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# Price, quality, and availability of gluten-free products in Australia and New Zealand – a cross-sectional study

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## ABSTRACT

Adhering to a gluten-free diet (GFD) is essential for individuals with gluten-related disorders such as coeliac disease, dermatitis herpetiformis, gluten ataxia, and wheat allergy. Approximately 1%-2% of the population is affected by these conditions. Access to affordable, high-quality gluten-free products (GFPs) is crucial for maintaining dietary compliance and well-being. This study explores the experiences of those on a GFD, focusing on the availability, quality, and cost of GFPs compared to non-GFPs. The study was conducted in two stages: (1) An online survey was distributed to Australian Coeliac Association and Coeliac New Zealand members to gather data on shopping habits, preferred GFPs, and opinions on product availability, value, and quality. (2) Retail observations involved creating a 'shopping basket/list' based on survey results to compare the availability and price of GFPs versus non-GFPs in major supermarkets across urban and rural areas. Results from 1501 Australian and 700 New Zealand respondents and retail observations revealed that GFPs are significantly more expensive and of lower quality than non-GFPs. Commonly purchased items include bread, pasta, crackers, flour, and breakfast cereals. The study highlights the need for improved availability, affordability, and quality of GFPs, especially in bridging the cost disparity between urban and rural areas.

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## Introduction

Lifeline long adherence to a gluten-free diet (GFD) is indicated in the treatment of coeliac disease, dermatitis herpetiformis and gluten ataxia (Al-Toma et al. 2019). These autoimmune disorders are caused by an aberrant immune response in a genetically

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predisposed population to the dietary intake of gluten-containing grains (wheat, rye and barley) following a hitherto unknown environmental trigger (Lebwohl et al. 2018).

The availability and affordability of GFPs are crucial for supporting the well-being of individuals with conditions requiring a GFD (Al-Sunaid et al. 2021). In the United States, the cost of GFPs has been linked to non-compliance with the GFD among those with coeliac disease (Lee et al. 2012). In Italy and the United Kingdom, national schemes subsidise the expense of GFPs for medically indicated individuals (Gorgitano and Sodano 2019). However, in countries like Australia and New Zealand, governments do not provide financial support for purchasing GFPs, despite the importance of adhering to a GFD (Lambert and Ficken 2016).

Over the last five years, the cost of GFPs compared to gluten-containing counterparts has been reported to be higher in the United Kingdom (Vriesekoop et al. 2020), United States (Lee et al. 2019), Italy (Gorgitano and Sodano 2019) and Greece (Panagiotou and Kontogianni 2017). However, recent data on the price ratio between GFPs and gluten-containing products has not been reported for Australia or New Zealand, nor has access, availability, or consumers opinions about the quality of GFPs. Therefore, the aims of this study were (1) to evaluate the experiences and opinions of people requiring a GFD with regards to (i) access to, (ii) availability of, and (iii) quality of GFPs, and (2) survey the actual availability of GFP and most common retail outlets in both urban and rural areas in both countries to determine the price ratio between GFPs and gluten-containing counterparts.

## Materials and method

This study was conducted in two stages and reported in accordance with the STROBE guidelines for observational studies (<https://www.strobe-statement.org/>). The first stage involved the dissemination of an online survey to a targeted population of members of the national coeliac associations in Australia and New Zealand. The second stage involved visiting supermarkets to determine the availability and cost of the GFPs in these two countries. Ethical approval to conduct the study was obtained from Harper Adams University, United Kingdom (Project number 0439-202106-STAFF-CO2).

### *The consumer survey*

The online surveys were disseminated between August and December 2021 via the online survey platform JISC [www.onlinesurveys.ac.uk](http://www.onlinesurveys.ac.uk). Invitations to participate in the survey were sent via the Australian Coeliac Association and Coeliac New Zealand to their members. The survey provided a brief introduction to the study followed by 4 sections consisting of a total of 13 items designed to gather data on:

- Demographics
- Shopping habits
  - Place of purchase for GFPs and non-GFPs
  - Type of GFP and frequency of GFPs purchased
  - Availability of GFPs
  - Online shopping activity and product substitution

- Comments about the quality of GFPs
  - Interpretation of the gluten-free label
  - Opinions about the quality attributes of products
- Opportunity for participants to offer additional information
  - Gaps in the GFP market
  - Other experiences related to availability, affordability, and quality of GFPs.

Categorical, continuous, and qualitative data were collected from responses to YES/NO, multiple choice, Likert scale and open-ended text questions. The survey took approximately 10 minutes to complete.

### ***Gluten-free shopping basket***

A GF shopping basket was created for both countries. The inclusion of the GFP in the gluten-free shopping basket was determined by the consumer survey responses based on their relative purchasing frequencies of many potential GFPs (Vriesekoop et al. 2020). GFPs that were indicated to be purchased ‘frequently’ were assigned a score of 3, items purchased ‘sometimes’ a score of 2, items purchased ‘rarely’ a score of 1, and zero to items that were ‘never’ purchased by participants. The total score for each item was divided by the total number of participants in each country, with GFPs that received an average score of 1.00 or higher to be included in the country’s gluten-free shopping basket.

The contents of the GF shopping baskets were used to: (1) establish a listing of the commonly purchased GF products in both countries; and (2) focus on a relevant range of GFPs to determine the price ratios of GF products versus equivalent gluten-containing products in the subsequent retail observation component of this study.

