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Investigating Food Allergen Labeling in Commercially Packaged Food Products

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ABSTRACT

Background: In 2017, Turkey introduced Turkish Food Codex Regulation on labeling and providing food information to customers, which has been revised on a regular basis ever since. The purpose of this study was to survey food allergen information regarding foods and beverages sold in Turkey and the extent to which food allergens and precautionary allergen labeling (PAL) are emphasized in the products. **Method:** Thirteen food and drink categories were reviewed in five physical food stores and three online stores. A total of 1,010 foods and beverages were checked for allergens according to their labels. **Results:** 1,116 allergenic foods were identified in 59.7% of foods and beverages,. Gluten-containing cereals were clearly labelled in every food category, and milk received the highest number of declarations (30.55%), followed by gluten (27.42%), and tree nuts (9.67%). Snacks contained the most number of allergens (14.8%), followed by dairy products (13.8%), and baked products (12.4%). **Conclusions:** Accurate and understandable food allergy labeling is essential in avoiding food allergies. Food allergy labeling legislation especially The EU Regulation No. 1169/2011 establishes uniform rules for allergen labeling, which is one of the most stringent food regulations in the world. Current allergen labeling restrictions and policies need to be improved to reduce the risk of food hypersensitivity.

Keywords: *Food allergy; Food labelling; Food legislation; Food packaging*

Introduction

Food allergies occur when one's immune system adversely reacts to food proteins, resulting in severe and life-threatening conditions. Depending on immune mechanisms, the allergies can be classified as IgE-mediated, non-IgE-mediated, and mixed type. The simplest definition of an allergen is a substance that causes an allergic reaction- a hypersensitivity immune response- ;but, it usually refers to a type I– or immunoglobulin E (IgE)-mediated hypersensitivity response. In practical terms, allergens are defined by being recognized by IgE from patients. Some allergens included by this definition are not very potent inducers of primary allergic immune responses; in other words, they are weak allergenic immunogens; but, if the IgE which is capable of

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binding them is present (perhaps because of cross-reactivity with a strong immunogen), it can trigger effector responses. Other structures (eg, some glycans discussed later) are inducers of IgE and are recognized by IgE in binding assays but may be impotent triggers of allergic responses (Masilamani *et al.*, 2012). Affecting 6% of children and 4% of adults in the global population, food allergies can cause symptoms that range from mild, such as cramping, vomiting, rashes, shortness of breath and asthma, to severe cases like trouble with swallowing or breathing, and death. As a result, 10,000 hospital emergency rooms are visited each year (Boye, 2012, Moore *et al.*, 2017). Medical experts advise cautious avoidance of the allergen because,currently, there is no cure to avoid major health problems (Sicherer and Sampson, 2018).

Food allergies in Western countries affect approximately 10% of the population, with the greatest prevalence being amongst younger children (Loh and Tang, 2018); 2 million people in the UK and 32 million in the US (with minimal data for Africa, Asia and South America) (Food Allergy Research and Education (FARE), 2020) live with food allergy (Food Standards Agency (FSA), 2017). Regulations are in place globally to protect consumers. The Codex Alimentarius (Food Code) is a set of international food standards and guidelines including food allergen labelling which is used as a key reference by 186 countries worldwide. Codex Alimentarius recommends the declaration of major food allergens (e.g., egg, fish, gluten, etc.) on food packaging (World Health Organization and Food and Agliculture Organization, 1991). It is currently mandatory that food labels declare 14 food allergens (European Union, 2011). Despite these stringent legal requirements, ,annually, thousands of individuals suffer from serious allergic reactions to the food they have purchase and consume (Food Allergy Research and Education (FARE), 2020, Marchisotto *et al.*, 2016, National Insttute for Health and care Excellence (NICE), 2015). Hospital admissions for food-induced anaphylaxis have increased three-fold over the past 20 years. The increase is likely an underestimation as Conrado *et al.'s* study only looked at UK hospital admissions. Many others who experience severe food allergic reactions are treated as an outpatient in Asia and Europe (Conrado *et al.*, 2021).

