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Original Article

Hidden Gluten Risk Management at Home and School: Parental Label Literacy and Cross-Contact Prevention Practices for Children with Celiac Disease

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ABSTRACT

Background:
Strict lifelong adherence to a gluten-free diet is essential for children with celiac disease (CD), whose dietary safety depends largely on parental supervision and school food-safety practices. This study examined how parents manage hidden gluten risks by investigating food label literacy and cross-contact prevention measures at home and school and their relationship with accidental exposure to gluten in children who have CD.

Materials and Methods:
A cross-sectional descriptive design was used on a sample of 120 parents of children with CD who were followed in pediatric clinics. A structured questionnaire defining socio-demographic characteristics, parental label literacy, cross-contact prevention behaviors, and the frequency of accidental exposure to gluten was used to collect data.

Results:
The results indicated that parental label literacy was mostly moderate, with significant differences between the ability to identify hidden gluten ingredients on a label and the ability to understand precautionary allergen statements on a label. Home settings had more consistent cross-contact prevention than schools, where shared food conditions and lack of supervision created a high exposure risk. The most common was accidental gluten exposure with repeated exposure that happened in a significant number of cases.

Conclusion:
The study also showed that higher parental label literacy and more effective cross-contact prevention, especially in schools, were closely linked to fewer incidents of accidental gluten exposure. These findings demonstrate the significance of implementing context-driven prevention interventions in conjunction with applied label literacy education, particularly in schools, in enhancing children with CD's nutritional safety and lowering the health risks associated with the condition.

Keywords: Celiac disease; Gluten-free diet; Food label literacy; Cross-contact prevention; Accidental gluten exposure; School food safety

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INTRODUCTION

Celiac disease (CD) is a chronic, immune-mediated disease that is stimulated by the ingestion of gluten protein in genetically predisposed individuals. It damages the small-intestinal mucosa and can manifest with gastrointestinal symptoms, nutritional deficiencies, growth impairment, or extraintestinal symptoms. CD has a high public health burden too, estimated in the global population to be around 0.7% of people, based on biopsy confirmation (1). Since there is no cure available at present, the main approach to manage the symptoms, achieve recovery of the intestinal mucosa, and reduce potential long-term complications is to maintain a strict lifelong gluten-free diet (2).

It is difficult to stick to a totally gluten-free diet, even though it is clinically effective. Some foods that may not list gluten as an ingredient can still contain it if they are processed foods, the ingredient list is unclear, eating utensils or surfaces are not cleaned, and/or the food is cooked with foods containing gluten. Even those that describe themselves as being on a 'gluton-free' diet (GFD) have reported symptomatic suspected gluten exposure (SSE) (3). Another risk in food preparation and storage, during cooking and serving, is cross-contact, especially when proper separation measures and hygiene are not strictly followed (4).

Parental and caregiver support plays a key role in children's dietary management. Their ability to read and understand ingredient lists, see hidden ingredients of gluten, work out precautionary statement(s), and safe food handling practices can directly affect the diet of the child. Previous studies suggest that parental knowledge, family support, and practical barriers determine adherence in children with CD (5). Parental interventions through education can enhance parental knowledge, attitudes, food-handling practices, and adherence to the gluten-free diet(6).

Schools can pose greater risk-management challenges, as parents have less control over preparation and serving. Children with CD (7) may be limited in their ability to take part in shared meals due to not getting adequate information, awareness about the school's meal procedures, and limited staff training. However, most of the previous research studies have investigated adherence to diet, parental education, food handling practices, or barriers to school completion separately. Limited evidence has assessed parental label literacy and cross-contact prevention jointly, at home and at school, or the relationship between the two and accidental gluten exposure. Thus, this study aimed to examine parental label literacy and cross-contact prevention practices as part of hidden-gluten risk management and to understand how they relate to accidental gluten exposure among children with CD.

Problem Statement

"Despite growing awareness, accidental exposure persists due to insufficient applied skills rather than lack of knowledge."

Aim and Objectives

This research will assess parental management of hidden gluten risks at home and school through food label literacy and cross-contact prevention practices, and their relationship to accidental gluten exposure in children with CD.

Objectives

1. To measure the food label literacy level among parents regarding awareness of labeling of hidden sources of gluten.
2. To determine the level and uniformity of cross-contact prevention practices in the home and school settings.
3. To examine the associations between parental food-label literacy, cross-contact prevention practices, and accidental gluten exposure.

Research Questions

The research questions that the study will attempt to answer are as follows:

RQ1: What is the parental food label literacy level regarding hidden gluten sources?

RQ 2: What is the consistency of cross-contact prevention practices among children with CD at home and at school?