### ***Retail observation study***

Informed by the participants responses to the survey about where they lived and shopped, a range of retail outlets were visited across urban and rural Australia and New Zealand between December 2021 and February 2022. This study included twelve grocery retailers in the Christchurch metropolitan area to determine the availability and price of GF products in New Zealand. In December 2021, two stores of each supermarket chain were visited. One, within the urban perimeter of Christchurch, and another in one of the surrounding towns: Lyttelton, Rangiora, Lincoln, West Melton, Rakaia and Rolleston. In Australia, the four major grocery retailers were visited within the metropolitan area of Sydney and their outlets were also visited in the rural town of Ballarat. To determine the availability and price of GFPs, information about the variety of GFPs, their total price and weight, price per 100 g, and available quantities were collected and recorded for comparison. The same information was recorded for the gluten-containing products to calculate a price ratio. If any discounted prices were advertised, the discounted prices were ignored and the non-discounted prices were recorded.

Different types of products that applied to the same category were included to maintain a good variety among the items in the basket. Wherever possible, products and brands

consistent across supermarkets were compared. In cases where the supermarket did not have a particular product or brand in stock, a similar one that was available was chosen. For instance, most supermarkets had gluten-free cornflakes; these were used as the 'cereal' option. However, if a retailer didn't have them in stock, another cereal of similar sizing was chosen (Vriesekoop et al. 2020). Supermarkets in this study are identified by a three-digit code. The first digit in the code, anonymously assigns for the supermarket brand, the second digit assigns the repeat for the same supermarket brand, and the third digit in the code indicates the approximate demographic area (R = rural, U = urban).

### ***Hierarchical cluster analysis***

Hierarchical Cluster Analysis was performed using Minitab 19.2020 to categorise the GFPs according to consumers' concerns raised about their quality attributes. The Squared Euclidean Distance Method calculates distances between GFPs based on differences in attributes. This method uses an analysis of variance approach for assessing the distances between clusters. Cluster membership was estimated by calculating the sum of the squared deviations from the group mean (Patil et al. 2020). Minitab-generated dendrogram similarity scales ranged from 100 (total similarity) to 25 (some resemblance). It was first necessary to perform a qualitative analysis of the participants' responses to feed the model. NVivo 12.7.0 (3873) was used to search for keyword frequencies and relationships. A matrix was designed to present GDPs in rows and quality concerns in columns. The variables of interest consisted of binary measures, obtained from participants' responses to closed questions regarding quality-related concerns; specifically, whether the participant was or was not concerned.

### ***Price discrimination ratio***

To investigate the occurrence of price discrimination between GFPs and non-GFPs, following a method Vriesekoop et al. (2020) applied in a similar study in the UK, a Price Ratio (PR) calculation was carried out. The PR compared the cost of GFPs with non-GFPs and determined whether GFPs were more or less expensive. The PR comprised of dividing the price per 100 g or unit of a GF item by the non-GF equivalent items. A PR of '1.00' indicates that both the GF and the non-GF product cost the same, a PR below '1.00' suggests that the GF product costs less, and a PR above '1.00' indicates that the GF product costs more than its gluten-containing equivalent (Vriesekoop et al. 2020).

## **Results**

Results are based on 1501 completed questionnaires from Australia and 700 from New Zealand and a subsequent retail observation in both countries to assess the availability and price ratio between GFPs and non-GFP equivalents.

### ***Survey demographics***

The age and gender distributions of participants across both countries are presented in Table 1 with the majority (>90%) of survey participants being female. Most participants

were aged between 25 and 64 years of age, representing 77% and 80% of participants in Australia and New Zealand respectively.

### **Survey participants reasons for purchasing GFPs**

The predominant reason survey participants purchased GFPs was because they were diagnosed with coeliac disease (Australia 76% and New Zealand 71%) (Table 2). A total of 2.9% of the participants in New Zealand and less than 1% of those in Australia reported purchasing GFPs for reasons other than a gluten-related intolerance.

### **Survey participants shopping habits and availability of GFPs**

In Australia, most people purchased their GFPs at the two large supermarkets chains (Coles and Woolworths) and some GF purchases in the IGA chain. While the main Australian budget supermarket (ALDI) was not a common place to buy GF items, it was a commonly used retailer for ‘the other’ grocery items. In New Zealand, the supermarket environment is structured very differently to the Australian situation. In New Zealand, the retail sector is dominated by two companies Foodstuffs and Woolworths, with a range of brands that compete in the high-end, convenience and top-up segments. Both companies have different strategies; however, they follow similar patterns regarding the availability of GF products. The retail observation study revealed the range of GF items in their high-end supermarkets is superior to their convenience brands and much more extensive than in top-up stores (see Section ‘The retail observation – availability price, price ratio GFPs in the New Zealand and Australia shopping basket’).

Participants responses to the question about ‘if and how often’ a GFP was purchased (never, rarely, sometimes, or often) are presented in Table 3. GF bread, pasta, crackers, flour, and GF condiments (like soy sauce and mayonnaise) were the most frequently purchased in both Australia and New Zealand. While GF pre-made/convenience meals, and noodles, were the least commonly purchased GF products (Figure 1). Some significant differences were found between the two countries in the relative purchasing frequency of the most common items acquired. While there were no significant differences in

**Table 1.** Demographic characteristics of survey participants.

	Australia <i>n</i> = 1501	New Zealand <i>n</i> = 700	<i>T</i> -test <i>p</i> -value
Gender			
Female	90.7%	91.9%	.382
Male	9.2%	7.8%	.290
Other	0.1%	0.3%	.303
Age bracket			
<18	1.3%	2.0%	.224
18–24	5.0%	8.9%	.002
25–34	12.5%	18.1%	.001
35–44	22.8%	25.3%	.204
45–54	22.7%	21.7%	.621
55–64	18.6%	14.6%	.016
65–74	13.8%	7.6%	.000
75–84	3.0%	1.9%	.091
84+	0.4%	0.0%	.014

