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2007

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# Economic burden of a gluten-free diet

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The authors declare that they have no conflict of interests.

## Keywords

celiac disease, cost burden, gluten-free diet.

## Introduction

Coeliac disease is a chronic inflammatory small intestinal disease occurring in genetically predisposed individuals because of an immune response to gluten. (Alaedini & Green, 2005) Gluten is the term for the storage proteins found in wheat, barley and rye. Coeliac disease is considered to

affect 1% of the population, though in the USA, the majority is currently undiagnosed (Fasano *et al.*, 2003; James, 2005). The only therapy of coeliac disease is dietary, a gluten-free diet.

Individuals with coeliac disease consume several types of gluten-free products. These products fall into the categories of naturally occurring gluten-free foods (fruits, vegetables, and unprocessed

## Abstract

**Background** Coeliac disease is a common, autoimmune disorder, for which the only treatment is lifelong adherence to a gluten-free diet. This study evaluates the economic burden of adhering to a gluten-free diet.

**Methods** A market basket of products identified by name brand, weight or package size for both regular wheat-based products and gluten-free counterparts was developed. The differences in price between purchase venues, both type of store (general grocery store, an upscale grocery store and a health food store and four internet-based grocery sites) and region was also analysed.

**Results** Availability of gluten-free products varied between the different venues, regular grocery stores carried 36%, while upscale markets carried 41%, and health food stores 94%, compared with 100% availability on the internet. Overall, every gluten-free product was more expensive than their wheat-based counterpart ( $P \leq 0.05$ ). Bread and pasta was twice as expensive as their wheat-based counterparts. Cost was affected more by shopping venue than geographic location.

**Conclusions** This study demonstrated that gluten-free foods have poor availability and are more expensive than their gluten-containing counterparts. The impact of these findings on dietary compliance and the quality of life needs to be addressed.

meat, fish and poultry) and gluten-free substitute foods (pasta, bread, cereals, crackers and snack foods) in which wheat flour is replaced by gluten-free flours. The latter are purchased at general and specialty food stores as well as via the internet.

The economic burden of adhering to a gluten-free diet in the USA is unknown. To explore the economic impact of a gluten-free diet, a cost survey was performed involving different gluten-free foods purchased in different regions of the USA.

## Method

A 'market basket' was developed of products (regular wheat-based and their gluten-free counterparts) identified by specific brand, weight or package size for both regular, wheat-based products and the gluten-free counterpart to evaluate the cost difference between the products. The market basket is a package of goods and services that consumers purchase for day-to-day living. The weight of each item was based on the amount of expenditure reported by a sample of households. The study market basket was compared with the United States Department of Agriculture (USDA) Economic Research Service food consumption pattern (Blisard, 2001). The USDA research on food consumption patterns reflect the broad spectrum of foods consumed as well as the distribution and production practices (Blisard, 2001). The food and beverage portion of the market basket used by the United States Department of Labor, Bureau of Labor statistics includes breakfast cereal, milk, coffee, chicken, wine, service meals and snacks (US Department of Labor, 2004, 2005).

The study 'market basket' focused on the foods that would necessitate a gluten-free substitute, such as pasta, bread, crackers, cereal, waffles, cookies, pretzels, pizza, macaroni and cheese, and cake. The list contained both basic staples such as bread and pasta, as well as snack foods including pretzels and crackers. The market basket also included some ready made or convenience-type foods like pizza, frozen macaroni and cheese and prebaked muffins and cake these would be similar to the 'service-type' foods used in the USDA market basket. The products were selected as

representative of a market basket modified for a gluten-free diet. The differences in price were also analysed between places of purchase, both type of store (the stores included in each region: a local grocery store, an upscale grocery store or regional small chain and a health food store. The internet was also included as a nationally available source of gluten-free products. Four different on-line sites were included (gluten solutions.com, kinnickinnick.com, fresh direct and pea pod). In addition, the regions within the USA were compared. To assess regional differences, stores were surveyed in five different states: New York (New York City and Westchester County), Oregon (Portland), Georgia (Atlanta), South Dakota (Rapid City) and (Illinois) Chicago. The availability and prices of the stores were obtained by store visitation. Where available, three samples were obtained from each store category. In some regions (South Dakota), there was limited availability in each store category. The price comparisons are reported in price per ounce for comparative purposes.