RQ3: Does high parental label literacy relate to the reduction of accidental gluten exposures?

Previous Studies

The existing studies related to the management of CD in children can be summarized into four categories: parents' knowledge, adherence to GFD, hidden sources of gluten, and environmental cross-contact. Although these areas are tightly intertwined in practice, researchers have often studied them separately. Thus, little data show how parents' food label interpretation skills relate to parenting and school food preventive measures and their impact on unintentional gluten exposure.

Parental Knowledge and Gluten-Free Diet Adherence

Parents' knowledge plays an important role in children following a gluten-free diet and has often been mentioned. Charalampopoulos and colleagues (8) found that only 44.4% of the children in their study were strictly adherent and concluded that adherence was independently correlated with perceived parental knowledge. However, they used a general view of perceived knowledge, not parents' ability to identify hidden gluten ingredients or understand precautionary language on food labels.

Parental competence may increase with an educational intervention. Structured educational intervention was effective in enhancing parental knowledge, attitudes,

practices, and gluten-free adherence (6). However, the intervention was multifaceted in terms of the education provided; it is unclear whether the observed improvement was due specifically to improved label interpretation, changes in food-handling practices, or a general increase in awareness about foods (6). Studies have not found a consistent relationship between knowledge and adherence. Among the adolescents, the parents had greater knowledge, with a rating of "good" compared to "fair" for the adolescents, in a study conducted by Pohoreski and others (9). But among adolescents, reported adherence was similar both in cases with adequate knowledge and those with inadequate knowledge. The implications of this finding indicate that knowledge alone does not always necessarily result in safer dietary behaviors, and practical, environmental, and social factors may influence the link between knowledge and compliance (9).

Similarly, Monzani et al. considered continuity in dietary counseling and the availability of a trained dietitian as factors associated with adherence to the pediatric gluten-free diet. Dietary counseling was, however, assessed as a general source of assistance and not assessed in terms of specific competencies, such as understanding 'hidden' gluten or the importance of preventing cross-contact in communal settings (10).

Limitations of Self-Reported Dietary Adherence

Another important point is how adherence is measured. Compared with a formal evaluation by a dietitian, Dowhaniuk and others reported that both children and their parents overestimated adherence. This means that a general question like whether a child is on a strict gluten-free diet won't necessarily reveal cross-contact mistakes or mistakes related to food labels(11).

According to Mehta and colleagues (12), about 73% of children were consistently adherent at 2 years post-diagnosis, while 67% were adherent at five years. Potential discrepancies between self-reported adherence and gluten intake were estimated from food records. The results indicate that adherence is unstable and complex, and that parents may underreport adherence (12).

This is a significant measurement difference in the current study. The current research does not include a single general adherence question; instead, it assesses label-reading ability, prevention practice, and self-reported frequency and source of accidental exposure separately.

Hidden Gluten and Accidental Exposure

The evidence on the occurrence of accidental exposure is also variable. Even among those who generally reported adhering to their diet, suspected symptomatic reactions to gluten were common. Silvester et al. found that a large proportion of exposures were unknown until symptoms occurred, and a smaller proportion were associated with food ordering and/or cross-contact. Even when a gluten-free diet is followed, unintended contact can still occur (3). In contrast, Monachesi et al. conducted a direct food test on 448 foods from the diet of 69 treated children with CD and found that only 2.7% of the foods tested contained gluten. Total gluten exposure was below the recommended safety dose in the affected children. This discrepancy from studies reporting high frequencies of suspected exposure might be due to differences in food regulations, family education, supervision of food consumption, measurement, and possible differences in national awareness of CD(13).

This also highlights the gap between gluten "exposure," as measured objectively, and gluten "exposure" as perceived by the parent. Symptoms can be non-gluten related, and exposure may go undetected. Hence, parent-reported exposure can be helpful in the clinical setting to better make sense of how this exposure relates to the family's experience but should not be confused as a laboratory measure of gluten intake.

Cross-Contact Prevention at Home and School

Food can become contaminated with other food through contact with the utensils used in food preparation, service, or storage. Damasceno et al. found that risk depends on the food, how it is prepared, how it is cleaned, and what equipment is used for shared food. They also found that some common kitchen practices people often fear are not necessarily indicative of gluten levels above normal when cleaning is done properly. Hence, preventing cross-contact should not rely on general restrictions but on evidence and the characteristics of a particular food environment(4).