**Table 2.** Reasons for purchasing GFPs.

Reasons for purchasing gluten-free products	Australia <i>n</i> = 1501	New Zealand <i>n</i> = 700	<i>T</i> -test <i>p</i> -value
Diagnosed with Coeliac Disease	76.9%	71.1%	.004
Carer for someone with Coeliac Disease or a gluten intolerance	15.3%	16.9%	.019
Diagnosed with a gluten intolerance	6.9%	9.9%	.365
Other reasons	0.9%	2.9%	.044

purchasing frequencies with regards to GF bread, crackers and condiments, Australians purchased marginally more GF pasta compared to the New Zealanders ( $p = .088$ ) while New Zealanders purchased more GF flour compared to the Australians ( $p < .000$ ) (Table 3).

Around 70% of participants seeking GFPs reported having to visit multiple stores to obtain what they needed. New Zealanders were more likely than Australians to visit multiple stores ( $p = .029$ ). Participants from both countries expressed frustration with this situation, stating that they had to go to various stores to find the necessary GFPs. They found it bothersome and challenging, with some mentioning the limited availability in rural areas, forcing them to travel to other towns or cities to purchase GF items.

### Survey participants opinions about the cost and value of GFPs

Survey participants expressed strong dissatisfaction with the value for money of GFPs (Table 4). Australians scored  $1.89 \pm 1.02$  on a 5-point Likert scale, while New Zealanders scored significantly lower at  $1.80 \pm 1.00$  ( $p < .05$ ). Furthermore, participants commented on the high prices and small portion sizes of GFPs compared to gluten-containing equivalents (Figure 2). They found GFPs to be expensive and questioned why they were often smaller and pricier than regular items. One carer of a family with multiple members having CD

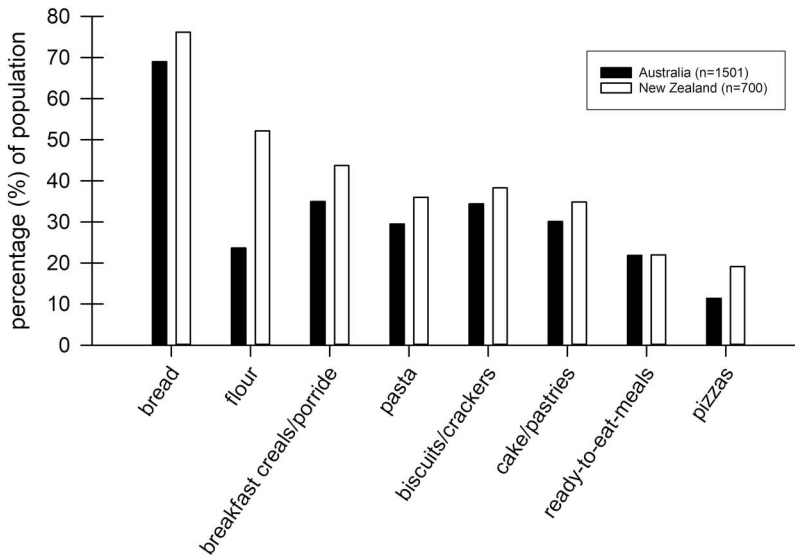
**Table 3.** Survey participants shopping habits: relative frequency of purchasing categories of GFPs.

Gluten-free product categories <sup>a</sup>	Relative purchasing frequency <sup>b</sup>		<i>T</i> -test <i>p</i> -value
	Australia <i>n</i> = 1501	New Zealand <i>n</i> = 700	
Bread	2.57	2.54	.403
Pasta	2.44	2.38	.088
Crackers	2.37	2.33	.139
Flour	2.23	2.38	.000
Condiments (soy sauce, mayonnaise, etc.)	2.33	2.33	.895
Crisps	2.23	2.33	.008
Breakfast cereals	2.12	2.07	.277
Biscuits	1.98	1.74	.000
Sauces and gravies	1.90	1.73	.000
Sausages	1.85	1.83	.597
Ice cream	1.81	1.83	.565
Stock cubes	1.66	1.63	.574
Wraps, etc.	1.59	1.77	.000
Noodles	1.48	1.23	.000
Cake mix	1.36	1.19	.000
Raising agents	1.35	1.63	.000
Pizza	1.15	1.06	.055
Cakes	1.10	0.89	.000

<sup>a</sup>Products included informed 'Gluten Free shopping basket'.

<sup>b</sup>The relative purchasing frequency was determined by assigning scores of three to items reported to be purchased often, two to items purchased sometimes, and one to items purchased rarely, and zero to items that are never purchased by participants. The total score for each item was divided by the total number of participants.





**Figure 1.** Survey participants reporting availability issues to categories of GFPs.

expressed the financial burden and challenges of buying GF food. Those surveyed acknowledged the higher cost of GF food production but still found it difficult to afford these items compared to gluten-containing counterparts. Feedback from participants suggested that supermarket GFPs often appeared to fall short in taste and quality compared to those found in specialty stores. This observation reflects a general perception among a notable segment of the respondents, highlighting perceived differences in product satisfaction between the two types of retail outlets. Trouble accessing GF bread and flour was reported by a significant percentage of Australian and New Zealand participants, with some in New Zealand having to travel to other towns or cities due to limited availability in rural stores.

