

Evaluation of Fermented Food Consumption During Pregnancy and Breastfeeding in Mothers of Children with Egg Allergy

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ABSTRACT

Objective: Fermented foods, such as yogurt and kefir, provide health benefits. This study explores how fermented food consumption during pregnancy and breastfeeding may affect the development of egg allergy in children.

Materials and Methods: The study included mothers of 50 children diagnosed with egg allergy and a control group of mothers of 52 healthy children of the same age group. Retrospective analysis was performed on data such as the mothers' consumption of fermented foods during pregnancy and breastfeeding, sociodemographic characteristics, and family history of allergies.

Results: It was observed that the case and control groups were similar in terms of age, gender, gestational age, maternal weight gain during pregnancy, and mode of delivery ($p>0.05$). However, the mean age of mothers in the case group was significantly lower than that in the control group ($p=0.008$). There was a significant difference in maternal education level between the groups ($p=0.044$). No statistically significant differences were found between the groups in terms of fermented food consumption, including yogurt, cheese, kefir, tarhana, pickles, and fermented sausage (sucuk), during pregnancy and breastfeeding ($p>0.05$).

Conclusion: The findings indicate that the fermented food consumption habits of mothers of children with egg allergy during pregnancy and breastfeeding were not different from those of mothers in the control group. These results suggest no relationship between fermented food consumption and the development of egg allergy in children. However, further extensive studies are needed on this subject.

Keywords: Allergic diseases, breastfeeding, egg allergy, fermented food consumption, pregnancy

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INTRODUCTION

Fermentation is defined as the food processing process that occurs through the activity of enzymes within microorganisms.^[1] Foods resulting from the fermentation process have been one of the main components of human nutrition for thousands of years.^[2] The ability of fermented foods to be well-preserved due to the fermentation process has made them an essential part of the diet.^[3]

Fermented foods are widely consumed in Turkish cuisine. Yogurt is made through the fermentation of milk and contains streptococci and lactobacilli. Tarhana is produced by fermenting a mixture of dough, vegetable purée, yogurt, flour, and spices for a period of 1 to 7 days. Kefir is a fermented product composed of diacetyl and acetaldehyde.^[1] Fermented foods generally originate from lactic acid and some acetic acid bacteria, such as *Lactobacillus*, *Streptococcus*, and *Pediococcus*.

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cus.^[4,5] It has been demonstrated that fermented foods have protective effects against various gastrointestinal diseases, obesity, cardiovascular diseases, and metabolic disorders.^[6]

Egg allergy is a significant health issue and one of the most common food allergens encountered in childhood. Egg white proteins are more allergenic than yolk proteins and tend to cause more severe reactions, although the body may react to both.^[7] The prevalence of egg allergy is increasing in Western countries, making it one of the most common food allergies, typically emerging in the first year of life.^[8,9] Previous studies have shown that cow's milk is the most common allergy, followed by egg allergy, which affects approximately 0.8% of children and 1.3% of those aged 0–5 years.^[10] Moreover, egg has been identified as the most frequent cause of anaphylaxis in the first year of life.^[11] Egg allergy has been associated with conditions such as urticaria, angioedema, eosinophilic esophagitis, and enteropathy.^[12] A strong link between egg allergy and atopic dermatitis has also been established, with egg allergy detected in two out of three patients with atopic dermatitis undergoing food provocation tests.^[13]

Regular consumption of fermented foods such as yogurt, kefir, and tarhana during pregnancy may beneficially alter the balance of lactic acid bacteria in the maternal gut microbiota, leading to increased production of short-chain fatty acids. These metabolites can modulate immune signals transmitted to the fetus via the placenta, strengthening T-cell tolerance mechanisms and reducing early-life sensitization to allergens. While existing studies have shown that probiotic use in pregnancy lowers the risk of atopic dermatitis, eczema, and food allergies, data specific to egg allergy are scarce. Accordingly, our study seeks to offer a novel scientific perspective on nutrition-based allergy prevention by both quantitatively and qualitatively assessing the relationship between maternal fermented food intake frequency and the development of egg allergy in offspring.