Parents have control over what they can do in their own homes, but less control in school settings. In their study, Du et al. reported that over half of the children with CD had not involved in school meal programs. Parents often voiced concerns that school foodservice would struggle to safely prepare gluten-free foods, that communication about gluten-free options would be lacking, and that cross-contact risk in the school cafeteria would be high. That study, however, focused mainly on perceived barriers to school-meal participation, and not directly on parental label literacy or home practices and their relationship to reported exposure(7). The safety of school food is the responsibility of many players, including parents, teachers, food-service workers, and students. It is not possible to prevent exposure even if the parents are informed well, if the school procedure is not uniform. On the other hand, good school management can minimize exposure even if parents don't know everything they should. These observations can help to examine prevention in homes and schools as distinct disciplines. Previous evidence is summarized in Table 1.

Table 1. Critical summary of previous evidence

Study	Main focus	Principal finding	Limitation relevant to the present study
Charalampopoulos et al.(8)	Parental knowledge and adherence	Perceived parental knowledge was associated with adherence	Evaluated broad perceived knowledge rather than applied label literacy
Elsahoryi et al.(6)	Parental educational intervention	Education improved knowledge, practices, and adherence	Did not isolate the effects of label reading or cross-contact prevention
Dowhaniuk et al.(11)	Assessment of pediatric adherence	Parents and children tended to overestimate adherence	Focused on overall adherence rather than specific hidden-gluten risks
Monachesi et al.(13)	Laboratory assessment of food contamination	Detectable gluten was uncommon in tested food samples	Short measurement period and limited assessment of school exposure
Pohoreski et al.(9)	Knowledge and adherence among adolescents	Knowledge was not consistently associated with adherence	Small sample and limited evaluation of environmental practices
Mehta et al.(12)	Long-term pediatric adherence	Adherence declined over time, with differences between reported and recorded intake	Did not identify specific hidden-gluten exposure pathways
Monzani et al.(10)	Determinants of pediatric adherence	Dietitian support was important for adherence	Examined dietary support broadly rather than applied parental skills
Du et al.(7)	Barriers to school-meal participation	Parents lacked confidence in the safety of school gluten-free meals	Focused on perceived barriers rather than documented exposure
Damasceno et al.(4)	Food-handling and cross-contact	Risk varied according to preparation and cleaning practices	Review evidence was heterogeneous and not specific to parental behavior

Research Gap and Contribution of the Present Study

Previous studies show that key factors in disease management include parental education, dietary counseling, and environmental control. However, three key areas remain lacking.

This study aimed to fill these gaps by separating applied label literacy from general awareness, calculating prevention scores separately for home and school, measuring reported unintentional exposure, and assessing the independent association of these factors after controlling for parental education and time since diagnosis. This study therefore adds to the evidence base and helps illuminate the pathway to dietary safety as it relates to parental competence and environment.

Because of the cross-sectional design and parent-reported exposure, the observed relationships should be regarded as associations, not cause-and-effect.

MATERIALS AND METHODS:

Study Design and Participants

This is a multicenter cross-sectional descriptive-analytical study that was carried out at three pediatric gastroenterology clinics in the outpatient department in Baghdad city, Iraq, from June 1 to October 31, 2025. The clinic is for children diagnosed with CD from various provinces of Baghdad and is limited to follow-up services. We used a non-probability convenience sampling strategy. Each parent or primary caregiver accompanied their child to a routine follow-up visit and was approached and screened for eligibility during the study period. All participation was voluntary, and we included only one parent or primary caregiver per child.

Eligible parents or primary caregivers of children aged 4-12 years had a physician diagnosis of CD recorded in their medical files. Caregivers were required to have a diagnosis for at least six months before recruitment to allow ample time to experience and manage a GFD. Children were also asked to attend school or kindergarten as the study considered cross-contact prevention practices at home and in school.

Parents or caregivers of kids with other chronic medical issues who needed to be on a special diet were excluded to minimize possible confounding. Questionnaires with significant missing data were also excluded from the statistical analysis.

We determined sample-size adequacy using a planned multiple linear regression model with five predictor variables. Assuming a medium effect size (f^2=0.15), The optimal number of participants for the study was assumed to be 92, based on an effect size of 0.15, statistical power of 80%, and a significance value of 0.05. Finally, 120 parents/primary caregivers were included in the final sample, which was more than the minimum number required 115 parents/primary caregivers) and provided sufficient statistical power for the analysis planned.

Recruitment took place daily at standard Clinique throughout the 5-month research period. After eligibility

screening, participating parents/caregivers were asked to complete one of two questionnaires (self-administered or researcher-administered), based on their choice and literacy preferences. We retained 120 questionnaires after checking eligibility and completeness.

We did not keep a separate log of the number of eligible caregivers first approached; therefore, we could not determine the overall response rate. This was thus identified as a reporting limitation. Table 2 provides an overview of key demographics and clinical variables.

