foods

MDPI

Article

Gluten-Related Knowledge, Beliefs, Information Sources, and Gluten-Free Diet Adoption: An Exploratory Online Survey

Mina Janković [1,*], Jelena Ostojić [1] and Ljilja Torović [2,3]

[1] Department of General Education Subjects, Faculty of Medicine, University of Novi Sad, Hajduk Veljkova 3, 21000 Novi Sad, Serbia; jelena.ostojic@mf.uns.ac.rs
[2] Department of Pharmacy, Faculty of Medicine, University of Novi Sad, Hajduk Veljkova 3, 21000 Novi Sad, Serbia; ljilja.torovic@mf.uns.ac.rs
[3] Center for Medical and Pharmaceutical Investigations, Faculty of Medicine, University of Novi Sad, Hajduk Veljkova 3, 21000 Novi Sad, Serbia
* Correspondence: mina.jankovic@mf.uns.ac.rs

Abstract

Background/Objectives: Gluten-free diets (GFDs) are increasingly adopted beyond medically diagnosed gluten-related disorders (GRDs), yet consumers' understanding of their clinical and nutritional implications remains insufficiently characterized. This study assessed gluten-related knowledge, beliefs, and information sources among adults, predominantly in Serbia. Methods: A cross-sectional, non-probability online survey was conducted from June 2025 to April 2026. Recruitment was conducted through a combination of a snowball (personal communication networks and respondent sharing) and a targeted approach (GFD-related organizations, online communities, and specialized food businesses). Most respondents were younger, well-educated women, which limits the generalizability of the results. Respondents were classified as those not following a GFD (No-GFD; n = 1467), following a GFD for a self-reported medical reason (M-GFD; n = 121) (diagnosis was not independently verified), or following one without such a reason (NM-GFD; n = 89). Self-reported medical reasons, including celiac disease (CD), wheat allergy and non-celiac gluten sensitivity (NCGS), were pooled in M-GFD. Group-specific frequencies and exploratory multiple correspondence analysis of response categories were used. Exploratory multivariable linear regression examined associations of the knowledge score with medical motivation, age, sex, and medical education background among GFD followers (n = 210). Results: Item-level responses described disease concepts and nutritional beliefs about gluten-free foods (GFFs). M-GFD respondents selected healthcare professionals and CD associations among their information sources. NM-GFD participants relied primarily on Internet searches, reported perceptions of GFFs as inherently healthier, and commonly cited feeling better, a healthy lifestyle, and self-assessed gluten sensitivity as reasons for gluten avoidance. Nevertheless, knowledge gaps persisted even in the M-GFD group, particularly regarding potential micronutrient risks. Internet and social-media use was widespread, and the AI-related information-source option was selected by approximately one-quarter of M-GFD and one-sixth of NM-GFD participants. The multivariable linear regression model explained 11.8% of 0–8 knowledge-score variance (R^2 = 0.118; adjusted R^2 = 0.101; $p < 0.001$). Medical motivation was associated with a 0.61-point higher score after adjustment for age, sex, and medical education background (95% CI 0.27–0.95; $p < 0.001$). Conclusions: These descriptive findings and exploratory adjusted associations identify possible targets for differentiated nutrition education and critical appraisal of digital information. The effectiveness of these proposed approaches requires evaluation.

Academic Editor: Osman Sagdic

Received: 1 October 2026
Revised: 14 November 2026
Accepted: 26 November 2026
Published: 29 November 2026

Copyright: © 2026 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license.

Keywords: gluten-related disorders; gluten-related knowledge; gluten-free diet adoption; dietary beliefs; information sources; nutrition education; online survey; Serbia

1. Introduction

Food allergies and food intolerances are common adverse reactions to foods, affecting millions of people worldwide. For most affected individuals, strict avoidance of the offending food component remains the primary effective management strategy [1]. Among these conditions, gluten-related disorders (GRDs) present unique challenges because successful treatment depends on dietary modification requiring consumer engagement with food purchasing, preparation, and consumption.

Gluten, a protein complex naturally present in wheat, rye, and barley, is responsible for a spectrum of GRDs, including celiac disease (CD), wheat allergy (among other wheat proteins), and non-celiac gluten sensitivity (NCGS). Collectively, GRDs are estimated to affect approximately 10% of the population, while CD alone has a global prevalence of about 1% [2]. Their incidence has increased in recent decades, partly because of improved diagnostic approaches and partly because of a genuine rise in disease occurrence [3]. These disorders fall into three main categories: autoimmune, allergic, and non-autoimmune/non-allergic [4]. In genetically predisposed individuals, autoimmune responses include conditions whose pathogenesis is mediated by T cells, such as CD, as well as dermatitis herpetiformis and gluten ataxia, which present with cutaneous and neurological manifestations [3]. Wheat allergy involves rapid immune responses primarily mediated by IgE, which can lead to severe reactions such as wheat-dependent exercise-induced anaphylaxis (WDEIA) [5]. NCGS has an incompletely understood pathogenesis; wheat components other than gluten, including fructans and amylase–trypsin inhibitors, may contribute [2,3]. These disorders differ in pathophysiology and dietary management must be tailored to the condition: CD requires a strict lifelong gluten-free diet (GFD), wheat allergy requires avoidance of the relevant wheat proteins with individualized allergy management, and NCGS may require individualized gluten or wheat restriction [3,4,6].

Successful GFD depends, among other things, on consumers' ability to identify safe foods. Within the European Union, allergen management and communication are regulated through a comprehensive legislative framework that requires mandatory declaration of priority allergens, including gluten-containing cereals, and establishes criteria for the voluntary use of the claims "gluten-free" (≤20 mg/kg gluten) and "very low gluten" (≤100 mg/kg gluten) [7,8].

Importantly, adherence to a GFD has expanded well beyond individuals with medically diagnosed GRDs. Increasing public interest in healthy lifestyles, weight management, and wellness, together with the influence of social media and digital health information, has contributed to the widespread perception that GFFs are inherently healthier than their gluten-containing counterparts [3,6,9–13]. Although the GFF market has grown substantially in response to this demand, evidence suggests that many individuals without a medical indication adopt a GFD based primarily on perceived health benefits rather than scientific evidence [14]. A cognitive bias, where consumers perceive a food product as overall healthy because of one or a few positive attributes (e.g., *gluten-free*, *organic*, *low-fat*), despite the product's other less healthy components/properties, is known as a health halo effect. This effect can lead to overestimating the product's overall healthiness, affecting purchasing and consumption habits [15]. This trend raises important questions regarding consumers' understanding of GRDs, their perceptions of the nutritional quality of gluten-free foods (GFFs), and the extent to which dietary decisions are driven by evidence-based knowledge or health-related beliefs. Despite growing interest in GFDs, data

on nutritional and gluten-related knowledge remain limited, and in some countries and regions, are entirely lacking.

Not only does gluten avoidance itself offer no proven benefit in individuals without a GRD, but long-term adherence to a GFD may also pose nutritional concerns and practical challenges. Compared with conventional products, many commercially available GFFs contain lower amounts of dietary fiber, vitamins, and minerals, while being higher in refined starches, simple sugars, saturated fats, sodium, and energy density; however, differences are not uniform. Thereby, individuals following a GFD may be at increased risk of nutritional inadequacies [3,6,9–12]. Consequently, successful long-term GFD management requires not only gluten avoidance but also informed food selection to ensure nutritional adequacy. This places nutrition knowledge at the center of effective dietary management and highlights the importance of distinguishing naturally occurring GFFs from highly processed gluten-free alternatives, since nutritional quality varies with formulation. Naturally gluten-free foods include legumes, vegetables, fruit, nuts, seeds, and suitable grains and pseudocereals [16]; however, their inclusion does not by itself establish a balanced diet. Gluten-free status and nutritional adequacy therefore require separate assessment.

Previous surveys have examined awareness among the public, chefs, and patients [17], food identification among people with CD [18], the GFD experience in the Greek population [19], knowledge among women at a Saudi health sciences university [20], and GRDs and GFD use in Paraguay [21]. These populations and instruments differ from the present setting. This study contributes an integrated description of disease-related concepts, nutritional beliefs, motivations, and information sources in Serbia and the Central Balkans, where data on these topics have previously been lacking.

The study objectives were to describe (1) item-level responses concerning disease-related and nutritional knowledge in a non-probability online sample of adults with and without GFD experience; (2) motivations for following a GFD among respondents without a medical indication and reasons for not adopting a GFD among those not following one; and (3) information sources reported by respondents with GFD experience. A secondary exploratory objective was to examine the association between self-reported medical motivation and the knowledge score among GFD followers.

2. Materials and Methods

2.1. Study Design and Participants

This cross-sectional, non-probability online study used a self-administered Serbian-language questionnaire implemented through web-based application Google Forms. Data were collected from June 2025 to April 2026. Recruitment and dissemination were centered in Serbia; the sample is therefore described as predominantly Serbian, although it included adults from Bosnia and Herzegovina and Montenegro.

The study protocol was approved by the Ethics Committee of the Faculty of Medicine, University of Novi Sad (Approval No. 01-39/63-4/2). The introductory page described the study objectives, explained that participation was voluntary, informed participants of their right to withdraw at any time, and assured anonymity and confidentiality.

Eligibility required prior electronic consent to participate in the survey, age ≥ 18 years, residence in Serbia, Bosnia and Herzegovina, or Montenegro, and submission of a complete questionnaire accepted after the eligibility and response-quality review described below. Individuals who did not provide consent, were younger than 18 years, resided outside the three eligible countries, or did not submit a complete and credible response were ineligible.

Recruitment occurred in two non-probability arms. One used personal communication networks and respondent sharing (snowball recruitment) to obtain a broad online

sample. Targeted recruitment was directed toward people with experience of a GFD to increase the number of GFD respondents for descriptive analysis; invitations were disseminated through patient organizations, Viber and Facebook communities related to GRDs, Instagram, and food businesses specializing in GFFs. This design likely enriched the final GFD groups with people who were more engaged with disease-specific organizations, online information, and specialized retailers. Due to respondent sharing of the questionnaire, the recruitment-source identifiers were not available. Consequently, arm-by-group counts cannot be reconstructed, precluding assessment of recruitment-channel effects.

The analytical data did not retain separate identifiers for current versus recent former GFD use (a reference period of the last two years, as defined on the survey's introductory page; respondents who had discontinued a GFD more than two years earlier were ineligible); therefore, separate counts and analyses were unavailable. They were pooled to describe GFD experience within the recent period and retain the available analytical sample. This does not establish equivalence between current and former followers; recall, dietary duration, and reasons for discontinuation may influence responses. Importantly, the reference timeframe was not accompanied by substantial changes in relevant external conditions, including the regulatory framework, market availability of GFFs, or healthcare systems in the three countries, as assessed through a review of relevant regulations, market insights, and consultations with public health professionals. Moreover, current followers themselves varied considerably in the duration of their GFD experience; therefore, current adherence did not represent a uniform duration of GFD exposure. Pooling these participants was thus considered appropriate for the present analysis.