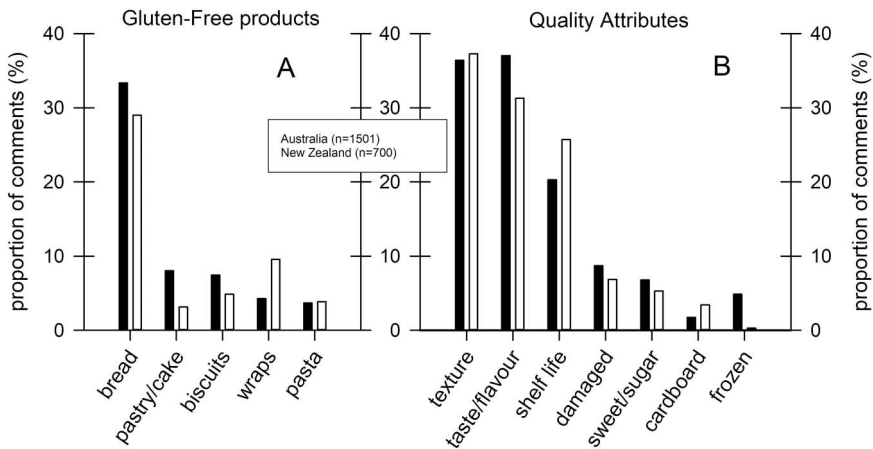
**Survey participants opinions about the range and quality of GFPs**

Participants in both countries were asked to what extent they agreed or disagreed (on the 5-point Likert scale) with a number of statements regarding the range, quality, availability, and costs associated with GFPs in supermarkets (Table 4).

**Table 4.** Participants responses to fixed statements about the accessibility, range, quality, and cost of GFPs in Australia (n = 1501) and New Zealand (n = 700).

Statements	Australia	New Zealand	T-test p-value
	Average ± SD		
	5-point Likert scale score <sup>a</sup>		
I often have to go to several different stores to get the GF products I need	3.84 ± 1.26	3.96 ± 1.28	.029
I am happy with the range of gluten-free products available in supermarkets	3.97 ± 1.10	2.81 ± 1.05	.000
I feel I get good value for money on the GF products that I purchase	1.89 ± 1.02	1.80 ± 1.00	.038
I am happy with the quality of gluten-free products available in supermarkets	3.08 ± 1.01	3.07 ± 1.00	.866
GF products that are available are as good as their non-GF alternatives	2.55 ± 1.09	2.47 ± 1.08	.173
I enjoy the gluten-free products that I purchase in supermarkets	3.42 ± 0.93	3.35 ± 0.94	.136
I prefer to make my own gluten-free products where possible	3.43 ± 1.32	3.35 ± 1.35	.239

<sup>a</sup>5 = strongly agree with the statement and 1 = strongly disagree with the statement.



**Figure 2.** Survey participants' opinions about the quality attributes of GFs. **A**, Product quality. **B**, Attributes of GF products. (Higher scores were associated with greater dissatisfaction.)

The Australians were significantly more content with the range of GF products available in their supermarkets (3.97) compared to the New Zealanders (2.81) ( $p < .000$ ). However, the satisfaction with the quality of the GF products received an equal scoring across both countries. A slightly above-average score was obtained regarding enjoyment of consuming GFP, while a slightly below average score was obtained with regard to the statement that GF products were as good as their gluten-containing equivalents, with no significant differences in the scores across the two countries.

### Quality of GFs

In both countries, the largest proportion of complaints with regard to the quality of GFs were aimed at GF bread (Figure 2A). Other baked goods and pasta received considerably fewer complaints by comparison. Across all GFs, the dissatisfaction with specific quality attributes was predominantly expressed with regards to texture, taste/aroma and shelf-life (Figure 2B).

### The quality of GF bread

40% of participants expressed concerns about the quality of GF bread (Figure 2). Common comments related to taste, texture, and shelf-life, with many mentioning the 'strange taste and texture' of GF bread in both countries. Some participants compared the texture to 'spongy rubber' and described it as 'cardboard-like' or needing to be toasted before being palatable. Retailers and manufacturers were criticised for offering GF bread that was deemed low-quality and high-priced. Additional comments highlighted issues with GF bread, including it not being comparable to regular bread and sometimes smelling 'like chemicals'. Some participants accepted the limited expectations of GF bread, as they had become accustomed to its poor quality over time. Regarding frozen bread, 1% of New Zealand and 13% of Australian participants reported quality issues associated with frozen bread, noting that it could become rock hard, wet, or mouldy. Some participants suggested that they would prefer to buy GF bread frozen

to defrost as needed, as supermarkets often thaw it before sale, limiting their ability to freeze it at home.

### ***The quality of GF pasta***

Concerns about the quality of GF pasta were similar in both countries, with 29% of Australian and 36% of New Zealand participants reporting issues related to the loose and ‘gluggy’ consistency of GF pasta (Figure 2). Some commented on the pasta disintegrating when cooked. Participants acknowledged that the quality of GF pasta varied significantly, and finding an acceptable product often involved trial and error. GF pasta was described as more ‘temperamental’ than regular pasta, with difficulties in achieving the correct texture, as it could go from undercooked to a gluggy mess quickly if not cooked precisely.

