


# Higher cost of gluten-free products compared to gluten-containing equivalents is mainly attributed to staple foods

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## Abstract

The high cost of gluten-free products (GFPs) is being discussed as a potential barrier to adherence to a gluten-free diet, rendering monitoring of their pricing an ongoing demand in a market subject to continuous fluctuations. The current study aimed to assess the current pricing status of GFPs in the Greek retail market, with a focus on differences between staple and non-staple foods. The retail price and packaging weight of all available GFPs and their gluten-containing (GCPs) counterparts of a GFP-shopping basket (formulated based on the results of a preceding online survey) were recorded by visiting one store of the five most popular reported supermarket chains. The food categories were grouped into staple (e.g. breads, pasta and flours) and non-staple (e.g. chips, sweets and sauces) foods. Adjusting for supermarket chain and product type, a quantile mixed regression model was applied to assess the extent to which median product price (per 100 g) differed between GFPs and GCPs. The unique products recorded were 1058 (of which 408 GFPs), with a total of 2165 retail price recordings. While the overall median price/100 g of GFPs was not found to be significantly different from that of GCPs, the median price of staple GFPs was estimated to be higher than staple GCPs (+€1.03 [95% CI: €0.93; €1.13] per 100 g), whilst that of non-staple GFPs was slightly lower (−€0.20 [95% CI: −€0.37; −€0.02] per 100 g). In conclusion, the persisting higher cost of staple GFPs suggests the need for ongoing financial support for people with coeliac disease.

## KEYWORDS

coeliac disease, consumer satisfaction, cost comparison, gluten-free diet, pricing, supermarkets

## INTRODUCTION

For people with coeliac disease (CeD), following a gluten-free diet (GFD) usually means having to rely on the availability of gluten-free (GF) products (GFPs) in the retail market. The need for GFPs is to substitute cereal-based gluten-containing (GC) foods and achieve a greater food variety in their ongoing diet.

However, the low availability and high pricing of GFPs have been highlighted as major factors impeding adherence to GFD and are acknowledged as barriers at an organisational level (Abu-Janb & Jaana, 2020). In Greece, individuals living with CeD have remarked on the high cost of GFPs as a perceived barrier, despite improvements over time (Bathrellou et al., 2023) and have reported difficulties in following GFD due to cost

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and availability issues (Spyridaki et al., 2022). An earlier study in the Greek GFPs' market has also verified the relative higher cost of GFPs compared to their GC counterparts (Panagiotou & Kontogianni, 2017).

The higher cost of GFPs is mainly attributed to food production procedures, extending from the infrastructure and the raw materials used to the food distribution system and population demand (Demirkesen & Ozkaya, 2022). Nevertheless, the market is a dynamic entity, subject to financial, political, geographical and even climate fluctuations, suggesting the need to assess the cost of products regularly. Others have already attempted to look at relevant changes in the GFPs market, finding that even if the market has grown in terms of availability, this has not translated to substantial decreases in prices (Hanci & Jeanes, 2019; Lee et al., 2019). This seems to hold especially true for staple foods, like bread, for which a persistently higher price has been found compared to gluten-containing breads, while for other foodstuffs, mixed differences have been observed (Hanci & Jeanes, 2019; Lee et al., 2019). These findings are being discussed in the context of supporting people with CeD at the system level, namely by providing a reimbursement plan, and are of special value to inform relevant governmental decisions (Kurien et al., 2018). Thus, assessing the cost of GFPs is an ongoing concern.

The economic challenges posed by the COVID-19 pandemic (International Monetary Fund, 2023), in addition to the latest GFPs pricing data for Greece dating about a decade earlier, in 2015 (Panagiotou & Kontogianni, 2017), informed our research. Thus, the present study aimed to assess the current pricing status of GFPs in the Greek retail market. To this end, we compared the retail price of the most frequently purchased GFPs with that of relevant GC products (GCPs) in the most frequently visited supermarkets in Athens, the capital of Greece, to assess potential pricing differences between staple and non-staple foods.

