

Knowledge of and behaviors toward a gluten-free diet among women at a health sciences university



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خلاصة

الغرض: اكتسب النظام الغذائي الخالي من الغلوتين شعبية في جميع أنحاء العالم. ومع ذلك، هناك القليل من المعلومات المتعلقة بالمعرفة والسلوك تجاه هذا النظام الغذائي بين البالغين في المملكة العربية السعودية. لذلك أجريت هذه الدراسة.

الطريقة: أجريت دراسة مقطعية مع استبيان على 352 امرأة في إحدى جامعات العلوم الصحية في المملكة العربية السعودية.

النتيجة: أظهرت التحليلات أن 11% من المشاركين اتبعن النظام الغذائي الخالي من الغلوتين مرة واحدة على الأقل. كان المصدر الرئيسي للمعلومات المتعلقة بهذا النظام الغذائي هو الإنترنت ووسائل التواصل الاجتماعي. 70% من المتبعات تطوعوا بتجربة هذا النظام الغذائي دون تشخيص طبي مؤكد. بالإضافة إلى ذلك، كان لدى متبعات هذا النظام الغذائي معرفة معتدلة بالجلوتين ومنتجاته ولكن أعلى مقارنة بغير المتبعات (65% مقابل 56%) وهذا الاختلاف معنوي احصائياً. ارتبط اتباع هذا النظام الغذائي بعمر 25 سنة فما فوق والتعليم العالي والتوظيف. على الرغم من أن 56% من المتبعات أفدن باتباع هذا النظام الغذائي 75% أو أكثر من أوقاتهن، إلا أن متوسط درجة الالتزام المحسوبة كان منخفضاً. أيضاً 95% من المتبعات لهذا النظام اكدوا ان أسلوب الحياة والحياة الاجتماعية تغيرت بعد بدئ هذا النظام. ومع ذلك، شعر 71% من المتبعات لهذا النظام بتحسن بعد اتباعه و 2.6% فقط شعروا بسوء. تم تأكيد هذه النتيجة المبلغ عنها ذاتياً بمتوسط درجة جودة الحياة المحسوبة البالغة 1.3، مما يشير إلى تحسن جودة الحياة بعد اتباع هذا النظام الغذائي.

الخلاصة: أشارت هذه الدراسة إلى معرفة معتدلة بالنظام الغذائي الخالي من الغلوتين من المتبعات له ولكن الالتزام الكامل بهذا النظام كان منخفضاً. يمكن أن يُعزى ذلك إلى ارتفاع نسبة المتبعات لهذا النظام بدون وجود حالة طبية مؤكدة أو التغيير الاجتماعي ونمط الحياة الكبير الذي يواجهه المتبعون. ننصح بتقديم البرامج التعليمية للجمهور لزيادة الوعي بالأطعمة والنظام الغذائي الخالي من الغلوتين.

الكلمات المفتاحية: نظام غذائي خال من الغلوتين؛ معرفة؛ سلوك؛ مرض الاضطرابات الهضمية؛ تغذية؛ عدم تحمل الغلوتين

Abstract

Purpose: Gluten-free diets have gained popularity worldwide. However, little information is available regarding the knowledge of, and behaviors toward, this diet among adults in KSA. This study was aimed at addressing this knowledge gap.

Methods: A cross-sectional survey was conducted in 352 women at a health sciences university in KSA.

Results: Eleven percent of participants had followed a gluten-free diet at least once, 70% of whom had voluntarily tried this diet without a confirmed medical diagnosis. The main source of information regarding this diet was the internet and social media. Additionally, followers of this diet had moderate knowledge of gluten and its products yet higher knowledge than that of non-followers (65% vs 56%, $P = .0055$). Following a GFD was associated with an age of 25 years or older, higher education, and being employed. Although 56% of participants reported following this diet 75% or more of the time, the average calculated adherence score was low. Although 95% of the followers indicated changes in their lifestyle and social life, 71% felt better after following this diet, and only 2.6% felt

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worse. This self-reported results were confirmed by a calculated average quality of life score of 1.3, indicating a good quality of life after following this diet.

Conclusion: This study indicated moderate knowledge and low adherence to a gluten-free diet among followers. This finding may be attributable to the high percentage of followers without a confirmed medical condition, or to the social and lifestyle changes faced by followers of GFDs. Educational programs should be introduced to the public to increase awareness of gluten-free foods and diets.

Keywords: Behavior; Celiac disease; Gluten intolerance; Gluten-free diet; Knowledge; Nutrition

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Introduction

Gluten is a composite of hundreds of proteins, mainly gliadin and glutenin. These proteins are associated with each other but are also quite distinct. Gluten is the main storage protein in wheat grains, and similar storage proteins include secalin in rye and hordein in barley; these proteins are collectively referred to as gluten.¹ Gluten has been associated with many inflammatory reactions in the gastrointestinal tract that cause a variety of diseases including celiac disease (CD), non-celiac gluten sensitivity (NCGS), gluten intolerance, wheat allergy, and irritable bowel syndrome.²

The reaction to gluten varies in intensity and depends on the severity of the individual's medical condition. However, the primarily clinical symptoms experienced by many individuals are bloating, diarrhea, constipation, cramping, and a loss of appetite that may progress over time to weight loss and anemia. Moreover, affected individuals may experience psychological symptoms such as fatigue and malaise.³ These symptoms affect many populations in various age groups, and can substantially affect people's lives.