Participants from different countries were pooled for the principal descriptive analysis to preserve the available sample, but the geographical imbalance was substantial: 94.5% of respondents resided in Serbia, 3.8% in Bosnia and Herzegovina, and 1.7% in Montenegro. Country-specific counts and percentages are reported in Table 1; the two smaller national subsamples were insufficient for meaningful country-level comparisons. Similarities in language, income, food labelling implementation, GFF availability, healthcare access, and diagnostic practice allowed use of one questionnaire; however, certain differences cannot be excluded. Therefore, pooling is treated as an analytical convenience rather than evidence of regional representativeness. Income bands were harmonized using the euro-equivalent thresholds displayed in Table 1.

Table 1. Socio-demographic data of participants.

Socio-Demographic Data	Number (%)			
	No-GFD (*N* = 1467)	**NM-GFD (*N* = 89)**	**M-GFD (*N* = 121)**	**Total (*N* = 1677)**
Sex:				
male	307 (20.9)	15 (16.9)	7 (5.8)	329 (19.6)
female	1160 (79.1)	74 (83.1)	114 (94.2)	1348 (80.4)
Age:				
18–20 years	351 (23.9)	6 (6.7)	11 (9.1)	368 (21.9)
between 21 and 35 years	715 (48.7)	30 (33.7)	40 (33.1)	785 (46.8)
between 36 and 50 years	241 (16.4)	38 (42.7)	58 (47.9)	337 (20.1)
between 51 and 65 years	146 (10.0)	15 (16.9)	11 (9.1)	172 (10.3)
more than 65 years	14 (1.0)	0 (0.0)	1 (0.8)	15 (0.9)
Highest completed level of education:				
no formal education	1 (0.1)	0 (0.0)	0 (0.0)	1 (0.1)
elementary school	10 (0.7)	0 (0.0)	2 (1.7)	12 (0.7)
high school	763 (52.0)	27 (30.3)	47 (38.8)	837 (49.9)

college	69 (4.7)	9 (10.1)	8 (6.6)	86 (5.1)
university	624 (42.5)	53 (59.6)	64 (52.9)	741 (44.2)
According to your highest completed level of education, you are:				
high school student in medical field	138 (9.4)	1 (1.1)	7 (5.8)	146 (8.7)
college or university student in the medical field	486 (33.1)	15 (16.9)	5 (4.1)	506 (30.2)
medical doctor, pharmacist, dentist, or other professional in the medical field	185 (12.6)	15 (16.9)	8 (6.6)	208 (12.4)
none of the above	658 (44.9)	58 (65.2)	101 (83.5)	817 (48.7)
Employment status:				
pupil or student	646 (44.0)	13 (14.6)	17 (14.0)	676 (40.3)
unemployed	157 (10.7)	8 (9.0)	14 (11.6)	179 (10.7)
employed	645 (44.0)	66 (74.2)	89 (73.6)	800 (47.7)
retired	19 (1.3)	2 (2.2)	1 (0.8)	22 (1.3)
Monthly income:				
under 48,000 RSD (<400 €)	673 (45.9)	15 (16.9)	26 (21.5)	714 (42.6)
48,000–96,000 RSD (400–800 €)	187 (12.7)	15 (16.9)	20 (16.5)	222 (13.2)
96,000–120,000 RSD (800–1000 €)	298 (20.3)	25 (28.1)	47 (38.8)	370 (22.1)
above 120,000 RSD (>1000 €)	309 (21.1)	34 (38.2)	28 (23.1)	371 (22.1)
The region you live in:				
Vojvodina	989 (67.4)	54 (60.7)	48 (39.7)	1091 (65.1)
Central and Western Serbia	246 (16.8)	12 (13.5)	14 (11.6)	272 (16.2)
Belgrade region	132 (9.0)	11 (12.3)	39 (32.2)	182 (10.9)
Eastern and Southern Serbia	23 (1.6)	3 (3.4)	14 (11.6)	40 (2.4)
Bosnia and Herzegovina	55 (3.7)	6 (6.7)	3 (2.5)	64 (3.8)
Montenegro	22 (1.5)	3 (3.4)	3 (2.5)	28 (1.7)
Type of settlement where you live:				
urban	1043 (71.1)	68 (76.4)	99 (81.8)	1210 (72.2)
suburban	201 (13.7)	13 (14.6)	14 (11.6)	228 (13.6)
rural	223 (15.2)	8 (9.0)	8 (6.6)	239 (14.3)
Marital status:				
single	991 (67.6)	31 (34.8)	42 (34.7)	1064 (63.4)
married	362 (24.7)	49 (55.1)	55 (45.5)	466 (27.8)
in a common-law partnership	74 (5.0)	7 (7.9)	15 (12.4)	96 (5.7)
divorced	27 (1.8)	2 (2.2)	8 (6.6)	37 (2.2)
widowed	13 (0.9)	0 (0.0)	1 (0.8)	14 (0.8)

Note: Sums may deviate from 100% due to rounding.

2.2. Questionnaire

The combined questionnaire was developed by translating items from published surveys [3,6,10–13,17,19,20,22–29] and was reviewed by the research team for relevance, clarity, and coverage of the study objectives. Terminology was adapted to Serbian and then pilot-tested in a convenience sample of 20 adults to assess comprehension, wording, branching, layout, and completion burden; minor wording and layout changes were made, and pilot responses were excluded. Formal forward–back translation, independent expert content-validity ratings, cognitive interviews, and psychometric validation were not performed. Consequently, the instrument should be interpreted as a study-specific questionnaire rather than a validated food-literacy scale. The complete English questionnaire in the Supplementary Material provides item wording, response options, and branching, as well as an answer key and guide to references for questionnaire preparation.

Eligibility and quality review included age/residence screening, embedded attention checks, inspection for duplicated or automated response patterns, implausible completion time, and visual review of internally inconsistent response strings. When examining potentially inconsistent or implausible answers, contextual judgment was sometimes

necessary because no definitive criterion applied; to retain objectivity, review was performed by two independent researchers reaching consensus through discussion.

The questionnaire comprised sections addressing sociodemographic characteristics; use of conventional medications, food allergies and special diets; awareness and knowledge of CD and NCGS; understanding of disease management and prevalence; reasons for adopting or not adopting a GFD; recognition of naturally occurring GFFs and their nutritional deficiencies; information sources and beliefs about processed GFFs. Survey branching ensured that participants following a GFD for medical and non-medical reasons received a set of relevant questions, distinct from the one presented to No-GFD respondents. Items were analyzed individually for descriptive reporting. A study-specific, unvalidated composite knowledge score (0–8) was additionally used for the exploratory regression described in Sections 2.3 and 2.4.

2.3. Assessment of Gluten-Related Knowledge

Gluten-related knowledge was assessed among GFD followers, with knowledge items from the questionnaire that were assessed against the study-defined answer key. The knowledge score was constructed from eight questions, including what CD is, what NCGS is, and the approximate proportion of the world population affected by CD, as well as additional questions on the nutritional aspects of a GFD. The total score ranged from 0 to 8, with higher values indicating greater concordance with the study-defined answer key; it was not a validated measure of general gluten-related knowledge. The knowledge-related questions, the study-defined answer key, and scoring rules are given in Supplementary Material. The knowledge score was used as the dependent variable in relation to medical motivation for following a GFD as the main independent variable; age, sex, and medical education background were included as covariates.

2.4. Statistical Analysis

Google Forms stored only complete submissions, and required-response settings prevented item-level missingness in the submitted forms; therefore, the number of surveys initiated but abandoned was unavailable. The final analyses included 1677 eligible, complete submissions that passed the response-quality review (38 submissions were excluded). Required-response settings applied to items within the branch a respondent received; questions not administered through branching were not treated as negative answers or as item-level missingness; thus, no imputation was required.

Participants were classified descriptively as No-GFD (n = 1467), NM-GFD (current/recent GFD followers without a self-reported medical reason; n = 89), or M-GFD (GFD for a self-reported medical reason; n = 121). M-GFD is a motivation label, not a verified diagnosis. A self-reported medical reason took precedence in group allocation, without implying that medical and lifestyle motivations were mutually exclusive. The M-GFD group was treated as a single category due to very low representation of conditions other than CD (16/121).

Data coding was performed in Microsoft Excel 2021 Professional Plus, and analyses were performed in TIBCO Statistica v.13.5. The analysis was exploratory; results were reported as group-specific frequencies and percentages. For multiple-response questions, each option was coded independently, and the resulting percentages may sum to more than 100%. Because group sizes differed markedly, percentage distributions—not raw counts—were used for visual comparison wherever appropriate. Except for the explicitly reported knowledge-score regression, between-group wording refers only to observed frequencies or percentages; no inferential comparison of individual items was performed. Population sampling margins of error are not reported because recruitment was non-probability based.

Multiple correspondence analysis (MCA) was used as an exploratory visualization of the co-occurrence of response categories. No null-hypothesis tests, causal contrasts, or confidence intervals for between-group differences were performed, and wording was chosen to describe observed response distributions and co-occurrence patterns. Variables were selected a priori to represent the nutritional dimension of GFD knowledge addressed by the study objectives, namely recognition of naturally gluten-free, nutrient-rich foods and perceptions of the nutritional composition of processed GFFs and the risks of long-term adherence. Because these items were presented only to participants with current or recent GFD experience (questionnaire branching), the MCA included the 210 GFD participants (M-GFD, n = 121; NM-GFD, n = 89); as only items presented in identical form to both GFD groups were included, branching did not produce structurally missing responses. No-GFD participants did not receive these items and were not included. Sixteen active variables were selected before the analysis as all items in Section 2.2. that concerned the nutritional profile of a GFD: selection or non-selection of five naturally gluten-free food options and the separate "I do not know" option (six binary variables; Figure S4); agreement with the statements that people on a GFD may be at risk of overweight or obesity and of nutritional deficiencies, and that processed GFFs may have a higher glycemic index; and the perception that processed GFFs differ in calories, saturated fat, simple carbohydrates, dietary fiber, salt (sodium), minerals, and vitamins from processed gluten-containing foods. The lists of micronutrients at risk were not included because their many options would have produced numerous low-frequency categories. Each option of the multiple-response question was coded as a separate binary variable (selected/not selected), and each yes/no item was coded yes/no, giving 32 active categories. The least frequent active category ("I do not know" selected) comprised 21 participants (10.0%); therefore, no categories were merged or excluded as rare (relative frequency below 5%). Required-response settings prevented missing answers, so no missing-data handling was needed. The self-reported reason for following a GFD (M-GFD vs. NM-GFD) was entered as a supplementary (passive) variable: its categories were projected onto the map but did not contribute to the construction of the dimensions. The MCA was computed with the Burt table (32 × 32) of the 16 active variables as input. All reported eigenvalues, principal coordinates, contributions, and squared cosines are on the indicator-matrix scale: the eigenvalues λk are the principal inertias of the 210 × 32 indicator matrix (the square roots of the principal inertias of the Burt table), and the total inertia is $(J - Q)/Q = 1$, where $Q = 16$ is the number of active variables and $J = 32$ the number of active categories. Because percentages of inertia from indicator or Burt analysis understate how well the low-dimensional map represents the associations between variables, Greenacre's adjusted inertias are also reported. For each dimension with $\lambda k > 1/Q$, the adjusted inertia is $[Q/(Q - 1)]^2 \times (\lambda k - 1/Q)^2$, and it is expressed as a percentage of the average inertia of the off-diagonal blocks of the Burt table, $[Q/(Q - 1)] \times [\Sigma \lambda k^2 - (J - Q)/Q^2]$, where the sum runs over the full spectrum of all $J - Q = 16$ non-trivial eigenvalues ($\Sigma \lambda k^2 = 0.1027$, which is the total inertia of the Burt table; denominator = 0.0429). Six dimensions had $\lambda k > 1/Q$; with this denominator, the adjusted percentages do not sum to 100%. Dimensions were interpreted from category contributions; categories with a contribution above the average (100/32 = 3.125%) were regarded as defining a dimension. Coordinates, contributions, and squared cosines of all categories are reported in Table S1. Proximity between categories of different variables on the map was not interpreted as evidence of association, and the map is regarded as descriptive and hypothesis-generating rather than as a validated latent structure. Clustering of response categories was not performed. With two dimensions that explain a limited share of the inertia, and with similar eigenvalues for the second and third dimensions, the stability and incremental value of groupings based on the two-dimensional map were

not established. The MCA therefore describes the structure of response categories; it does not define clusters or profiles of individual respondents.