Turkey is a melting pot of culture; hence, both the Mediterranean and Eastern Food Culture constitute the country's diet (Gelincik *et al.*, 2008). The diversity of diet may influence the prevalence of food hypersensitivities in the region. To date, there has been limited nationwide epidemiologic studies on the prevalence of food allergic reactions in the general Turkish population. However, some studies addressed the prevalence of IgE-mediated reactions in specific populations. For example, oral food challenges conducted among schoolchildren revealed foods such as beef, cow's milk, cocoa, hen's egg and kiwi are common triggers, while the prevalence rate of IgE-mediated food allergy among adolescents was 0.16% according to a study conducted in 2009 (Orhan *et al.*, 2009). Mustafayev *et al. also* found that common foods involved in allergic reactions include walnut, beef, and hen's egg (Mustafayev *et al.*, 2013). Cow's milk protein is a common food allergen among infants and young children where Doğruel and Guler and reported the incidence of food challenge Cow Milk Protein Allergy (CMPA) to be 1.45% (Doğruel *et al.*, 2016, Guler *et al.*, 2020). Recent studies revealed that 0-2-year-old children experience egg white, cow's milk and tree nut allergies more frequently compared to other food allergens (Kahveci *et al.*, 2020). Similarly, Akarsu demonstrated that the most common food allergies among children and adolescents are tree nuts, cow's milk, egg white, peanuts, and seeds (Akarsu *et al.*, 2021).

One of the best strategies to prevent food allergic reactions is to avoid triggering food or ingredient. Education and understanding food labels are very important to individuals with food allergies (Lanser *et al.*, 2015). Hence, the accuracy of food allergen labeling for foods and beverages is crucial. Turkey implemented Turkish Food Codex Regulation on labeling and providing food information to consumers in 2017 (Turkish-Food-

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Codex, 2017). The Regulation was drafted in accordance with Regulation (EU) No. 1169/2011 of the European Parliament and of the Council on 25 October 2011 (European Union, 2011). Accordingly, it is mandatory to label foods or beverages which contain substances or products and cause allergies or intolerances i.e., cereal containing gluten, celery, crustaceans, eggs, fish, lupin, milk (including lactose), molluscs, mustard, peanuts, sesame, soy, sulphite (>10 mg/kg), and tree nuts (Turkish-Food-Codex, 2017). The purpose is protecting consumers' health and ensuring that information on food labels by producers, including ingredients and allergens are correct.

The importance of food labelling is very frequently overlooked; however, it is essential to help consumers make healthy and safe choices regarding food purchasing ,which directly affects societal wellbeing. Thus, clear and unambiguous food labeling is vital for presenting critical safety information to consumers. Several studies concerning the characteristics of food allergen labeling had been conducted in Latin America (Ontiveros *et al.*, 2020), the Netherlands (Blom *et al.*, 2021), Malawi (Mfueni *et al.*, 2018), Malaysia (Soon, 2018), and Serbia (Davidović *et al.*, 2022).

Food allergen labeling plays a crucial role in preventing the development of food allergies among the allergic individuals. So, the significance of allergen rules on food labels led to this comprehensive study to evaluate commercial food labels sold in Turkey. Currently, there is no published study with respect to food allergen labeling of commercially prepacked food in Turkey. This study aims to review food allergen information presented on foods and beverages sold in Turkey and the extent to which food allergens and precautionary allergen labeling (PAL) are emphasised in the products.

According to a 2012 study, the production and sell-by dates were the most important label components for meat, fish, poultry, dairy products, and snacks; however, this study did not review the expiration dates as the focus of the research was food allergen labelling (Besler *et al.*, 2012). Therfore, The purpose of this study was to survey food allergen information regarding foods and beverages sold in Turkey and the extent to which food allergens and precautionary allergen labeling (PAL) are emphasized in the products.