## METHODS

This is a retail observational study about recording the pricing of the most frequently purchased GFPs in the Greek retail market, being part of a European multicentred two-pronged study (Vriesekoop et al., 2020). To define which products were most commonly bought, an online survey was launched in 2022 (Ethical approval by Harper Adams University Research Committee, HAU-0439-202106, July 2021), aimed at people who buy GFPs for any reason, whether due to CeD or gluten intolerance or another non-medical reason. The questionnaire was sent directly to our network of people with CeD and was also distributed through official societies and associations with potential users,

such as the Hellenic Coeliac Society, the Hellenic Foundation of Gastroenterology and Nutrition, the Hellenic Association of Dietitians-Nutritionists, as well as famous CeD blogs. Informed consent, confidentiality and data protection statements were provided at the beginning of the questionnaire. Individuals were informed that their participation was entirely voluntary, without remuneration, and that their consent to partake was implied by answering the questionnaire. They were also informed that the survey was entirely anonymous, without the use of cookies, and that the information provided and the results produced would be used for research purposes and might be used in the production of a dissertation and/or dissemination by any other form of publication. A data storage safety statement was also included.

Consumers were asked about the frequency of purchasing GFPs (with potential answers: never, rarely, sometimes and often) from a list of 27 food groups (plus the additional option of 'Other'; Table S1), alongside the places of purchase, having to choose from a list of 12 supermarkets with the greatest market share in Greece (also allowing for the option to add one store in free-text). Moreover, they were asked to express their opinion about the availability and quality of GFPs in the Greek retail system by scoring various statements on a 5-point Likert scale ranging from 'strongly agree' to 'strongly disagree' (5 to 1 respectively), with 'neither agree nor disagree' as the neutral point.

Based on the findings of the first part of the study, a 'Greek GFPs shopping basket' was formulated, including those GF food groups that were stated to be purchased more frequently. To this end, a purchasing score between 0 and 3 was assigned per individual response regarding the frequency of purchases, corresponding to 'never' to 'often', respectively. Calculating the average purchasing score for each food category and setting the value of 1 as a cut-off value, reflecting an at least rare purchase of GF items of a food group, the GF food groups with an average purchasing score of greater than 1 were finally included in the GFPs basket. In this manner, 18 of the 27 food groups originally included in the questionnaire were used in this analysis (Table S1). These food groups were grouped into staple (i.e. breads, cereals, flours, pasta and rusks) and non-staple (i.e. chips, sweets, sauces and processed meat/meals) foods (Table 1), based on their role in a typical diet: those cereal-based foods eaten mostly in the context of a meal were regarded as staples while those mainly consumed as snacks or foodstuffs not being cereal-based were grouped as non-staple foods. Five supermarket chains (Sklavenitis, Lidl, MyMarket, AB Vassilopoulos and Masoutis) emerged as the most frequent places of GFPs purchases using the same survey. Following granted permission from relevant supermarkets, field investigators visited one retail shop of each supermarket chain in the province of Attica from

**TABLE 1** Counts and distribution of the 1058 unique gluten-free (GFPs) and gluten-containing (GCPs) products recorded, within the staple and non-staple food categories.

Food group	Food products	GFPs, <i>n</i> = 408, <i>n</i> (%)	GCPs, <i>n</i> = 650, <i>n</i> (%)
<b>Staple foods</b>		153 (38.7)	242 (61.3)
Breads	White, whole wheat, multigrain, for toast, for hamburger, baguette, ciabatta	16 (10.5)	28 (11.6)
Cereals	Breakfast cereals (e.g. corn flakes, muesli, granola, chocolate crispies and multigrain) and oat flakes	11 (7.19)	45 (18.6)
Flours	Bread flour (white and brown), all-purpose flour, organic and pastry mixes (for muffins, biscuits and cakes)	13 (8.50)	25 (10.3)
Pasta	Different kind of pasta (e.g. spaghetti, orzo, tortellini, lasagna, penne and fusilli)	35 (22.9)	71 (29.3)
Rusks	Rusks (dried bread), crackers, breadsticks, tortilla, rice and corn wafers, pizza base	78 (51.0)	73 (30.2)
<b>Non-staple foods</b>		255 (38.5)	408 (61.5)
Chips	Potato chips, nachos, popcorn, corn snacks	46 (18.0)	57 (14.0)
Sweets	Cookies, biscuits, chocolates, wafers, pralines, snack bars and ice creams	80 (31.4)	267 (65.4)
Sauces	Cold sauces and dressings (e.g. mayonnaise, mustard and ready-to-eat sauces) and baking agents (baking powder, yeast)	56 (22.0)	55 (13.5)
Processed meat/meals	Sausages of various types and flavours, and ready-to-eat pizza	73 (28.6)	29 (7.11)

