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ORIGINAL RESEARCH

The gluten-free diet: access and economic aspects and impact on lifestyle

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Background: The cost and availability of gluten-free products (GFPs) are aspects associated with gluten-free dietary compliance. In turn, following a gluten-free diet (GFD) could impact on lifestyle.

Objectives: To investigate the availability and cost of GFPs in Northwestern Mexico, to associate these factors with gluten-free dietary noncompliance, and to evaluate the impact of the GFD on lifestyle.

Materials and methods: Gluten-containing foods were compared with their gluten-free versions. The data were collected by store visitation (16 supermarkets and 10 health food stores). Individuals prescribed a GFD by a physician were surveyed (n=36).

Results: The gluten-free versions investigated (n=16) had limited availability (average 26.9%; 4.3 gluten-free versions available per store) and were more expensive than their gluten-containing counterparts (190%–1088%, $P<0.05$). Poor gluten-free dietary compliance was attributed to the high cost (n=36) and low availability (n=30) of GFPs. Most respondents were afraid of dining out (n=35), were limiting their social activities (n=32), and had difficulties traveling (n=30).

Conclusion: Health care professionals who counsel gluten-sensitive patients should provide tools to facilitate access to GFPs and to minimize the cost of the GFD, and consider the diet-associated social restrictions.

Keywords: gluten-free diet, cost, availability, lifestyle, Mexico

Introduction

Following a gluten-free diet (GFD) is the only accepted treatment for gluten-related disorders such as celiac disease and non-celiac gluten sensitivity. The former condition could affect between 0.3% and 1% of the population.[1,2] The prevalence of non-celiac gluten sensitivity remains unknown, but recent studies suggest that this can range between 0.96% and 7.6%.[3,4] Formally diagnosed gluten-sensitive patients are advised to consume gluten-free products (GFPs) in order to avoid gluten-induced symptoms and/or long-term complications.[5] However, limited availability and high cost of GFPs have been documented in developed countries such as the UK and North America.[6–8] These access and economic aspects could influence gluten-free dietary noncompliance.[9–11] Despite the benefits of the GFD in gluten-sensitive cases, following a strict GFD for health-related benefits is challenging and could impact on lifestyle.[12–14] Furthermore, the diet should be instructed by a health professional in order to avoid micronutrients deficiencies and improve fiber intake.[15–17] Different from the developed world, the economic burden of following a GFD and the availability of GFPs remain unknown in

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most developing countries. Consequently, in these countries, there is scarce information about both the impact of these factors on gluten-free dietary compliance and the impact of following a GFD on lifestyle in those who truly benefit from a GFD. Thus, the aim of this study was to investigate the availability and cost of GFPs in Mexican supermarkets and health food stores located in Northwestern Mexico. The cost and availability of GFPs as factors influencing a poor gluten-free dietary compliance, as well as the impact of the GFD on some aspects of life were also investigated.

Materials and methods

Availability and cost of GFPs

A "Mexican market basket", previously established by the National Council for the Evaluation of Social Development Policy, was chosen for the purposes of this study. Wheat-based foods included in the market basket (n=14) and another two food products that gluten-sensitive individuals or parents of celiac children would purchase for day-to-day living (nachos and chips and baby porridges) were also investigated. Availability of gluten-free versions (n=16) and different GFPs were measured by quantifying whether a specific version was available or not and the number of different GFPs available, respectively.[6–8] This procedure has recently been described as follows:[18]

Based on the number of gluten-free versions (16 versions),

$$AR_v = \left(\frac{\text{NV}}{\text{TGFv}}\right)\times 100$$

Based on the total number of GFPs (100 GFPs in this study),

$$AR_{\text{GFPs}} = \left(\frac{\text{NDGFPs}}{\text{TDGFPs}}\right)\times 100$$

where AR_v is the availability rate by gluten-free versions, NV the number of versions with at least one gluten-free version available in a single store, TGFv the total of gluten-free versions (TGFv=16 in this study), AR_{GFPs} the availability rate by GFPs, NDGFPs the number of different GFPs available per supermarket or specialized store, and TDGFPs is the total of different GFPs available in Northwestern México (Σ of the different versions of GFPs available in all the stores visited).

