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Food allergens in skincare products marketed for children

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Abstract

Background: The application of preparations containing food allergens can cause percutaneous sensitization and provocation. The prevalence of food allergens in children's cosmetics is unknown.

Objectives: To analyse the prevalence of food allergens in skincare products marketed for children and their association with marketing claims and product price.

Methods: We reviewed 276 skincare product ingredient labels for the presence of milk, eggs, wheat, soy, oats, tree nuts, peanuts, and sesame.

Results: More than one-third (108; 39.1%) of the products listed at least one allergen. A total of 156 allergens were recorded, of which 65 (41.7%) were almonds, 35 (22.4%) wheat, 24 (15.4%) soy, 16 (10.3%) oats, 13 (8.3%) sesame, 2 (1.3%) milk, and 1 (0.6%) peanuts. Products that claimed to be "natural" or "ecological" were more likely to contain food allergens than those not labelled so ($P < .001$). The prices were higher for products containing food allergens compared with allergen-free products ($P = .028$).

Conclusions: Food allergens are prevalent in children's cosmetics, especially those that claim to be natural or ecological. The most incorporated food allergens are almonds, wheat, and soy. Products containing food allergens cost more than allergen-free ones.

KEYWORDS

children, cosmetics, food allergens, food sensitization, skincare

1 | INTRODUCTION

Food allergy is a common health problem in children, with a prevalence of up to 8% in the paediatric population.¹ Epidemiological studies have shown a global tendency toward an increase in the incidence of food allergy, though there is a lack of oral food challenge-confirmed epidemiological studies.² Food allergy has a negative impact on the quality of life of children and their parents.^{3,4} It imposes a substantial economic burden on individuals, their families, and society.⁵⁻⁷ Therefore, considerable efforts are being made within the medical community to identify the possible etiological factors and develop strategies to prevent food allergy.

The dual-allergen exposure hypothesis was a pioneering theory that has transformed the understanding of food allergy pathogenesis.⁸ Previously, food sensitization was thought to occur through the

digestive tract, and the primary means of preventing food allergy was the elimination of allergenic products. The dual-allergen exposure hypothesis suggests that low levels of an allergen can cause percutaneous sensitization and early food introduction promotes food tolerance.⁸ Several studies have reinforced this hypothesis and found that percutaneous sensitization can occur upon allergen-skin contact.⁹⁻¹¹ The use of food allergen-containing skincare products, subsequent sensitization, and allergic reactions have been reported in both children¹²⁻¹⁵ and adults.¹⁶⁻²³

Today parents may choose between hundreds of skincare products marketed for children. Marketing terms can create the impression that the products are beneficial for their child's skin, but little is known about their safety for children. The purpose of marketing terms is to describe the effects of the product and to help consumers make informed decisions when choosing a product; however, the European

Union Regulation on cosmetic products currently does not require these terms to be supported by clinical trials, nor does it require a harmonized presentation of potential food allergens in the ingredient lists of skincare products.²⁴

There is a lack of knowledge about common food allergens in children's skincare products. It is important to know whether they are incorporated into children's cosmetics, because percutaneous sensitization and adverse reactions can occur when using cosmetic products containing food allergens.^{25–28} The aim of this study was to analyse the prevalence of common food allergens (milk, eggs, wheat, soy, oats, tree nuts, peanuts, and sesame) in skincare products marketed for children in Lithuania and its association with cosmetic label claims and product price.

2 | METHODS

We reviewed the labels of skincare products available as of January 2020 in Lithuanian convenience stores and online shops for advertising terms that indicated marketing for children: “for children,” “for kids,” “for babies,” and “for infants.” Product labels were examined for the terms “natural” or “organic,” “ecological,” “for sensitive skin,” “hypoallergenic,” and “dermatologically tested.” We analysed the ingredient labels for the prevalence of common food allergens: milk, eggs, wheat, soy, oats, tree nuts, peanuts, and sesame. Keywords used to identify food allergens are presented in Table 1. Information about the product marketing terms, disclosed food allergens, formulation (eg, extract, oil) and price was tabulated into an Excel spreadsheet. The prices were logged per product and per measurement unit (millilitre, gram, or unit). Products intended to treat specific conditions were not included.