Table 2. Demographic and clinical characteristics of parents and children (N = 120)

Variables	Category	n (%) / Mean ± SD
Parent age (years)	—	36.8 ± 7.4
Parent sex	Female (mother)	86 (72.0)
	Male (father)	34 (28.0)
Educational level	Less than secondary	20 (16.7)
	Secondary education	46 (38.3)
	University degree or higher	54 (45.0)
Employment status	Employed	68 (56.7)
	Unemployed / homemaker	52 (43.3)
Child age (years)	—	8.1 ± 2.4
Child sex	Male	58 (48.3)
	Female	62 (51.7)
Duration since diagnosis (years)	—	3.2 ± 1.9
School type	Public school	72 (60.0)
	Private school	48 (40.0)

Data Collection Instrument

The data were collected by a structured questionnaire which was author-designed to measure the management of hidden gluten risks amongst children who have CD by their parents. The instrument was developed based on the largest gaps identified in the literature on dietary management in gluten-free nutrition, interpretation of food labels, avoidance of cross-contact, and avoidance of accidental gluten exposure. Items in the questionnaire aligned with the study aims to ensure the instrument covered parental knowledge, label-reading skills, preventive behaviors at home and school, and reported exposure outcomes.

The final questionnaire comprised 40 questions in four sections. The full survey can be found in Supplementary Material 1.

Section A: Socio-Demographic and Clinical Information

This section included 10 items: parent age, parent gender, educational level, employment status, child age, child sex, time since diagnosis of CD, eating a strict low-gluten diet, type of school attended, and use of any meals or snacks at school. These items were analyzed as continuous or categorical variable (as appropriate)

Section B: Parental Food Label Literacy

The 14 food-label literacy items measured parental food-label literacy. Items 11–20 assessed factual knowledge, with questions about gluten-containing grains, malt extract, modified starch, precautionary allergen statements, oats, hydrolyzed vegetable protein, sauces and seasonings, gluten-free claims, manufacturing cross-contact, and the potential presence of gluten in medications or supplements. Items 21–24 measured parents' confidence and label-reading behavior using a five-point Likert-type scale from strongly disagree to strongly agree. These covered his or her confidence in detecting hidden gluten, understanding of precautionary allergen statements, the reading of complete lists of ingredients, and his or her detection of ingredients that might be unsafe.

Label literacy scores were calculated by awarding two points for each factual answer (correct) and zero points for any incorrect answers. Responses to the four Likert scale items were re-coded as zero (strongly disagree and disagree), one (neutral), and two (agree and strongly agree). Thus, the overall score could be from 0 to 28 (higher scores reflecting a more food-label literate parent). A cut-off score of 0-16 was considered low literacy, 17-22 moderate, and 23-28 high literacy.

Section C: Cross-Contact Prevention Practices

Cross-contact prevention was measured with a 10-question instrument on a five-point Likert scale (1 = never, 5 = always). Items 25-29 evaluated home practices such as use of separate cooking utensils and toasters, cleaning of kitchen surfaces, separate food storage, and no sharing of condiments.

Items 30-34 asked about activities related to school, including informing school personnel, preparing school meals separately, teaching children not to share food, communicating with teachers, and confidence in school procedures.

Mean scores for home practices and school were calculated separately. The scores for each subscale were between 1 and 5, with higher scores being more consistent in terms of cross-contact prevention

Section D: Accidental Gluten Exposure

This section included six items measuring unintentional gluten exposure over the past 3 months. Addressed questions were whether participants had been exposed and, if so, at what frequency; whether this was likely to be a particular setting such as a home, school, or a childcare facility; if

they had a perception of how the exposure occurred; if they did so, experienced symptoms; and if they did, what type. Exposure frequency categories were "no exposure," "one exposure," "two exposures," and "three or more exposures. These categories were coded as 0, 1, 2, or 3. Data related to exposure setting, cause, and symptom were analyzed by percentages and frequencies.

Summarizes the structure of the questionnaire, including domains, number of items, and response formats(Table 3).