To examine whether medical motivation was associated with gluten knowledge independently of age, sex, and medical education background, exploratory multivariable linear regression was performed. Medical education background was defined as being a high-school or university student, or a medical doctor, pharmacist, dentist, or other professional in the medical field (the highest completed education and current medical-study/professional status are separate, mutually independent variables). The model was not prespecified and should be interpreted as hypothesis-generating associations rather than causal effects. All predictors were entered in the model simultaneously (standard method); no stepwise selection was used. The coding is given in the Supplementary Materials. The analysis included GFD followers only (n = 210). The 8-question knowledge score (the dependent variable, treated as continuous; Section 2.3) was regressed on medical motivation (M-GFD vs. NM-GFD), adjusted for age, sex, and medical education background. Results are presented as unstandardized coefficients (b) with 95% confidence intervals (CI), standardized coefficients (β), and p-values; model fit is reported as R^2, adjusted R^2, and the F-test. Multicollinearity was assessed with variance inflation factors (VIF), and residuals were inspected for normality and outliers. A p-value < 0.05 was considered statistically significant.

3. Results and Discussion

3.1. General Data on Participants

The socio-demographic data of participants are given in Table 1; anthropometric features and general lifestyle data in Table A1; self-reported reasons for the use of conventional drugs, declared by 45.5% of participants, in Table A2; and information on diagnosed food allergies, self-declared by 10.0%, and special diets, followed by 27.7% of participants, in Table A3. These factors may influence nutrition-related knowledge and beliefs; thus, they should be considered when interpreting the study findings.

Consistent with previous web-based nutrition surveys, in which women and younger adults are generally more likely to participate [30], the study population was dominated by younger, urban, well-educated women who were Serbian residents (Table 1). Lifestyle characteristics indicated generally health-conscious behaviors (Table A1). Most respondents reported consuming alcohol only occasionally (72.3%), whereas regular alcohol consumption was uncommon. Similarly, the majority had never smoked cigarettes (72.6%). Consumption of coffee and other caffeinated beverages was widespread, with more than half of respondents reporting regular intake and a further third consuming such beverages occasionally. Self-reported physical activity levels suggested a relatively active population, with moderate activity reported most frequently, followed by satisfactory, low, and intensive. Participants also reported a positive perception of their overall quality of life, with 39.4% rating it as very good and 12.0% as excellent, whereas only a small proportion rated it as poor. Overall, these findings are consistent with previous dietary surveys conducted among adults in the Central Balkans [30], indicating broadly comparable lifestyle characteristics.

The use of prescribed medications was relatively frequent (Table A2), suggesting that the study population included individuals with a broad spectrum of acute and chronic health conditions, although medications for common short-term conditions, particularly infections and headache, were reported most frequently. The relatively high prevalence of prescription medication use, consistent with [30], should be considered when interpreting dietary practices, particularly among individuals receiving long-term therapy for endocrine, cardiovascular, gastrointestinal, or autoimmune diseases, where dietary modifications and supplements may have clinical relevance.

The questionnaire asked about food allergy reportedly confirmed by a healthcare professional and offered "gluten/wheat" and "lactose" among the options. The gluten/wheat option was offered considering that many of the major wheat allergens belong to gluten proteins [4], but the wording may have encouraged conflation of allergy and intolerance. Therefore, 102 of 167 respondents answering yes (61.1%; Table A3) for "gluten/wheat" cannot be interpreted as subjects with verified wheat allergy. CD and NCGS are not food allergies, and lactose intolerance is distinct from milk-protein allergy [4]. Reported current or previous adherence to a special diet most frequently identified a ketogenic diet, a diet rich in fruits and vegetables with reduced meat intake, a lactose-free diet, a vegetarian or vegan diet, and a diet adapted for diabetes (Table A3). The findings indicate that more than one-quarter of respondents had experience with dietary modification, primarily related to weight management, chronic disease management, or food intolerance and allergy.

Of the final study sample comprising 1677 participants, 1467 (87.5%) reported not following a GFD (No-GFD), for reasons presented in Figure 1.

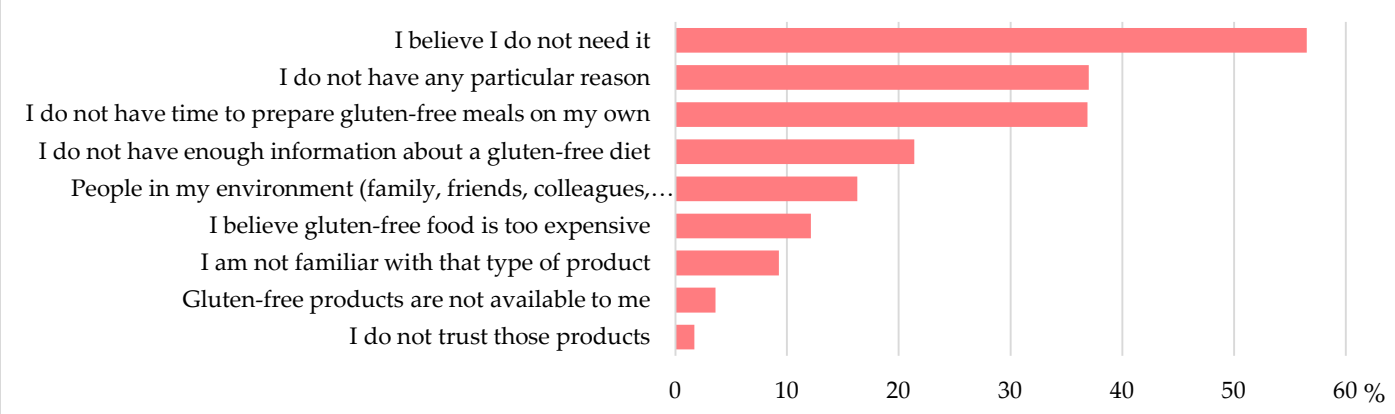


Figure 1. Reasons for not following a GFD among No-GFD participants (multiple-choice; percentages are based on the participant subgroup and may sum above 100%).

3.2. Nutrition and Gluten-Related Knowledge

Successful implementation of a GFD requires more than avoidance of gluten-containing foods; nutrition and gluten-related knowledge should encompass GRDs and their management, and awareness of the nutritional implications of dietary treatment. Furthermore, GFD followers should be able to translate this knowledge into informed dietary decisions. Nevertheless, important misconceptions persisted even among participants following a GFD for medical reasons, although the present analysis did not test the effect of dietary duration on understanding.

Disease concepts, nutritional beliefs, and self-rated knowledge were examined separately. Knowledge of CD was far greater than knowledge of NCGS across dietary groups. Recognition of CD as an autoimmune disorder increased markedly from No-GFD to NM-GFD and M-GFD participants, reaching 95.9% in the medically indicated group; however, its lifelong nature and potential to develop at any age were recognized less consistently (Figure 2A). Awareness of NCGS was considerably poorer, particularly among No-GFD participants, more than half of whom had never heard of the condition (Figure 2B). Knowledge of CD epidemiology was likewise limited, with relatively few participants correctly identifying its approximate global prevalence (Figure 2C). Similar observations have been reported previously, with public awareness of CD consistently exceeding that of NCGS, reflecting its longer clinical recognition and greater public visibility, while misconceptions regarding disease prevalence and characteristics remain common [17].

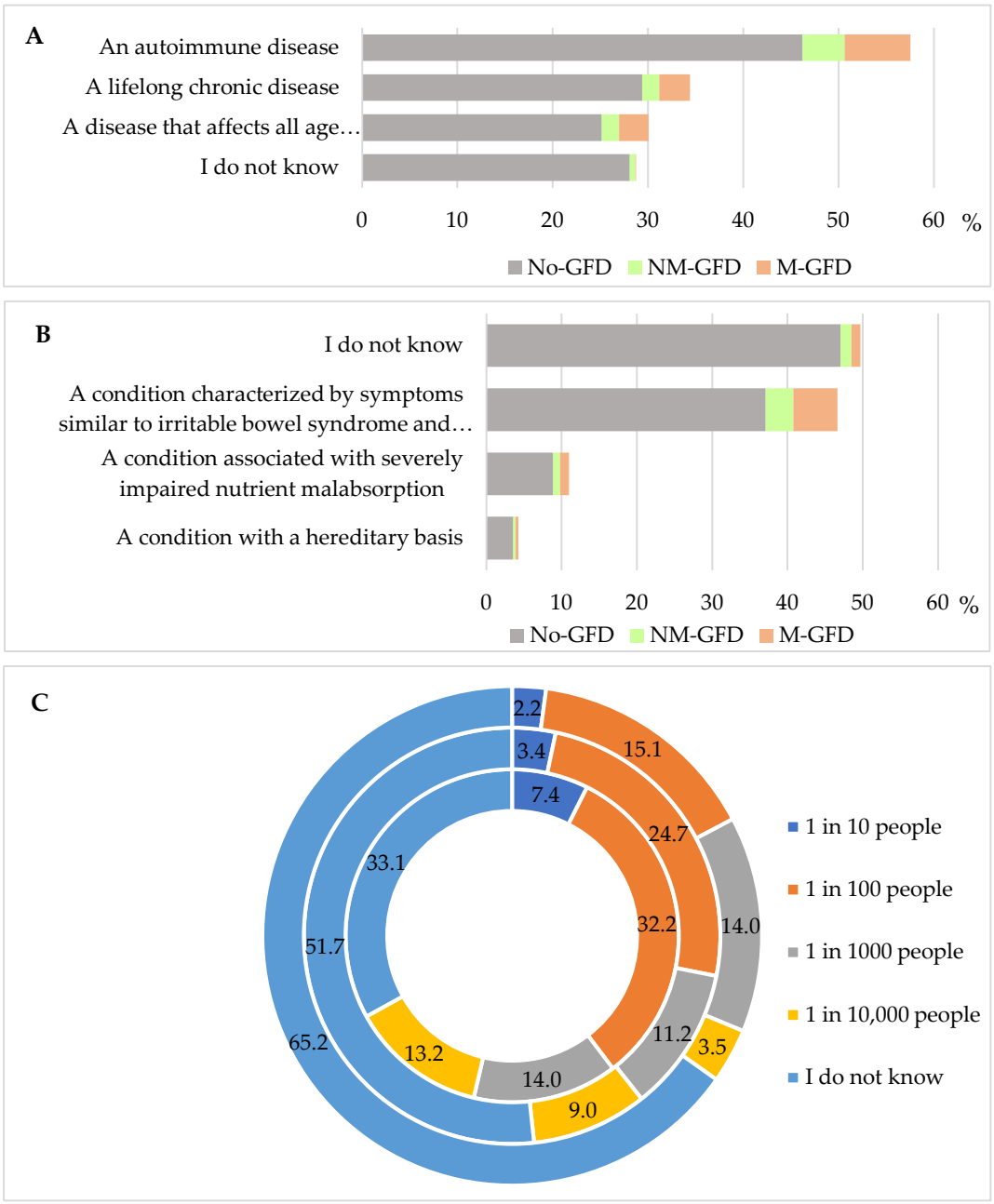


Figure 2. Knowledge of (**A**) CD, (**B**) NCGS, and (**C**) the approximate global prevalence of CD (%). *Note:* Panels (**A**,**B**) represent multiple-choice questions; percentages are based on the total number of participants and may sum to more than 100%; the entire sample (n = 1677) was the denominator for displayed group contribution. In panel (**C**), circles from outside to inside represent No-GFD, NM-GFD, and M-GFD participants, respectively; panel (**C**) uses the respective group denominator.