Data were presented as frequencies (absolute and/or proportion, means and SD). The differences in quantitative data were analysed with the Student *t* test and the values were given as mean and SD. The differences between categorical variables were assessed by chi-square test. A *P*-value less than .05 was considered significant. Statistical analysis was performed using SPSS 21.0 statistical software.

3 | RESULTS

We examined 276 skincare products marketed for children. Only 11 (4%) were manufactured in Lithuania, whereas 265 (96%) were manufactured in other countries. The range of products comprised rinse-off products (shampoos, body washes, etc.), as well as creams and lotions, cosmetic oils, wet wipes, and baby powders. The majority (168; 60.9%) of products did not list any food allergens; however, the remaining 108 (39.1%) contained food allergens, of which 65 (60.2%) contained one, 38 (35.2%) two, and 5 (4.6%) three food allergens. A total of 156 food allergens were recorded, of which 65 (41.7%) were almonds, 35 (22.4%) wheat, 24 (15.4%) soy, 16 (10.3%) oats, 13 (8.3%) sesame, 2 (1.3%) milk, and 1 (0.6%) peanuts (Figure 1). None of the products listed eggs or tree nuts other than almonds.

TABLE 1 Terms used to identify food allergen ingredients in skincare product labels

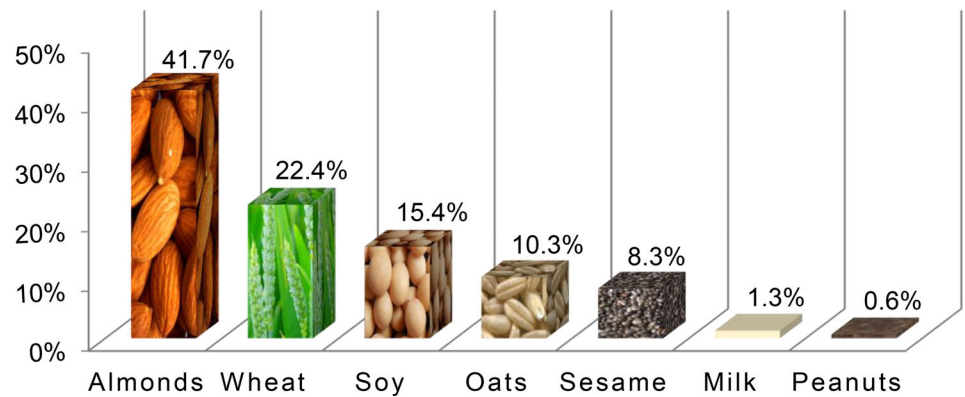
Food allergen	Terms
Milk	Lac, caseinate, hydrolysed casein, casein hydrolysate, whey hydrolysate, whey protein hydrolysate, lactic yeast, lactitol monohydrate, lactoglobulin, lactose, lactulose, caramel, lactoferrin, colostrum, lactoperoxidase, <i>lactis proteinum</i>
Egg	Ovum, albumin, apovitellin, globulin, livetin, lysozyme, ovalbumin, ovoglobulin, ovomucin, ovomucoid, ovotransferrin, ovovitelia, ovovitellin, silici albuminate, vitellin
Wheat	<i>Triticum vulgare</i> , seitan, tabbouleh, triticale, triticum, dextrin, maltodextrin
Soy	<i>Glycine soja</i> , <i>Glycine max</i>
Sesame	<i>Sesamum indicum</i>
Oats	<i>Avena sativa</i> , <i>Avena strigosa</i>
Peanuts	<i>Arachis hypogaea</i>
Almonds	<i>Prunus amara</i> , <i>Prunus dulcis</i> , <i>Prunus sativa</i> , <i>Amygdalus amara</i> , <i>Amygdalus dulcis</i> , <i>Amygdalus sativa</i>
Brazil nuts	<i>Bertholletia excelsa</i>
Cashews	<i>Anacardium occidentale</i>
Pistachios	<i>Pistacia vera</i> , <i>Pistacia manshurica</i>
Walnuts	<i>Juglans regia</i> , <i>Juglans nigra</i>
Hazelnuts	<i>Corylus rostrate</i> , <i>Corylus americana</i> , <i>Corylus avellana</i>
Pecans	<i>Carya illinoensis</i>