Materials and Methods

Type of the study: This was a cross-sectional study conducted from December 2021 to January 2022. The inclusion criteria consisted of the products that were packaged and sold commercially, and can could be easily found all over Turkey. The exclusion criteria were unpackaged products, those were not sold commercially in markets or online markets, and the products that only belonged to a certain region. In addition, the Ethics Committee approval was not required in this study, so it was not applicable.

Physical stores: Five mega physical stores in Turkey were visited. Two of them were supermarkets and three of them were convenience stores. These stores were chosen as they are part of a retailer chain and are widespread in Turkey. Prior to the visit, verbal consent was obtained from each store manager. All packaged foods' labels obtained from physical stores were photographed from all sides (front, back and other sides), and foods and beverages were randomly selected from the shelves.

Online stores: Premium, regular, and budget stores (n=3) which provided online deliveries were selected. Each page in online store webpage offered a selection of 40-50 items per food category. Five items per page were selected systematically by choosing every 8th or 10th item listed on the page.

Survey: The labeling of commercially processed and packaged food products was evaluated regarding the declaration of food allergens and "contains" or PAL statements for labelling. Thirteen food categories were selected. The foods and beverages were representative of the range of commonly purchased foods in Turkey (Gül and Dikmen, 2018). Data were collected from December 2021 to January 2022, and two or three digital photographs were taken for each product.

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The photographs were evaluated and items such as the place of manufacture (local or foreign), allergen(s) (if declared), and 'contains' and PAL statement. Data from each label were entered into an Excel sheet according to the food category. Then, the ingredients list was checked for allergenic foods such as gluten, tree nuts, peanuts, soybean, fish, milk, eggs, celery, lupin, mustard, sesame seed, and sulphites. This was according to the guidelines for allergen labeling in Turkey. In food labels with "contains" or PAL statements, the description of the statement and the type of food allergen were noted. The characteristics of font such as the type, bold, italic, contrasting color, highlighted, enlarged font, and asterisk to demonstrate ingredients, 'contains' statement or PAL were recorded. Information of labels were checked and documented for ambiguous or contradictory statements and examples of good allergen labeling practices were recorded. Food products with good allergen labelling practices were identified based on the provision of alergen names in plain English (e.g. casein [milk]), and the sources of generic ingredients such as oil, flour, or starch were also provided.

Data analysis: Descriptive statistics were used and the results were presented in percentages. Then, the results were entered into an Excel data sheet and percentages were calculated.

Results

Declaration of food allergens: A total of 1010 foods and beverages were evaluated for their allergen labelling. 1,116 allergenic foods were identified in 603 foods and beverages. Gluten-containing cereals were consistently addressed across all food categories. Milk received the highest number of documentation (30.55%), followed by gluten (27.42%), tree nuts (9.67%), soybean (9.50%) and eggs (8.60%). Molluscs received the lowest number of documentation (0%), followed by crustaceans (0.1%) and lupin (0.1%). Other allergens (1.43%) were sourdough, yellow pea, malt extract, enzyme modified cheese, sodium metabisulphite, and malt extract. (**Figure 1**).