Table 3. Summarizes the structure of the questionnaire, including domains, number of items, and response formats

Questionnaire domain	Description	Number of items	Response format and scoring
Socio-demographic and clinical information	Parent, child, disease and school characteristics	10	Continuous and categorical responses
Parental food-label literacy	Factual knowledge, label interpretation and applied label-reading skills	14	Ten true-or-false items and four Likert items; total score 0–28
Cross-contact prevention practices	Home and school prevention practices	10	Five-point Likert scale; separate home and school mean scores
Accidental gluten exposure	Frequency, setting, cause and reported symptoms	6	Binary, frequency-based and categorical responses
Total	All questionnaire sections	40	Mixed response formats

Table 4. Descriptive statistics for the principal study variables (N = 120)

Study variable	Possible range	Mean	SD	95% CI for mean
Parental food-label literacy	0–28	19.18	4.11	18.44–19.92
Home cross-contact prevention	1–5	3.6	0.63	3.49–3.71
School cross-contact prevention	1–5	3.24	0.69	3.12–3.36
Accidental gluten-exposure frequency	0–3	2.08	0.81	1.94–2.23

Data Analysis

Data generated were coded, entered, cleaned, and analyzed using statistical software developed by IBM SPSS Statistics for Windows version 29.0. The data underwent data screening prior to analysis, focusing on the analysis of incomplete responses, out-of-range values, coding errors, and logical inconsistencies. Only questionnaires that met the pre-established criteria of completeness were included. The final analysis included 120 fully complete questionnaires, and no imputation for missing values was needed (Table 4).

We used frequencies and percentages to summarize categorical variables. Means, standard deviations (SDs), minimum and maximum values, and 95% confidence intervals (CIs) were calculated to describe continuous variables and questionnaire scores. Histograms, normal probability plots, skewness and kurtosis were also examined for score distributions.

Parental food-label literacy scores ranged from 0 to 28. Mean scores were calculated separately for cross-contact prevention practices at home and at school (each ranging from 1 to 5). Accidental gluten exposure was assigned an ordered frequency score: none (0), one time (1), two times (2), and 3 or more times (3).

If continuous questionnaire scores were approximately normal and relationships were linear, Pearson's correlation coefficient was used to examine relationships between the scores. When accidental gluten-exposure frequency was added, the measurement was on an ordered scale, and Spearman's rank correlation coefficient was used. Correlation coefficients were considered weak around 0.10, moderate around 0.30, and strong at 0.50 and higher.

We performed a modified multiple linear regression analysis to identify factors associated with accidental GEF. The dependent variable was the frequency score for accidental exposures. We simultaneously entered parental food-label literacy, cross-contact prevention practices at home, cross-contact prevention practices at school, parental educational level, and duration since diagnosis as independent variables. Educational level was assigned in an ascending scale with less than secondary education, secondary education, college education, and university education/higher.

We first checked the regression model assumptions before interpreting the model. Scatterplots and partial regression plots were used to evaluate linearity. We checked residual normality using a residual histogram and a normal probability plot. Assessment of homoscedasticity was done through the plotting of the standardized residuals against the standardized predicted values. A Durbin–Watson test was used to assess residual independence.

Tolerance and Variance Inflation Factor (VIF) values were examined to assess multicollinearity. Tolerance values of less than 0.20 and VIF values > 5 were not considered acceptable. Standardized residuals, leverage values and Cook's distance were used to assess potentially influential observations. Standardized residuals outside the range of –3 to +3 were judged as potentially influential, as were Cook's distances that were close to or greater than 1.

The diagnostic assessment did not indicate major violations of linearity, residual normality, homoscedasticity, independence, or multicollinearity, and no observation met the predetermined criteria for exclusion as an influential case. Regression results were reported using unstandardized coefficients (B), standard errors (SEs), standardized coefficients (β), 95% CIs, and p-values. Model performance was evaluated using R^2, adjusted R^2, and the overall F-test. All statistical tests were two-sided, and P values below 0.05 were considered statistically significant.

Ethical Considerations

Before starting data collection, we obtained consent from the personal Research Ethics Committee in Baghdad, the Iraqi Republic. The Ethics Committee approved the data collection plan, questionnaire protocols, participant recruitment, and data protection in May 2025. Evidence of ethics approval is provided on reasonable request. All research activities were carried out in accordance with the ethical principles from the Declaration of Helsinki. Parents/primary caregivers were asked to provide informed written and verbal consent before administering the questionnaire, after a clear written and verbal explanation of the study aims, procedures, the voluntary nature of participation, and the intended use of the information collected.

All participants signed written informed consent before taking part. Participants were told that they were free to decide not to participate, or to take part for the first time, or to withdraw from the study at any point without having to justify their decision to anyone, including without prejudice to the health care and follow-up provided to their children. There was no cash for hills, crevasse cracking, or similar cold-zone surface features. Children were not directly interviewed, nor questioned, nor given any clinical procedures. Caregiver-reported information was collected, but no clinical information outside of what was necessary to verify eligibility was included.

To safeguard the privacy and confidentiality of all participants, no names, contact information, medical record numbers, or other direct identification data were added to the study databases. Each questionnaire was assigned a unique ID number. The research team kept paper questionnaires secure and electronic data in password-protected files accessible only to the research team. The gathered data were used only for research and reported in general form.