Although gluten has held significance in the food industry for many years, it has also proven useful in other industries. The chemical structure of gluten allows dough to rise during baking and confers an elastic texture, thus explaining the wide range of uses of gluten in the baking industry. Moreover, gluten is used as a stabilizing agent and flavor enhancer in many food products, including some that do not contain any grains in their ingredients, such as ice creams and cooking sauces, which are known hidden gluten sources.⁴ Bietz and Lookhart⁵ have described the non-food uses of gluten, including those in the pet food industry, which is the second largest user of gluten. Additionally, gluten is often used in cosmetics and pharmaceutical products.

In the past few years, gluten-free diets (GFDs) have become very common worldwide, mainly because of an increase in physicians' awareness of the effects of gluten on patient health.⁶ Currently, lifelong adherence to a GFD is the most effective treatment for millions of people with gluten sensitivity, and GFDs are often adopted by people trying to improve their health.⁷ Adherence to a GFD has been shown

to significantly ameliorate most clinical symptoms associated with gluten sensitivity. However, many barriers to GFD adherence exist, including cost, given that GFD food is usually very expensive; a lack of nutritional value; and the social restrictions typically faced by people following a GFD.⁶

Recently, awareness of GFDs has remarkably improved. Most people with strict adherence to a GFD have ascribed therapeutic value to the diet, and many people have associated this diet with a healthier lifestyle. The popularity of this diet is reflected in the GFD food market. From 2013 to 2015, the intake of GFD products has grown to 136%.⁸ Approximately .5% of the US population strictly adheres to a GFD.⁹ A study in 2015 has indicated that 25% of Americans consume gluten-free food.⁹ Many studies have indicated that women show better adherence to GFD than men, possibly because women are more affected by auto-immune diseases and hypersensitivity diseases.² Furthermore, a significant relationship has been observed between both educational level and socioeconomic status and GFD adherence.¹⁰

In KSA, no data have been reported regarding gluten-associated sensitivities and diseases.¹¹ However, some studies in several regions of KSA have measured the prevalence rate of CD.¹² A study conducted from 2007 to 2008 has identified the seroprevalence rate of CD among Saudi adolescents. Students were randomly selected from schools in three regions, and KSA was found to have one of the highest seroprevalence prevalence rates worldwide (2.2%).¹³ Furthermore, because CD is a chronic condition that is managed primarily by lifelong adherence to a GFD, measuring dietary adherence to GFD among Saudis is of interest. One study in children younger than 18 years has revealed that Saudi children have poor GFD adherence.¹² This poor compliance with this diet might be attributed to many factors including the limited availability of gluten-free products in many cities in KSA, particularly small cities. In addition, social and financial stress is imposed on people following a GFD and their families, thereby decreasing GFD compliance.¹²

Although GFDs have gained popularity worldwide, knowledge and information regarding behaviors toward this diet among adults in KSA are lacking. Therefore, this study was conducted to explore the knowledge of, and behaviors toward, GFDs, primarily among adults living in the KSA, and to examine the socio-demographic characteristics of followers of this diet. Additional aims were identifying the different perspectives among public attitudes and the willingness to follow GFDs, and assessing awareness regarding gluten-free food.

Materials and Methods

The study was conducted with women at a health sciences university in KSA. This cross-sectional study used a survey to collect data. The survey was developed by using a Google form, and its questions were adapted from a PhD thesis.² The sample size was calculated in Raosoft software.

The content validity of the survey was assured by using the translation and back-translation method. The questionnaire was translated from English to Arabic with the help of a bilingual (Arabic and English) linguist. In addition, a pilot study was conducted on a group of students to test the

validity of the survey questions. The Likert scale survey questions were evaluated for internal reliability with Cronbach's alpha coefficient, which was found to be 0.70, thereby indicating acceptable internal reliability. The online link to the survey, in addition to a description of the study, was sent through the university email system. The data were collected from women who provided consent to participate before filling out the survey.

The survey contained 33 questions in four parts. The first part collected information regarding participants' demographics. The second part consisted of four questions regarding participants' knowledge of GFDs. The third part consisted of seven questions about eating behaviors. The last part consisted of 12 questions designed for participants who had followed a GFD at least once in their life, to determine the frequency of consumption of gluten-free products, buying patterns, dietary changes, and perception of quality of life after following a GFD. The survey also included some questions involving Likert scale ratings and multiple choice.

Analysis plan

The data collected with the survey were analyzed in Google Sheets and JMP Pro 15.2.0. Descriptive statistics (frequencies, percentages, means, and standard deviations) were used for demographic data. Associations between following or not following a GFD at least once and the other characteristics were assessed with a T-test or ANOVA for continuous variables, and the chi-square test or Fisher exact test for categorical variables. Findings with a p -value of ≤ 0.05 were considered statistically significant.

Results

A total of 352 women at a health sciences university with three campuses in three cities in KSA agreed to participate in the study. Only 39 women (11% of the participants) indicated having followed a GFD at least once. Demographic and other characteristics of the women who followed or did not follow this diet are shown in [Table 1](#).

Herein, GFDp is used to denote female participants who had followed a GFD at least once, and nonGFDp is used to denote female participants who had not followed a GFD.

As shown in [Table 1](#), following a GFD was associated with an age of 25 years or older, being employed, and having a high education level. In addition, participants who lived alone were more likely to follow a GFD.

The main source of information about GFDs was internet news/social media (GFDp = 95%, nonGFDp = 61%, $p < .0001$). The second source of information was a medical physician or a health care provider (GFDp = 26%, nonGFDp = 22%, $p = .236$). Family or friends were the third main information source (GFDp = 23%, nonGFDp = 19%, $p = .505$). However, a considerable number of participants in the nonGFDp group indicated that they did not receive any information about GFDs (nonGFDp = 33%, GFDp = 0%, $p < .0001$; faculty = 10%, staff = 13%, student = 77%).