## Statistical methods

The data was compiled from each region and venue. The raw cost was broken down into per ounce cost for comparison. Data was analysed and compiled into means and students *t*-test.

## Results

### Availability of products

The availability of gluten-free products varied between the shopping venues. In comparison, the regular wheat-based market basket items were available in all venues and in all regions. The on-line sites and the health food stores carried the largest selection of gluten-free products, while the other stores carried 0–83% of our gluten-free market basket (Table 1, Fig. 1). The internet sites carried 100%; health food stores 94%, upscale grocery 42% and grocery stores 36% of the study market basket (Fig. 1). Regular grocery stores in all five locations were missing at least 2–3 gluten-free products from the study market basket. As seen in Table 1 there were differences in

**Table 1** The availability and cost of gluten-free products across USA region and venue

Food	New York			Atlanta			Chicago			South Dakota			Portland			
	Regular	Health	Upscale	Regular	Health	Upscale	Regular	Health	Upscale	Regular	Health	Upscale	Regular	Health	Upscale	Internet
Bread	NA	0.18	0.17	NA	0.29	0.21	NA	0.19	0.15	0.24	0.23	0.24	0.25	0.25	0.24	0.23
Muffin	NA	NA	0.39	NA	NA	NA	NA	0.23	0.22	NA	0.28	NA	NA	0.25	NA	0.57
Cereal	0.29	0.33	0.33	NA	NA	0.31	0.29	0.33	0.31	0.33	0.34	0.33	0.31	0.29	NA	0.27
Waffle	0.39	0.37	0.25	NA	0.38	0.33	NA	NA	0.27	0.38	0.27	0.38	0.37	0.30	NA	0.42
Crackers	0.89	0.68	0.54	NA	0.63	NA	NA	1.83	NA	NA	0.50	0.48	0.40	0.44	NA	0.75
Cookies	NA	0.51	0.41	NA	0.42	NA	NA	0.42	0.50	0.68	0.84	0.68	0.77	0.08	NA	0.48
Pretzels	NA	0.44	0.37	NA	0.68	NA	NA	NA	NA	NA	0.31	0.71	0.64	NA	NA	1.09
Pasta	0.18	0.19	0.17	NA	0.32	NA	NA	0.23	0.22	0.27	0.40	0.27	0.34	0.27	NA	0.27
Pizza	NA	0.60	0.52	NA	NA	0.34	NA	NA	0.56	NA	0.64	NA	NA	0.52	NA	0.38
Macaroni and cheese	NA	0.33	0.28	NA	NA	0.35	NA	0.45	0.30	NA	0.28	NA	0.32	0.33	NA	0.42
Cake	NA	NA	0.67	NA	NA	NA	NA	NA	0.64	NA	0.44	NA	0.32	0.42	NA	0.49

The exchange rate at the time of the survey ranged from 1.7507 to 1.7944 with an average rate of 1.77255 US dollars to British pounds. Price is expressed as dollar per ounce. NA, not available.

availability among the type of stores as well as across the regions. For example, there were no gluten-free products available in the regular grocery store in Atlanta. Whereas in Portland there were many products available in the regular grocery store and the health food store and virtually none in the upscale store. The region with the greatest availability in all types of venues was New York. Most notably missing in all venues and regions were the prepared products such as gluten-free muffins, pizza, macaroni and cheese and bread.

### Cost of products

#### *Place of purchase*

**Venue:** When place of purchase were compared it was found that generally the health food stores were more expensive (mean \$0.43 ± 0.18) than the regular grocery store (mean \$0.32 ± 0.15) or the upscale markets (\$0.38 ± 0.15) for the gluten-free products (Table 2). The gluten-free products were generally 123% more expensive in the health food store.