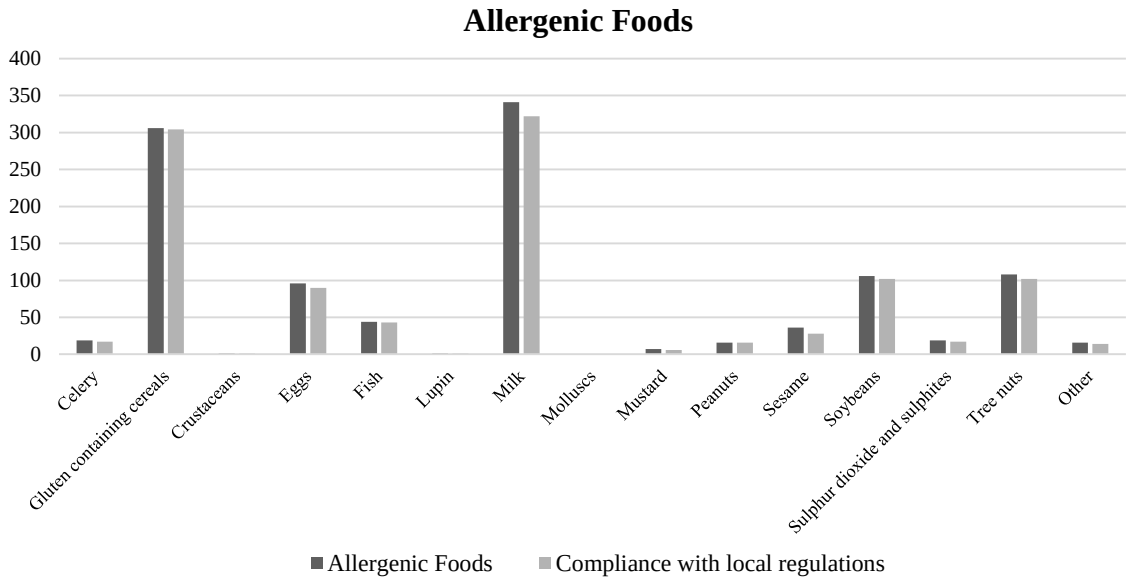

Figure 1. The number and types of food allergens inserted in the product's ingredient list or and compliance with local regulations.

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Snacks (22.62%), baked goods (22.62%), baby and young children's food (12.12%), frozen food (8.26%) and ready-to-eat food (6.64%) were the food categories with the highest number of registered allergens. The major proportion of food allergens were inserted in bold font (88.72%) and/or italic (21.56%) and/or underlined (1.99%). This study recorded 160 good labeling practices in snacks (38.13%), baby and young children's food (23.75%), jam and spread (8.75%), baked goods (7.5%), frozen food (6.25%) and dairy (4.38%). Some examples of proper labeling practices includeemulsifier (especially soy lecithin), whey (milk), malt extract (containing gluten) for snacks, lactose (from cow's milk), maltodextrin, emulsifier (soy lecithin), vegetable oils for baby and young children's food, preservatives (contains sulphur dioxide), skimmed milk powder (cow's milk), emulsifier (soy lecithin) for jams and spread; whey proteins and emulsifiers for baked products, whey proteins for frozen food, additives, whey proteins, and emulsifiers for dairy products.

Contains statement and PAL: 174 foods and beverages contained a' contains' statement in addition to the allergens in the ingredient list. 13.22% (n=23) of these products showed discrepancies between the ingredient list and 'contains' statement. Baked (34.78%) and ready-to-eat foods (17.39%) had the highest number of discrepancies. For example, in baked goods (e.g., croissants), the 'contains' statement showed the presence of gluten and egg while the ingredients list declared gluten, egg, sesame, and tree nuts. In chilled foods (e.g., chicken dumplings), egg was not mentioned in the ingredients list but contained the statement, 'contains gluten, milk and egg'.

PAL statements were found on 377 labels. Manufacturers were mostly consistent in using 'may contain traces of …' (93.89%), followed by 'produced in a factory that also handles' (2.65%), 'produced on the same line as (1.86%) and others (1.59%). The following food categories included the highest number of PAL statements i.e., snacks (21.22%), dried food and ingredients (15.65%), condiments and sauces (11.94%), baked products (11.67%) and confectionary (11.14%). Up to 1,385 food allergens were labelled in PAL statements considering all the food and beverage categories. Sesame (10.69%), gluten-containing cereals (10.18%), peanuts (10.04%), soybean (9.96%), and hazelnuts (9.03%) were the top five food allergens consistently labelled in PAL. Some examples of PAL statements are shown in **Table 1**.