Most participants indicated that they brought their food from their homes to the university. However, this percentage

was significantly higher in GFDp (GFDp = 82%, nonGFDp = 59%, $P = .0049$).

As shown in [Table 1](#), GFDp were more likely to follow other diets in addition to a GFD (GFDp = 79%, nonGFDp = 35%, $p < .0001$). GFDp, compared with nonGFDp, showed a significant association with trying low sugar, vegetarian, and/or weight watcher diets.

When choosing a food product, GFDp considered all food label information more important than nonGFDp. However, only the mean differences regarding ingredients, calories, and gluten-free descriptors were statistically significant, with $p < .05$ ([Table 2](#)).

Analysis of grocery shopping locations indicated that GFDp showed a significant association with buying from natural/health food stores (36% vs 14%, $P = .0007$). However, GFDp were less likely than nonGFDp to buy from convenience stores (21% vs 37%, $P = .0379$) or national stores (41% vs 62%, $P = .0106$).

The main reasons for following a GFD were feeling better when eating gluten-free, weight loss, and self-diagnosis on the basis of symptoms ([Figure 1](#)). Furthermore, 40% ($n = 17$) of the participants indicated having medical conditions, such as diagnosis with CD, gluten sensitivity, and/or wheat allergy. However, 7 of those 17 participants indicated that they had diagnosed themselves according to their symptoms. This finding suggested that approximately 70% of the participants were following a GFD voluntarily and not because of confirmed medical conditions.

Analysis of the frequency of following a GFD ([Figure 2](#)) indicated that 31% of GFDp had tried a GFD only once, whereas more than half the GFDp followed a GFD 75% or more of the time. In addition, 88% of GFDp with gluten sensitivity and 100% of GFDp with wheat allergy followed the diet strictly, whereas 60% of GFDp with CD had tried a GFD only once. However, the main reason for strictly following the diet 100% of the time was self-diagnosis according to symptoms. Feeling better when following a GFD was the main reason for following a GFD 50% or more of the time. In contrast, weight loss was the main reason for trying a GFD once.

The results also indicated that GFDp had a more negative perception than nonGFDp of consuming wheat and gluten. Regarding wheat, GFDp ($M = 2.56$, $SD = 1.23$) rated the wholesomeness of wheat lower than nonGFDp ($M = 3.57$, $SD = .0.9$) with $p < .0001$. Furthermore, GFDp ($M = 1.95$, $SD = 1.5$) indicated that gluten is worse than indicated by nonGFDp ($M = 3.02$, $SD = .83$) with $p < 0.0001$.

The gluten knowledge score was calculated on the basis of choosing the correct definition of gluten in one question and indicating all products containing gluten in another question.² The maximum score that a participant could receive was 33. Comparison of knowledge scores between GFDp and nonGFDp indicated that the former ($M = 21.38$, $SD = 5.57$) had a significantly higher mean knowledge score than the latter ($M = 18.68$, $SD = 4.40$; $P = .0055$). The mean knowledge score was higher in GFDp with higher adherence levels ([Figure 3](#)); however, the differences between groups were not statistically significant ($P = 0.438$), perhaps because of the small sample size.

Examination of the frequencies of purchasing GFD food revealed a similar pattern to the adherence levels to the GFD ([Figure 4](#)). The main factors that promoted purchasing of

Table 1: Characteristics and demographics of the female participants.

Characteristics	All		Have you ever tried a gluten-free diet?				P value
			No (nonGFDp)		Yes (GFDp)		
	N	%	N	%	N	%	
	352	100	313	100	39	100	
Age (years)							
18–24	209	59.38%	195	62.30%	14	35.90%	.0160*
25–34	70	19.89%	59	18.85%	11	28.21%	
35–44	46	13.07%	37	11.82%	9	23.08%	
45–54	21	5.97%	18	5.75%	3	7.69%	
55–65	6	1.70%	4	1.28%	2	5.13%	
Nationality							
Saudi	313	88.92%	279	89.14%	34	87.18%	.7185
Non-Saudi	39	11.08%	34	10.86%	5	12.82%	
Region							
Riyadh	157	44.60%	140	44.73%	17	43.59%	.7986
Al-Ahsa	119	33.81%	107	34.19%	12	30.77%	
Jeddah	76	21.59%	66	21.09%	10	25.64%	
Education							
High school diploma or equivalent GED	35	9.94%	35	11.18%	0	.00%	<.0001
College student	159	45.17%	147	46.96%	12	30.77%	
Bachelor's degree	73	20.74%	67	21.41%	6	15.38%	
Master's degree	46	13.07%	32	10.22%	14	35.90%	
Doctorate	32	9.09%	28	8.95%	4	10.26%	
Professional degree	7	1.99%	4	1.28%	3	7.69%	
Employment							
Student	226	64.20%	210	67.09%	16	41.03%	.0150*
Faculty	62	17.61%	50	15.97%	12	30.77%	
Staff	57	16.19%	47	15.02%	10	25.64%	
Joint appointment	7	1.99%	6	1.92%	1	2.56%	
On-campus housing	37	10.51%	31	9.90%	6	15.38%	.2927
Living alone	20	5.68%	15	4.79%	5	12.82%	.0411*
Bringing food from home	216	61.36%	184	58.79%	32	82.05%	.0049*
GFD source of information							
Medical doctor/health care professional	81	23.01%	69	22.04%	12	30.77%	.2222
Internet with news and social media	227	64.49%	190	60.70%	37	94.87%	<.0001*
Friends	67	19.03%	58	18.53%	9	23.08%	.4952
I did not get any information	104	29.83%	104	33.23%	0	.0%	<.0001*
Grocery shopping locations							
National stores	211	59.94%	195	62.30%	16	41.03%	.0106*
Convenience stores	125	35.51%	117	37.38%	8	20.51%	.0379*
Health food stores	59	16.76%	45	14.38%	14	35.90%	.0007*
Farmer's markets	59	16.76%	50	15.97%	9	23.08%	.2628
International stores	286	81.25%	253	80.83%	33	84.62%	.5680
Other diets							
Low-fat diet	80	22.73%	69	22.04%	11	28.21%	.3867
Low-sugar diet	87	24.72%	68	21.73%	19	48.72%	.0002*
Vegetarian	24	6.82%	16	5.11%	8	20.51%	.0003*
Weight Watchers	45	12.78%	34	10.86%	11	28.21%	.0022*
Atkins	45	12.78%	38	12.14%	7	17.95%	.3057