The internet was the most expensive venue (\$0.49 ± 0.26) for gluten-free products. However, these findings were not statistically significant because of small sample size; four internet sites and four types of stores. In examining the specific items, pretzels, cookies, and crackers displayed the largest price variations between venues. For example, pretzels were \$1.09 per ounce on the internet and only \$0.37 per ounce in an upscale market. While the price for pasta was fairly consistent \$0.27 on the internet and \$0.20 in the upscale market. Each type of product was more expensive on line compared with the other venues. The exchange rate at the time of the survey ranged from 1.7507 to 1.7944 with an average rate of 1.77255 US dollars to British pounds. This further demonstrates the added cost of gluten-free products in the USA compared with the UK.

**Geographic location:** Geographic location between the states studied did not affect the cost comparisons of gluten-free products as markedly as venue except for bread and pasta. Interestingly, although the prices did not vary greatly between regions, availability did. Fresh and ready-made



**Figure 1** Availability of gluten-free products according to venue: the bars represent the mean of all products for all the regions analysed (Table 1).

**Table 2** Comparison of cost of gluten-free products across venue in price per ounce

Gluten-free products	Grocery	Health food	Upscale	Internet	Standard deviation
Bread	0.19	0.24	0.18	0.23	0.0294
Muffin	NA	0.31	0.38	0.57	0.1345
Cereal	0.32	0.33	0.31	0.27	0.0263
Waffle	0.27	0.28	0.26	0.42	0.0754
Crackers	0.46	0.73	0.54	0.75	0.1426
Cookies	0.2	0.4	0.46	0.48	0.1279
Pretzels	0.64	0.59	0.37	1.09	0.3020
Pasta	0.22	0.25	0.2	0.27	0.0311
Pizza	NA	0.6	0.54	0.38	0.1137
Macaroni and cheese	0.28	0.33	0.29	0.42	0.0638
Cake	NA	0.66	0.64	0.49	0.0929
Mean	0.3225	0.4290909	0.379091	0.4881818	0.0707
Standard deviation	0.1546193	0.1799141	0.15003	0.2609811	
Standard deviation between the mean of all 4 groups	0.0707				

gluten-free muffins and cakes were not available even in the health food store or upscale market in either the Portland or Rapid City areas. The only products that were statistically different across regions were bread and pasta, largely because of the lack of availability of the other products for comparison.

#### *Cost of gluten-free foods*

Every gluten-free product was more expensive than their wheat-based counterparts (Table 3). Generally the gluten-free products were more costly by 240%. The increase in cost varied for the different food types (Fig. 2). Interestingly, cereal and cake prices were the only products not statistically significant in price difference between gluten-free and regular products. The highest cost difference was between regular and gluten-free pasta. The gluten-free pasta was two times the

**Table 3** National comparison of regular and gluten-free products

	Regular	Gluten free	P-value
Bread (price/oz)	0.15	0.23	0.00
Cereal (price/oz)	0.32	0.35	0.27
Waffles (price/oz)	0.27	0.35	0.05
Crackers (price/oz)	0.36	0.78	0.00
Cookies (price/oz)	0.34	0.51	0.00
Pretzels (price/oz)	0.34	0.77	0.01
Pasta (price/oz)	0.11	0.24	0.00
Pizza (price/oz)	0.33	0.55	0.00
Macaroni and cheese (price/oz)	0.25	0.34	0.01
Cake (price/oz)	0.31	0.86	0.12

Significant at a 5% confidence interval excluding cereal and cake.

price of the wheat-based pasta. The type of gluten-free products that were markedly more expensive was the snack foods, for example pretzels, crackers and cookies (Table 3).

