

Following Gluten Free Diet: Less Available, Higher Cost and Poor Nutritional Profile of Gluten-Free School Snacks

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Abstract Background. Celiac disease has a high prevalence globally and to date the only effective treatment is a strict gluten-free diet for life. Diet compliance is difficult due to current unhealthy eating habits and increasing overweight/obesity, especially for school age children. Objectives. To assess availability, cost and nutritional adequacy of gluten-free school snacks. Methods. Five store categories (large, regular-size and wholesale supermarkets, health food stores and corner shops) were assessed in districts representing low, middle and high socioeconomic levels. Three categories of school snacks were surveyed: dairy products (milk boxes, yogurts), cereals (in bulk, cereal bars) and baked goods (various cookies). Portions and prices were standardized and the closest gluten-containing products were matched for comparison. Availability, cost and nutritional quality (total calories, total fat, carbohydrates and sodium) were then evaluated. Results. A total of 1562 products were assessed. Gluten-free products were less available, with significant differences among the socioeconomic levels for cereals and baked goods ($P < 0.05$). Also, they were more expensive than gluten-containing products. Except for cereal calories and sodium in the upper socioeconomic level, less than one third of the products available met FAO/WHO recommendations. Products meeting all 4 characteristics (total calories, total fat, carbohydrates and sodium) analyzed were 7.8%, 7.3% and 7.3% in the upper, middle and low socioeconomic level, respectively. Conclusions. Gluten-free dairy products, cereals and baked snacks available as snacks for school-age celiac children are fewer, with less variety and more expensive than gluten containing counterparts; the majority of them not meeting current nutritional recommendations.

Keywords: celiac disease, nutritional adequacy, availability, cost, gluten-free school snacks

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1. Introduction

Celiac disease (CD) is a condition observed only in humans. It results from the interaction of genes and the environment (gluten), with participation of the immune system and host microbiota. A complex and only partially understood damage to the small intestinal mucosa develops, which includes an inflammatory disease and autoimmune phenomena [1,2,3]. Today is known that its frequency is close to 1% in most of the assessed countries [4]. Increasing attention is currently given to the difficulties that pose maintaining a gluten-free diet, the only efficacious treatment of CD [5]. Compliance to a gluten-free diet results in symptom remission, histological and functional recovery of the small intestinal mucosa, and decreased risk of complications [6]. Although a gluten-free diet benefits celiac patients in many ways [7], evidence shows that expenditures increase in those who follow it [8,9]. Data also show that following strict gluten-

free diet deteriorates significantly quality of life, an area that is poorly managed, mainly in less developed countries. Gluten is widely used in food processing and gluten contamination during the process of industrialized food production is of frequent occurrence [10]. Because these foods have poor elasticity due to the absence of gluten, other specific components are added, often resulting in increased content of fat and starch, i.e., higher in calories in comparison with their gluten-containing counterparts [11,12].

Given the changes of eating habits that modern life has introduced in western societies favoring the consumption of highly-processed foods, compliance to a strict gluten-free diet is increasingly more difficult. Most studies in this respect refer to US and European populations, but data about the situation in other areas of the world is scant, especially in those where bread and wheat based flour consumption is high. Availability and cost of gluten-free products is relevant because it may favor or hinder compliance to treatment, and lower compliance is

associated with medical detriment of patients' condition and with psychosocial effects derived from accepting that they, willingly or unwillingly, must consume foods that may be harmful to them [13]. For the Food and Agriculture Organization of the United Nations (FAO) food security implies that "all people have physical, social and economic access to sufficient, safe and nutritious food, which meets their dietary needs and food preferences for an active and healthy life" [14]. For celiac individuals, food security refers to availability of gluten-free products in which their gluten content has been demonstrated to be lower than the cutoff. Chile is a middle income country where a public National Health Service provides health care to the population in a variety of areas [15], but lacks specific acts for CD, including no obligation to declare the gluten content in product labels. At the same time, in Chile as in most countries in Latin America bread consumption is very high and overweight/obesity is vastly prevalent. This is especially so among school-age children, where it reaches ~40% [16,17]. Following WHO and

FAO's concepts, in this study we assessed the availability and cost of gluten-free snacks for school-age children and to what extent these snacks meet nutritional recommendations.