Conceptual Framework

To depict the interrelations between parental features, label literacy, cross-contact prevention practices, and accidental exposure to gluten, a conceptual framework was created. The theory is based on the idea that socio-demographic parental characteristics affect label literacy, which subsequently impacts the prevention practices at home and school. The practices have a direct effect on the probability of accidental gluten exposure.

Figure 1 visualizes this framework and shows the direct and indirect relationships between parental competencies and the final outcome of dietary safety in children with CD.

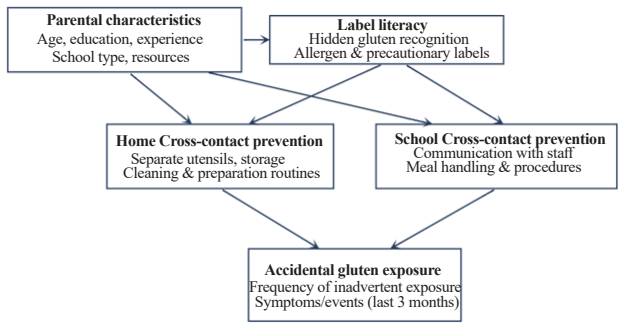


Figure 1. Conceptual framework illustrating parental label literacy, cross-contact prevention practices, and accidental gluten exposure in children with CD

RESULTS

Participant profile

120 parents of children with medically diagnosed CD were included. Table 2 provides an overview of key demographics and clinical variables. The average parental age was 36.8 +/- 7.4 years, with a higher percentage of mothers (72%). The average age of children was 8.1 ± 2.4 years, and the average period of diagnosis was 3.2 ± 1.9 years. The sample comprised 60% public schools and 40% private schools.

Parental label literacy

The parent food-label literacy mean score with a 95% confidence interval (CI) was 19.18 ± 4.11 out of 28. This mean score falls within the moderate-literacy classification, according to the predetermined classification thresholds. The fairly large standard deviation suggests there is significant variation in parents' ability to identify hidden gluten sources and to read information on food labels.

The most common challenges related to reading the labels to identify ingredients containing gluten and checking

the source to determine if modified starch was safe to eat, understanding what it meant that an item used the precautionary phrase "may contain gluten from wheat," and knowing when to make an exception to read the entire list of ingredients when the food had a gluten-free designation. Figure 2 shows how the respondents were spread across the low, moderate, and high literacy levels.

Figure 2 presents the distribution of label literacy and the score distribution in each literacy category, and the score's maturity is evident across the low, moderate, and high literacy groups.

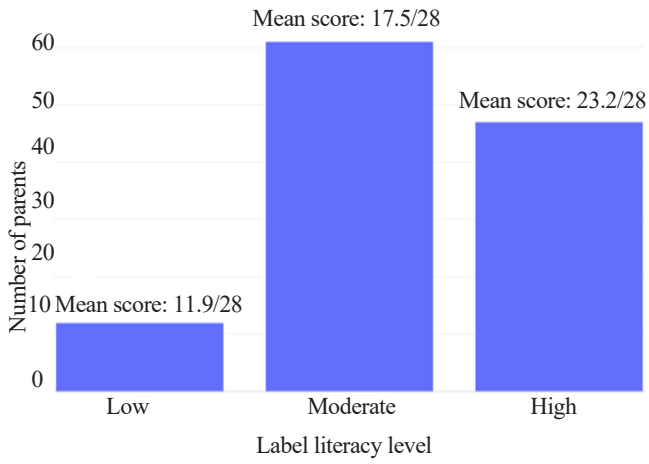


Figure 2. Distribution of parental label literacy levels

Cross-contact prevention practices at home vs. school

The mean score of home cross-contact prevention was 3.60 ± 0.63 between 3.49 and 3.71 (95% confidence intervals). The school prevention score was lower, with a mean score of 3.24 ± 0.69 and a 95% confidence interval of 3.12 to 3.36.

The results showed that preventive measures were carried out more uniformly at home than at school. Common challenges cited by the schools were limited supervision on their handling of food, inconsistent awareness throughout the school regarding food, communal preparation spaces and utensils used in school, and food sharing during breaks, celebrations, and other leisurely moments.

Accidental gluten exposure frequency

There was a high prevalence of accidental gluten exposures in the previous 3-month period. Three parents (2.5%) reported no exposure, 25 (20.8%) reported one event, 51 (42.5%) reported 2 events, and 41 (34.2%) reported 3 or more events. Thus, 92 participants (76.7%) reported accidental gluten exposure ≥ 2 times in their children during the 3-month reference period.