September to November 2022 and recorded all available GFPs and their gluten-containing (GCPs) counterparts, alongside their packaging weight and retail price. Any product being labelled gluten-free or being stocked in the gluten-free supermarket section without labelling but having a GF ingredient list was considered for inclusion in the study's GFPs data set. As GF counterparts, any conventional GC product best matched for the product characteristics was considered for inclusion in the study's GCPs data set. Thus, for a given GF product, all equivalent GCPs in terms of type, flavour and any special characteristics were recorded.

Categorical data (i.e. sample per food category) are presented as absolute (*n*) and relative frequencies (%). Graphical methods (histogram, boxplot) were used to assess the normality of the product price distribution. Continuous data (i.e. retail price per 100g of product) are shown as median (25th percentile; 75th percentile). A two-level linear mixed quantile regression model was used to compare the median price per 100g of the product between GFPs and GCPs. The model accounted for the skewness in the distribution of the price product and allowed for random slopes for product type and random intercepts for supermarkets. These levels were selected to account for the hierarchical structure of the data, as the product price is nested within the product type, which is nested within the food market. Parameters in the random effects model were estimated with the gradient search algorithm. The model's fit against the random intercept-only model was

assessed with Akaike's Information Criterion. Results are shown as regression coefficients alongside 95% confidence intervals (CI). All tests were two-sided, and all analyses were performed in R (R Core Team, 2022). Linear mixed-model analyses were performed using the 'lqmm' package in R (Geraci, 2014).

## RESULTS

Respondents to the online survey were 453 adults (85% females), 90% of whom were between 18 and 54 years old, 41% were living in the province of Attica and 73% reported buying GFPs due to CeD (being diagnosed with or being a carer of someone with CeD). Across the five supermarket chains, recording of all the products available on the shelves of the 18 food categories that had emerged as the most frequently purchased, resulted in a total sample of 1058 unique products, 408 GFPs and 650 matched GCPs (equivalent to 1.6 GCPs available for every 1 GFP). Of the staple GFPs, approximately half were rusks (e.g. crispbreads, crackers and breadsticks) and just under 25% were pasta, while these figures were about 30% each for the GCPs (Table 1). About 60% of the non-staple GFPs were products of processed meat/meals and sweets, with sweets alone accounting for approximately 65% of the non-staple GCPs (Table 1).

Of the 408 unique GFPs, 235 (57.6%) were products recorded in a single supermarket, whilst the remainder,

173 (42.4%) were found in at least two supermarkets. On the contrary, out of the 650 GCPs, a minority of 228 (35.1%) were recorded in a single supermarket and the rest 422 (64.9%) products were available in multiple supermarkets. Thus, in total, the number of retail prices available for analyses was 2165 (696 pricing values for GFPs and 1469 pricing values for GCPs; Table 2). The median price per 100 g for GFPs was €1.30 (IQR: €0.85–€2.00) compared to €1.05 (€0.54–€1.54) for GCPs, regardless of the market or the product type (Figure 1). On average, overall staple GFPs were about three times (3.22; 95% CI: –3.21 to 9.65) more expensive than equivalent GCPs (median price per 100 g [IQR]: €1.48 [€0.90; €1.96] vs. €0.46 [€0.28; €0.80], respectively), with breads being the most expensive GFPs, followed by pasta, rusks and flours (Table 2). Nevertheless, absolute differences in median prices ranged from approximately €0.30 to €1.00 (Table 2). The non-staple GCPs exhibited a slightly elevated median price per 100 g in comparison to the corresponding GFPs. However, the median price was higher for GFPs ‘Sweets’ and ‘Processed meat/meals’, though the difference was minimal (Table 2).