Only one-third of No-GFD participants correctly identified dietary gluten avoidance, rather than pharmacological therapy, as the principal management approach for CD and NCGS (Figure S1). This limited awareness of diet-based management may underestimate both its therapeutic importance and the practical, social, and economic demands associated with sustained gluten avoidance, particularly for individuals with CD who require lifelong strict adherence.

Knowledge of CD risk factors was also incomplete among NM-GFD participants, among whom 57.3% recognized a positive family history as increasing the likelihood of CD (Figure S2). Related awareness examined among Spanish GFD users following

educational content [31] appeared rather high, but different instruments, recruitment, and educational exposure preclude direct quantitative comparison with the present NM-GFD.

Self-perceived knowledge showed a similar gradient: advanced knowledge was reported approximately twice as often by M-GFD as by NM-GFD participants (Figure S3). Taken together with the objective knowledge findings, these results indicate that voluntary dietary restriction may not be accompanied by a comprehensive understanding of GRDs or evidence-based dietary management.

Feeling better when eating gluten-free was the most frequently reported motivation among NM-GFD participants, followed by healthy-lifestyle considerations and self-assessed gluten sensitivity (Figure 3).

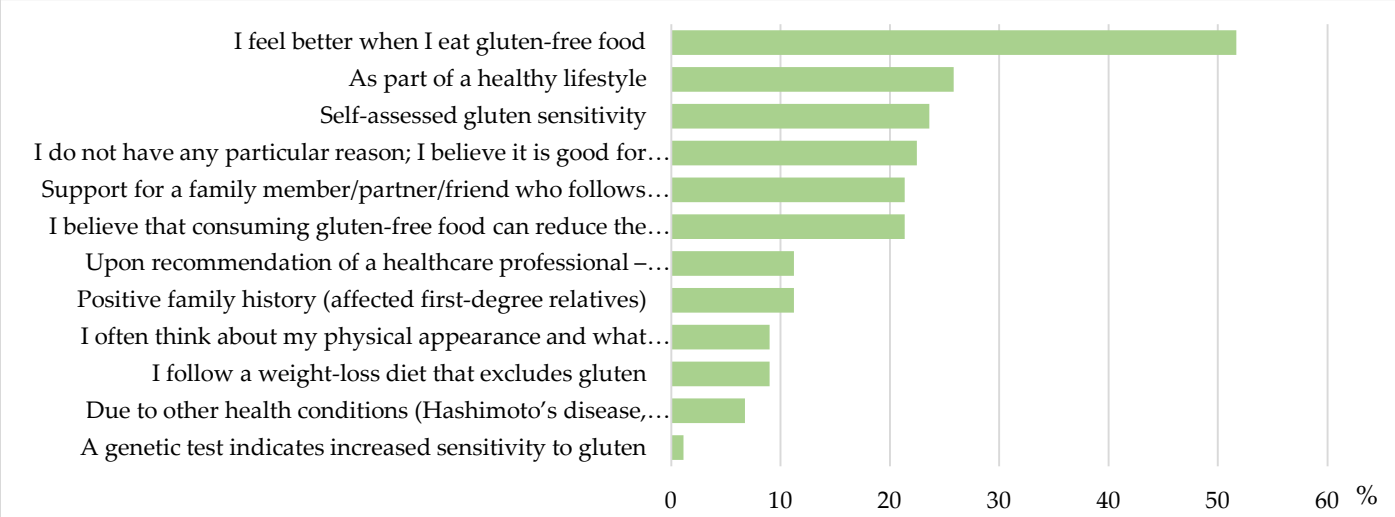


Figure 3. Reasons for following a GFD among NM-GFD participants (multiple-choice; percentages are based on the participant subgroup and may sum to more than 100%).

International studies similarly indicate that people adopting GFDs for perceived health benefits often rely on self-directed decisions rather than medical advice. In a nationally representative US survey, individuals without diagnosed gluten sensitivity were more likely to follow a GFD when they believed GFFs were healthier or more nutritious [14]. Studies from Saudi Arabia and Paraguay provide context for the motivations reported here; they likewise identified perceived health improvement, symptom relief, healthy lifestyle, and weight management as major motivations for voluntary gluten avoidance [20,21]. Collectively, these findings show that perceived health benefits were commonly reported as motivations for a GFD adoption. Importantly, reports of "feeling better" after adopting a GFD should be interpreted cautiously, as perceived benefits do not necessarily indicate gluten-specific effects or objectively verified clinical improvement. Some respondents may have had undiagnosed CD, particularly if they eliminated gluten before diagnostic testing, potentially reducing the sensitivity of subsequent investigations. In such cases, symptom relief could reflect a response to treatment of an unrecognized condition. Alternatively, placebo effects associated with expectations of benefit, or nocebo responses to anticipated gluten exposure, may influence symptom perception and attribution. Concurrent changes in eating habits and lifestyle—such as reduced consumption of highly processed foods, greater attention to meal preparation, or increased physical activity—could also contribute to improved well-being. Reduced intake of wheat-derived fructans, rather than gluten itself, offers another possible explanation for gastrointestinal symptom relief. Thus, self-reported improvement alone cannot establish the underlying mechanism or demonstrate clinical benefit attributable specifically to gluten exclusion.

Nutrition and gluten-related knowledge also encompasses understanding of the nutritional consequences of long-term dietary treatment. Participants generally recognized several naturally gluten-free, nutrient-rich foods, including buckwheat, chia seeds, and quinoa; rice flour was also a response option (Figure S4). However, gluten-free status does not imply comparable nutrient density. Rice flour varies with milling and formulation and should not be treated as uniformly rich in all noted nutrient groups. This item may therefore be interpreted as ingredient recognition rather than a validated assessment of nutritional quality. No regional product-composition dataset or matched product comparisons were collected, so these selections cannot be classified universally as correct or incorrect. Likewise, although naturally gluten-free foods can support a nutritious diet, their inclusion does not automatically ensure dietary balance, which depends on the variety, proportions, and overall nutritional adequacy of the foods consumed.

Figure 4A describes group-specific agreement with the proposed nutritional risks of a GFD; agreement with these broad statements is not a product-specific assessment of nutritional accuracy. M-GFD participants more frequently agreed with statements concerning a higher glycemic index, more simple carbohydrates in processed GFFs, and possible nutritional deficiencies. In contrast, NM-GFD participants more often attributed favorable nutritional characteristics to processed GFFs, including higher fiber, vitamin, and mineral contents and lower calorie, sodium, and saturated fat (Figure 4B). These perceptions contrast with the composition of many commercially available GFFs, which frequently rely on refined starches and provide less protein, dietary fiber, vitamins, and minerals than gluten-containing counterparts, while often containing more simple carbohydrates, saturated fat, and sodium and, in some product categories, having a higher glycemic index [3,6,9–13]. Gluten-free labeling alone does not establish nutritional superiority; individual product composition and the overall diet require assessment. Individuals adopting a GFD for perceived health benefits may unintentionally replace nutritionally balanced foods with highly processed gluten-free alternatives of lower nutritional value, particularly when naturally GFFs are not prioritized. These general perceptions identify possible topics for evidence-based nutrition education that extends beyond gluten avoidance and promotes balanced dietary patterns based predominantly on naturally GFFs.



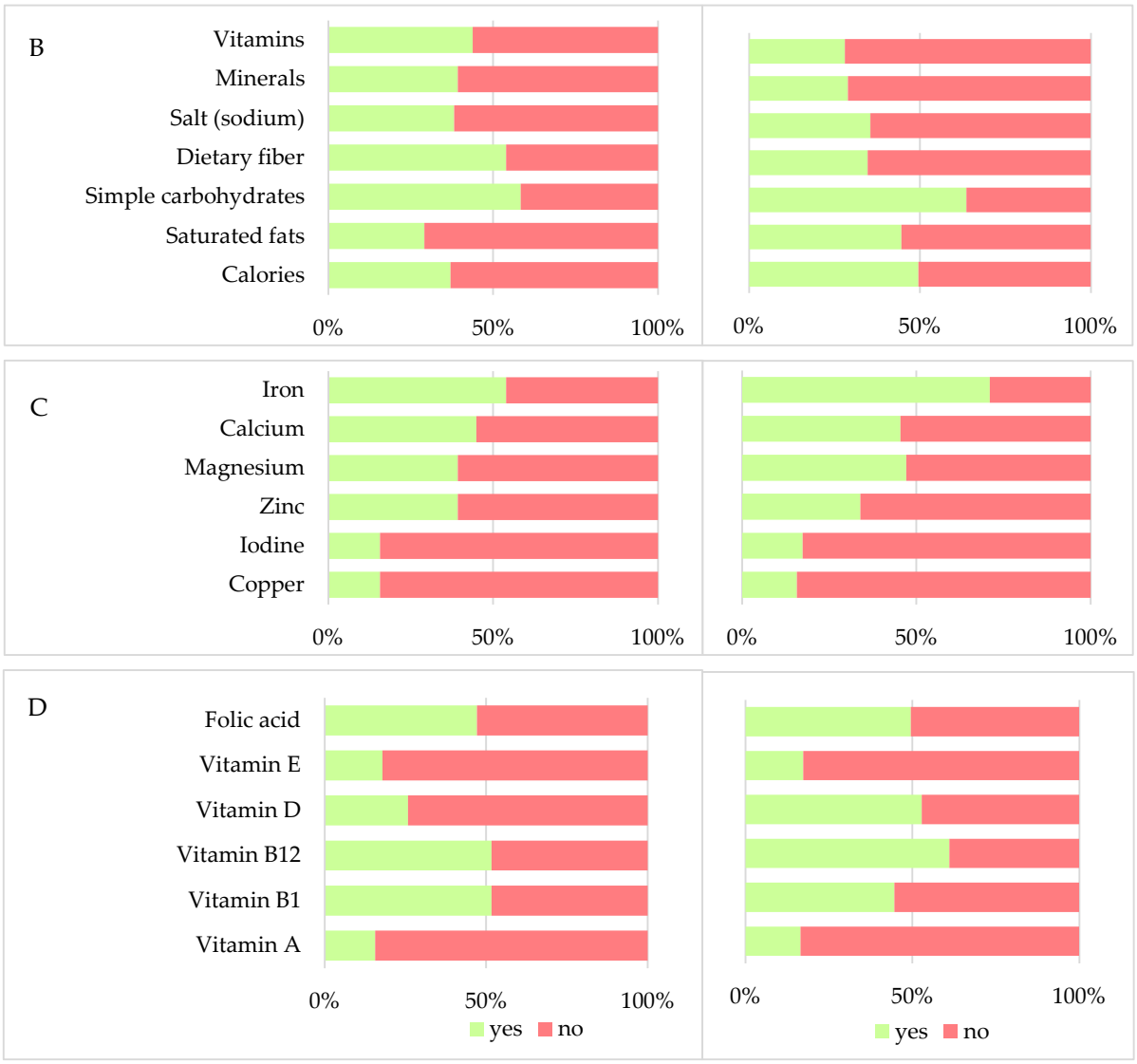


Figure 4. Knowledge and attitudes regarding the nutritional aspects of a GFD: (**A**) attitudes toward nutritional aspects of a GFD; (**B**) perceived nutritional composition of processed GFFs compared with processed gluten-containing foods; and (**C**) minerals and (**D**) vitamins perceived to be at risk of deficiency during a GFD. *Note:* All panels represent multiple-choice questions.