Table 2: Importance of food labels for GFDp and nonGFDp

	GFDp (39) mean	SD	NonGFDp (313) mean	SD	p-value
Calories	4.44	.75	3.86	1.2	.0037 *
Ingredient	4.67	.7	4.04	.99	.0002 *
Health	4.26	.97	4.05	1.01	.2371
Gluten-free	3.85	1.16	2.38	1.18	.0001 *

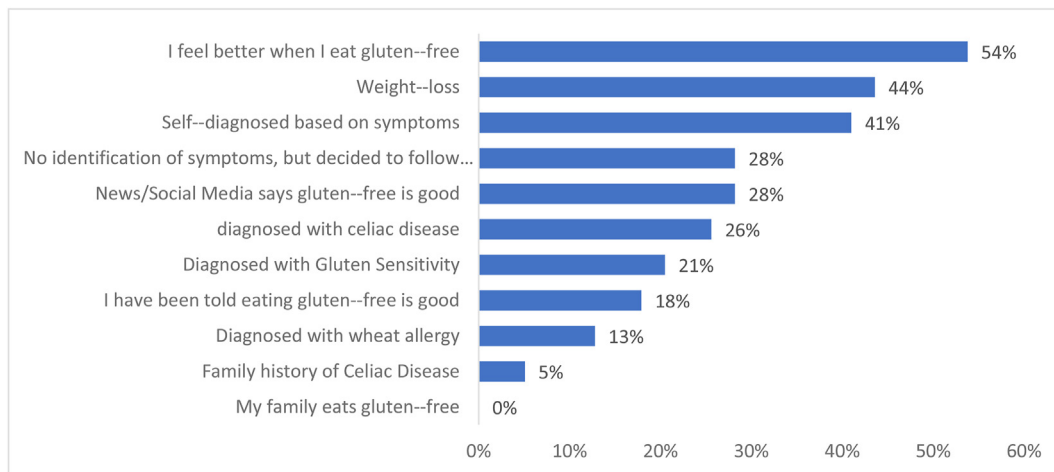


Figure 1: Reasons for following a gluten-free diet.

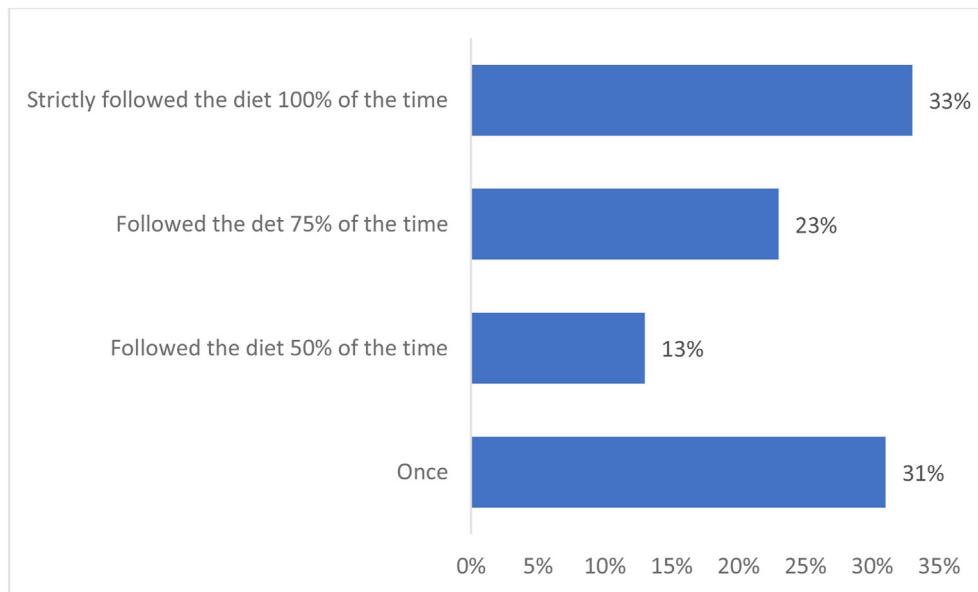


Figure 2: Frequency of following a gluten-free diet.

gluten-free products by GFDp were health and nutrient values ($n = 18$, 46%), food intolerance or allergies ($n = 15$, 38%), and quality ($n = 13$, 33%; [Figure 5](#)). Product cost was also a factor indicated by GFDp ($n = 8$, 21%).

Food intolerance and allergies were the main reasons for strictly buying GF products. However, GFDp who purchased gluten-free products 50%–75% of the time considered health and nutrient values as the main factor. In contrast, quality and cost were the main factors considered by the groups who rarely or never purchased gluten-free products.