According to the random effects model, overall, no significant differences were found in the median price of GFPs compared to GCPs (0.12 EUR per 100 g [95% CI: –0.13 to 0.37,  $p=0.35$ ]), although this value differed between staple and non-staple items. Staple GF food groups were estimated to have a higher median price by approximately €1.03 (€0.93–€1.13) per 100 g, compared to their GC counterparts, while non-staple GF items were estimated to have a slightly lower median price relative to the one of the GC equivalents, with a decrease of approximately €0.20 (–€0.37 to –€0.02) per 100 g. Individual inspection of the food groups suggested a higher cost of the GFPs compared to the relevant GCPs, although no differences were found for cereals, and a slightly lower price was observed for chips and sauces (Figure 2; Table S2). Specifically, among the staple food items, the median price per 100 g of the GFPs was estimated to range from €0.28 (€0.24; €0.32) more for ‘Flours’ to €1.14 (€1.00; €1.28) more for ‘Rusks’, whereas within non-staple food items, the median price per 100 g for GFPs was estimated to be approximately €0.54 (€0.49–€0.60) more for ‘Sweets’ and €0.19 (€0.008–€0.37) for ‘Processed meat/meals’ food

Food group	GFPs, <i>n</i> = 696, Price (EUR) per 100g	GCPs, <i>n</i> = 1469, Price (EUR) per 100g	Price ratio (95% CI)	Median price (EUR per 100g) difference (95% CI)
Staple foods	1.48 (0.90; 1.96)	0.46 (0.28; 0.82)	3.22 (–3.21; 9.65)	1.02 (–0.71; 2.75)
Breads	1.43 (1.19; 1.55)	0.45 (0.34; 0.49)	3.18 (1.25; 5.11)	0.98 (0.41; 1.55)
Cereals	1.00 (0.92; 1.11)	0.96 (0.64; 1.06)	1.04 (0.32; 1.76)	0.04 (–0.63; 0.71)
Flours	0.51 (0.47; 0.58)	0.23 (0.22; 0.28)	2.22 (1.13; 3.31)	0.28 (0.10; 0.46)
Pasta	0.86 (0.75; 1.42)	0.28 (0.23; 0.37)	3.07 (–1.06; 7.20)	0.58 (–0.41; 1.57)
Rusks	1.93 (1.49; 2.55)	0.82 (0.65; 1.00)	2.35 (–0.03; 4.73)	1.11 (–0.51; 2.73)
Non-staple foods	1.23 (0.85; 2.00)	1.41 (1.03; 1.85)	0.87 (–0.52; 2.27)	–0.18 (–2.23; 1.87)
Chips	1.14 (0.99; 1.93)	1.30 (1.11; 1.54)	0.88 (–0.26; 2.01)	–0.16 (–1.66; 1.34)
Sweets	2.13 (1.35; 2.33)	1.58 (1.10; 2.25)	1.35 (–0.34; 3.03)	0.55 (–1.65; 2.75)
Sauces	0.73 (0.62; 0.97)	0.84 (0.72; 1.26)	0.87 (–0.14; 1.88)	–0.11 (–1.04; 0.82)
Processed meat/meals	1.21 (0.91; 1.43)	1.05 (0.80; 1.22)	1.15 (0.17; 2.14)	0.16 (–0.81; 1.13)

Note: Data are shown as median (1st quartile; 3rd quartile). Price ratio calculated as GFP/GCP price. Median price difference (EUR per 100g) calculated as GFP–GCP price. 95% confidence intervals (CI) calculated using an approximation approach to estimate the standard errors of the medians from interquartile range. To compute the CIs we assumed a normal distribution for the ratio and the difference in median price.

**TABLE 2** Pricing (EUR per 100g) of 2165 products per food group for the gluten-free (GFPs) and gluten-containing (GCPs) product categories, and the relative difference of the median prices between GFPs and GCPs per food category.



groups, compared to the equivalent GCPs (Figure 2; Table S2).