The MCA (Figure 5; Table S1) was based on the responses of the 210 GFD participants. The first two dimensions had eigenvalues of 0.175 and 0.159 and accounted for 17.5% and 15.9% of the total inertia (33.4% cumulatively); after Greenacre's adjustment, they accounted for 33.7% and 24.6% of the average off-diagonal Burt inertia (58.3% cumulatively). The third dimension had a similar eigenvalue (0.148; adjusted inertia 19.2%) and was not interpreted; the two-dimensional map therefore shows only part of the structure of the data, and it should be interpreted cautiously.

Dimension 1 was defined mainly by the perceived composition of processed GFFs. Categories indicating that processed GFFs contain more saturated fat (contribution 11.8%), calories (11.2%), salt (10.5%), and simple carbohydrates (6.2%) and have a higher glycemic index (5.8%) lay on the negative side, opposite the corresponding "no" responses (simple carbohydrates 9.8%, calories 8.9%, saturated fat 7.2%, glycemic index 7.1%, salt 6.1%) and rejection of the risk of nutritional deficiencies (3.4%). Together, these categories accounted for 88% of the inertia of Dimension 1, which can therefore be described as contrasting agreement and disagreement with the proposed nutritional comparisons for processed GFFs. Dimension 2 was defined mainly by recognition of naturally gluten-free,

nutrient-rich foods. Selecting "I do not know" (12.5%) and not selecting quinoa (10.7%), chia seeds (10.2%), or buckwheat (9.6%) lay on the negative side, together with the perception that processed GFFs contain more minerals (5.6%), vitamins (4.1%), and dietary fiber (3.2%), whereas recognition of quinoa (5.7%), sprouted amaranth (5.5%), chia seeds (4.7%), and buckwheat (4.0%) lay on the positive side (76% of the inertia of Dimension 2 in total). This axis places categories for food recognition and perceived fiber and micronutrient content in similar directions. Their proximity alone does not establish an association between the underlying variables. Rice flour contributed little to either dimension (≤0.5%).

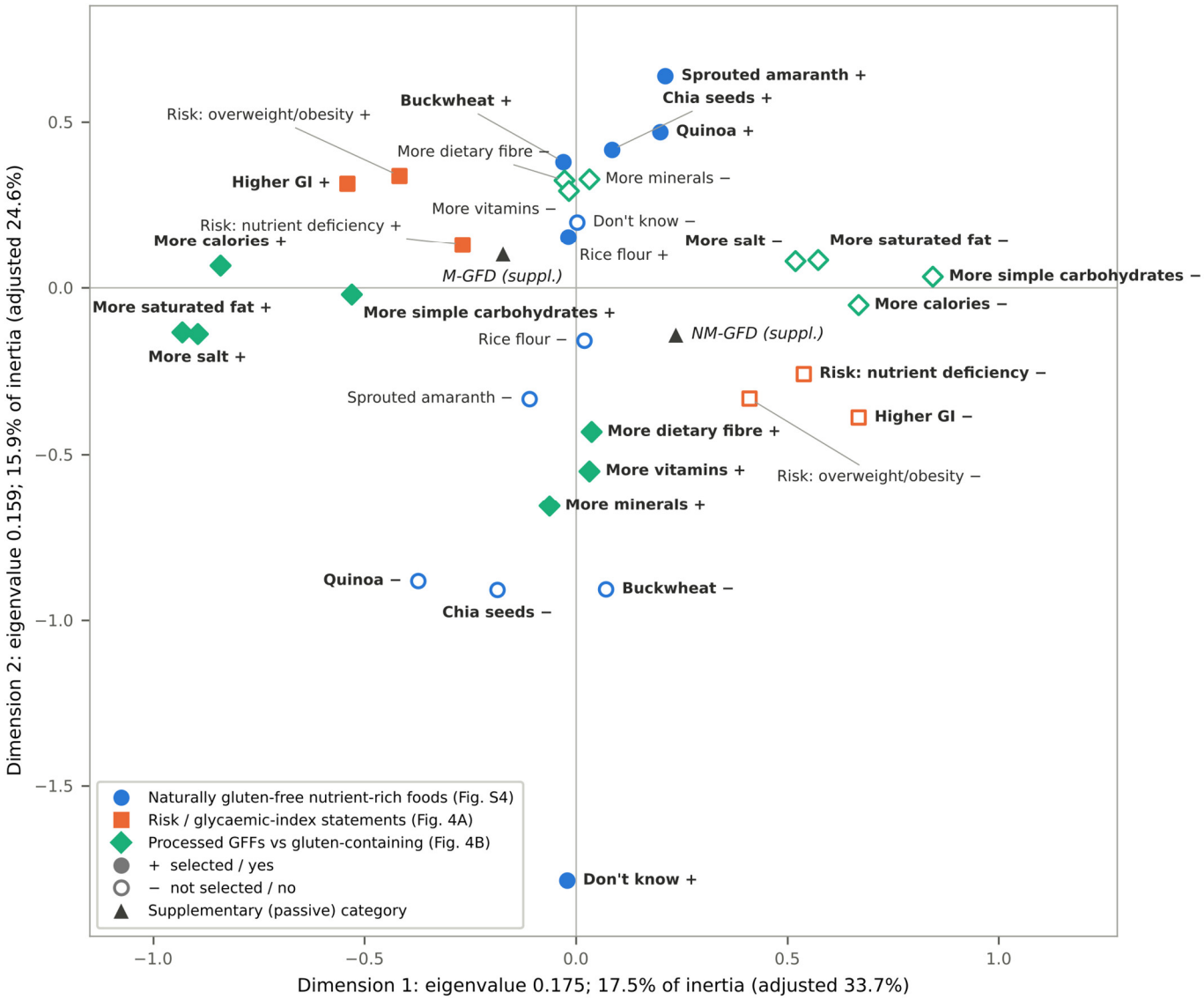


Figure 5. Multiple correspondence analysis (MCA) map of response categories for items on the nutritional aspects of a GFD, GFD participants (n = 210). Active categories: circles, recognition of naturally gluten-free nutrient-rich foods (Figure S4); squares, statements on risks of a GFD and on the glycemic index (GI) of processed GFFs (Figure 4A); diamonds, perceived content of processed GFFs compared with processed gluten-containing foods (Figure 4B). Filled markers and "+" denote selected/yes; open markers and "−" denote not selected/no. Labels in bold mark categories with an above-average contribution (>3.1%) to Dimension 1 or 2. Triangles are supplementary categories for the self-reported reason for GFD (M-GFD, n = 121; NM-GFD, n = 89), projected onto the map without

contributing to the dimensions. Adjusted inertia, Greenacre's correction. Category coordinates and contributions are given in Table S1.

The supplementary categories for the self-reported reason for GFD lay close to the origin: M-GFD (coordinates −0.17; 0.10) on the side of agreement with the proposed less favorable composition of processed GFFs and recognition of the listed naturally GFFs, and NM-GFD (0.24; −0.14) on the opposite side. Their squared cosines were low (0.041 on Dimension 1 and 0.015 on Dimension 2; Table S1), indicating that group status was only weakly represented on the map. This direction is consistent with the group-specific percentages in Figure 4, but because group status was supplementary, it did not shape the dimensions, and the response-category groupings on the map should not be read as knowledge or belief profiles of M-GFD or NM-GFD participants. The response pattern may be compatible with a gluten-free health halo, but label effects, purchasing decisions, and individual-level links between beliefs and dietary adoption were not tested.

Similar misconceptions have been reported among consumers without medically diagnosed GRDs, where interest in healthy lifestyles, weight management, and wellness, together with social media and digital nutrition information, has contributed to the perception that GFFs are intrinsically healthier than conventional alternatives [3,6,9–13]. Such perceptions may encourage unnecessary dietary restriction while simultaneously favoring highly processed GFFs over naturally gluten-free alternatives with superior nutritional profiles.

Even among M-GFD participants, awareness of micronutrient risks remained incomplete (Figure 4C,D). Iron deficiency was recognized most frequently, by 71.1% of participants, whereas deficiencies of calcium, magnesium, zinc, vitamin D, folate, and vitamin B_{12} were identified less consistently. This pattern is similar to findings of Abdelaziz et al. [32], who found that awareness was concentrated on the most widely recognized nutritional consequences, particularly iron deficiency, while knowledge of the broader spectrum of potential micronutrient inadequacies was more limited. Differences in instruments, recruitment, and populations limit this comparison. Noteworthy, the present responses concern awareness of potential risks, not measured intake or biochemical deficiency.

The dietitian-consultation item elicited the following response distribution: in both GFD groups, approximately half of participants rejected the statement that a GFD does not require consultation with a dietitian (Figure 4A), which does not show understanding of the dietitian's role, use of dietetic services, or adequacy of dietary counselling—those outcomes were not assessed.