The calculated score of total adherence to GFD was based on four questions.² The maximum score that a participant could receive was 11, indicating total adherence. However, only one GFDp had a score of 11, and the mean adherence score for GFD followers was 2, indicating low adherence.

The results also indicated that following a GFD affected the consumption of different food groups ([Figure 6](#)). A

decrease in consumption of various foods, such as carbohydrates, sweets or candy, dairy, and fat, was observed. However, some participants indicated an increase in fruit and vegetable or protein intake in their diet.

A total of 95% of GFDp indicated that following a GFD affected their lifestyle and social life, whereas only 5% reported no changes in their lives. A high level of lifestyle and social life change was more likely among participants with higher adherence to a GFD ([Table 3](#)).

Approximately 28% of GFDp felt embarrassed to ask for gluten-free food in restaurants or gatherings. In addition, 5% of GFDp did not indicate this feeling explicitly, but their responses suggested embarrassment. One participant indicated a lack of awareness regarding GFDs in some food locations or even in social gatherings, stating that when she asked about gluten-free food, many people thought that she wanted free food. Another participant indicated that she never asked for gluten-free food, and she eats a small amount

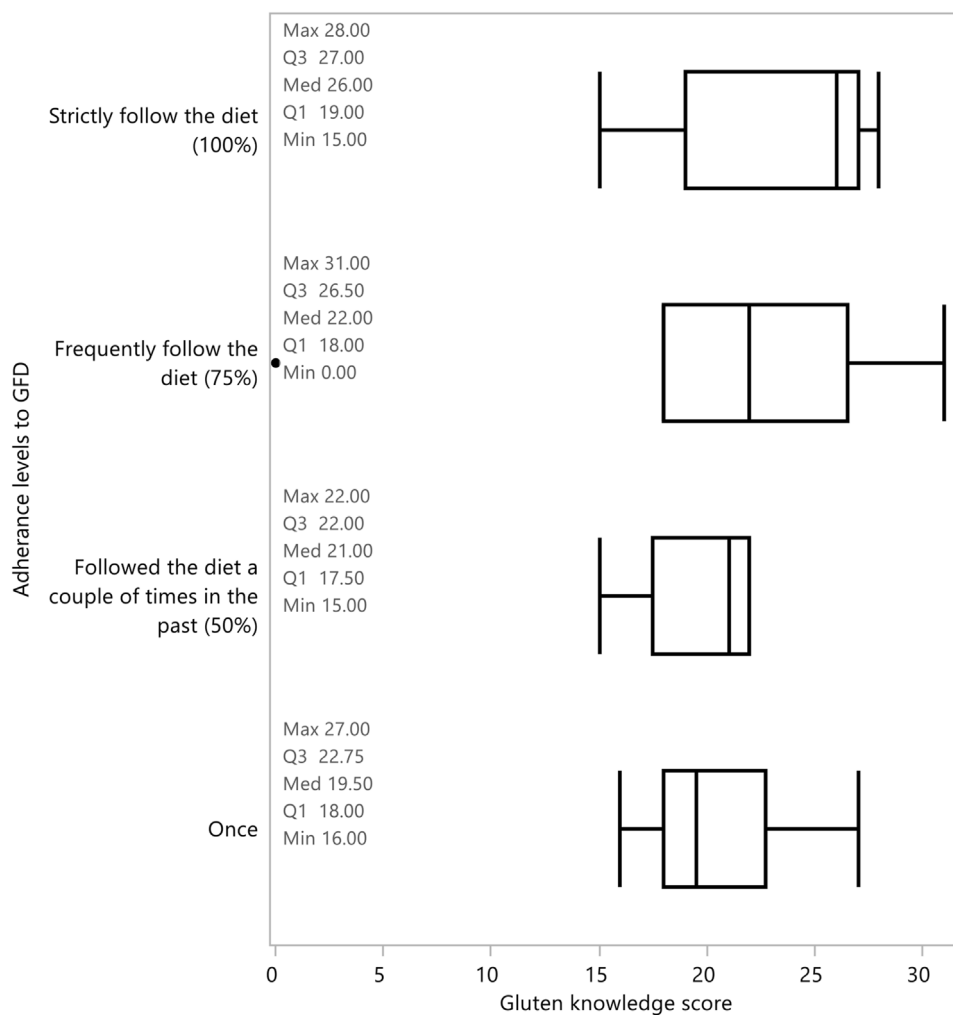


Figure 3: Gluten knowledge scores among GFDp, according to dietary adherence.