MATERIALS and METHODS

This analytical case-control study was conducted between October 1, 2024, and December 1, 2024, at the Pediatric Health and Diseases, and Pediatric Allergy and Immunology outpatient clinics of , Health Sciences University, Ümraniye Training and Research Hospital. The study included mothers of children aged 0–2 years diagnosed with egg allergy, whose consumption of homemade fermented foods during pregnancy was evaluated. It also involved mothers of healthy children in the same age group with no history of allergies. The control group consisted of mothers of children attending the well-child outpatient clinic for routine check-ups. The children in the control group had no history of allergic diseases.

The study included mothers of children aged 0–2 years diagnosed with egg allergy by positive skin prick test and/or specific IgE results and confirmed by oral egg provocation testing, as well as mothers of healthy children in the same age group with no history of allergies. Exclusion criteria comprised mothers who provided incomplete information about their fermented food consumption during pregnancy and individuals whose children had a history of other allergic conditions. Sampling was performed from eligible participants attending the outpatient clinics during the study period.

Participant data were reviewed and included in the study through surveys. The survey included questions regarding the frequency of consumption of homemade fermented foods such as yogurt, cheese, kefir, tarhana, pickles, and fermented meat products during pregnancy and breastfeeding. Additionally, information about the children's allergy history, age at symptom onset, family allergy history, and other environmental factors was recorded.

Consumption of fermented dairy products (FDPs), including yogurt, cheese, tarhana, kefir, pickles, and sucuk, was calculated separately for pregnancy and breastfeeding periods in grams or milliliters. The frequency of consumption was categorized into four groups: daily, every other day, every three days, and less frequently. Weekly consumption was calculated by multiplying the daily consumption amount by the number of days consumed per week and expressed in milliliters for kefir and grams for other foods.

Statistical Analysis

Statistical analysis and data recording were carried out using SPSS version 25.0 for Windows (SPSS25; Armonk, New York). Descriptive statistics were expressed as medians, ranges (minimum and maximum values), frequencies (n), and percentages (%). The assessment of normality was performed through the Kolmogorov–Smirnov/Shapiro–Wilk tests, Q-Q plots, and boxplots. The Mann–Whitney U test was utilized for comparing two independent groups with non-normally distributed data, while categorical variables were analyzed using the Chi-square test. A p-value below 0.05 was considered to indicate statistical significance.

Ethical Committee Approval

The study received ethical approval from the , University of Health Sciences, Ümraniye Training and Research Hospital's Ethics Committee (decision number: 287, dated 05/09/2024). All participants provided informed consent prior to their inclusion in the study. The research adhered to the principles outlined in the Declaration of Helsinki.

Table 1. Sociodemographic characteristics of case and control groups and method of birth with gestational age

	Group				p
	Case		Control		
	n	%	n	%	
Child's age, median (min-max)	13.0 (1.0–24.0)		10.0 (2.0–32.0)		0.117
Mother's age, median (min-max)	29.0 (21.0–42.0)		31.0 (20.0–43.0)		0.008
Gestastional week, median (min-max)	38.0 (36.0–41.0)		38.0 (30.0–41.0)		0.208
Gestational weight gain, median (min-max)	15.0 (5.0–70.0)		14.0 (5.0–25.0)		0.129
Maternal education					
Primary School	3	6.5	8	16.3	0.044
High School	17	37.0	8	16.3	
University	26	56.5	33	67.3	
Child gender					0.436
Female	25	50.0	22	42.3	
Male	25	50.0	30	57.7	
Method of birth					
Cesarean	21	42.0	18	34.6	0.443
Vaginal (NSD)	29	58.0	34	65.4	

Min: minimum; Max: maximum; NSD: Normal spontaneous delivery.

RESULTS

Data from 50 participants in the case group and 52 participants in the control group were analyzed. The two groups were comparable in terms of age, gender, gestational age, maternal weight gain during pregnancy, and delivery method ($p>0.05$) (Table 1-3).

No significant differences were found between the groups regarding a family history of food allergies or respiratory allergies ($p=0.156$ and $p=0.649$, respectively). Similarly, there were no notable differences in other variables.

The consumption of yogurt during pregnancy was lower in the case group when compared to the lactation period, but this difference was not statistically significant ($p=0.510$). Likewise, there were no significant differences between the groups regarding fermented food consumption during lactation ($p>0.05$).