Cost comparisons were performed according to Singh and Whelan.[8] Regular supermarkets and health food stores were included in the study (at least three supermarkets and two health food stores per city). The three mainstream supermarkets established in each city were included in the study. The health food stores from each city were selected from the National Statistical Directory of Economic Units published by the National Institute of Statistics and Geography.[19] The number of supermarkets and health food stores were chosen based on the number of establishments available and agreement to be surveyed. These store categories were previously described.[10,20] All data were collected by store visitation and the costs calculated per 100 g of product. As people without special dietary requirements usually buy their food products in supermarkets and it is uncommon that Mexican health food stores have for sale food products other than special dietary ones, the cost of the 16 gluten-containing versions was recorded in supermarkets only. A dietitian reviewed all ingredient labels for sources of gluten (wheat, rye, or barley) during the survey. Two border cities to USA (Tijuana and Mexicali, Baja California Norte) and three non-border cities (Hermosillo, Sonora; Culiacan, Sinaloa; and La Paz, Baja California Sur) were included in the study. These five cities were chosen because they are the most populated cities in Northwestern Mexico and larger supermarkets chain stores are located in these cities. The exchange rate at the time of the survey (March 20 to May 20, 2014) ranged from 13.1675 to 12.9193 Mexican Peso/US Dollars according to Banco de México (the Mexican central bank) data.

GFD survey

Celiac disease-specific questions were chosen from previous scientific publications and validated questionnaires.[10,11,13,21–23] Questions published in English were translated into Spanish, and language equivalence was assessed using the translation/back translation procedure. The sections of the questionnaire included the following: 1) Health improvement (Did your health improve after the introduction of the GFD?), 2) Difficulty following a GFD (Is the GFD difficult to follow?), 3) Information sources (Who instruct you about the GFD?; If you are seeing a physician/gastroenterologist or dietitian, how do you rate the information received?), 4) Reasons that influence poor dietary compliance (it is difficult to find GFPs in local stores; the cost of commercially available GFPs limits their purchase; unsatisfied with the taste and texture of GFPs), and 5) Lifestyle (Are you affected by the limitations in your meals with your family?; Do you avoid social activities?; Do you have difficulty to travel?; Are you limited in your work/school activities because of the GFD?; Are you afraid of dining out because of gluten contamination of food?). The questionnaire was self-administered

containing 16 questions. No respondent identification was collected, ensuring anonymity. The survey was carried out during the first Mexican Symposium on Celiac Disease held in Mexico City (June 20, 2014). The study inclusion criteria were as follows: 1) Mexican individuals; 2) >18 years old; and 3) were following a GFD by recommendation of their physician/dietitian because of symptoms triggered after gluten ingestion. Questionnaire completion and return was regarded as consent. The Ethics Review Board of the Autonomous University of Sinaloa approved the protocol. Ethical approval number CE-UACNYG-2013-ABR-001.

Statistical analysis

Statistical analyses were carried out using PASW statistics version 18.0 (SPSS Inc., Chicago, IL, USA). Mann–Whitney test was used for cost comparisons. A P value <0.05 was considered statistically significant. Availability was expressed as percentage of availability. Cost comparisons among cities could not be carried out due to the low availability of most gluten-free versions. Thus, a minimum of four stores contributing data to the cost was chosen as an arbitrary cutoff for statistical cost comparisons between the gluten-free versions and gluten-containing products available in Northwestern Mexico, the border and non-border cities to USA, and the types of food stores. For the survey purposes, categorical variables were summarized by descriptive statistics, including total numbers and percentages.

Results

Availability of GFPs

The 16 gluten-containing food versions investigated had a gluten-free version available in one border city (100% availability), but availability of different GFPs (total number=100) per city ranged between 18% and 50% (Table 1). Availability of gluten-free versions was 87% and 81% for supermarkets and health food stores, respectively, while availability of different GFPs was 67% and 42%, correspondingly (Table 2). Availability of gluten-free versions per store ranged between 0% and 81% in supermarkets (average 28.8%) and between 6.2% and 62.5% in health food stores (average 25%), as shown in Figure 1A. Availability of GFPs per store ranged between 0% and 36% and between 1% and 17% for supermarkets and health food stores, respectively. Notably, 13 out of 16 supermarkets and 9 out of 10 health food stores had an average availability rate of <10% for different GFPs (Figure 1B).