### ***The quality of GF breakfast cereals***

Participants from both Australia and New Zealand expressed concerns about the taste and flavour of some GF cereals and associated products (Figure 2). Comments included descriptions like ‘horrible’, ‘odd’, and ‘disgusting’ taste of certain cereals. Some participants mentioned that some cereals lacked good taste, and others criticised excessive sugar usage in cereals to compensate for the lack of flavour. Despite the negative feedback, some participants found that larger established brands offered cereals that tasted more normal. Overall, the sentiment was that the quality of GF cereals varied, leading to a ‘hit and miss’ experience for consumers.

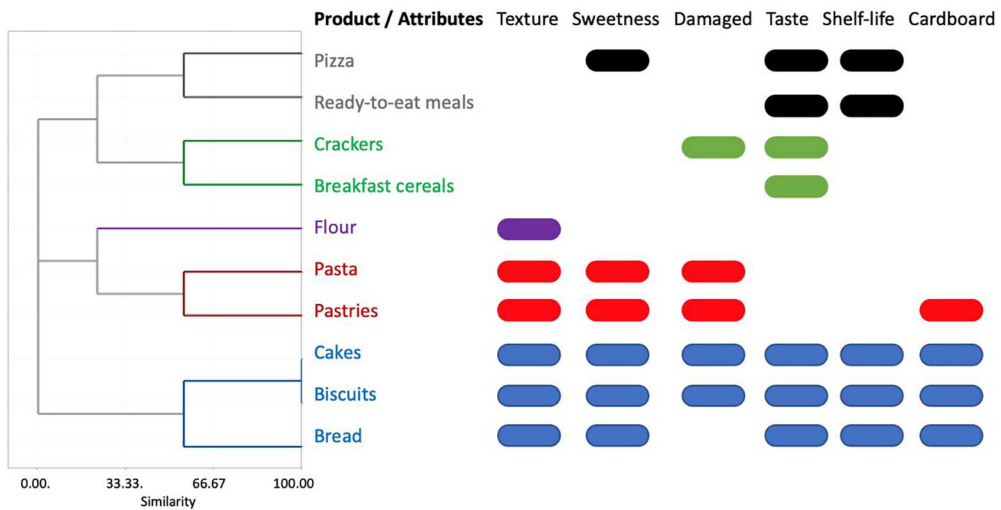
### ***The quality of GF flour***

Most of the expressed concerns about the quality of GF flour are related to its texture (Figure 3). Some participants reported issues with weevils in buckwheat flour and found certain brands of GF flour unsuitable for baking. Others mentioned that GF flours were gritty in texture and had unpleasant smells when baking. Despite the quality issues with GF flours, many participants opted to make and bake their own GF products (Table 4). They found commercially available GF products even more disappointing in terms of quality, with some describing them as dry and flavourless. Baking at home allowed some of them to achieve better results and create more enjoyable GFPs. Participants highlighted that access to good, flavoured GF cakes and baked goods was limited, motivating them to bake their own bread, cakes, and other items to ensure better quality.

### ***The texture and taste of GFPs***

Participants expressed dissatisfaction with a range of sensory attributes of GFPs, including texture, taste, and flavour issues (Figure 2). Some comments about ‘cardboard-like’ textures were mentioned before in relation to GF bread but were also raised concerning pastries, cakes, wraps, and biscuits (Figure 3). Some GFPs were found to be dry and crumbly, with biscuits and crackers specifically mentioned in this context. In addition to dryness and crumbliness, comments highlighted the heavy and dense structures/textures of certain GFPs, with cake-like bread being dense and chewy, often with large holes.

Participants expressed that GFPs tasted ‘terrible’, ‘horrible’, or ‘awful’, with some noting an ‘iffy’ smell. In particular, many participants highlighted the high sugar content and excessive sweetness of numerous GFPs, finding them too sugary and bland.



**Figure 3.** GFPs clustered by concerns about the product quality.

### *The shelf-life of GFPs*

Some GFPs, like bread, wraps, and pizza bases, were reported to become mouldy quickly, leading some participants to freeze anything they didn't consume immediately. Others noted that once opened, wraps and bread didn't last as long and developed visible mould before their expiry date. Participants also observed GFPs on supermarket shelves that were already mouldy or close to expiration. Concerns were raised about the use of preservatives in GFPs, with some mentioning an after-taste possibly due to these additives. Calls were made for healthier options without preservatives or additives in GFPs. People who rely on GFPs, particularly bread, emphasised the importance of having access to decent, fresh, and ready-to-eat options.

### *Results of hierarchal cluster analysis regarding the quality of GFPs*

As presented in a cluster diagram in [Figure 3](#), five groups of GFPs attracted similar comments regarding product quality. Cluster one highlights that bread, biscuits and cakes were similar across all six indicators of poor quality. In cluster two, texture, sweetness and damaged products were the most common quality concerns for pasta and pastries. The third cluster illustrates that the texture of GF flour was a concern. Damaged products and the taste of cereals and crackers were clustered as the fourth group given similar concerns. Taste and shelf-life as common issues with pizza and ready-made or convenience meals.

### *The retail observation – availability price, price ratio GFPs in the New Zealand and Australia shopping basket*

In this stage of our study, the retail observation, we analysed the price and the price ratios of commonly purchased GFPs in both countries ([Tables 5 and 6](#)), compared to their gluten-containing equivalent products. The results of the price ratio calculation highlighted the cost of GFPs to be substantially higher than the non-GF equivalents. The cost of GFPs from smaller stores in rural areas were the highest, with the lowest

availability and often less than half of the shopping basket items being available. In the New Zealand retail observation, only one store stocked 100% of the GF shopping basket items, while none of the urban-based mainstream supermarket stores in either New Zealand or Australia stocked a full complement of the GF shopping basket items (Tables 5 and 6).