Table 1. Examples of food allergen labeling practices

Food categories	Examples of food allergen labeling practices.[a]
Snacks	Produced in a factory that also handles products containing peanuts, hazelnuts, other nuts, egg and sesame
Dairy products	May contain traces of gluten containing cereals and nuts
Baked products	May contain traces of sesame and nuts
Baby and young children's food	May contain traces of soybeans, egg, sesame, hazelnut, and peanut
Beverages	Produced on the same line with products containing eggs
Canned food	Produced on the same line with products containing mustard
Confectionary	May contain traces of pistachio, almond, hazelnut, sesame, milk products, and peanuts
Condiments and sauces	May contain traces of nuts
Chilled food	Produced in a factory that also handles products containing gluten, soy products, and nuts.
Dried food and ingredients	May contain traces of treenuts, gluten, soy products, milk products, mustard, sulphite, and celery
Frozen food	May contain traces of milk products
Jams and spread	May contain traces of walnut
Ready-to-eat	May contain traces of soy products, peanuts, celery, and sulphite.

[a]: One food item may have more than one example.

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Unclear food allergen information: All the foods and beverages showed a low level of ambiguity. Out of 1,010 products, only 42 (4.16%) items were found to have vague information regarding food allergen. Among the food products, confectionery (35.71%), dairy (26.19%), and baked goods (16.67%) contained the highest amount of unclear information regarding allergens due to unsuitable format. Most of the affected items in the confectionary did not record the allergens with a suitable bold, italic, or underlined font. The ambiguity associated with dairy products were due to the missing declaration of milk or lactose in the ingredient list. The ambiguity in baked goods were due to an unsuitable font format. 389 of food and beverage items contained Turkish and English statements. There were discrepancies in only 2 food categories of snacks (0.51%) and baked goods (0.51%) between the languages. Discrepancies between the languages means that all the allergens declared in the Turkish ingredient list were not declared in the English ingredient list in the same way. Thus, this study proposed 68 recommendations to improve the current food allergen labeling. The highest number of recommendations belonged to confectionary, baked foods, and dairy products; they included ensuring consistency between the allergens declared in the ingredients list and the 'contains' statement, consistency in labels with bilingual terms (English and Turkish) and ensuring that allergens are emphasised correctly.

Correct allergen labeling practices: Correct allergen labeling includes practices where manufacturers or packers provided clear and thorough information about the product's contents. Examples included declaring the source of emulsifiers, additives, whey proteins, malt extract, brand, source flour treatment agent, vegetable oil, antioxidants, etc.

Even though 1,010 food labels were evaluated, only 159 food items had good allergen labeling practices. According to this evaluation, the highest number of good allergen practices belonged to snacks (38.4%) followed by the baby and young children (23.3%) food category, which consisted of infant formula and cereal-based foods. However, beverages, canned foods, chilled foods, dried foods ,and ready-to-eat food products did not have proper labeling. The ingredients list contained food allergens such as lactose (milk and dairy products), whey proteins (milk and dairy products), emulsifiers (especially soy lecithin), additives (snacks, confectionery), flour treatment agents, malt extract (snacks), and vegetable oils (snacks, jams and spread). Most of the evaluated labels complied with legal regulations., especially, all babies and young children's foods, beverages, canned foods, dried foods, jams and spreads label's were completely appropriate according to the food allergen labeling characteristics. All the food categories and examples are shown in **Table 2**.

Discussion

The list of food allergens that must be recorded in Turkish included cereals containing gluten, celery, crustaceans, eggs, fish, lupin, milk (including lactose), molluscs, mustard, peanuts, sesame, soy, sulphite (>10 mg/kg), and tree nuts (Turkish-Food-Codex, 2017). The regulation was developed using Regulation (EU) No. 1169/2011 from the European Parliament and Council on October 25 , 2011 as a reference (European Union, 2011). Most food categories abide by Turkish Food Codex Regulation with regard to labeling and recorded food allergens in the ingredients list or 'contain' statement.