Leave-on products that come in contact with the skin for prolonged periods (oils, creams, and lotions) were significantly more likely to contain food allergens than other types of products (wet wipes, powders, and rinse-off products; *P* = .002; Table 2). Products that claimed to be “natural” or “ecological” were significantly more likely to contain food allergens than those not labelled so (*P* < .001; Table 3). The prevalence of food allergens in various formulations is listed in Table 4. No statistically significant difference was found in the prevalence of food allergens regarding the country of production.

The products' prices ranged between € 0.59 and 26.87, with a mean (SD) of € 7.03 (±4.56). They were statistically higher for products containing any food allergen, with a mean (SD) of € 7.80 (±4.78), compared with € 6.50 (±4.36) for products without food allergens (*P* = .028). The price difference per unit of measurement was significant in products measured by millilitres (*N* = 251) which was € 0.07 (±0.08)/mL for allergen-containing products and € 0.05 (±0.07)/mL for allergen-free products (*P* = .038); however, no significant difference was observed in products measured in grams (*N* = 7) or wet wipes measured in units (*N* = 18).

4 | DISCUSSION

There seems to be a fine balance between the development of food allergy and food tolerance. Early high-dose oral food ingestion is

FIGURE 1 Prevalence of food allergens in skincare products marketed for children in Lithuania**TABLE 2** The distribution of product types and food allergen prevalence

Product type	Analysed products		Products containing food allergens	
	N = 276	%	N = 108	%
Rinse-off product	131	47.5	44	40.7
Creams and lotions	91	33.0	41	38.0
Oils	32	11.6	20	18.5
Wet wipes	18	6.5	2	1.9
Powders	4	1.4	1	0.9

TABLE 3 The distribution of label claims and food allergen prevalence

Label claim	Analysed products		Products containing food allergens	
	N = 317	(%)	N = 145	(%)
"Ecological"	53	16.7	36	24.8
"Natural" or "organic"	63	19.9	40	27.6
"For sensitive skin"	107	33.8	35	24.1
"Hypoallergenic"	52	16.4	19	13.1
"Dermatologically tested"	42	13.2	15	10.3

TABLE 4 The frequencies of different food allergen formulations in analysed skincare products

	Oil, n (%)	Extract, n (%)	Maltodextrin, n (%)	Hydrolysed protein, n (%)	Protein, n (%)	Caramel, n (%)
Almonds (N = 65)	56 (86.2)	7 (10.8)	-	-	2 (3.1)	-
Wheat (N = 35)	6 (17.1)	13 (37.1)	2 (5.7)	14 (40.0)	-	-
Soy (N = 24)	20 (83.3)	2 (8.3)	-	-	2 (8.3)	-
Oats (N = 16)	2 (12.5)	12 (75.0)	-	-	2 (12.5)	-
Sesame (N = 13)	13 (100)	-	-	-	-	-
Milk (N = 2)	-	-	-	-	-	2 (100)
Peanuts (N = 1)	1 (100)	-	-	-	-	-

thought to promote tolerogenic T-helper 1 and regulatory T-lymphocyte responses. By contrast, low-dose percutaneous exposure to environmental allergens may lead to T-helper 2 lymphocyte-mediated responses that enable immunoglobulin E (IgE) production by B lymphocytes.⁸ The role of skin barrier and percutaneous sensitization in the development of food allergies has been outlined in several studies.