In both countries, GF bread, pasta, and flours were available in all stores visited. However, GF wraps were not stocked in Australian budget supermarkets and rural local shops, while GF breakfast cereals were not present in New Zealand rural budget supermarkets. The average price ratio of GF breads, ranging from white to brown, both own-brand and branded, was 2.73 in New Zealand and 3.04 in Australia, indicating that GF breads were more expensive compared to their gluten-containing equivalents (Figure 4). Figure 4 presents a contrast of the average price ratios (PRs) in relation to each GFPs in a disaggregated shopping basket across Australia and New Zealand. The high price ratio for supermarket own-brand GF white bread in New Zealand was due to the very low pricing of gluten-containing supermarket own-brand white bread. GF pasta was also commonly purchased, with an average price ratio of 2.38 in New Zealand and 2.68 in Australia indicating that in Australia (Figure 4), GF pasta was more expensive compared to New Zealand. GF flour was sought-after for home-cooking and baking of GF products, and it had the largest price inflation compared to basic wheat flours. The price ratio for GF flours in Australian and New Zealand supermarkets was 3.47 and 4.86, respectively, with GF baking powders/raising agents being 3.70–4.25 more expensive in Australian and New Zealand supermarkets, respectively (Figure 4).

### ***Participants' awareness of overseas GF market***

Participants in both Australia and New Zealand compared the availability and quality of GF items in their countries to those in other countries. Some New Zealanders noted the greater variety of GF items in Australia and expressed feelings of missing out on many options. However, there were no reciprocal comments from Australians about the New Zealand GF market. Both Australian and New Zealand participants, at 30 and 28 specific responses respectively, also compared their GF market to that of the UK. They mentioned that the range and quality of GF products in the UK were much better, with GF bread tasting like real bread. As such, they highlighted a limited variety in their own countries compared to the UK. Participants expressed that there were great GF baked goods in the UK that were not available in Australia or New Zealand. Some participants also highlighted that GF options in New Zealand were significantly more expensive than in other countries they had lived in, such as Australia and the UK, where GF products were more affordable.

## **Discussion**

The novelty of this study is the design that enabled the retail observation to be guided by the lived experience of people living with a medical need for a GFD (the survey). Overall, the key findings from the survey suggest there are multiple concerns regarding GFP product quality. The main quality concerns were associated with the taste, texture and shelf-life of staple goods such as breads, cakes and pastries. Importantly,

**Table 5.** Retail observation NZ – availability of GFP shopping basket items and price ratios (December 2021 and March 2022).

Supermarket <sup>a</sup> →	A1U	A2U	D1U	D2U	C1R	C2R	B1R	F2R	E1U	E2U	B2R	F1R
Retail sector <sup>b</sup> →	Mainstream				Local				Budget			
↓ Basket item ↓												
Bread	3.30	3.80	2.70	3.70	2.40	2.40	2.50	2.60	2.40	2.40	2.30	2.30
Pasta	1.97	2.12	2.96	2.00	2.16	2.16	2.11	2.36	3.19	3.19	1.97	2.42
Flour	4.53	4.29	3.58	4.47	6.96	6.52	6.67	6.67	3.67	3.67	3.58	3.74
Wraps	1.75	1.75	1.79	1.76	1.64	2.04	1.31	1.75	1.50	1.50	1.78	2.46
Crackers	1.33	1.74	1.85	1.40	na <sup>c</sup>	na	1.28	1.61	6.88	6.88	3.28	3.28
Condiments	3.32	3.32	na	na	na	na	2.22	2.15	2.15	2.15	3.72	3.72
Crisps	2.57	2.57	1.97	1.47	na	na	1.78	1.78	2.67	2.67	na	na
Breakfast cereals	2.81	2.62	2.88	2.34	2.29	2.29	2.99	2.72	2.91	2.91	na	na
Biscuits	2.35	2.27	2.43	2.85	na	na	2.96	2.62	1.17	1.17	2.90	2.90
Sauces and gravies	1.00	1.00	0.36	0.80	1.47	1.47	0.72	na	2.72	2.72	na	na
Sausages	1.00	1.00	1.00	1.00	1.00	na	1.00	1.00	1.00	1.00	1.00	1.00
Ice cream	1.00	1.00	1.00	1.00	na	na	1.00	1.00	1.00	1.00	1.00	1.00
Stock cubes	na	na	0.74	na	na	na	1.00	0.87	0.88	0.88	na	na
Noodles	na	2.01	1.72	na	na	na	1.21	1.31	1.14	1.14	na	na
Cake mix	1.40	1.29	1.56	1.14	1.86	1.48	3.12	2.21	2.22	2.22	na	na
Raising agents	5.50	5.20	na	4.47	na	na	3.53	na	3.41	3.41	na	na
Pizza	2.25	2.25	na	2.25	na	na	2.16	2.16	2.37	2.37	2.65	na
Cakes	1.96	2.03	na	na	na	na	2.61	2.61	na	na	na	na
<i>Overall availability</i>	<i>89%</i>	<i>94%</i>	<i>77%</i>	<i>77%</i>	<i>44%</i>	<i>39%</i>	<i>100%</i>	<i>89%</i>	<i>94%</i>	<i>94%</i>	<i>56%</i>	<i>50%</i>

<sup>a</sup>Supermarkets in this study are identified by a three-digit code. The first digit in the code, anonymously assigns for the supermarket brand, the second digit assigns the repeat for the same supermarket brand, and the third digit in the code indicates the approximate demographic area (R = rural, U = urban).