Gluten-related knowledge score of GFD followers was the following: in the M-GFD group ranged from 1.74 to 7.04, with the mean at 4.22 ± 1.22, while NM-GFD group ranged from 1.16 to 6.29, with the mean at 3.60 ± 1.18. A multivariable linear regression model including medical motivation, sex, age, and medical education background of GFD followers (n = 210) was statistically significant ($F(4,205) = 6.87$; $p < 0.001$) and explained 11.8% of the variance in gluten knowledge scores ($R^2 = 0.118$; adjusted $R^2 = 0.101$). Medical motivation for following a GFD was the covariate with the largest standardized adjusted association with the study-defined knowledge score ($\beta = 0.24$). Participants who followed the diet for medical reasons scored on average 0.61 points higher on the 8-question knowledge score than those following it for non-medical reasons (b = 0.61; SE = 0.17; 95% CI 0.27–0.95; t = 3.51; $p < 0.001$), after adjustment for age, sex, and medical education background. Female sex (b = 0.65; SE = 0.27; 95% CI 0.12–1.19; $\beta = 0.16$; t = 2.39; $p = 0.018$) and higher age category (b = 0.26 per age category; SE = 0.10; 95% CI 0.06–0.46; $\beta = 0.17$; t = 2.51; $p = 0.013$) were also independently associated with higher knowledge scores. Medical education background was not significantly associated with knowledge (b = 0.19; SE =

0.20; 95% CI −0.21 to 0.60; β = 0.07; t = 0.94; p = 0.35). These findings indicate that self-reported medical motivation was associated with a higher study-defined knowledge score among GFD followers after adjustment for the included covariates, although the model explained only a modest proportion of the variability in knowledge.

Overall, nutrition and gluten-related knowledge provide the cognitive foundation for successful GFD management by integrating disease knowledge, treatment principles, nutritional risks, and critical evaluation of GFD quality. The convergence of findings with studies from Europe, North America, South America, and the Middle East [14,17,20,21,31,33] indicates that important knowledge gaps occur across different populations and healthcare settings.

3.3. Reported Information Sources

Access to reliable dietary information is an important component of successful long-term GFD management. In addition to acquiring factual knowledge, individuals must be able to identify credible sources, critically evaluate potentially conflicting nutrition messages, and translate evidence-based recommendations into everyday practice. Information-seeking patterns differed according to the reason for GFD practice, suggesting differences in healthcare engagement and reliance on professional versus publicly available information.

Participants following a medically indicated GFD relied on healthcare professionals and disease-specific support networks, particularly gastroenterologists and CD associations, while also using GFF manufacturers, cookbooks, Internet resources, and social media (Figure 6). By contrast, NM-GFD participants relied primarily on Internet searches and selected alternative medicine practitioners, with homeopathy and quantum medicine given as examples in the response option. Described patterns are consistent with international evidence. Among US adults without diagnosed gluten sensitivity, personal Internet searches were the principal source of GFD information, whereas healthcare professionals were consulted less frequently [14]. Silvester et al. [26] similarly reported frequent use of Internet resources and cookbooks. Conversely, studies among patients with medically diagnosed CD in Greece and Spain identified gastroenterologists, dietitians, and CD associations as major information sources, alongside an increasing role for social media in disseminating practical dietary advice [19,34]. Thus, the reason for following a GFD appears closely linked to the information environment in which dietary decisions are made.

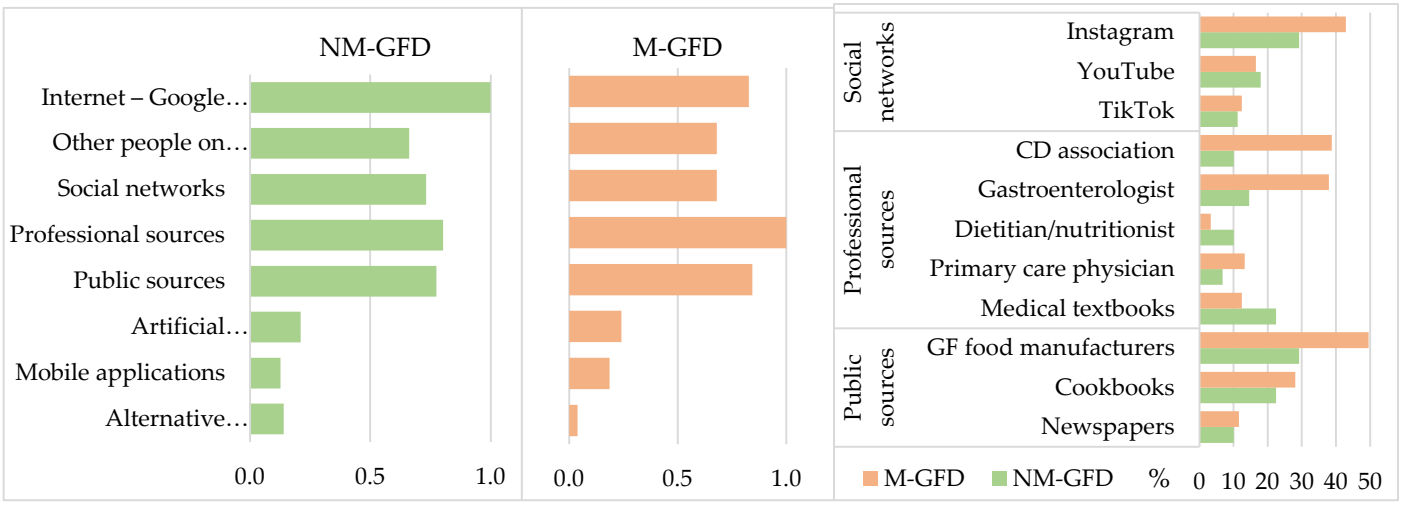


Figure 6. Sources of information about CD and GFDs (multiple-response item; the right panel reports within-group percentages; the two left panels are normalized to a maximum of 1 within each panel, while respondent percentages are shown in Table S2).

The distinction by the reason for following a GFD is important because information availability does not necessarily imply information quality. Professional and patient-support sources are more likely to provide guidance aligned with clinical and regulatory recommendations, whereas publicly accessible online information may combine evidence-based advice with commercial messaging, anecdotal experience, celebrity endorsement, and dietary trends. Yet, whether Internet searching is associated with misinformation exposure or knowledge in this sample remains untested. The survey did not assess content accuracy, misinformation exposure, healthcare access, or whether respondents acted on advice. It therefore cannot attribute any knowledge response to Internet searches, professional advice, or alternative medicine.

Figures S5 and S6 separately describe association membership and physician notification: a minority of NM-GFD participants (6/89, 6.7%) reported membership in a CD association, and approximately one-quarter (23/89, 25.8%) reported informing their physician that they followed a GFD. In the M-GFD group, around one-third (39/121, 32.2%) of participants declared themselves as members of a CD association, suggesting that medical indication may be associated with greater engagement with professional and patient-support sources that may facilitate access to evidence-based guidance. This analysis did not establish the quality of advice received or access to healthcare.

Social media further illustrates the changing information environment surrounding GFDs; however, selecting a platform does not demonstrate exposure to misinformation or benefit from educational content. Instagram was commonly used in both groups, alongside other selected information sources; the multiple-response design did not establish whether social media supplemented or replaced them (Figure 6). Such platforms can facilitate access to recipes, product recommendations, practical advice, peer experience, and social support, but can also accelerate dissemination of simplified or unsupported nutrition messages. This dual role is consistent with observations from Spain, where social media has become an increasingly important channel for GFD education while highlighting the need for professionally developed, evidence-based content [34].

The AI-related information-source option is described here as ChatGPT. Approximately one-quarter of M-GFD participants and one-sixth of NM-GFD participants selected the AI-related information-source option (Figure 6). The questionnaire did not ask about frequency of AI use, model version, specific purpose, trust, accuracy, or outcomes. These data establish reported source selection only and do not demonstrate the usefulness or safety of AI-generated dietary advice. Potential uses of AI tools for ingredient interpretation, label evaluation, recipe modification, and meal planning are topics for future evaluation. Their usefulness may depend on the accuracy, transparency, and clinical reliability of the information generated. AI-based tools may therefore represent an additional source of dietary support, but their role in medically indicated GFD management should be considered complementary to individualized guidance from appropriately qualified healthcare professionals and further investigated.

The information-seeking patterns observed here paralleled the broader differences in nutrition and gluten-related health knowledge identified in this study. M-GFD participants, who engaged more with healthcare professionals and patient organizations, generally scored higher concerning knowledge of GRDs and nutritional aspects of GFDs. Together, these patterns indicate that the information environment in which individuals manage a GFD may be closely related to their nutrition and food knowledge, whereas greater reliance on informal or non-professional sources coincided with more frequent misconceptions among those whose gluten avoidance was primarily caused by perceived health benefits. Nevertheless, this indication should be confirmed through further investigation.

Overall, successful GFD management requires not only access to information but also the ability to evaluate its credibility in an increasingly digital information environment. The present findings, together with evidence from the United States and Europe [14,19,26,34], indicate a growing coexistence of professionally mediated and digital sources of GFD information. Educational strategies should therefore combine evidence-based GFD guidance with stronger nutrition information knowledge, enabling consumers to distinguish validated recommendations from misinformation, commercial messaging, and anecdotal advice. As AI and other digital decision-support tools become increasingly integrated into food purchasing and meal planning, critical evaluation of AI-generated nutrition information should likewise become part of future nutrition literacy initiatives. Future intervention studies could evaluate whether evidence-based GFD education and critical appraisal of online or AI-generated advice improve understanding or dietary outcomes.

3.4. Study Strengths and Limitations

This study sample captured adults not practicing a GFD as well as people following a GFD for self-reported medical reasons and without such reasons, enabling a broad descriptive assessment of disease knowledge, nutritional beliefs, motivations, and information sources. The findings related to NM-GFD and M-GFD groups revealed a coherent gradient across Sections 3.1–3.3: medically motivated followers generally showed greater gluten-related knowledge and stronger engagement with professional and patient-support sources, whereas non-medically motivated followers attributed favorable nutritional properties to processed GFFs and more often relied on informal information. The questionnaire was adapted from published surveys (with a literature-informed answer key), pilot-tested before data collection, and supported by response-quality checks. The study also provided timely evidence on social media and AI use in local settings for which comparable data remain limited.

Nevertheless, these strengths must be considered alongside important limitations. First, the non-probability online design and two-arm recruitment strategy introduced substantial potential for selection bias. Participant classification relied on self-reported diagnoses and dietary experience, creating potential for misclassification between groups. The M-GFD group may have included respondents whose medical indication was unconfirmed or inaccurately reported. NM-GFD may include unrecognized gluten-related disease. The No-GFD label is an operational self-report category, and misclassification remains possible through inaccurate self-report despite the study-defined reference period. Consequently, group membership should not be interpreted as a clinically verified distinction between affected and unaffected individuals. As a result of targeted recruitment, GFD respondents may have been more engaged with disease-specific networks, digital information, and specialized retailers than the broader population of GFD followers. Therefore, observed group percentages are descriptive rather than representative estimates.

Second, the impact of pooling participants currently following a GFD with those who had discontinued it within the previous two years, or the impact of GFD duration, was not assessed.

Third, the sample was predominantly Serbian and consisted largely of younger, urban, well-educated women, including many with prior experience with medications, food allergies, and medical or health-related education, which could influence disease-related knowledge, nutritional understanding, and access to information. Medical educational/professional background was reported by 51.3% of respondents: 55.1% in No-GFD, 34.8% in NM-GFD, and 16.5% in the M-GFD group. Although age, sex, and medical background were included in the exploratory regression, this does not remove selection bias

or confounding by unmeasured factors. The small subsamples from Bosnia and Herzegovina and Montenegro precluded meaningful country-level comparisons. The findings may therefore not generalize to the broader adult population, particularly men, older adults, rural residents, people with lower educational attainment, or those with limited access to digital health information.