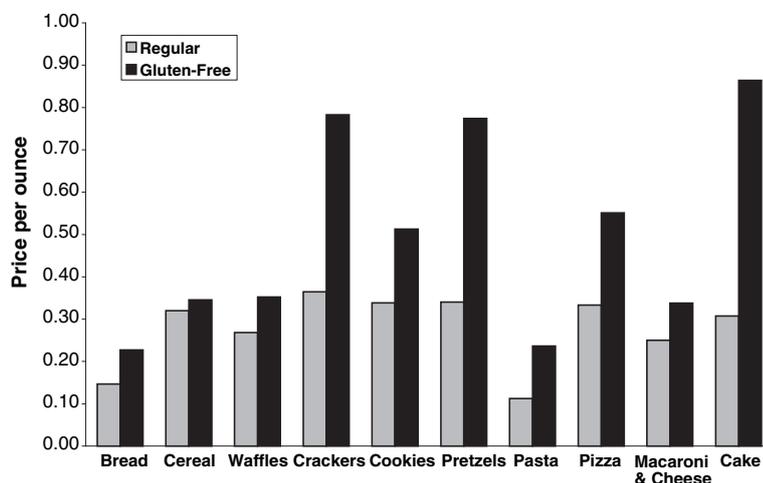


Figure 2 Comparison of regular and gluten-free products: the values are mean of price per ounce of all venues in all regions.

## Discussion

To date there have not been any studies evaluating the cost of gluten-free foods or maintaining a gluten-free diet. Cost studies on a healthy diet have been done in the USA, France and the UK. These studies focused on the cost of a healthy diet and the relationship to obesity (Cade *et al.*, 1999; Raynor *et al.*, 2002; Drewnowski *et al.*, 2004). In each of these studies it was found that the cost of fruits, vegetables and nonprocessed foods accounted for the increased (Cade *et al.*, 1999) cost of the healthy diet. In the second study, it was found that diets high in fats and sweets represented a lower-cost diet (Drewnowski *et al.*, 2004). Consumption of fruits, vegetables and meats were associated with a higher-cost diet (Drewnowski *et al.*, 2004). A gluten-free diet tends to include more fruits, vegetables and meats, as these products are naturally gluten-free and more readily available than some gluten-free products. The added cost of the purchases of meat, fruit or vegetables as part of the gluten-free diet was not assessed in this study. However, this study demonstrated firstly, that the availability of packaged gluten-free foods is limited. Not all regular grocery stores carry gluten-free products. This forces patients to purchase gluten-free products at either specialty stores or via the internet. In addition, it was determined that overall gluten-free products

are far more expensive than their regular gluten-containing products, at a rate of 2–3 times.

The availability of gluten-free products across regions within the USA was somewhat predictable with the two northern coastal cities of New York and Portland offering the widest variety of products. Chicago and Atlanta had a more limited offering of gluten-free products. In contrast to the limited availability of gluten-free products in the USA, markets in the UK tend to offer a wider variety of gluten-free products.

When comparing the place of purchase of gluten-free products, it was found that the cost of the products also varied with the place of purchase. The internet, which has the greatest variety of products, is also the most expensive. Health food stores were more expensive than the general grocery store and the upscale markets. The regular grocery store was the least expensive but usually had the most limited variety. Although four venues were surveyed the descriptors were not uniform across regions. Therefore, comparison between venues was confounded by lack of uniform definitions. For example in some locations, there was only one store that fit both the health food store and upscale market definition. However, certain trends did emerge despite the blurring of venue boundaries.

As mentioned, however there were geographic variations. In comparing the different regions of

the USA, it was found that availability did vary considerably across regions. Interestingly as the availability of products varied across the regions, the price of many products did not. The only two products that were statistically different in price across regions were pasta and bread. Also curious was the fact that they were not uniformly different in price in the same region. The pasta was cheapest in New York and the most expensive in Atlanta. The bread was cheapest in Portland and relatively uniform in price in other regions. Generally, it was found that the cost of gluten-free products was almost three times as much as their gluten-containing counterparts. This increased cost poses an added layer of burden to dietary compliance.

There are other difficulties in the gluten-free diet. As reported by Thompson (2000) and Haller *et al.* (2002), the traditional gluten-free diet which includes many commercially prepared gluten-free foods was nutritionally deficient compared with a regular diet. This would require supplementation of the diet with both vitamin and fibre supplements, adding to the cost of adhering to the diet.