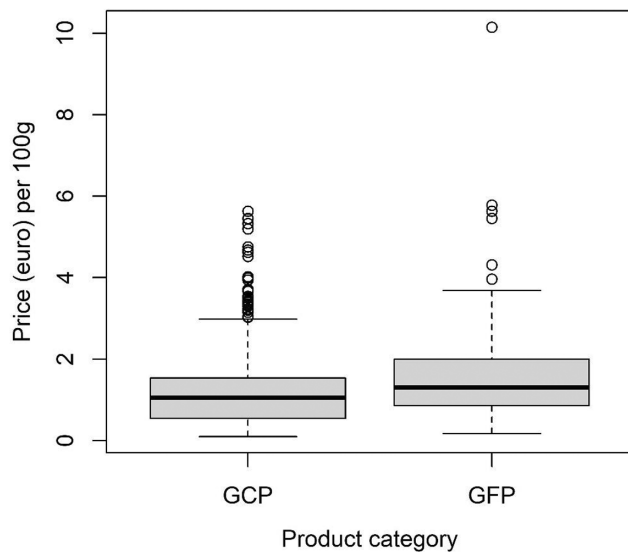
Consumers of GFPs indicated a low degree of satisfaction with availability, as more than two-thirds of the surveyed population expressed their disagreement with the statements about well-stocked GF shelves and agreed they often had to visit multiple stores to obtain the GFPs they required. Moreover, they scored a median value of 2.00 (1.0, 2.0) on the question about the 'value for money' of GFPs they bought from Greek

supermarkets, with 7 out of 10 stating their disagreement with the pricing of GFPs (Table 3).

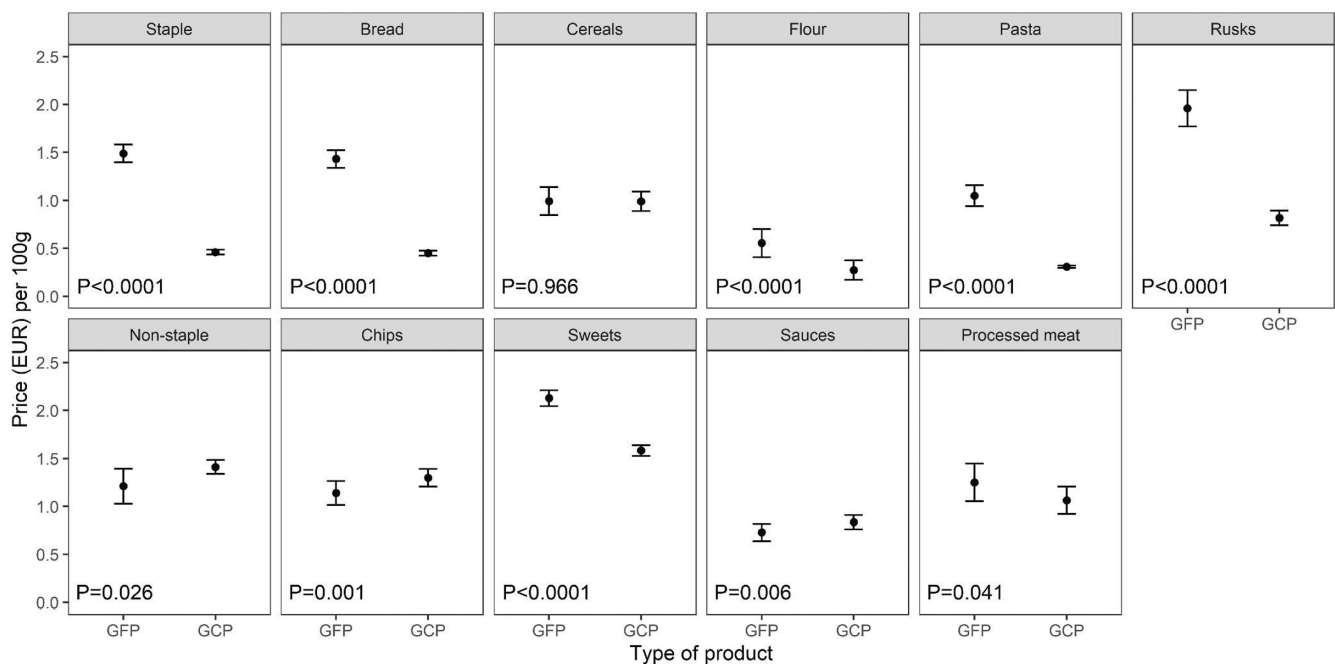
## DISCUSSION

The findings of the present study indicate that the average price of staple GFPs in the Greek market was higher than that of their GC counterparts, with the price differences being most pronounced for breads, rusks and pasta within the GF group. Furthermore, GFPs classified under the non-staple food groups of sweets and processed meats/meals exhibited higher prices than their corresponding GCPs.