Cost of GFPs in Northwestern Mexico

Twelve out of 14 gluten-free versions were significantly more expensive than their gluten-containing counterparts (P<0.05; Table 3). Gluten-free pastas and multipurpose mixes were far more expensive than their counterparts (7–10 times), as shown in Table 3. Statistical cost comparisons for the other two gluten-free versions (breading mixes and batter mix for pizza crust) could not be performed due to the low availability

Table 1 Availability rates of gluten-free versions (total versions=16) and different GFPs (total number=100) in five cities from Northwestern Mexico

Food	% of availability/100 (number of different versions)				
	Tijuana	Mexicali	La Paz	Hermosillo	Culiacan
Cookies	0.71 (5)	0.71 (5)	0.28 (2)	0.42 (3)	0.28 (2)
Crackers	0.75 (6)	0.37 (3)	0	0.37 (3)	0.37 (3)
Loaves	0.66 (2)	0.33 (1)	0	0.33 (1)	0.66 (2)
Pastas	0.54 (6)	0.45 (5)	0.27 (3)	0.45 (5)	0.54 (6)
Noodles	1.0 (3)	0.33 (1)	0	0.66 (2)	0.66 (1)
Lasagna	0.66 (2)	0	0	0	0.66 (2)
Maize cereals	0.66 (2)	0.33 (1)	0	0.66 (2)	0.66 (2)
Rice cereals	0.6 (3)	0.4 (2)	0.2 (1)	0.4 (2)	0
Breading mixes	0.5 (1)	0	0	0	1.0 (2)
Mixes for cakes and hot cakes	0.55 (5)	0.11 (1)	0.11 (1)	0.33 (3)	0.55 (5)
Multipurpose mixes	0.55 (5)	0.11 (1)	0.22 (2)	0.22 (2)	0.44 (4)
Mixes for pizza crust	0.5 (1)	0	0	0	0.5 (1)
Mixes for cookies	0.33 (1)	0.33 (1)	0.33 (1)	0	1.0 (3)
Nachos and chips	0.33 (3)	0.22 (2)	0.22 (2)	0.44 (4)	0.55 (5)
Cereal bars	0.22 (4)	0.22 (4)	0.33 (6)	0.27 (5)	0.33 (6)
Baby porridges	0.20 (1)	0.20 (1)	0	0.20 (1)	0.80 (4)
Availability (gluten-free versions)[a]	1.0 (16)	0.81 (13)	0.5 (8)	0.75 (12)	0.94 (15)
Availability (different GFPs)[a]	0.50 (50)	0.28 (28)	0.18 (18)	0.33 (33)	0.48 (48)

Note: [a]Average availability is based on supermarkets and specialized stores visited in each city.
Abbreviation: GFPs, gluten-free products.

Table 2 Availability rates of gluten-free versions (total versions=16) and different GFPs (total number=100) per store category

Food	% of availability/100 (number of different versions)		
	Supermarkets	Health food stores	Overall
Cookies	1.0 (7)	0	1.0 (7)
Crackers	1.0 (8)	0	1.0 (8)
Loaves	0.66 (2)	0.33 (1)	1.0 (3)
Pastas	0.72 (8)	0.54 (6)	1.0 (11)
Noodles	1.0 (3)	0.66 (2)	1.0 (3)
Lasagna	0.33 (1)	0.66 (2)	1.0 (3)
Maize cereals	1.0 (3)	0.33 (1)	1.0 (3)
Rice cereals	1.0 (5)	0	1.0 (5)
Breading mixes	0	1.0 (2)	1.0 (2)
Mixes for cakes and hot cakes	0.44 (4)	0.66 (6)	1.0 (9)
Multipurpose mixes	0.77 (7)	0.33 (3)	1.0 (9)
Mixes for pizza crust	0.5 (1)	0.5 (1)	1.0 (2)
Mixes for cookies	0	1.0 (3)	1.0 (3)
Nachos and chips	0.55 (5)	0.44 (4)	1.0 (9)
Cereal bars	0.66 (12)	0.38 (7)	1.0 (18)
Baby porridges	0.2 (1)	0.8 (4)	1.0 (5)
Availability (gluten-free versions)[a]	0.87 (14)	0.81 (13)	1.0 (16)
Availability (different GFPs)[a]	0.67 (67)	0.42 (42)	1.0 (100)

Note: [a]Average availability is based on 16 supermarkets and 10 health food stores.
Abbreviation: GFPs, gluten-free products.