2. Materials and Methods

2.1. Design

Based on a convenience design, this study was conducted during the first semester of 2013 (fall/winter seasons) in three districts of different socioeconomic status (SES) in Santiago, Chile (Figure 1). Districts were chosen as representing low, middle and high SES levels, using the Socioeconomic Map of Chile/Distribution of the Regions of the Metropolitan Area, Santiago-Esomar Chile [18]. As an additional requirement, at least one large and one regular-size supermarket had to be present in the selected districts [19].

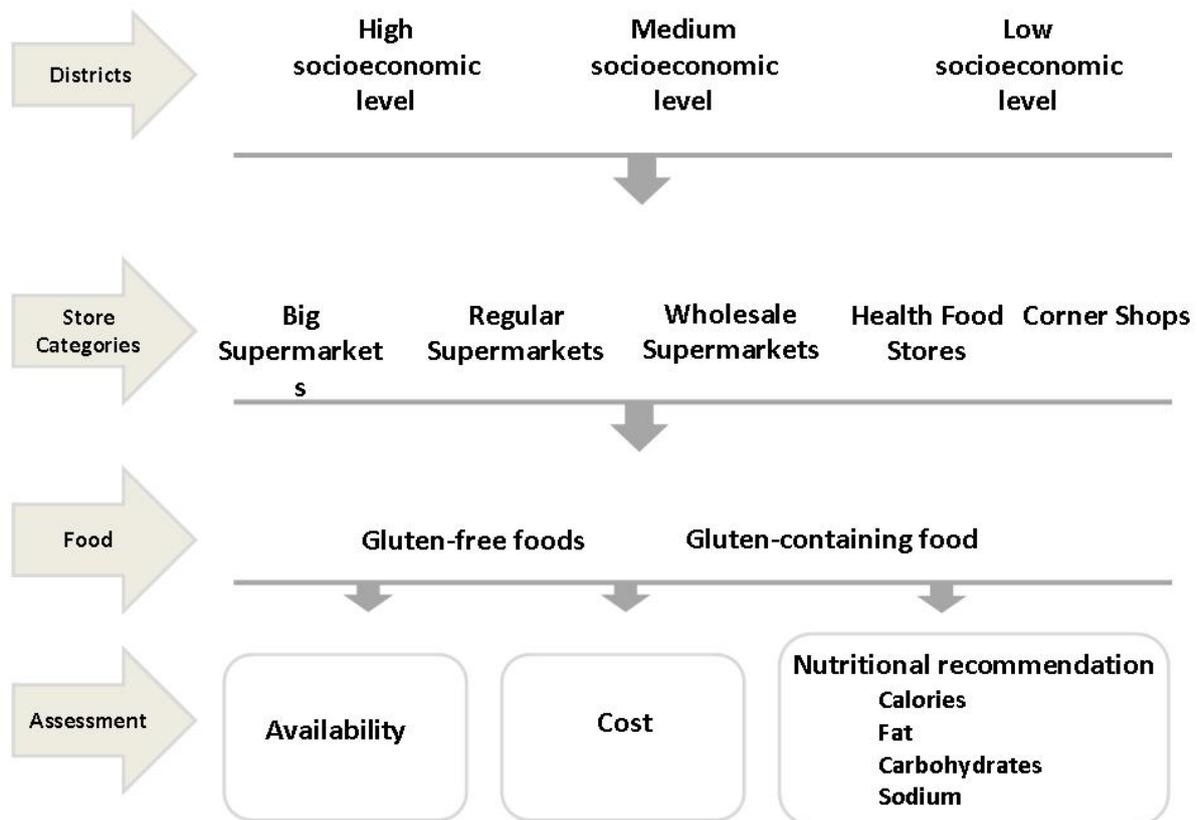


Figure 1. Algorithm

Five store categories were defined and visited (Figure 1): large supermarkets (wide variety, high quality food and high cost); regular supermarkets (wide variety and competitive cost); wholesale supermarkets (limited variety and lower cost); health food stores (containing specialized health foods); and corner shops (small, local businesses with essential products). Three categories of food were surveyed, based on current standard school snacks distributed in the country. Fruits or other natural foods were not included. Dairy products category consisted of individual milk boxes and "simple" yogurts (with no fruits or cereals added, because these were the only gluten-free yogurts available). The cereal category included cereals in bulk and cereal bars and the baked goods category

consisted of various forms of crackers and cookies. In all three categories the closest gluten-containing products were matched to allow comparison with existing gluten-free equivalents, but it was clear that there was a much wider variety of more complex gluten-containing products, which could not be included because they had no gluten-free counterparts. Relevant exclusions consisted of yogurts containing fruits or other additions and cookies with various fillings and/or chocolate cover. To allow comparison, portion sizes were standardized to 200ml for milk, 125ml for yogurt, and single serving cereal bars. Cereals in bulk and individual biscuits were evaluated for a 30g portion.