Milk received the highest number of declarations (30.55%), followed by gluten (27.42%), tree nuts (9.67%), soybean (9.50%), and eggs (8.60%). Similarly, Battisti *et al.* reported that the most common allergen categories in the ingredients lists were milk, gluten, and egg (Battisti *et al.*, 2021). This was partly due to the fact that these allergens were contained in basic ingredients which were widely used in the processed foodstuff. By comparison, an Australian study on over 1,355 food products showed that the most common categories of allergens contained in the ingredients list were wheat (66.5%, soy (48.1%) and milk (45.1%) (Zurzolo *et al.*, 2013). Soybean was also found in 9.50% of the products,

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particularly due to the use of soy lesitin. Soon also reported that soybeans were very common allergens because of soy lesitin (Soon, 2018).

Most of the allergens were recorded correctly such as using bold or italic font. Compared to previous studies, 23.8% (n=105) of food products used a special kind of emphasis (e.g., bold, contrasting color, italic) in Malawi (Mfueni *et al.*, 2018), 43.46% (n=474) used different fonts or interfaces (e.g. bold font, brackets, capital letters) in Malaysia (Soon, 2018), and 99.63% (n=276) of products used different typographies (e.g. bold, capital, bold+capitals) in the Netherlands (Blom *et al.*, 2021).

Table 2. Food categories and examples.

Food categories	Examples	Locally	Foreign	Number of items	Compliance with local regulations	Number of allergens declared
		n(%)	n(%)	n(%)	n(%)	n(%)
Snacks	Chocolate, biscuits, chips	92(9.8)	4(5.5)	96(9.5)	93(9.6)	89(14.8)
Dairy products	Milk, cheese, yoghurt	78(8.3)	5(6.9)	83(8.2)	70(7.2)	83(13.8)
Baked products	Bread, cakes and pastries, and gluten-free products	76(8.1)	2(2.8)	78(7.7)	71(7.3)	75(12.4)
Baby and young children food	Formulas, baby beverages, and snacks	29(3.1)	40(55.6)	69(6.8)	69(7.1)	58(9.6)
Beverages	Fizzy drinks, tea, coffee	76(8.1)	2(2.8)	78(7.7)	78(8.0)	12(2.0)
Canned food	Canned fish, corn, pickles	92(9.8)	1(1.4)	93(9.2)	93(9.6)	21(3.5)
Confectionary	Jelly, traditional confectionaries, and dragee	81(8.6)	1(1.4)	82(8.1)	75(7.7)	35 (5.8)
Condiments and sauces	Ketchup, mayonnaise, and mustard	71(7.6)	11(5.3)	82(8.1)	80(8.3)	40(6.6)
Chilled food	Chilled chicken fillets, cooked meats, and chilled bacon	66(7.0)	4(5.6)	70(6.9)	69(7.1)	23(3.8)
Dried food and ingredients	Legumes, dried vegetables, and dried fruits	69(7.4)	1(1.4)	70(6.9)	70(7.2)	42(7.0)
Frozen food	Frozen meats, frozen vegetables, and frozen fruits	86(9.2)	1(1.4)	87(8.6)	85(8.8)	54(8.9)
Jams and spread	Honey, grape molasses, jams, and marmalades	67(7.1)	0(0.0)	67(6.6)	67(6.9)	32(5.3)
Ready-to-eat	Packed appetizers and ready meals	55(5.9)	0(0.0)	55(5.4)	51(5.2)	39(6.5)
Total		938	72	1010	971	603

Based on Article 24(1)/c, the 'contains' statement can be used in the absence of a list of ingredients (Turkish-Food-Codex, 2017). PAL is not mandatory in Turkish food labeling system as noted in Article 43. However, food producers should ensure that food information provided on a voluntary basis does not mislead customer, is not ambiguous or confusing, and where appropriate, is based on scientific data. The most common PAL statement identified in this study was 'may contain traces of…' Similarly, this PAL statement was the most common type of PAL in Serbia (Davidović *et al.*, 2022). According to a great amount of evidence, PAL was confusing and unhelpful to customers when making a purchasing decision (Allen and Taylor, 2018, Blom *et al.*, 2021). The variations and overuse of PAL were also a source of confusion (DunnGalvin *et al.*, 2019) as few products with PAL contained the allergens stated in PAL statement (Bedford *et al.*, 2017, Khuda *et*

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al., 2016, Manny *et al.*, 2021); this may indicate different levels of risk to customers . For example, customers reported that 'produced in a factory that also handles' as less risky compared to 'may contain' or 'traces of' (Blom *et al.*, 2021, Soon and Manning, 2017).