<sup>b</sup>Supermarkets in this study are grouped according to their relative size/sector.

<sup>c</sup>Certified gluten-free product not available.

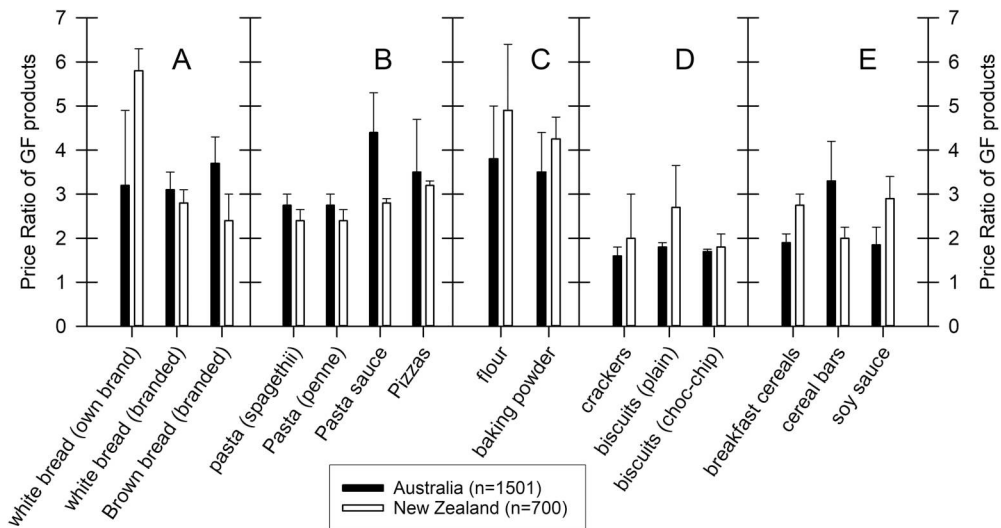
**Table 6.** Retail observation Australia – availability of GFP shopping basket items and price ratios (December 2021 and March 2022).

Supermarket <sup>a</sup> → Retail sector <sup>b</sup> →	C1U	C2R	W1U	W2R	G1U	G2R	A1U	A2R
	Mainstream				Local		Budget	
↓ Basket item ↓								
Bread	3.14	3.18	2.54	2.51	2.93	3.04	3.57	3.44
Pasta	3.08	2.77	2.46	2.73	2.19	2.56	3.13	2.50
Flour	4.67	2.80	2.40	2.87	3.67	3.64	3.84	3.84
Wraps	2.50	2.27	2.18	2.18	4.45	na <sup>c</sup>	na	na
Crackers	na	3.55	1.63	2.28	1.73	2.59	1.57	7.10
Condiments	2.63	2.55	1.46	1.43	1.50	na	na	na
Crisps	2.08	2.00	1.37	1.37	1.71	1.21	1.76	na
Breakfast cereals	2.50	2.39	2.45	2.01	1.44	2.40	2.16	1.62
Biscuits	1.76	0.73	1.67	4.58	1.71	3.32	na	na
Sauces and gravies	6.45	1.59	na	na	2.40	na	na	na
Sausages	1.00	1.00	0.64	0.64	1.33	1.00	1.00	na
Ice cream	1.32	1.16	2.21	2.21	na	na	na	na
Stock cubes	0.86	1.03	1.04	1.03	0.97	na	na	na
Noodles	2.01	na	2.67	2.44	na	na	na	na
Cake mix	1.14	1.24	1.41	1.20	3.03	na	na	na
Raising agents	4.44	4.40	4.44	3.48	1.75	na	na	na
Pizza	3.67	2.42	1.46	3.40	na	na	na	na
Cakes	na	na	na	na	na	na	na	na
<i>GF basket availability</i>	<i>89%</i>	<i>89%</i>	<i>89%</i>	<i>89%</i>	<i>78%</i>	<i>44%</i>	<i>39%</i>	<i>28%</i>

<sup>a</sup>Supermarkets in this study are identified by a three-digit code. The first digit in the code, anonymously assigns for the supermarket brand, the second digit assigns the repeat for the same supermarket brand, and the third digit in the code indicates the approximate demographic area (R = rural, U = urban).

<sup>b</sup>Supermarkets in this study are grouped according to their relative size/sector.

<sup>c</sup>Certified gluten-free product not available.



**Figure 4.** Average price ratios (PRs) in relation to each GFPs in a disaggregated shopping basket across Australia and New Zealand supermarkets included in this study. Error bars represent the standard deviation of the PR per line item. **A**, Bread. **B**, Pasta and pizzas. **C**, GF flour and baking powder. **D**, Crackers and biscuits. **E**, Miscellaneous GF items.

the retail observation and shopping basket study identified that GFPs continue to cost significantly more than non-GFP equivalents in Australia and New Zealand. GFP availability and price ratio demonstrated variability between rural and urban areas, generally characterised by higher price ratios, and reduced availability in rural outlets. Comparatively, New Zealand participants were less satisfied than those in Australia regarding value for money, travel effort associated with accessing the GFPs, and product quality.