The mean score, when exposure frequency was coded from 0 to 3, was 2.08 ± 0.81 (95% CI: 1.94 to 2.23). The distribution shows that repeated accidental gluten exposures remained prevalent despite continued efforts to follow a gluten-free diet (Table 5).

Table 5. Distribution of accidental gluten-exposure frequency during the previous three months (N = 120)

Exposure frequency	N	Percentage	95% CI for percentage
No exposure	3	2.50%	0.9–7.1%
One exposure	25	20.80%	14.5–28.9%
Two exposures	51	42.50%	34.0–51.4%
Three or more exposures	41	34.20%	26.3–43.0%
Total	120	100.00%	—

Association between label literacy, practices, and exposure

This multiple regression model was statistically significant, $F(5, 114) = 16.51$, $P < 0.001$. The R-squared for this model was equal to 0.420 with an adjusted R-squared of 0.395, explaining 42.0% of the variance in the accidental gluten-exposure frequency. The standard error of the estimate was 0.627.(Table 6)

More parents accidentally exposed to food were significantly less likely to be in the higher food-label literacy groups (B = −0.28, 95% CI: −0.40 to −0.16, β = −0.41, $P < 0.001$). The standardized coefficient suggests that none of the other items in the model were as significantly associated with exposure frequency as was parental FL literacy.(Table 7)

The school cross-contact prevention index was also significantly associated with less exposure frequency (B = −0.24, β = −0.35, 95% CI: −0.36 to −0.12, $P < 0.001$). Home cross-contact prevention demonstrated a similar but comparatively smaller association (B = −0.19, β = −0.29, 95% CI: −0.33 to −0.05, P = 0.004).

Higher parental educational level was associated with fewer exposure events (B = −0.11, β = −0.17, 95% CI: −0.21 to −0.01, P = 0.031). Duration since diagnosis was not statistically significant at the 0.05 level (B = −0.08, β = −0.12, 95% CI: −0.16 to 0.01, P = 0.067).

Table 6. Multiple regression model summary

R	R^2	Adjusted R^2	Standard error of estimate	F	Df	P value
0.648	0.42	0.395	0.627	16.51	5, 114	<0.001

Table 7. Multiple regression analysis predicting accidental gluten-exposure frequency (N = 120)

Predictor	B	SE	β	95% CI for B	P value
Parental food-label literacy	−0.28	0.06	−0.41	−0.40 to −0.16	<0.001
Home cross-contact prevention	−0.19	0.07	−0.29	−0.33 to −0.05	0.004
School cross-contact prevention	−0.24	0.06	−0.35	−0.36 to −0.12	<0.001
Parental educational level	−0.11	0.05	−0.17	−0.21 to −0.01	0.031
Duration since diagnosis	−0.08	0.04	−0.12	−0.16 to 0.01	0.067

Figure 3 displays exposure frequency categories (0, 1, 2, ≥3) by label literacy level as stacked percentages. A clear pattern is observed:

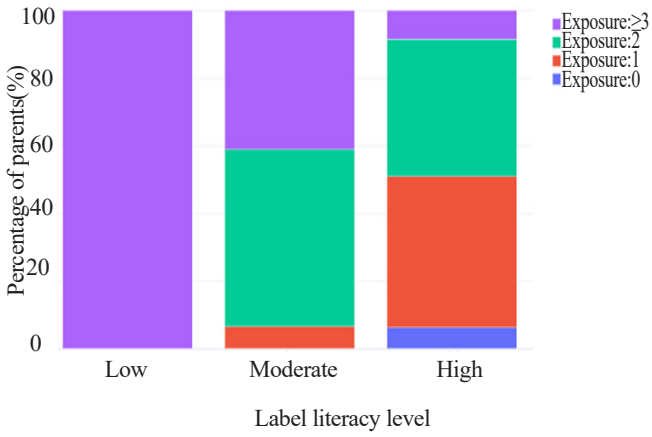


Figure 3. Accidental gluten exposure frequency by label literacy level

Higher literacy groups have a higher proportion of low exposure (01).
Lower-literacy groups have a greater proportion of frequent exposure (≥3).
This visualization provides evidence of the following pathway suggested in the conceptual framework: enhanced label literacy is associated with safer practices and reduced accidental exposures, particularly when converted into action-oriented preventive measures in schools.