With the information of the increased economic burden of commercially prepared gluten-free foods one would hope there will be a move to the more nutrient dense alternative grains, such as quinoa, buckwheat, and amaranth and naturally gluten-free foods. Although not studied as yet these products tend to be considered more mainstream foods and readily available in regular grocery stores, therefore the assumption would be that using these naturally gluten-free products and alternative grains would not only lessen the economic burden of the diet but enhance its nutrient value as well.

The rate of diagnosis of coeliac disease is increasing (Murray *et al.*, 2003). Both the incidence and prevalence have doubled between 2000 and 2003 (Green & Lee, 2005). As a result there are increasing demands for gluten-free products. This study indicates that gluten-free products are difficult to obtain and more expensive, placing great burdens on the patient population that is trying to address the therapy of their disease.

All patients after diagnosis of coeliac disease are advised to adhere strictly to a gluten-free diet. Adherence to the diet is considered to minimize

symptoms and improve nutritional status (Smeuol *et al.*, 1997) as well as prevent the development of complications that include osteoporosis and malignancies (Holmes *et al.*, 1989; Cellier *et al.*, 2000). Noncompliance to the diet is a factor contributing to an increased mortality rate in patients with coeliac disease (Corrao *et al.*, 2001), as well as to a worse quality of life compared with those compliant with the diet (Usai *et al.*, 2002).

Compliance to the gluten-free diet, the only available therapy, varies. In Europe compliance was low for both teenagers and adults (Kumar *et al.*, 1988; Mayer *et al.*, 1991; Bardella *et al.*, 1994; Ciacci *et al.*, 2002; Usai *et al.*, 2002; Vahedi *et al.*, 2003). Reasons for noncompliance include poor palatability of gluten-free food and older age of the patients (Lamontagne *et al.*, 2001), and poor initial education about the diet (Mayer *et al.*, 1991). A British study demonstrated poor compliance with South Asian patients compared with Caucasians, amongst the Caucasians, the factors correlating with compliance were support group membership, understanding food labelling, obtaining sufficient gluten-free products, explanation by a physician and regular dietetic follow-up. The South Asian patients were less likely to attend dietetic clinics, join the Coeliac Society and be satisfied with information provided by doctors and dietitians (Butterworth *et al.*, 2004).

Studies in the USA are limited though compliance is generally good for both children and adults (Green *et al.*, 2001; D'Amico *et al.*, 2005). The major problem with studies of dietary compliance in the USA is that the information is obtained through the support groups that tend to have the involvement of the most compliant patients. One study of African-American patients in the USA with coeliac disease demonstrated low compliance (Brar *et al.*, 2006).

In none of the European studies is the cost of gluten-free food mentioned as a reason for poor compliance. This may be related to fact that in many countries gluten-free food is provided as a pharmaceutical benefit and supported by National Health systems. This is not the case in the USA.

This study demonstrates that in the USA gluten-free food is not readily available and in considerably more expensive than regular, gluten-containing

foods. As the rate of diagnosis increases, the economic burden of the diet will need to be addressed. The increased cost of gluten-free products and their lack of availability may impact compliance. The additional financial barriers may be a powerful negative influence on quality of life of individuals with coeliac disease in the USA.

## Glossary of terms

### Regular grocery store

The local market that provides a wide range of products including fresh and frozen foods, fruits, vegetables, dairy products as well as baked products.

### Health food store

A market that carries foods specifically designed for special dietary needs such as diabetes, organic products, foods free of artificial colours and gluten-free foods.

### Upscale market

A store that caters to gourmet or special dietary products, offers a wider variety of selected foods, often imported foods or more specialty items, such as fine cheeses and organic foods.

### Internet sites

These internet sites were selected because they specifically carry food products.

### Market basket (Consumer Price Index)

The market basket is a package of goods and services that consumers purchase for day-to-day living. The weight of each item is based on the amount of expenditure reported by a sample of households.

## Author contributions

Lee: Originator of concept and design of study. Responsible for substantial acquisition of the data.

Primary author of article. Responsible for final approval of version to be published. Ng: Substantial collection and analysis of data. Zivin: Primarily responsible for data analysis and statistical interpretation. Green: Revising article critically for important intellectual content.

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