The high cost of GFPs is a consistent finding across countries, regions and venues. Studies on cost assessment conducted in Europe, especially in the United Kingdom (Capacci et al., 2018; Fry et al., 2018; Hanci & Jeanes, 2019; Vriesekoop et al., 2020), Austria (Missbach et al., 2015) and Spain (De Las Heras-Delgado et al., 2021), and in North (USA (Lee et al., 2019), Canada (Jamieson & Gougeon, 2017)) and South America (Brazil, do Nascimento et al., 2014), Chile (Estevez et al., 2016), unanimously find GFPs to be more expensive than their GC counterparts. This observation seems to persist over time. Vriesekoop and colleagues (Vriesekoop et al., 2020) formed a GF basket in the United Kingdom and tracked the retail price of its GFPs over 4 years. They found that the overall GFPs-to-GCPs price ratio increased, due to a greater increase in the retail prices of the GFPs per se



**FIGURE 1** Distribution of price (EUR) of food items per 100g between gluten-free (GFP) and gluten-containing (GCP) products.



**FIGURE 2** Fitted values for prices (EUR) of food groups per 100g between gluten-free (GFP) and gluten-containing (GCP) products by food group. Dots represent point estimates, bars represent 95% confidence intervals. Data were calculated from estimates shown in Table S2.

**TABLE 3** Participants' satisfaction with availability and cost statements related to their experiences in purchasing gluten-free products (GFPs;  $n = 453$ ).

Statements about GFPs	Median score (Q1, Q3), ( $n = 453$ )	Mainly disagree, $n$ (%)	Mainly agree, $n$ (%)
I am satisfied with the range of GFPs available in supermarkets	3.0 (2.0, 3.0)	200 (44.2)	98 (21.7)
I think that the shelves in the 'gluten-free' section of supermarkets are well stocked	2.0 (1.0, 3.0)	297 (65.6)	60 (13.3)
I often have to go to many different stores to get the GFPs I need	5.0 (3.0, 5.0)	68 (14.7)	336 (71.2)
I feel that there is a good value for money in the GFPs I buy from supermarkets	2.0 (1.0, 3.0)	314 (69.3)	41 (9.1)

Note: Values are median scores (Q1, Q3) of the responses on a 5-point Likert scale ranging from 'strongly agree' to 'strongly disagree' (5 to 1, respectively), with 'neither agree nor disagree' as the neutral point. Opinions have been grouped as mainly disagree (strongly disagree or disagree) and mainly agree (agree or strongly agree) with each statement, for which two grouped categories of responses, absolute number and percentage of the surveyed population, are also presented (the rest of the responses, out of the 453 total ones, correspond to the neutral opinions, data of which are not shown).

rather than a decrease in the price of their GC comparators. Hanci and Jeanes (Hanci & Jeanes, 2019), who compared UK data between 2017 and 2011, concluded that no narrowing of the percentage difference between GFPs and GCPs has been seen over time, and though changes compared to the past varied among food categories, breads were found with a relatively higher price. Similarly, in the comparison of the relative cost of GFPs in the United States over a decade (2016 vs. 2006; Lee et al., 2019), breads were found to be more expensive than in the past, whilst the pricing of other food categories, such as mass-market manufactured products (e.g. cakes), decreased. However, accounting for inflation, an overall decrease in the relative cost of GFPs (i.e. from 240% in 2006 to 183% in 2016) was observed (Lee et al., 2019). Apart from the retail price observations, the high cost of GFPs has also been highlighted by consumers (do Nascimento et al., 2017; Ferster et al., 2015; Muhammad et al., 2017; Vriesekoop et al., 2020), in accordance with the low 'value-for-money' perception stated by the participants in the current study.

Bread and staple flour-based foods merit a special mention when it comes to the cost of GFPs. In accordance with our results, the relative difference in prices between GFPs and GCPs mainly includes staple foods, with breads and flours mostly found at the top of such rankings (Capacci et al., 2018; Chrysostomou et al., 2020; Fry et al., 2018; Jamieson & Gougeon, 2017). Previous work in Greece (Panagiotou & Kontogianni, 2017) has also designated breads as the relatively most expensive product category. Based on our current findings, GF consumers are required to pay, on average, €3.4 more for an ordinary loaf of bread (around 350g), compared to a GC one. Data altogether indicate that the GFD is

associated with higher costs, with particular implications for financially vulnerable populations. However, the absolute differences are not as pronounced in all groups. Addressing the high costs, Chrysostomou and colleagues (Chrysostomou et al., 2020) found a healthy GF basket to be unaffordable for low-income people in Cyprus, accounting for about half of the guaranteed minimum income, while Capacci and colleagues (Capacci et al., 2018) found that a GF basket accounts for about one-third of the food budget, but the ratio is higher for those on the lowest compared to the highest income quartile.