2.2. Availability

Availability was measured following Singh and Whelan [20], registering all products with and without gluten at the given store as declared in the labels, including brand name, cost and weight/pack size.

2.3. Cost

Cost was recorded in Chilean pesos and then transformed into US dollars; serving sizes were also standardized such that costs could be compared.

2.4. Nutritional Assessment of Gluten-free Products

Nutritional information was obtained from the products labels. Total calories, total fat, carbohydrates and sodium in gluten-free snacks were documented. These data were compared with recommendations for healthy snacks set forth by the FAO/WHO [14]. For the purposes of this study we defined a healthy snack for school age children as containing no more than 130 calories, three grams of fat, 20 grams of carbohydrates per serving and no more than 140 milligrams of sodium per portion.

2.5. Statistical Analysis

One way Anova was used to examine differences in the availability and cost of gluten-free foods across the three socioeconomic levels, in each of the five store categories. Analyses of nutritional characteristics in the products were performed by Chi square, calculating difference between

socioeconomic levels. The statistical analysis was performed using SPSS 21.0 (SPSS Inc., Chicago, IL, USA). Statistically significance was set at $p < 0.05$.

3. Results

In general, the five store categories were found in the three socioeconomic level areas, except for the low socioeconomic district, which had no health food stores. A total of 1562 products were included in the analysis. Several stores lacked some of the food items to be analyzed both for some gluten-containing and gluten-free products and this limited the analysis; in a few cases some categories resulted with zero items.

3.1. Availability

In the dairy products category differences between socioeconomic levels were not significant, but gluten-free dairy products were plain and of simpler formulation in comparison with their gluten-containing counterparts. The variety of gluten-free products available was lower than their gluten-containing counterparts both in the cereal and baked goods categories, in all three socioeconomic levels (Table 1). In the cereal and baked goods categories differences among socioeconomic levels were significant (one way Anova $P < 0.05$); for cereals, the main difference was seen in the large supermarket category, which had a much larger variety of gluten-containing products. In the baked goods category, only the differences in regular supermarkets was significant (one way Anova, $P < 0.05$).

Table 1. Number of gluten-containing and gluten-free products available in the five shop categories, distributed by socioeconomic level

Food categories	Shop categories	Socioeconomic level						P*
		Upper		Middle		Lower		
		With gluten	Gluten free	With gluten	Gluten free	With gluten	Gluten free	
Dairy								
	1	38	14	28	10	29	11	0.953
	2	35	9	25	9	27	10	0.457
	3	30	10	24	9	23	8	0.922
	4	0	0	0	0	0	0	-
	5	0	4	10	4	9	4	-
	Total	103	37	87	32	88	33	0.869
Cereals								
	1	109	15	67	6	94	3	0.014
	2	83	2	67	4	51	2	0.578
	3	25	0	36	0	29	0	-
	4	0	4	0	7	0	0	-
	5	2	0	10	0	4	0	-
	Total	219	21	180	17	178	5	0.019
Baked Goods								
	1	64	18	47	19	80	18	0.500
	2	44	14	58	9	59	2	0.001
	3	14	0	33	0	32	0	-
	4	0	0	0	6	0	0	-
	5	19	0	13	0	13	0	-
Total		141	32	151	34	184	20	0.013

One way Anova, $P < 0.05$. 1= Large supermarkets. 2= Regular supermarkets. 3= Wholesale supermarkets. 4= Health food stores. 5= Corner shops.

3.2. Cost

Gluten-free products were more expensive than gluten-containing equivalents in each food category and in all three socioeconomic levels (Table 2). There were very small differences among stores that offered the same

product, while the greatest differences in costs were found among smaller shops, although this analysis was limited due to the small number of gluten-free products found in them. Dairy products appeared to be more available and with a smaller price difference in relation to gluten-containing dairy products, but it must be noted that this

study revealed that there was only one dairy brand available that had gluten-free milk and yogurts and these products were available everywhere, a fact that reduced the possibilities of analysis. Some baked goods were

~300% more expensive than their gluten-containing counterparts in the big and medium supermarkets of middle socioeconomic status (Table 2).