DISCUSSION

Parent food-label literacy in the current research was generally moderate, and parents reported specific challenges in correctly identifying hidden gluten content and understanding precautionary allergy labeling. This is in alignment with findings by Pohoreski and colleagues suggesting that while parents tended to have greater knowledge, there were gaps in gluten-free diet knowledge across both the parents and children's groups. But knowledge is not enough to get compliance, and the ability to read labels may be more significant than general awareness (9).
More consistency of cross-contact prevention practices at home than at school. Parents may have more control within the home about what foods are prepared, where foods are stored, what utensils are used, and how the messes are cleaned up, while safety in schools relies on staff awareness, school procedures, the way foods are prepared, and supervision. This finding is consistent with a previous study by Du et al. which found that many parents did not feel confident that school cafeterias could deliver safe gluten-free food (7).
The same individuals were accidentally exposed multiple times. This aligns with other findings: Monachesi et al. detected gluten in only a fraction of the food items tested. This discrepancy may reflect how exposure was measured, as the current study relied on parentally suspected exposure rather than laboratory confirmation of gluten consumption. The symptoms of gluten exposure might not have been gluten-related, and exposure to gluten might not have been detected(13).
More label literacy and more cross-contact preventing capacities were associated with fewer exposure events (P values 0.01 and 0.006, respectively). Label literacy showed the strongest association, as did school prevention, after controlling for home practices and parental education. This may indicate that teaching skills alone is not enough, and that schools need to use consistent food-safety procedures. No difference was found between groups regarding duration since diagnosis (P value not significant). Therefore, experience alone may not be enough to enhance safety at the food level without continuous education and updated practical advice for families. The cross-sectional design of the study did not allow the associations found to be interpreted as causal.

Limitations

This study has several drawbacks. The study used convenience sampling at three clinics in Baghdad, which limited the generalizability of the results. The response rate could not be calculated because the total number of individuals eligible to sit with a caregiver was not documented. Parent-reported data were collected, which may have been subject to recall and social-desirability bias. The study did not use laboratory testing, food analysis, or biological markers to confirm accidental exposure.

Besides, the questionnaire used in the study was not fully externally psychometrically validated and was developed by the researcher. Furthermore, the regression model did not include potentially relevant factors (such as household income, access to dietitians, the availability of gluten-free products, and school food policies). Future studies should consider a longitudinal design and use validated instruments and objective measures of gluten exposure.

CONCLUSION

This paper explored the role of parental intervention in managing the risks of hidden gluten in children with CD, focusing on food label literacy and the prevention of cross-contamination at home and at school. The results indicate that accidental gluten exposure remains common despite parental awareness and ongoing dietary management measures. Most parents had a moderate level of label literacy, with clear discrepancies in identifying hidden gluten ingredients and understanding precautionary labeling statements.

The outcome also indicated that prevention of cross-contact was more consistently practiced at home than at school. School environments proved vulnerable, with a lack of proper supervision, shared food preparation areas, and irregular institutional practices that increased the chance of unintended gluten exposure. Statistical tests showed that increased parental label literacy and better cross-contact prevention practices, especially in schools, strongly correlated with fewer accidental gluten exposure incidents. Comprehensively, the paper points out the need to note that the appropriate management of a gluten-free diet among children is not merely a matter of general awareness but rather involves a mix of label literacy skills and prevention-related behaviors (which are context-specific). Combining these aspects is required to enhance nutrition safety and minimize risks to the health of children with CD.

Recommendations

The recommendations will be as follows based on the outcomes of the study:

1. Enhancing education among parents.

Specific educational programs must be designed to increase food label literacy among parents, with a focus on determining the origins of hidden gluten, learning the terminology related to technical ingredients, and properly decoding the precautionary allergen statements.

2. Enhancement of gluten safety in schools.

Schools should use standardized procedures for producing, handling, and storing gluten-free meals, along with staff training on cross-contact prevention and dietary safety, to support children with CD.

3. Improving parent-school communication.

Organize direct contact between parents and school employees to implement gluten-free guidelines consistently and address emergent issues promptly.

4. Creating effective guidance tools.

Parents and teachers can use checklists, illustrative instructions, and easy-to-use materials to implement effective cross-contact prevention methods.

5. Future research directions

It is preferable to conduct longitudinal studies which would help to estimate the changes in parental competencies over time and evaluate the efficacy of educational and institutional interventions in preventing accidental exposure to gluten.

DATA AVAILABILITY STATEMENT

Anonymized data, questionnaire, coder's guide, and statistical results can be made available upon reasonable request by the corresponding author, subject to ethical and confidentiality considerations.

DECLARATION OF ARTIFICIAL INTELLIGENCE USE

When preparing the manuscript, the authors relied solely on ChatGPT (OpenAI) to edit, correct, and clarify the English language. The authors did not use this tool for data collection, generation, analysis, or conclusions. All authors have reviewed and approved the final version of the manuscript and accept full responsibility for its contents.

CONFLICT OF INTEREST

The authors declare no conflict of interest related to this work.

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