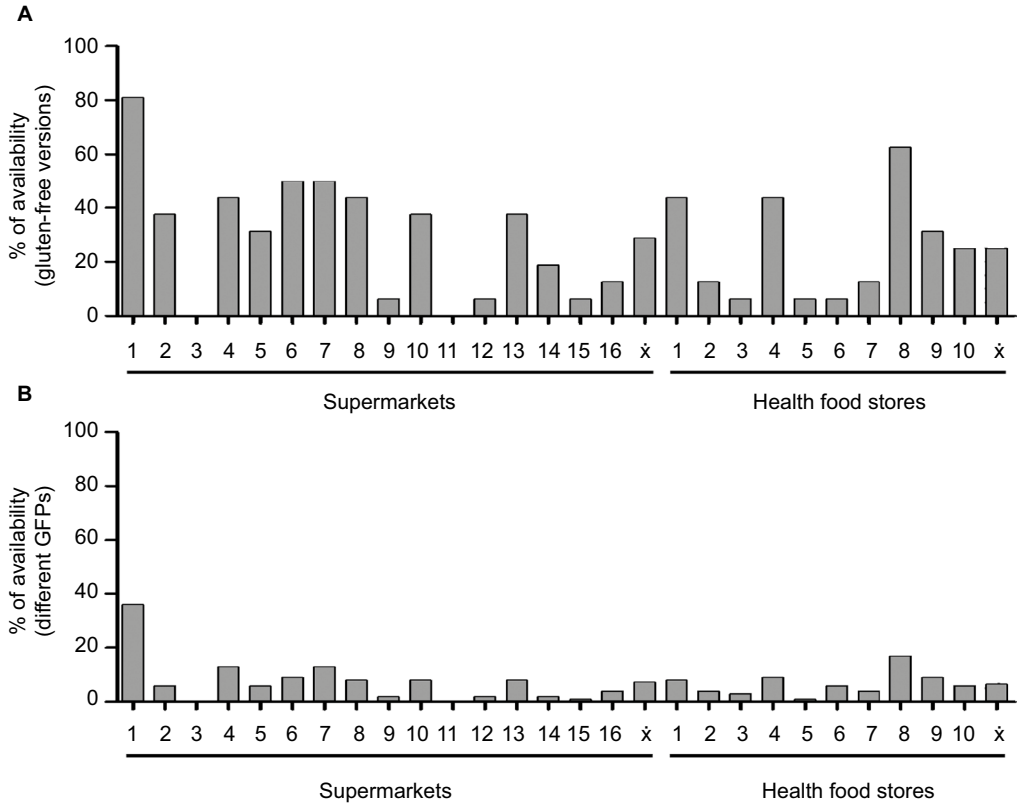

Figure 1 Availability rates per store.
Notes: (**A**) Availability of gluten-free versions (n=16 [100%]). (**B**) Availability of different GFPs (n=100 [100%]). The x-axes show individual results for each supermarket and health food store surveyed. ẋ represents either all supermarkets (n=16) or all specialized stores (n=10).
Abbreviation: GFPs, gluten-free products.

Table 3 Cost comparison of gluten-free versions vs gluten-containing products

Food	Mean[a] (SD) [n][b]		*P*-value
	GFP	Gluten-containing	
Cookies	51.8 (30.8) [10]	11.0 (8.2) [16]	**0.008**
Crackers	39.8 (21.4) [8]	7.6 (4.4) [16]	**0.004**
Loaves	23.0 (7.3) [5]	9.0 (8.0) [16]	**0.029**
Pastas	26.5 (15.3) [13]	3.5 (1.9) [16]	**0.005**
Noodles	31.5 (13.7) [5]	11.8 (5.5) [16]	**0.015**
Lasagna	35.2 (14.3) [4]	9.2 (4.6) [16]	**0.028**
Maize cereals	33.5 (10.3) [6]	11.0 (4.0) [16]	**0.002**
Rice cereals	21.0 (4.8) [6]		**0.004**
Breading mixes	45.0 (22.6) [2]	7.3 (2.8) [16]	ND
Batter mixes for cakes and hot cakes	26.1 (11.8) [16]	7.1 (4.4) [16]	**0.010**
Multipurpose mixes	28.3 (19.7) [9]	2.6 (2.7) [16]	**0.005**
Batter mix for pizza crust	19.5 (2.1) [2]	7.0 (0.0) [12]	ND
Batter mix for cookies	20.5 (10.9) [4]	8.2 (0.9) [12]	**0.028**
Nachos and chips	58.5 (50.9) [13]	14.6 (10.6) [16]	0.179
Cereal bars	57.0 (42.7) [13]	16.5 (3.8) [16]	0.126
Baby porridges	37.8 (25.6) [5]	7.9 (0.6) [16]	**0.002**

Notes: The cost (Mexican pesos) of 100 g of each food product was used for comparisons. [a]Average of branded gluten-free, cheapest gluten-free, or branded gluten-containing, cheapest gluten-containing. [b]Number of stores that contributed cost data. Bold values indicate statistically significant differences.
Abbreviations: GFP, gluten-free product; ND; not determined due to insufficient sample.

of these products (Table 1). GFPs cost comparisons between border and non-border cities to USA as well as between types of food stores were performed for 7 out of 16 GFPs, but these were not significant (*P* values between 0.19 and 0.88). Other cost comparisons could not be performed due to the low availability of GFPs.