A study by Lack et al¹¹ found that most children who were sensitized or allergic to peanuts during the first 6 months of life were exposed to peanut oil-based creams applied to the mother's breast. Other studies have postulated the link between the use of hydrolysed wheat protein (HWP)/oat-containing cosmetics and sensitization to food allergens.^{27,28}

Percutaneous sensitization to food allergens is facilitated by environmental exposure, such as skin contact with food protein-containing dust or food-derived ingredients in cosmetics.²⁹ Sensitization and allergic reactions due to food allergen-containing skincare have been reported in children^{12–15} and adults.^{16–23} Allergic reactions may manifest as contact dermatitis^{15,21} and immediate contact urticaria^{14,30} upon cosmetic product-skin contact, or severe systemic reaction following the oral ingestion of the culprit allergen.^{13,16,17,22} In addition, food allergens in cosmetics can cause allergic reactions to previously sensitized individuals.^{31–33} Therefore, it is important to know whether food allergens are incorporated in cosmetic products marketed for children.

Several studies have reported on the prevalence of contact allergens in cosmetics, including one on botanical ingredients.^{34–36} To the best of our knowledge, no study has addressed the prevalence of food allergens in skincare products marketed for children. Our study found that over one-third (39.1%) of cosmetic products marketed for children in Lithuania contain at least one common food allergen. The most frequent food allergens are almonds, wheat, and soy.

The most relevant study on the pattern of food sensitization in Lithuania was carried out from 2006 to 2007, which was a part of the “EuroPrevall” birth cohort project. At 12 months of age, the majority of symptomatic children were sensitized to milk, egg, and wheat. In our study, wheat and milk-derived ingredients were found in the analysed products; however, it is not possible to correlate these findings due to the disparity of time between the two studies. Further investigations need to be carried out in order to analyse the relation between food ingredients in cosmetic products and the development of immunoglobulin E (IgE) and non-IgE-mediated food allergies in Lithuania.³⁷

The self-reported lifetime prevalence of tree nut, wheat, and soy allergy in Europe is 1.3%, 3.6%, and 0.4%, respectively.³⁸ Several clinical case reports have described percutaneous sensitization to these foods facilitated by cosmetic products. One clinical case reported on percutaneous sensitization to almond oil. A 5-month-old infant with atopic dermatitis developed sensitization and contact dermatitis after 2 months of topical use of almond oil.¹²

The use of cosmetic products containing HWP has been associated with numerous reports of allergic reactions. Cases of contact dermatitis,^{15,21} contact urticaria,^{14,30} and systemic allergic reactions due to HWP ingestion have been reported.^{18,22} It is postulated that the use of a popular soap containing HWP may have contributed to an outbreak of adult-onset wheat allergy in Japan.²⁸ Two clinical cases reported on HWP allergy in children. The first case described a 3-year-old atopic boy who developed IgE-mediated contact urticaria caused by skin contact with an HWP-containing cream, which his mother had been using for 3 months.¹⁴ Another case report described a 3-year-old girl with atopic dermatitis who developed contact dermatitis to an emollient containing HWP.¹⁵

Several cases of adult-onset percutaneous sensitization to soy-containing cosmetics are described in the literature.^{39–41} One report described a new-onset sensitization in an atopic patient after occupational exposure to lotions containing soy. Interestingly, the patient,

previously tolerant to soy, developed anaphylaxis after oral soy ingestion.³⁹ Two other cases of adult patients described contact dermatitis to soy-containing skincare products.^{40,41}

Case reports of children developing percutaneous sensitization to food allergens and allergic reactions on account of cosmetic products describe alarming symptoms.^{12–15,31,32} In some cases, children experienced life-threatening allergic reactions.^{13,32} The scarcity of cases could be partially due to the limited recognition of skincare as an eliciting factor of food allergy, especially in milder cases.

New-onset food allergy to previously orally tolerated foods, elicited by food allergen-containing skincare, was reported in adults to various foods, including goat's milk,¹⁶ oats,¹⁷ egg,²⁰ and soy.³⁹ In most cases, patients had atopic dermatitis,^{16,17,39} yet in other cases, no atopic diathesis was observed.^{18,20,23} These findings suggest that the application of skincare products containing food allergens may be hazardous to a consumer of various ages irrespective of atopic status.