Fourth, the adapted questionnaire was pilot-tested but lacked formal translation, content validation, cognitive interviews, and psychometric assessment; thus, item responses should not be interpreted as scores from validated scales. The answer key used to classify knowledge responses was not formally validated. Some answers may depend on context, product category, or formulation, limiting the certainty with which responses can be classified as correct or incorrect. Item responses and the derived composite knowledge-scale should therefore be interpreted against the study-defined key, not a validated measure of overall knowledge. Sensitivity to alternative defensible scoring rules remains untested.

Fifth, all variables were self-reported and may be affected by recall, reporting, and social-desirability bias. Inappropriate self-diagnosis, diagnostic delay, and consequences of dietary restriction were not measured; these outcomes cannot be inferred from the present response distributions.

Sixth, associations between knowledge and information sources do not demonstrate that particular sources improved or impaired knowledge, because reverse direction and residual confounding are plausible.

Finally, the multiple correspondence analysis was restricted to GFD participants and described the structure of response categories on the first two dimensions, which accounted for 33.4% of the total inertia (58.3% after adjustment); it did not define participant profiles, and the self-reported reason for GFD was only weakly represented on the map. These visual patterns should therefore be treated as hypothesis-generating. Representative studies using validated measures, verified diagnoses, longitudinal designs, and intervention evaluation are needed to test the relationships suggested here.

The cross-sectional analysis combined descriptive reporting with post hoc exploratory regression. The regression identifies adjusted associations rather than causal effects or validated prediction, and sparse male representation warrants caution in interpreting the sex coefficient. No statistically significant medical-background association does not establish the absence of an effect.

3.5. Future Perspectives

The coexistence of professional, public, and digital source selections identifies an area for further investigation. Trials could evaluate whether nutrition education or critical appraisal of online and AI-generated content improves understanding and dietary outcomes. The present study did not test these interventions.

Future research should test whether professionally developed digital education can improve disease knowledge, recognition of nutritionally adequate naturally GFFs, and understanding of micronutrient risks. Longitudinal and intervention studies should compare dietitian-led counselling, patient-organization programs, social-media education, and blended models, with outcomes that extend beyond factual knowledge to dietary quality, diagnostic pathways, sustained adherence when clinically required, and avoidance of unnecessary restriction when no medical indication is present. Whether label-related (*gluten-free*) expectations influence dietary restriction or product selection remains a hypothesis for future research.

The reported use of AI applications warrants specific investigation. Studies should evaluate the accuracy, consistency, transparency, and safety of AI-supported ingredient

interpretation, label evaluation, recipe modification, and meal planning, particularly when advice concerns hidden gluten or nutritional supplementation.

Research across more representative and socio-demographically diverse samples, with adequate country-specific recruitment, is also needed to determine whether the patterns observed in this predominantly Serbian, digitally engaged sample extend to the wider Central Balkan population.

4. Practical Implications for Healthcare Professionals and Conclusions

In this non-representative online sample, the reason for following a GFD was accompanied by distinct descriptive patterns of knowledge, beliefs, and information seeking.

The findings suggest topics for future evaluation of clinical and public-health education across GFD groups. The adjusted regression identified an association between self-reported medical motivation (M-GFD group) and the study-defined composite knowledge score; yet, the micronutrient selections indicate possible topics for education. For people requiring lifelong gluten avoidance for CD, comprehensive follow-up could include more than identifying obvious gluten sources, including prioritization of naturally gluten-free, nutrient-rich foods, assessment of diet quality, and monitoring of potential nutritional inadequacies. Registered dietitians are well positioned to translate these requirements into individualized, sustainable practices across home, retail, and food-service settings.

The NM-GFD responses also identify possible topics for further assessment. Their comparatively limited knowledge of GRDs, selection of Internet sources and complementary or alternative medicine, and more favorable perceptions of processed GFFs suggest that voluntary gluten avoidance may be shaped by perceived benefit and a gluten-free health halo rather than by a balanced appraisal of evidence and nutritional quality. Public-health communication should clearly distinguish the necessity of a strict lifelong GFD for CD and condition-specific dietary management for other GRDs from the unsupported assumption that gluten-free labeling denotes a healthier product. It should also encourage appropriate clinical evaluation before gluten is eliminated, because self-directed restriction may complicate diagnosis, as gluten elimination before diagnostic testing can affect serological and histological assessment of CD [3], and introduce unnecessary dietary and economic burdens.

Digital information is relevant to both groups. Internet resources and social media were widely used, while the AI-related source option was selected by approximately one-quarter of M-GFD and one-sixth of NM-GFD participants. Future studies could evaluate accessible evidence-based content and training in appraisal of online and AI-generated information.

Taken together, the findings suggest an integrated approach involving clinical care, dietitian-led follow-up, patient-organization support, and nutrition and digital-information literacy for future evaluation. However, these practical recommendations (differentiated interventions, dietitian-led follow-up) were not tested and should be considered as proposals.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/foods15234309/s1, Questionnaire: Prevalence, knowledge and attitudes towards a gluten-free diet; Knowledge score questions, answer key and scoring rules; List of references for the survey questions and answers; Multivariable regression model coding; Figure S1: Do you know what the therapeutic approach is for patients with celiac disease and non-celiac gluten sensitivity?; Figure S2: The likelihood of developing celiac disease is higher if someone in your family has celiac disease. Do you agree with this statement?; Figure S3: How would you rate your knowledge of a gluten-free diet?; Figure S4: Naturally occurring gluten-free sources of protein,

fiber, and minerals?; Table S1: MCA results for active and supplementary response categories (GFD participants, n = 210). Eigenvalues: Dimension 1, 0.175 (17.5% of total inertia; 33.7% adjusted); Dimension 2, 0.159 (15.9%; 24.6% adjusted); Table S2: Individual information sources; Figure S5: Are you a member of an association for people/support for people with celiac disease?; Figure S6: Have you informed your doctor that you follow a gluten-free diet?.

Author Contributions: Conceptualization, L.T.; methodology, M.J. and L.T.; formal analysis, M.J. and J.O.; data curation, M.J. and J.O.; writing—original draft preparation, M.J.; writing—review and editing, L.T.; visualization, M.J.; supervision, L.T.; project administration, J.O. and L.T.; funding acquisition, J.O. and L.T. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the AP Vojvodina Provincial Secretariat for Higher Education and Scientific Research, grant numbers 003862016 2025 09418 003 000 000 001 and 003878458 2025 09418 003 000 000 001.

Institutional Review Board Statement: The study was approved by the Ethics Committee of the Faculty of Medicine, University of Novi Sad (Approval No. 01-39/63-4/2 on 31 May 2025).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data will be available on request to the corresponding author.

Acknowledgments: During the preparation of this work, the authors used ChatGPT (OpenAI) to improve the manuscript's English and Gemini Notebook (Google LLC, Mountain View, CA, USA) to assist in preparing a graphical abstract based on the manuscript content. The authors have reviewed and edited the output and take full responsibility for the content of this publication.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

GFD	Gluten-free diet
GRD	Gluten-related disorder
CD	Celiac disease
NCGS	Non-celiac gluten sensitivity
GFF	Gluten-free food
No-GFD	Individuals not following a GFD
NM-GFD	Respondents with current or recent GFD experience without a self-reported medical reason
M-GFD	Respondents with current or recent GFD experience for a self-reported medical reason
MCA	Multiple Correspondence Analysis
AI	Artificial intelligence

Appendix A

Table A1. Anthropometric features and general lifestyle data of participants.

Anthropometric Features and Lifestyle Data	Value/Number (%)
Your height: (cm; median [Q1–Q3])	All: 170.0 [165.0–175.0] M: 188.0 [177.1–189.8] W: 170.0 [165.0–174.0]
Your body weight: (kg; median [Q1–Q3])	All: 61.8 [55.2–68.0] M: 92.0 [75.5–111.5] W: 60.0 [55.0–66.0]

Body mass index (calculated based on participants' data):	Underweight: 101 Normal/Healthy weight: 1149 Overweight: 328 Obesity: 99
Do you consume alcohol?	
No, never	427 (25.5)
Yes, occasionally	1212 (72.3)
Yes, regularly	38 (2.3)
Do you smoke cigarettes?	
No, never	1217 (72.6)
Yes, occasionally	228 (13.6)
Yes, regularly	232 (13.8)
Do you consume coffee or other caffeinated beverages (e.g., energy drinks)?	
No, never	220 (13.1)
Yes, occasionally	547 (32.6)
Yes, regularly	910 (54.3)
Rate your average (physical) activity level?	
Low	380 (22.7)
Satisfactory	517 (30.8)
Moderate	603 (36.0)
Intensive	177 (10.6)
How do you rate the overall quality of your life?	
Poor	69 (4.1)
Satisfactory	746 (44.5)
Very good	660 (39.4)
Excellent	202 (12.0)

Table A2. Use of conventional drug therapy reported by participants.

Conventional Drug Therapy	**Number (%)**
Do you use/have you used any medicine (prescribed by a health professional)?	
Yes	763 (45.5)
No	914 (54.5)
Please indicate the reason for its/their use (multiple answers)	
Bacterial infection of any organ requiring or having required antibiotic therapy	216 (28.3)
Headache	197 (25.8)
Diseases associated with hormonal disorders or use of oral contraceptives (e.g., *diabetes mellitus, thyroid diseases)*	189 (24.8)
Cardiovascular diseases (e.g., *hypertension, cardiac arrhythmias, vascular protection or prevention of blood clots, anemia)*	170 (22.3)
Gastrointestinal diseases (e.g., *gastritis, increased stomach acidity, liver or biliary tract)*	123 (16.1)
Skin diseases	90 (11.8)
Preventive use	89 (11.7)
Autoimmune diseases	84 (11.0)
Diseases of the nervous system (e.g., *depression, anxiety/tension/insomnia, Alzheimer's disease, or Parkinson's disease)*	51 (6.7)
Diseases of muscles, joints, and/or bones	44 (5.8)
Severe gastrointestinal diseases (e.g., *ulcerative colitis, Crohn's disease, IBD)*	25 (3.3)
Allergy	15 (2.0)

Metabolic syndrome	14 (1.8)
Cancer	13 (1.7)
Diseases of the respiratory organs (e.g., *asthma)*	11 (1.4)
Eye diseases	2 (0.3)
Diseases of the urogenital system	1 (0.1)

Table A3. Food allergies and special diets reported by participants.