The cost of GFPs is studied under the umbrella of potential barriers to adherence to the GFD, with implications for providing financial support to people with CeD. The high cost of GFPs is regarded as a barrier at an organisational level, while lack of reimbursement is one at the system level (Abu-Janb & Jaana, 2020). Across countries, different financial strategies may be in place, including tax reduction, cash transfer, food provision and subsidy, though in some countries no such measurements exist or they are shrinking due to changes in health policy (Bozorg et al., 2024; Pinto-Sanchez et al., 2015). In Greece, there is a law in place for reimbursing people with CeD a specific amount of money (100 euros per month for adults, 150 euros per month for children) for purchases of GFPs, mainly falling in the staple food categories, but also allowing reimbursement for some flour-based sweet snacks (Greek Government Gazette, 2018). People with CeD living in Greece underscored the high cost of GFPs and acknowledged the importance of receiving state reimbursement (Bathrellou et al., 2023). The same perception has been also recorded by others (Xhakollari & Canavari, 2019). The findings of the present study may serve as an argument for retaining the state refund. Nevertheless, the cost

associated with GF food is considered only a part of the 'economic iceberg of CeD', referring only to direct costs incurred by individuals with CeD (Bozorg et al., 2024), which is a minor part of the overall economic burden of CeD for the healthcare system (Mårild et al., 2020). Considering that not following a GFD may result in greater societal and human costs (Bozorg et al., 2024), providing a state refund for GFPs purchases seems a cost-effective strategy. Among the strengths of the current study is that the GF food categories and supermarkets included were informed by prior relevant survey results focused on the purchasing habits of GF product consumers. Moreover, the products (GF and GC) to be recorded on-site were selected by dietitians after thoroughly checking food labels. Involving five different supermarket chains contributed to greater variation of the product pricing, also allowing for a greater sample size, counting 114 GFPs and 142 GCPs brands and more than 2000 price recordings. Lastly, the hierarchical modelling considered variation in prices based on supermarket/chain and brand/type, permitting attribution of differences in retail prices between GF and GC products solely to the gluten status of products. Nevertheless, there are a few limitations. Products were recorded only in physical supermarkets and not in online stores, where availability, but also cost, may have been greater (Hanci & Jeanes, 2019), as the online consumer survey did not differentiate between the two modes of purchase. Moreover, although recording was limited within the Attica province, data were collected from five supermarket chains present all over Greece holding similar prices. Whilst transportation cost is added when forming the prices in distal areas, it is anticipated to encumber GFPs and GCPs alike, resulting in constant expected differences in pricing between the two groups. Lastly, pricing variability resulted in wide confidence intervals, precluding statistical significance in the ratio and median differences. However, some of the variation in prices due to the type and the supermarket was accounted for in the multilevel modelling.

In conclusion, the findings of the present study highlight the persisting higher cost of staple GFPs, thus supporting the need for ongoing financial support for people with CeD. Assessing the extra cost of the GFD posed to people with CeD based on actual dietary intake data rather than assessing the cost of GFPs in the retail market would provide better insight into the adequacy of the support provided.

### AUTHOR CONTRIBUTIONS

Conceptualisation: FV, MDK, Data collection: DL, EP and EF, Analyses: EB, VB, Draft and visualisation: EB, Editing: VB, MDK, Reviewed by all. All authors are in agreement with the manuscript and declare that the content has not been published elsewhere.

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### CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

### DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

### ETHICS STATEMENT

The study did not require approval by an Ethics Committee. The main protocol involved pricing recording of products in supermarkets. However, an online survey preceded, addressed to gluten-free product consumers, for which approval by the Harper Adams University Research Ethics Committee (HAU-0439-202 106) was obtained. Informed consent, confidentiality and data protection statements were provided at the beginning of the questionnaire; thus, consent to partake was implied by answering the questions.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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