We found that products which come in contact with the skin for prolonged periods (oils, creams, and lotions) were significantly more likely to contain food allergens than other types of products (wet wipes, powders, and wash-off products). A study that described nine patients sensitized to cosmetics containing HWP found that the majority of skincare products used by the patients were moisturizers.¹⁸ By contrast, an outbreak of allergy caused by HWP soap in Japan was described.²⁸ More studies are required to evaluate the impact of food allergen-containing skincare formulation, and the frequency and duration of application of these products on the development of food sensitization.

The majority of potential allergens in the ingredient lists were listed as oils, extracts, proteins, or hydrolysed proteins. It is known that processing can affect the allergenicity of foods.⁴² The allergenicity of oils is drastically reduced by refinement.^{43,44} Hydrolysis may also impact the allergenicity of proteins; higher-molecular-weight proteins retain higher allergenicity compared with lower-molecular-weight proteins, which was demonstrated in HWP.⁴⁵

Nevertheless, even highly allergenic substances such as proteins, under normal circumstances, should not penetrate the stratum corneum barrier due to a high molecular weight⁴⁶; however, factors such as dermatitis, physical or chemical damage, increased hydration, or skin occlusion may disrupt this barrier, allowing proteins to penetrate the skin.⁴⁷ In the case of HWP allergy, many patients did not have atopic dermatitis, so it is postulated that the surfactants present in the cosmetics may have facilitated the skin barrier impairment.⁴⁵ This suggests that possibly combined factors, such as the modification of allergens, the overall composition of the cosmetic product, and consumer-related factors (eg, skin barrier impairment), may determine whether the consumer will develop percutaneous sensitization to food allergens.

In our study, products claiming to be natural or ecological contain food allergens more often than those without such a claim. The topical use of natural products may produce health benefits for some individuals.^{48–50} Nevertheless, natural skincare products containing food ingredients cannot be considered safe for all consumers. The natural origins of a product and safety under customary use are not

equivalent to safety when the food ingredients are used in altered conditions.⁵¹

In contrast to a study on contact allergens, where sensitizer-containing products tended to cost less than those without contact allergens,³⁴ in our study the prices are statistically higher for the products containing food allergens compared with those without. This could be explained by a higher demand for natural skincare products from consumers,^{52,53} as well as the shorter shelf life of organic products.⁵⁴

Our study was descriptive, and further research is required to assess the clinical relevance of food allergens in skincare products marketed for children. Further, it is important to explore how cofactors, such as food allergen configuration; other chemical substances in the cosmetic product; and consumer-related factors (eg, skin damage), impact the allergenicity of food allergen-containing skincare products.

5 | CONCLUSIONS

Food allergens are prevalent in children's skincare products, especially those that claim to be "natural" or "ecological". The most often incorporated food allergens are almonds, wheat, and soy. Products containing food allergens tend to cost more than allergen-free ones. Given the fact that cosmetic products contain the most common food allergens, parents may be advised to read the composition of cosmetic products carefully and to avoid food allergens in cosmetics. Special caution should be taken in choosing skincare products for infants to whom solid foods have not been introduced and who have not developed an oral tolerance, as well as those with impaired skin barrier function, such as an inflamed diaper area. In addition, international regulatory institutions should encourage manufacturers to provide food allergen warning statements in skincare (cosmetic) products.

CONFLICT OF INTEREST

The authors declare no potential conflict of interests.

AUTHOR CONTRIBUTIONS

Ieva Adomaite: Conceptualization; formal analysis; visualization; writing-original draft; writing-review and editing. **Angele Vitkuvienė:** Investigation; writing-review and editing. **Sigita Petraitiene:** Supervision; writing-review and editing. **Odilija Rudzeviciene:** Conceptualization; methodology; supervision; writing-original draft; writing-review and editing.

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