GFD survey

A total of 97 participants were approached, but only 36 of them (25 females, 11 males) met the criteria for the study. Respondents' age ranged from 18 to 85 years, and the time following a GFD ranged from 2 months to >10 years. Twenty-four respondents (66.6%, 17:7 female:male) were following a GFD for >2 years. All respondents (n=36) perceived a health improvement after the introduction of the GFD, but most of them (n=33; 91.6%) perceived that the diet was moderately (n=6; 16.6%, 5:1 female:male) or very difficult (n=27; 75%, 19:8 female:male) to follow. Main difficulties for following a GFD were the high cost (n=36; 100%) and the low availability of GFPs (n=36; 100%), as shown in Table 4. Additionally, respondents were asked about their diet information sources. Twenty-two respondents (61.1%, 16:6 female:male) stated that they received information about the GFD from a physician/gastroenterologist and the other 11 (30.5%, 9:2 female:male) from a dietitian. However, of these 33 respondents, only 15 (45.4%, 13:2 female:male) rated the diet information received from the health professional they were seeing as helpful (Table 4). Regarding lifestyle, most respondents stated that they were afraid of dining out because of gluten contamination of foods (n=35; 97.2%, 25:10 female:male), were avoiding social activities (n=32; 88.8%, 22:10 female:male), and had difficulties traveling (n=30; 83.3%, 23:6 female:male), as shown in Table 4.

Discussion

In this study, we investigated the cost and availability of GFPs, the impact of these aspects on gluten-free dietary compliance, and the impact of following a GFD for health-related benefits on lifestyle. Gluten-free foods that consumers would purchase for day-to-day living were poorly available in supermarkets and health food stores located in Northwestern Mexico. Although the availability of gluten-free food versions was good in the four cities surveyed, one city showed limited availability (47%). Most notably, the availability of gluten-free food versions per store was quite low (<27%), as was the availability of different GFPs (average availability <7.1%). This means that on average, only 4.3 out of 16 gluten-free food versions and 7 out of 100 different GFPs were available per store in the 26 food stores surveyed. Consequently, there was a reduced variety of most of the gluten-free food versions investigated. This is in line with studies carried out in the USA and the UK,[6,8] which have reported poor availability of GFPs in supermarkets. On the contrary, a more recent study carried out in the UK reported good availability of GFPs.[20] The median availability of GFPs in this study was 22 (interquartile range=17.5–109.5 [quality

Table 4 GFD survey results stratified by concept

Concept	Affirmation/question	Options	Percentage (n)
Health improvement	Did your health improve after the introduction of the GFD?	Improved a lot	86.1 (31)
		Moderate improvement	13.8 (5)
		Little improvement	0
		No improvement	0
Difficulty following a GFD	Is the GFD difficult to follow?	Very difficult	75 (27)
		Moderately difficult	16.6 (6)
		Not difficult	8.3 (3)
Information sources	Who instruct you about the GFD? (you can choose more than one option)	I look for information on the Internet	88.8 (32)
		I consult books and other sources	30.5 (11)
		Physician/gastroenterologist	61.1 (22)
		Dietitian	30.5 (11)
	If you are seeing a physician/ gastroenterologist or dietitian, how do you rate the information received?	Very helpful	33.3 (11)
		Moderately helpful	12.1 (4)
		Unhelpful	54.5 (18)
Reasons that influence poor dietary compliance (rate the following affirmations)	It is difficult to find GFPs in local stores	Strongly influences	83.3 (30)
		Moderately influences	16.6 (6)
		No influence	0
	The cost of commercially available GFPs limits their purchase	Strongly influences	100 (36)
		Moderately influences	0
		No influence	0
	Unsatisfied with the taste and texture of GFPs	Strongly influences	0
		Moderately influences	52.7 (19)
		No influence	47.2 (17)
Lifestyle	Are you affected by the limitations in your meals with your family?	Yes, I am	47.2 (17)
		No, I am not	52.7 (19)
	Do you avoid social activities?	Yes, I do	88.8 (32)
		No, I do not	11 (4)
	Do you have difficulty to travel?	Yes, I do	83.3 (30)
		No, I do not	16.6 (6)
	Are you limited in your work/school activities because of the GFD?	Yes, I am	33.3 (14)
		No, I am not	66.6 (24)
	Are you afraid of dining out because of gluten contamination of food?	Yes	97.2 (35)
		No	2.7 (1)