In this study, regarding declared allergen categories, snacks (14.8%) had the most declared allergen statements followed by dairy products (13.8%) and baked products (12.4%). For instance, a study on more than 20,241 processed foods collected in 2006 in the United States showed that the highest recorded allergen statements belonged to chocolate candy (54%), and cookies (53%) (Pieretti *et al.*, 2009).

Consumers with food allergies or those who were the primary caregivers or were partly responsible for food allergic individuals in the United States were more likely to purchase food with 'good manufacturing practices used to segregate ingredients in a facility that also processed allergen label (65.0%), compared to 'may contain traces of allergen' label (14.5%) (Gupta *et al.*, 2021). This study revealed that the use of PAL was consistent with most of food and beverage items. Most foods and beverages only used 'may contain traces of…' This will benefit consumers as it helps to reduce incorrect risk interpretation posed by-products. Blom *et al* recommended compliance with PAL using one simple, uniform statement like: 'may contain X' or 'maybe present: X' (Blom *et al.*, 2021). Similarly, Brown *et al.* suggested that PAL should be standardized and mandated for food manufacturers (Brown *et al.*, 2015).

Good allergen labeling practices were primarily observed in snacks and babies and young children's foods. The findings of this study were in line with previous findings by Soon who reported that babies and young children foods' category demonstrated the highest number of proper allergen-labeling practices, where allergens were entered next to uncommon terminologies or generic food additives e.g. lactose (milk), whey (milk), emulsifier (soy lecithin), and docosahexaenoic acid (fish oil). More than half of babies and young children's food products in this study were foreign brands, which may have affected allergen labeling practices (Soon, 2018). However, most snacks were produced locally, demonstrating the ability of local producers to ensuring that food allergen information was declared clearly and comprehensively. This researchrevealed some gaps in current food allergen labeling practices regarding some food categories. It was recommended that if 'contains' statement was used, the recorded allergens should be cross-checked with the allergens listed in the ingredient list to ensure that correct ingredients were used and declared. Similarly, both Turkish and English statements should be consistent. Allergens should be declared using a bold or italic font or should be underlined. Furthermore, the allergens that are declared in the ingredient list should not appear in the precautionary allergen statement to avoid confusion.

Conclusions

This is the first empirical study to evaluate food allergen information regarding commercially packaged foods and beverages. Turkey implements the Turkish Food Codex Regulation on Labeling developed in 2017. Food manufacturers have successfully followed food allergen labeling requirements, as most commercially packaged food and beverages abide by the regulations and declared food allergens in the ingredients list or 'contain' statement. Milk, gluten, tree nuts, soybean, and eggs were some of the most common allergens declared across food categories. Using PAL was consistent in most food products with 'may contain traces of…' , which was the most common PAL statement. Only a small number of food products demonstrated unclear food allergen information, mostly due to incorrect usage of emphasis on food allergen and inconsistencies between the allergens declared in the ingredients list and 'contains' statement. Further studies are recommended to capture the views of consumers, especially those affected by food allergies and intolerances (including caregivers) on the current food allergen labeling format in Turkey and the

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way they undertake individualised risk assessment when making a purchase. Investigating the presence or quantity of food allergens in food products with the PAL label could further support food manufacturers on risk assessment and the correct application of PAL.

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Conflicts of Interest

The authors declared no conflict of interests.

Authors' contributions

Gul FH. and Soon JM. designed the research; Gul FH. conducted the study; Soon JM. analyzed data; Gul FH. and Soon JM wrote the paper, and J.M.Soon had primary responsibility for final content. All the authors approved the final manuscript.

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