%	52.0%	23.4%
Boys	43.8%	30.3%	58.6%	29.1%
Total	40.9%	30.1%	54.1%	28.0%

4. Discussion

Data were obtained with the support of the Portuguese Celiac Association and reveals a higher incidence of CD in girls, but far from the value presented by reference [47] and reference [48], which reflects the fact that twice as many girls than boys are diagnosed with CD. As well as Lerner *et al.* [2] that associated a high frequency of CD linked with other autoimmune pathologies, also this study revealed high percentages of several autoimmune diseases associated with CD. Nonetheless, these values are not associated with children with low weight. It is generally accepted that GFD provides the decrease of systemic symptoms and patient's weight recover [18,49,50,51]. However, the nutritional adequacy of this diet has been

questioned, mainly because there is conflict data regarding anthropometric parameters for children with CD [11,32,33,34,35,36].

The present study results reinforce that the GFD is favorable for the recovery of diagnosed children, once the nutritional status (pBMI) evolved positively with a slight increase in the number of overweight obese children. These values highly contracts with reference [11] results that showed overweight children frequency with CD nearly doubling after one year of GFD. With a similar study design, reference [33] obtained similar results for Italian children with CD. A decrease in individual's number with low weight was obtained such as a minimum increase in the number of individuals with overweight. Also, Reilly *et al.* [52] observed a BMI decrease and an increase of overweight and obese in American children. Reference [12] recently showed a weight improvement of children with CD who were overweighted or obese at diagnosis. All these studies highlight the risk of following a GFD without adequate information that is essential for a careful food choice.

There is a trend that shows an increase in consumption of all macronutrients and consequently of total energy intake (Figure 2). This pattern is also present in several

studies that refer the GFD to be associated with high protein and lipid intake [32,53,54,55,56]. However, this imbalance cannot be considered only for CD children, since there is a large difference between the nutritional recommendations and the actual consumption of protein reported for general population. The unexpected negative value for the relative percentage of boy's lipid intake observed is not in agreement with general literature and probably could be a specificity of the analyzed sample.

The percentage of macronutrients in daily intake followed the pattern between the different studies for energy, protein, carbohydrate and lipids, 40.9%, 30.1%; 54.1%, 28.0%, respectively (Table 2.). However, it is in contrast with reference [49] research, where the intake of energy and nutrients were evaluated for children of the same age with and without CD (following diet with gluten) and was found that thirteen of twenty-five children (52%) did not reach the energy intake recommendations.

Despite the availability of many natural gluten free products, the lack of adequate information and the media disclosure of processed products, also gluten free, promote a general inflated demand and consumption of the latter ones. This situation leads to an increase of processed food consumption and frequently nutrients imbalance diet [57,58,59,60,61]. However, foods with lower frequency intake are associated with the term "fast food" and as such, are regarded as being harmful. In this specific population the concern with diet is certainly more common what is demonstrated by the strong choice of natural gluten free products (Figure 3). Another important and positive aspect was the ingestion of soup and vegetables, fruit and dairy products once or twice a day. Regarding maize, a natural gluten free product with an easy access and inexpensive, it was not much consumed, with the exception of corn bread, perhaps because it is not common in the Mediterranean diet. These adjustments are of enhanced importance, not only because nutritional balance but also because gluten-free products are more expensive than equivalents with gluten, adding costs for families [62].

5. Conclusion

This weight dynamic study strengthens that following a GFD the proper anthropometric values can be established. However, any restrictive diet is inherently at risk of nutritional inadequacy and therefore the publicizing, information dissemination and specialized monitoring of CD children are mandatory.

The existence of many naturally gluten free products should be taken into account, even if some Mediterranean habits must change by helping these children and their families in the choice of good food options to avoid shortages or nutritional excesses. For example, inclusion of cassava, amaranth, buckwheat and maize promotion could be a good strategy for all stakeholders.

Furthermore, all health professionals leading diagnosis must remain vigilant and invest in their own training since knowledge about symptoms, diagnosis and anthropometric marker are in constant evolution. The strength of our study lies in the fact that this is an important contribution for anthropometric markers in Portuguese children's with CD. This topic has been receiving a lot of attention from de

Associação Portuguesa de Celiacos in attempt to spread scientific information around members, their families and general interested public. However, exist low confidence that the evidence reflects the true effect of GFD in BMI since it was achieved with a reduced sample.

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