Table 2. Cost in dollars* of gluten containing and gluten- free products in the five shop categories, by socioeconomic level

Food categories	Shop categories	Socioeconomic level								
		Upper			Middle			Lower		
		With gluten	Gluten- free	p	With gluten	Gluten- free	p	With gluten	Gluten- free	p
Dairy										
	1	0.48±0.10	0.45±0.18	0.449	0.46±0.10	0.42±0.08	0.171	0.47±0.11	0.41±0.07	0.054
	2	0.42±0.11	0.36±0.06	0.127	0.40±0.10	0.35±0.07	0.244	0.44±0.24	0.36±0.08	0.295
	3	0.49±0.15	0.34±0.06	0.004	0.40±0.11	0.36±0.09	0.321	0.39±0.11	0.35±0.09	0.296
	4	-	-	-	-	-	-	-	-	-
	5	-	0.61±0.00	-	0.51±0.13	0.45±0.08	0.413	0.38±0.13	0.39±0.09	0.900
	Mean	0.46±0.12	0.44±0.10	0.056	0.44±0.11	0.40±0.08	0.040	0.42±0.15	0.38±0.08	0.055
Cereals										
	1	0.36±0.24	0.85±0.40	0.000	0.42±0.27	0.66±0.10	0.035	0.35±0.22	0.72±0.12	0.005
	2	0.26±0.14	0.70±0.17	0.000	0.33±0.12	0.84±0.54	0.000	0.24±0.07	0.56±0.00	0.000
	3	0.49±0.12	-	-	0.23±0.08	-	-	0.21±0.05	-	-
	4	-	0.59±0.13	-	-	0.77±0.34	-	-	-	-
	5	0.68±0.00	-	-	0.3±0.18	-	-	0.38±0.01	-	-
	Mean	0.45±0.12	0.71±0.23	0.000	0.34±0.16	0.76±0.33	0.000	0.30±0.09	0.64±0.06	0.000
Baked Goods										
	1	0.29±0.37	0.82±0.34	0.000	0.28±0.21	0.81±0.32	0.000	0.29±0.28	0.77±0.35	0.000
	2	0.21±0.10	0.81±0.50	0.000	0.23±0.12	1.13±0.49	0.000	0.24±0.12	0.65±0.18	0.000
	3	0.25±0.09	-	-	0.16±0.05	-	-	0.17±0.07	-	-
	4	-	-	-	-	1.07±0.52	-	-	-	-
	5	0.25±0.10	-	-	0.17±0.05	-	-	0.12±0.02	-	-
	Mean	0.25±0.17	0.1±0.42	0.000	0.21±0.11	0.97±0.44	0.000	0.20±0.12	0.71±0.27	0.000

Results expressed as mean ± SD. One way Anova, P<0.05.*= 1dollar= \$557 Chilean pesos. “-”= not found
1= Largesupermarkets. 2= Regular supermarkets. 3= Wholesale supermarkets. 4= Health food stores. 5= Corner shops.

3.3. Nutritional Quality

As a whole, only a small proportion of all gluten-free school snacks met nutritional recommendations (Table 3). Except for cereal calories and sodium in the upper socioeconomic level, less than one third of the products available met FAO/WHO recommendations. Products meeting all 4 features (total calories, total fat, carbohydrates and sodium) analyzed were 7.8%, 7.3% and 7.3% in the upper, middle and low socioeconomic status, respectively; the differences observed being always in

excess of the recommendation. The poorest values were for baked goods in all three socioeconomic levels; in contrast, the best figures were in the high socioeconomic level, where imported products were more frequently available; 50% and 58.3% of the analyzed cereals in the high socioeconomic level met recommendations of calories and sodium, respectively. Although analyzing the ingredients used to produce gluten-free foods was not an objective of this study, it was noticeable that rice was the main ingredient in all baked goods identified.