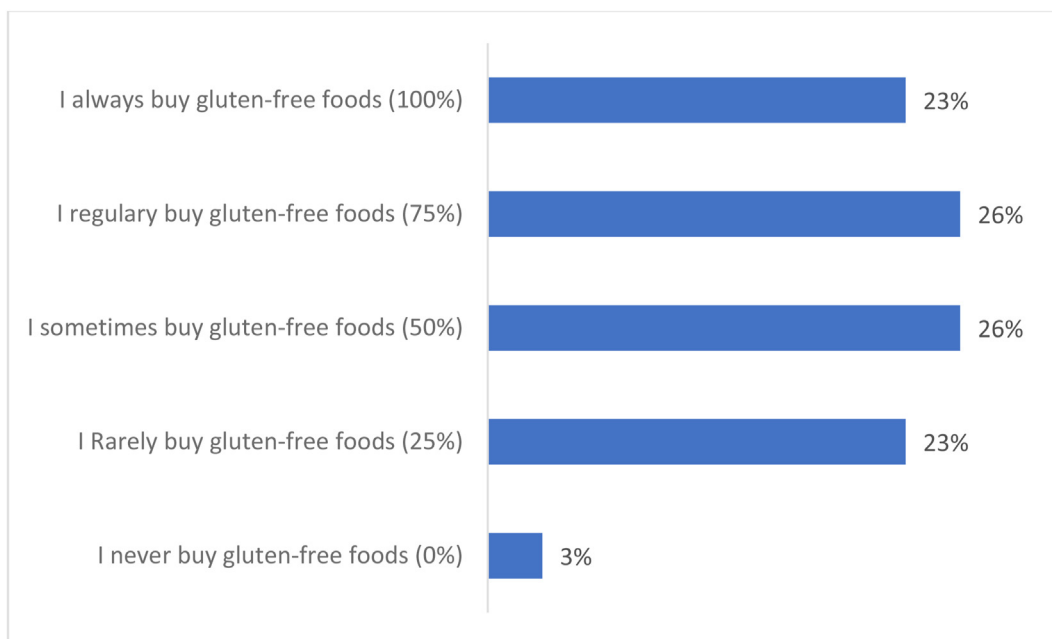


Figure 4: Frequencies of purchasing gluten-free foods.

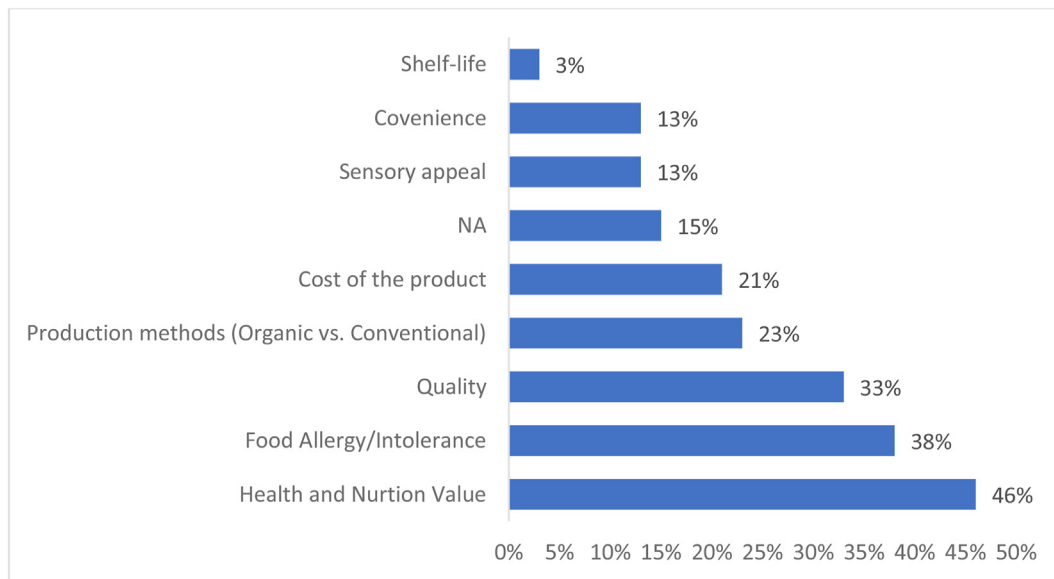


Figure 5: Factors promoting purchase of gluten-free products.

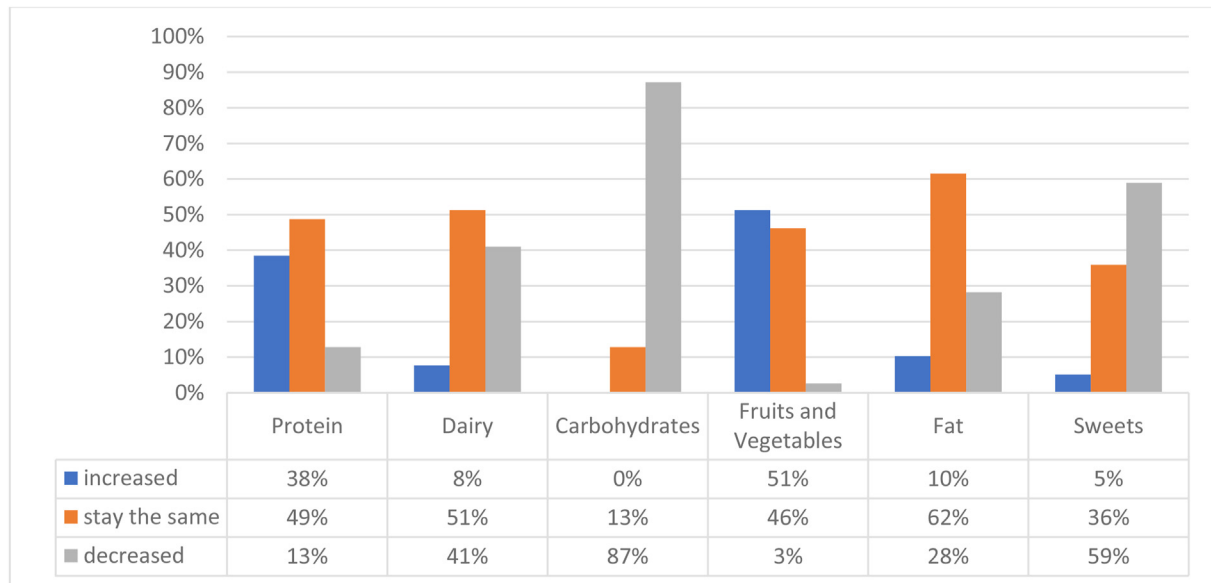


Figure 6: Change in consumption of food groups after following a gluten-free diet.

of food that she knows contains gluten if necessary outside her home. However, most GFDp (67%, $n = 26$) indicated that they were not embarrassed.