Abbreviations: GFD, gluten-free diet; GFPs, gluten-free products.

supermarkets] and 0–39 [regular supermarkets]),[20] which represents a higher availability of GFPs than the one reported in the present study (median 6; interquartile range=2–9 regular supermarkets). These findings become relevant as poor variety and availability of GFPs is commonly referred as a barrier for gluten-free dietary compliance.[11] Accordingly, the 36 individuals enrolled in the present study were following a GFD by the recommendation of their physician/dietitian and stated that the poor availability of GFPs strongly (83.3%) or moderately (16.6%) influenced dietary noncompliance.

Budget supermarkets and corner stores are usually included in studies of cost and availability of GFPs. However, these store categories had no GFPs available in the first two cities surveyed (Culiacan, Sinaloa and Hermosillo, Sonora) in the present study (data not shown). Subsequently, budget supermarkets and corner stores were excluded in the study. Quality supermarkets could not be investigated due to the lack of this store category in the five cities surveyed. Overall, the results show that the cost of GFPs in Northwestern Mexico is higher than that of their gluten-containing counterparts (up to 10 times). Similar studies conducted in the other countries of North America, Europe, and Oceania reported that GFPs are costly.[6–8,20,24,25] Certainly, the economic burden associated with following a GFD could be significant for gluten-sensitive Mexican individuals since subsidies for gluten-free foods are not provided in Mexico. In fact, the 36 gluten-sensitive individuals surveyed in the present study stated that the high cost of GFPs is one of the reasons that strongly influenced poor dietary compliance. These findings are consistent with previous studies carried out in Brazil and Canada, and highlight that health care professionals such as dietitians should be trained to help their patients to

minimize the cost of the GFD in order to increase dietary compliance and, consequently, decrease the risk of disease complications such as malignancy, osteoporosis, and anemia in celiac disease cases.[11,25,26]

Previous studies reported that following a GFD is challenging and can be a limiting factor affecting decisions in social activities.[9,11,13,21,27] In our study, most respondents were affected in social activities such as dining out (97.2%) and had difficulties traveling (83.3%). Based on previous findings,[10,21] social activities are more commonly affected in gluten-sensitive Mexican individuals following a GFD, when compared to adult Canadian celiac patients. Overall, our results highlight that common social activities are affected in Mexican adults following a GFD for health-related benefits.

Providing understandable information about the disease and GFD is part of dietary counseling. In the current study, only 15 out of 33 (45.4%) respondents who received diet information from a physician/dietitian rated it as helpful. Studies carried out in developed countries, which included cohorts of hundreds or thousands of gluten-sensitive individuals, have reported similar findings.[13,21] Physicians/dietitians are the official source of trustable information for patients in need of a GFD, and when this information is not properly understood is of concern. After a dietetic consultation, gluten-sensitive patients expect to increase their knowledge about the GFD and disease and to understand the relevance of the GFD, in addition to nutritional and health aspects.[28] Although limited in sample size, our results show that Mexican health care professionals need education regarding the proper management of patients following a GFD.

We should acknowledge that our study lacks evaluations of the gluten-containing and GFPs' nutritional quality. Studies based on the nutrition information from the food labels have concluded that the consumption of GFPs is unlikely to confer health-related benefits in the absence of gluten intolerance.[29] However, composition analyses of the food should be performed in order to establish whether or not the consumption of GFPs confers health-related benefits or has a negative impact on the individuals' health status due to their low nutritional quality.

Conclusion

The present study shows that GFPs have limited availability in Northwestern Mexico and that most GFPs are more expensive than their gluten-containing counterparts. This represents a significant challenge for gluten-free dietary compliance. Furthermore, following a GFD for health-related benefits negatively impacts on lifestyle in gluten-sensitive Mexican individuals. Therefore, physicians/dietitians who counsel gluten-sensitive individuals should be knowledgeable about gluten-related disorders and provide tools to facilitate access to GFPs and to minimize the cost of the GFD. They should also take into account the diet-associated social restrictions.

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Disclosure

The authors report no conflicts of interest in this work.

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