Table 3. Percentage of processed gluten-free school snacks that meet nutritional requirement by FAO/WHO, shown in brackets for each individual nutrient

Socio economic level (SEL)*	Recommendation														
	Calories (130 kcal)			Total Fat (3g)			Total Carbohydrate (20g)			Sodium (140mg)			All 4 critical nutrients		
	Upper SEL (%)	Middle SEL (%)	Lower SEL (%)	Upper SEL (%)	Middle SEL (%)	Lower SEL (%)	Upper SEL (%)	Middle SEL (%)	Lower SEL (%)	Upper SEL (%)	Middle SEL (%)	Lower SEL (%)	Upper SEL (%)	Middle SEL (%)	Lower SEL (%)
Food categories															
Dairy (n=102)	17.6	16.7	15.7	15.7	14.7	15.7	16.7	16.7	15.7	36.3	31.4	32.4	14.7	13.7	14.7
Cereals (n=36)	50.0	25.0	13.9	47.2*	13.9*	8.3*	16.7	16.7	5.6	58.3	27.8	13.9	5.6	2.8	0.0
Baked goods (n=80)	23.8	25.0	21.3	13.8	16.3	11.3	16.3	13.8	10.0	30.0	27.5	18.8	0.0	1.3	1.3
Total (n=218)	25.2	21.1	17.4	20.2	15.1	12.8	16.5	11.0	11.9	37.6	29.4	24.3	7.8	7.3	7.3

*= Significant differences for total fat in the cereals category of the upper-middle-lower SE levels, (P<0.03, chi square).

4. Discussion

Results showed reduced availability and higher costs of gluten-free snacks, increasing the difficulties for school-

age children with CD to comply with a gluten-free diet, also increasing the economic burden that celiac patients and their families face [8]. These results are relevant because at the same time the Chilean population has inadequate eating habits and white bread based on wheat

is a main daily foodstuff, especially for lower income groups [17]. Thus, findings on baked products are relevant, especially in places with high wheat consumption as the case of Chile, where bread consumption is about 90 kg per person per year, among the highest globally [17]. Except for Argentine, several other countries in this geographical area also lack public health policies regulating gluten declaration in processed foods. Although this kind of data is absent in Latin America, results in general are not particularly unexpected; in Nova Scotia MacCulloch et al [21] also found that gluten-free products were fewer, more expensive and less available than their gluten-containing counterparts. Studies in Spain describe higher contents of calories, macronutrients, sodium and cholesterol in gluten-free as compared with gluten-containing foods [22]. Accessing gluten-free products may increase the amount of time spent on food shopping and reading food labels to ensure the product is safe and does not contain gluten, making shopping for food a time consuming task. Bellini et al found a relationship between people's perception of the degree to which they can control their environment (here meaning reading food labels) and compliance with a gluten-free diet [23]. For school-age children, parents are often in charge of purchasing their school snacks; while it is true that they need more time to read the labels, this may also have a positive outcome by improving parents knowledge, which can be passed to the child and encourage him/her to follow the diet.

An important finding of this study is the large proportion of products available that do not meet nutritional requirements. Today, the presence of the global pandemic of obesity and non-communicable chronic diseases (e.g. diabetes, hypertension and others) at progressively earlier ages [17] becomes a relevant factor to consider among celiac patients, a group where overweight/obesity is also increasing [17]. Indeed, celiac patients should follow current dietary recommendations and limit their intake of (saturated) fat and (added) sugar [24,25]. It is true that producing healthy processed gluten-free products is more difficult to accomplish, because gluten substitution often results in higher content of added sugar and fat. An alternative often offered to celiac patients is to increase naturally gluten-free foods, such as fruits and vegetables, but consumption of these is low in most western countries; in less developed countries, unavailability and higher prices are often cited as reasons that constraints eating healthier, especially in low income groups [26,27]. It seems reasonable to promote the nutritional improvement of highly processed gluten-free foods. In this study, low income areas had the poorest availability of gluten-free products and most of those present did not meet nutritional requirements.

The gluten-free products market is globally increasing, not only because the frequency of cases diagnosed with CD has increased [4], but also as a result of non-celiac groups that follow a gluten-free diet, due to wheat allergy, non-celiac gluten sensitivity or in hope of losing weight. Increased participation of these latter groups in gluten-free diets has led to a substantial increase in sales of gluten-free products [28]. Thus, it is time that gluten-free foods producers focus not only on the absence of gluten in their products, but also on their nutritional quality, paying especial attention to fiber content and the use of non-fortified raw materials.

5. Conclusions

This study shows that gluten-free dairy products, cereals and baked snacks available to school-age children in Santiago, Chile are fewer, less diverse and more expensive than gluten-containing products; and most importantly, the vast majority of them do not meet nutritional recommendations. These results should alert health policy planners and gluten-free producer companies that are working to improve the management of CD and patients' quality of life.

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