A total of 71.8% of GFDp felt better after following a GFD than their previous diets, whereas 2.6% felt worse. The remaining 25.6% of participants did not observe an apparent change. A total of 80%, 70%, and 50% of GFDp with wheat allergy, gluten sensitivity, and/or CD, respectively, felt better after trying a GFD. The remaining participants felt the same, except for 10% of GFDp with CD, who felt worse. Participants with higher adherence to a GFD felt better after following the diet, whereas only 11% of GFDp following the diet 75% of the time felt worse (Table 3).

For scoring quality of life in GFDp, we used three questions from the survey.² The maximum score that a

participant could receive was 3, suggesting a poor quality of life. The mean quality of life score for GFDp was 1.31 from a maximum score of 3, thus indicating a good quality of life on average. The mean quality of life scores were 1.5 and 1.1 among participants who followed a GFD 75% of the time or more, and 50% of the time or less, respectively. However, this difference was not statistically significant ($p = 0.0901$).

Table 4 shows the differences between GFDp who followed the diet voluntarily or because of confirmed medical conditions, in terms of mean gluten knowledge scores, dietary adherence, and quality of life. Although no significant statistical differences were found, the findings suggested higher knowledge and GFD adherence among participants with confirmed medical conditions.

Table 3: Changes in social life and feelings by adherence to a gluten-free diet.

	Adherence levels to GFD			
	Once	50% of the time	75% of the time	100% of the time
GFD effect on followers' social life				
Never	8%	0%	11%	0%
Rarely	25%	60%	0%	0%
Sometimes	17%	40%	11%	38%
Often	42%	0%	44%	15%
Always	8%	0%	33%	46%
Feelings after following GFD				
Worse	0%	0%	11%	0%
The same	42%	40%	11%	15%
Better	58%	60%	78%	85%

Table 4: Differences among GFDp according to reasons for following a gluten-free diet.

Variable	Confirmed medical condition (N = 10)	Voluntary (N = 29)	P-value
Knowledge of gluten and its products	M = 23.3, sd = 4.37	M = 20.7, sd = 5.85	.1578
Calculated adherence score	M = 3, sd = 4.03	M = 1.8, sd = 2.77	.3839
Calculated quality of life score	M = 1.6, sd = .52	M = 1.21, sd = .62	.0641

Discussion

Recently, the popularity of GFDs has greatly increased. Beyond people with CD and NCGS, many people are embracing GFDs without having a medically confirmed condition.¹⁴ The reasons for following a GFD remain under investigation. The current study was aimed at filling this knowledge gap by assessing women' awareness of, and attitudes toward, GFDs, as well as understanding the demographics and characteristics of people following GFDs. The results indicated that 11% of participants had followed a GFD at least once. However, approximately 70% of the GFD followers had followed the diet voluntarily rather than because of a medical condition confirmed by health professionals.

Comparison of the characteristics between GFD followers and non-followers indicated that following a GFD was strongly influenced by age, education level, and employment status. The highest percentage of followers were 25 years old or older. The followers had high educational levels, such as master's or doctorate degrees. In addition, the majority were faculty and staff at the university. A previous study has indicated that high socioeconomic levels are significantly associated with greater adherence to a GFD. Gluten-free food can be expensive and inaccessible in national grocery stores in KSA, particularly for people who live in non-central regions.¹⁵ Furthermore, in our study, participants living alone were more likely to follow a GFD. This result might be explained by increased self-efficacy and the absence of social pressure to follow a GFD. Our study also indicated that GFDp showed an association with bringing food from their homes. This finding correlates with those from a previous study indicating that GFD followers who prepare their food can decrease the risk of gluten contamination.¹⁶ Nonetheless, the availability of gluten-free products on campus is limited.

The main source of information about GFD was the internet and social media. Indeed, multiple researchers have found that media have influenced many individuals to try a

GFD.¹⁴ The second source of information about GFDs was medical physicians and health care professionals. This finding might be attributable to this study having been conducted in a health professions university, where the students and staff might have above-average knowledge in this area. The third source was family and friends, who were found to have substantial influence. Xhakollari et al.¹⁷ have categorized followers of a GFD into various subgroups. One of these subgroups included participants with a family member with CD who followed a GFD, to prevent the risk of cross-contamination in the home. In addition, this disease can be inherited.

Most GFDp preferred to purchase their groceries from international supermarkets. This finding might have been due to the limited availability of gluten-free products in national groceries in KSA.¹⁵ International supermarkets usually dedicate an entire section to gluten-free products and snacks, thus providing consumers with a variety of options to suit their tastes and budgets. The same applied to shopping at health food stores, which showed a significant association with GFDp in our study.

Previous studies have shown that reading food labels can be challenging, particularly for consumers who have newly started a GFD. Consumers have reported many difficulties in tracing small amounts of gluten that are not listed as an ingredient or in gluten-free grains that are often cross-contaminated.¹⁸ Our findings indicated that GFDp paid great consideration to food labels, particularly in terms of ingredients, calories, and gluten-free descriptors.

To our knowledge, few studies have investigated the reasons for following a GFD in KSA. A previous study has stated that some factors encouraging GFD adherence include weight loss, digestive health, and better skin appearance. However, these beliefs have not been scientifically demonstrated, mainly among individuals without any type of gluten sensitivity.¹⁴ Our findings were similar to those reported earlier. A high percentage of GFDp stated that they feel better after eating gluten-free food. However, other participants acknowledged that they followed a GFD to lose weight; this belief might have

been because gluten is associated primarily with wheat products, which are high in carbohydrates, and decreasing daily carbohydrate consumption might influence weight. However, gluten-free products are known to have lower nutritional value than gluten-containing products. Therefore, for non-gluten-sensitive individuals, strict adherence to a GFD may cause nutrient deficiencies.¹⁴ In addition, some GFDp indicated that they had diagnosed themselves according to their symptoms and consequently decided to follow a GFD. Without a confirmed medical diagnosis based on blood tests and a biopsy from the small intestine, there is no way to know whether symptoms are associated with CD or a type of gluten or wheat sensitivity. However, such knowledge was greatly associated with the degree of GFD adherence.