Food Allergies and Special Diets	**Number (%)**
Do you have any food allergy confirmed by a healthcare professional?	
Yes	167 (10.0)
No	1510 (90.0)
If yes, please indicate the type of food causing the allergy *(multiple answers)*	
Gluten/wheat	102 (61.1)
Lactose	32 (19.2)
Nuts	24 (14.4)
Various fruits and vegetables	25 (15.0)
Peanuts	14 (8.4)
Eggs	7 (4.2)
Seafood/Soy	6 (3.6) each
Fish	5 (3.0)
Honey	4 (2.4)
Sesame/Cocoa/chocolate	3 (1.8) each
Cinnamon/Synthetic food colours	2 (1.2) each
Casein	1 (0.6)
Do you currently follow or have you previously followed any special diet?	
Yes	465 (27.7)
No	1212 (72.3)
If yes, please indicate the type of diet *(multiple answers)*	
Ketogenic diet	113 (24.3)
Diet high in fruits and vegetables with reduced meat intake	89 (19.1)
Diet adapted for lactose intolerance (milk and dairy products)	76 (16.3)
Vegetarian or vegan diet	64 (13.8)
Diet adapted for diabetes	61 (13.1)
Organic diet	36 (7.7)
Diet adapted for elevated blood lipids	35 (7.5)
Raw food diet	19 (4.1)
FODMAP diet	11 (2.4)
High-protein diet	9 (1.9)
Orthodox fasting	8 (1.7)
Autophagy	7 (1.5)
Chrono nutrition	5 (1.1)
Mediterranean diet/Autoimmune protocols	4 (0.9) each
Customized sports nutrition/Nutritionist's recommendations/Low-calorie/Halal	2 (0.4) each
LCHP (Low-Carbohydrate High-Protein)/Hepatoprotective/Low-spice diet	1 (0.2) each

Note: Original response labels are retained; CD, NCGS, and lactose intolerance are distinct from food allergy.

References

1. Smits, N.G.; Ballin, N.Z.; Bruggeman, C.; Fæste, C.K.; Pastorelli, A.A.; van Poucke, C.; Voorhuijzen-Harink, M.M.; Westphal, Y.; Walker, M.; Winkel, M.; et al. The changing food allergen landscape in Europe calls for harmonised food allergen monitoring: Position paper. *Food Control* **2025**, *168*, 110915.
2. Biesiekierski, J.R.; Jonkers, D.; Ciacci, C.; Aziz, I. Non-coeliac gluten sensitivity. *Lancet* **2025**, *406*, 2494–2508.
3. Al-Toma, A.; Volta, U.; Auricchio, R.; Castillejo, G.; Sanders, D.S.; Cellier, C.; Mulder, C.J.; Lundin, K.E. European Society for the Study of Coeliac Disease (ESsCD) guideline for coeliac disease and other gluten-related disorders. *United Eur. Gastroenterol. J.* **2019**, *7*, 583–613.
4. Taraghikhah, N.; Ashtari, S.; Asri, N.; Shahbazkhani, B.; Al-Dulaimi, D.; Rostami-Nejad, M.; Rezaei-Tavirani, M.; Razzaghi, M.R.; Zali, M.R. An updated overview of spectrum of gluten-related disorders: Clinical and diagnostic aspects. *BMC Gastroenterol.* **2020**, *20*, 258.
5. FAO; WHO. *Risk Assessment of Food Allergens. Part 2: Review and Establish Threshold Levels in Foods for the Priority Allergens. Meeting Report*; Food Safety and Quality Series No. 15; Food and Agriculture Organization of the United Nations: Rome, Italy, 2022.
6. McDermid, J.M.; Almond, M.A.; Roberts, K.M.; Germer, E.M.; Geller, M.G.; Taylor, T.A.; Sinley, R.C.; Handu, D. Celiac disease: An Academy of Nutrition and Dietetics evidence-based nutrition practice guideline. *J. Acad. Nutr. Diet.* **2023**, *123*, 1793–1807.
7. EC. Regulation (EU) No 1169/2011 of the European Parliament and of the Council of 25 October 2011 on the provision of food information to consumers, amending regulations (EC) No 1924/2006 and (EC) No 1925/2006 of the European Parliament and of the Council. *Off. J. Eur. Union* **2011**, *L304*, 18–63.
8. EC. Commission Implementing Regulation (EU) No 828/2014 of 30 July 2014 on the requirements for the provision of information to consumers on the absence or reduced presence of gluten in food. *Off. J. Eur. Union* **2014**, *L228*, 5–8.
9. Romão, B.; Botelho, R.B.A.; Alencar, E.R.; da Silva, V.S.N.; Pacheco, M.T.B.; Zandonadi, R.P. Chemical composition and glycemic index of gluten-free bread commercialized in Brazil. *Nutrients* **2020**, *12*, 2234.
10. Cardo, A.; Churruca, I.; Lasa, A.; Navarro, V.; Vázquez-Polo, M.; Perez-Junkera, G.; Larretxi, I. Nutritional imbalances in adult celiac patients following a gluten-free diet. *Nutrients* **2021**, *13*, 2877.
11. Catassi, C.; Verdu, E.F.; Bai, J.C.; Lionetti, E. Coeliac disease. *Lancet* **2022**, *399*, 2413–2426.
12. González, M.P.; Ballestero-Fernández, C.; Fajardo, V.; Achón, M.; García-González, Á.; Alonso-Aperte, E.; Úbeda, N. Gluten-free product contribution to energy and macronutrient intakes in Spanish children and adolescents with celiac disease. *Foods* **2022**, *11*, 3790.
13. El Khoury, D.; Balfour-Ducharme, S.; Joye, I.J. A Review on the gluten-free diet: Technological and nutritional challenges. *Nutrients* **2018**, *10*, 1410.
14. Arslain, K.; Gustafson, C.R.; Baishya, P.; Rose, D.J. Determinants of gluten-free diet adoption among individuals without celiac disease or non-celiac gluten sensitivity. *Appetite* **2021**, *156*, 104958.
15. Center for Nutritional Psychology. Health Halo Effect. In *Encyclopedia of Nutritional Psychology*; CNP Encyclopedia Editorial Board, Ed.; The Center for Nutritional Psychology: San Jose, CA, USA, 2026. Available online: https://www.nutritional-psychology.org (accessed on 11 November 2026).
16. Melini, V.; Melini, F. Gluten-free diet: Gaps and needs for a healthier diet. *Nutrients* **2019**, *11*, 170.
17. Simpson, S.; Lebwohl, B.; Lewis, S.K.; Tennyson, C.A.; Sanders, D.S.; Green, P.H. Awareness of gluten-related disorders: A survey of the general public, chefs and patients. *e-SPEN Eur. e-J. Clin. Nutr. Metab.* **2011**, *6*, e227–e231.
18. Gutowski, E.D.; Weiten, D.; Green, K.H.; Rigaux, L.N.; Bernstein, C.N.; Graff, L.A.; Walker, J.R.; Duerksen, D.R.; Silvester, J.A. Can individuals with celiac disease identify gluten-free foods correctly? *Clin. Nutr. ESPEN* **2020**, *36*, 82–90.
19. Aspasia, S.; Emmanuela-Kalliopi, K.; Nikolaos, T.; Eirini, S.; Ioannis, S.; Anastasia, M. The gluten-free diet challenge in adults with coeliac disease: The Hellenic survey. *PEC Innov.* **2022**, *1*, 100037.
20. Alkhalifa, F.M.; Deeb, F.A.A.; Al-Saleh, W.M.; Al Hamad, S.S.; Adams, C. Knowledge of and behaviors toward a gluten-free diet among women at a health sciences university. *J. Taibah Univ. Med. Sci.* **2023**, *18*, 1567–1576.
21. Ontiveros, N.; Real-Delor, R.E.; Mora-Melgem, J.A.; Beltrán-Cárdenas, C.E.; Figueroa-Salcido, O.G.; Vergara-Jiménez, M.D.J.; Cárdenas-Torres, F.I.; Flores-Mendoza, L.K.; Arámburo-Gálvez, J.G.; Cabrera-Chávez, F. Prevalence of wheat/gluten-related disorders and gluten-free diet in Paraguay: An online survey-based study. *Nutrients* **2021**, *13*, 396.
22. de Oliveira, P.M.; Zandonadi, R.P.; Cutrim, A.M.V.; Nakano, E.Y.; de Queiroz, F.L.N.; Botelho, R.B.A.; Saraiva, A.; Raposo, A. Eating competence and aspects related to a gluten-free diet in Brazilian adults with gluten-related disorders. *Nutrients* **2022**, *14*, 2815.

23. Avena-Woods, C.; Mangione, R.A.; Wu, W.K. Exploring the community pharmacist's knowledge of celiac disease. *Am. J. Pharm. Educ.* **2018**, *82*, 6353.
24. Lu, Z.; Zhang, H.; Luoto, S.; Ren, X. Gluten-free living in China: The characteristics, food choices and difficulties in following a gluten-free diet—An online survey. *Appetite* **2018**, *127*, 242–248.
25. Muhammad, H.; Reeves, S.; Ishaq, S.; Mayberry, J.; Jeanes, Y.M. Adherence to a gluten free diet is associated with receiving gluten free foods on prescription and understanding food labelling. *Nutrients* **2017**, *9*, 705.
26. Silvester, J.A.; Weiten, D.; Graff, L.A.; Walker, J.R.; Duerksen, D.R. Living gluten-free: Adherence, knowledge, lifestyle adaptations and feelings towards a gluten-free diet. *J. Hum. Nutr. Diet.* **2016**, *29*, 374–382.
27. Pohoreski, K.; Horwitz, S.L.; Gidrewicz, D. Gluten-free diet knowledge and adherence in adolescents with celiac disease: A cross-sectional study. *JPGN Rep.* **2023**, *4*, e330.
28. Dembiński, Ł.; Mazur, A.; Dąbrowski, M.; Jackowska, T.; Banaszkiewicz, A. Knowledge of medical students and medical professionals regarding nutritional deficiencies in patients with celiac disease. *Nutrients* **2021**, *13*, 1771.
29. Zingone, F.; Maimaris, S.; Auricchio, R.; Caio, G.; Carroccio, A.; Elli, L.; Galliani, E.; Montagnani, M.; Valiante, F.; Biagi, F. Guidelines of the Italian societies of gastroenterology on the diagnosis and management of coeliac disease and dermatitis herpetiformis. *Dig. Liver Dis.* **2022**, *54*, 1304–1319.
30. Hitl, M.; Kladar, N.; Bijelić, K.; Banović Fuentes, J.; Djermanović, M.; Torović, L. Knowledge and consumption patterns of omega-3 fatty acids among the central Balkan population—A prospective cross-sectional study. *Nutrients* **2025**, *17*, 122.
31. Vázquez-Polo, M.; Navarro, V.; Larretxi, I.; Perez-Junkera, G.; Lasa, A.; Miranda, J.; Churruca, I. Effectiveness of a nutrition education programme for individuals with celiac disease and their supporters through social media (GLUTLEARN project). *Comput. Biol. Med.* **2025**, *184*, 109505.
32. Abdelaziz, M.N.; Azzam, H.; Hefnawy, A.; Moustafa, A.R.; Elkasabi, H.G.; Elkasabi, A.; Abdallah, O. Knowledge and attitudes toward nutritional deficiencies in celiac disease among medical students and healthcare providers in Egypt. *Sci. Rep.* **2025**, *15*, 27894.
33. Hassan, H.F.; Mourad, L.; Khatib, N.; Assi, R.; Akil, S.; El Khatib, S.; Hteit, R. Perceptions towards gluten free products among consumers: A narrative review. *Appl. Food Res.* **2024**, *4*, 100441.
34. Vázquez-Polo, M.; Navarro, V.; Larretxi, I.; Perez-Junkera, G.; Lasa, A.; Matias, S.; Simon, E.; Churruca, I. Uncovering the concerns and needs of individuals with celiac disease: A cross-sectional study. *Nutrients* **2023**, *15*, 3681.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.