The findings of this study regarding the higher cost of GFPs compared to non-GFP equivalents, and availability of staple products are consistent with findings previously reported in Australia (Lambert and Ficken 2016), Austria (Missbach et al. 2015), Brazil (do Nascimento et al. 2014), Chili (Estévez et al. 2016), Spain (Babio et al. 2020), Greece (Panagiotou and Kontogianni 2017), Norway (Myhrstad et al. 2021), and the UK (Burden et al. 2015; Fry et al. 2018; Hopkins and Soon 2019; Vriesekoop et al. 2020). The relevance of this finding to the health and well-being of people with a medical indication for strict adherence to a GFD is of socio-economic and health importance (Xhakollari et al. 2019). In the case of wheat allergy, the consequence of consuming wheat in the diet can have serious and life-threatening consequences (Cianferoni et al. 2013). In the case of coeliac disease and gluten-related disorders, the effectiveness of treatment outcomes depend on the affected person's adherence to a GFD (Lebwohl et al. 2018). The availability of a variety of affordable and good-quality GFPs is considered among the key determinants of dietary adherence among this population (Xhakollari et al. 2019).

The finding that the most frequently purchased items in Australia and New Zealand were bread, flour, pasta, crisps (chips), and crackers are similar to those of the aforementioned studies (do Nascimento et al. 2014; Burden et al. 2015; Missbach et al. 2015; Estévez et al. 2016; Lambert and Ficken 2016; Panagiotou and Kontogianni 2017; Fry et al. 2018; Hopkins and Soon 2019; Babio et al. 2020; Vriesekoop et al. 2020; Myhrstad et al. 2021) and support the presence of a western societal demand for these products. Bread and its principal ingredient flour are a fundamental component in many western populations' diet. Bread, in various shapes and forms, has been a staple food of humans for thousands of years, and it remains the most regularly consumed food in the western world due to its convenience, portability, nutrition, and taste (Valavanidis 2018). Considering this high prevalence of use, and the concerns about the quality of GF breads taste, texture and product quality (damaged goods), this area of manufacturing requires concerted attention. Some of the challenges with overcoming the quality issues reported in our and other studies relate to the absence of the properties of gluten itself. Glutens heat-stable matrix of properties enables it to act as a binding and extending agent that results in baked products that are light in texture, improved taste and can retain moisture (Biesiekierski 2017).

The estimated western prevalence of gluten-related disorders is approximately 5% but the prevalence of individuals following a gluten-free diet much higher at 10%–20% (Tovoli et al. 2015). The GFD boom and its necessity outside that of a gluten-related disorder have been heavily marketed and promoted in popular health media (Aziz 2018). It has been proposed that the increased demand for GFP has resulted in marketing that promotes to the broader market rather than what people with gluten-related disorders need (Gorgitano and Sodano 2019). This was exemplified in our study when we searched one supermarkets website and



found 4675 stock-keeping units of GFPs. These included naturally gluten-free foods such as fruits and vegetables, milk and cheese and non-processed meats that typically do not contain wheat, rye, barley or oats. However, there are some dairy products where wheat starch might have been used as a thickening agent (Vriesekoop et al. 2020). After filtering the search and excluding fruits, vegetables, meats and dairy from the results, 100 stock-keeping units were identified. Although Food Standards Australia New Zealand 'requires that ingredients derived from cereals containing gluten, mainly: wheat, rye, barley, oats and spelt, must always be declared on their food labels' (FSANZ 2017, St. 1.2.7); there are no guidelines about the labelling of the food that is gluten-free in its natural form nor precautionary statements around potentially cross-contamination with wheat.

This study is not without limitations. As the survey and retail observation were conducted during the COVID-19 pandemic, product supplies may have been influenced by disruption to production and transportation. We did not collect data about where and how easy GFPs were to find in the supermarkets. Another limitation lies in the scope of store and product sampling, as it covered only a subset of outlets and products, potentially skewing the perceived availability and cost of GFPs. The prices recorded were standard, non-discounted prices, avoiding the temporary effects of promotions on market conditions. The participating population is predominantly female, with 90.7% in Australia and 91.9% in NZ. While this gender imbalance may be attributed to various factors, exploring these reasons is beyond the scope of our study. Our study focused on people living with a gluten-related disorder who had a medical indication for a GFD and belonged to representative organisations and may not reflect the opinions and experiences of those who choose GFPs as a personal health choice.

## Conclusion

This study provides valuable insights into the experiences of individuals living with gluten-related disorders in Australia and New Zealand and their challenges in accessing and affording GFPs. The findings highlight concerns about the quality of GFPs, particularly related to taste, texture, and shelf-life of staple goods such as breads, cakes, and pastries. The study also reveals that GFPs continue to be significantly more expensive than non-GFP equivalents, with variations in availability and cost between rural and urban areas, further exacerbating the financial burden on individuals.

These findings are consistent with previous studies conducted globally, underscoring the need to improve the availability, affordability, and quality of GFPs not only in Australia and New Zealand but across various countries. Access to a variety of affordable and superior-quality GFPs is crucial for individuals with a medical need for a strict gluten-free diet to effectively manage their health conditions and adhere to the recommended dietary guidelines.

Moreover, addressing the disparities between rural and urban areas in terms of cost and availability is essential to ensure fair access to GFPs for all individuals, regardless of their geographical location. Closing this gap would alleviate the financial strain and improve the overall well-being of individuals in rural communities who face additional challenges in accessing suitable GFPs.

There is a significant opportunity to improve the availability, affordability, and quality of GFPs in Australia and New Zealand. This requires collaboration among policymakers,

food manufacturers, and relevant stakeholders to address the identified concerns and implement measures to ensure the accessibility and affordability of GFPs for individuals with gluten-related disorders. Doing so can enhance the health, well-being, and quality of life of those who require a strict gluten-free diet as part of their medical treatment.

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## Disclosure statement

No potential conflict of interest was reported by the author(s).

## Data availability statement

Data can be made available by contacting the corresponding author

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