Following a GFD can be an active process that requires continuous evaluation and knowledge of gluten and gluten-free products¹⁹; this process is necessary to avoid consumption of hidden gluten and cross-contaminated products. Our results indicated that GFDp scored higher in their knowledge of gluten and its products than nonGFDp. This finding is consistent with those from a previous study showing that students with higher knowledge of gluten and its products were more willing to try a GFD.¹⁰ In addition, this result correlated with our previous finding that most GFDp voluntarily sought to be healthier or in shape, and therefore they educated themselves by using the internet and social media. Although complex products that contain many ingredients can be challenging to identify correctly, these obstacles are usually overcome over time, as GFDp develop the necessary skills to identify suitable foods for their diet.

Comparison of the frequency of buying gluten-free products to GFD adherence levels revealed three groups. The first group consisted of GFDp who always purchased gluten-free products. Their main reason for buying gluten-free food was food intolerance and allergies. Thus, their adherence level was higher than those in the other groups. The second group included GFDp who purchased gluten-free products 50%–75% of the time. The health and nutritional values of the products were their main reasons for purchase; however, their GFD adherence was considered moderate. The third group of GFDp consisted of GFD followers who rarely purchased gluten-free products. Cost was indicated as the main factor preventing this group from purchasing; consequently, their adherence level was considered low. In 2021, a study in KSA linked socioeconomic status and GFD adherence: low income was strongly associated with poor GFD adherence.¹⁵

Analysis of the attitudes among GFDp, and how their consumption of different food groups was affected, indicated decreased consumption of carbohydrates, dairy, and fat, but increased consumption of fruits, vegetables, and protein after following a GFD. Similarly, Arslain et al.¹⁴ have found a positive relationship between following a GFD and having healthier eating habits. They have noted that GFD followers, compared with non-followers, consume more servings of fruits and vegetables per day, and avoid sodium, fats, and sugar.

Social life can greatly affect GFD adherence. Herein, 95% of the participants indicated that following a GFD influenced their lifestyle, particularly their social life. In several

studies, the GFDp highlighted some of the restrictions that they experienced in their social lives after following a GFD, such as avoiding eating out, travel, and even accepting invitations.^{15,18} One participant described a similar situation, in which she asked for gluten-free food and was thought to have been asking for free food, thus making her feel uncomfortable. This finding highlights insufficient awareness of GFDs in the general population. In contrast, 67% (n = 26) of the GFDp reported that they did not feel embarrassed asking for gluten-free food when they ate out.

The quality of life of GFDp is an important aspect in assessing the success of the diet. In this study, 71% of GFDp indicated feeling better after following the diet. This outcome was confirmed by most participants with a wheat allergy, gluten sensitivity, or CD. Following a GFD substantially alleviates most gastrointestinal symptoms and also may prevent long-term effects in people with these conditions. Consequently, they feel better and are more functional in their lives. Mustalahti et al.²⁰ have reported that following a GFD is strongly associated with enhanced quality of life among patients with CD. Likewise, a study in 2015 has revealed that patients who followed a GFD had lower depression scores than patients who did not follow a GFD.²¹

Limitations

This study has several limitations that should be considered. First, this study included participants at three campuses of a health science university located in the main regions of KSA. Thus, the participants had substantial access to gluten-free products. However, a previous study has reported limited availability of gluten-free products in non-central regions in KSA, thereby potentially influencing the dietary adherence.¹⁵ Second, the use of self-reported questionnaires should ideally be combined with a dietitian's assessment and serology testing to enable valid measurement of GFD adherence. Third, this study reports only women's knowledge and attitudes toward GFDs; therefore, further studies should consider both genders. Finally, for the GFDp who diagnosed themselves according to symptoms, these symptoms were not clinically investigated; this aspect can be considered a study limitation, because the severity of these symptoms might have affected dietary adherence.

Conclusion

In this current study, only 11% of the female participants had followed a GFD at least once. Their knowledge regarding gluten and its products was moderate; however, the calculated adherence score was low. Most followers did not have a confirmed medical condition. For those individuals, consultation with a health provider is important before strictly engaging in a health behavior that might have negative consequences on their health. Further research is needed, particularly regarding the attitudes and behaviors toward GFDs, to identify factors that may enhance adherence, and consequently improve patient quality of life, protect against symptom progression, and decrease the costs of medical treatment. Furthermore, educational and behavioral programs should be introduced to the public to promote awareness of gluten-free foods and diets.

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Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

This study was approved by the Institutional Review Board of the university, reference No.:RA19.005.A, Date: 12 March 2019.

Consent to participate

All participants were presented with a consent form before filling the survey and were required to fill out the form if they chose to participate in the study.

Consent for publication

Not applicable.

Authors' contributions

FMK: Conceptualization, supervision, writing—original draft preparation, and writing—reviewing and editing. **FAA:** Methodology, formal analysis, visualization, and writing—reviewing and editing. **WMS:** Data collection with form preparation, and writing—reviewing and editing. **SSH:** Data collection with form preparation, and writing—reviewing and editing. **CA:** Writing—reviewing and editing. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

Availability of data and materials

The data will be available upon request.

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