DISCUSSION

Various studies have investigated the relationship between the consumption of fermented foods during pregnancy and egg allergy. These studies suggest that the foods consumed during pregnancy may influence the immune system of the unborn child and their predisposition to allergic diseases. For

instance, one study reported a close association between egg allergy and asthma risk.^[14] In the study by Leduc et al.,^[15] yogurt consumption during pregnancy was found to reduce the incidence of atopic dermatitis, allergic rhinitis, and asthma, but it had no significant effect on food allergies. This finding partially aligns with our study, as we also observed lower yogurt consumption during pregnancy in the case group; however, this difference did not reach statistical significance. On the other hand, this discrepancy may be attributed to cultural dietary habits or nuances in maternal immune responses.

Another study reported that 9.5% of children reacted to raw egg by the age of one, but this rate declined to 1.2% by the age of four.^[16] In a study conducted in the United States, it was shown that half of the children outgrew egg allergy by the age of six, while a similar study reported a remission rate of only 12% initially, which increased to 68% by the age of sixteen.^[17,18] These studies suggest that egg allergy tends to decrease over time; in contrast, our study contributes to the literature by examining the impact of maternal dietary habits during pregnancy on the development of egg allergy.

A previous study on children with cow's milk protein allergy (CMPA) analyzed 80 cases and 80 controls, identifying cheese, yogurt, and tarhana (a traditional fermented soup) as the most frequently consumed FDPs. In that study, FDP

Table 2. Family history, place of residence, pets, family smoking, and antibiotic use

	Group				p
	Case		Control		
	n	%	n	%	
Family food allergy					
None	39	78.0	46	88.5	0.156
Present	11	22.0	6	11.5	
Family respiratory allergy					
None	32	64.0	31	59.6	0.649
Present	18	36.0	21	40.4	
Family allergic rhinitis (AR)					
None	40	80.0	47	90.4	0.139
Present	10	20.0	5	9.6	
Family asthma					
None	43	86.0	47	90.4	0.492
Present	7	14.0	5	9.6	
Family atopic dermatitis (AD)					
None	42	84.0	49	94.2	0.096
Present	8	16.0	3	5.8	
Pets					
None	48	96.0	48	92.3	0.678
Present	2	4.0	4	7.7	
Place of Residence					
Rural	3	6.0	1	1.9	0.358
Urban	47	94.0	51	98.1	
Maternal smoking during pregnancy					
Yes	1	2.0	6	11.5	0.113
No	49	98.0	46	88.5	
Maternal smoking during breastfeeding					
Yes	3	6.0	7	13.5	0.319
No	47	94.0	45	86.5	
Paternal smoking during pregnancy					
Yes	28	56.0	27	51.9	0.680
No	22	44.0	25	48.1	
Paternal smoking during breastfeeding					
Yes	29	58.0	25	48.1	0.316
No	21	42.0	27	51.9	
Maternal antibiotic use during pregnancy					
Yes	9	18.0	12	23.1	0.526
No	41	82.0	40	76.9	

consumption during pregnancy and lactation was significantly lower in the case group than in the control group.^[19] In our study, although yogurt consumption during pregnancy was lower in the case group compared to the lactation period, this difference was not statistically significant. Moreover, no sig-

nificant difference was found between the two groups in terms of FDP consumption during lactation. In this regard, our study differs from the CMPA study, and this discrepancy may stem from the type of allergy studied (egg vs. milk), sample size, methodology, or cultural differences in dietary habits.

Table 3. Consumption of fermented dairy products during pregnancy and breastfeeding

	Group						p
	Case			Control			
	Median	Minimum	Maximum	Median	Minimum	Maximum	
Pregnancy							
Yogurt (gr/wk)	700	0	1400	840	0	1750	0.510
Cheese (gr/wk)	385	0	1000	350	70	1750	0.121
Tarhana (gr/wk)	38	0	1750	70	0	2450	0.733
Kefir (mL/wk)	0	0	3500	35	0	2800	0.483
Pickles (gr/wk)	70	0	2100	0	0	1260	0.248
Fermented Sausage (gr/wk)	700	0	2100	305	0	2100	0.053
Breastfeeding							
Yogurt (gr/wk)	700	0	2100	700	100	2800	0.302
Cheese (gr/wk)	350	0	2000	280	0	2000	0.210
Tarhana (gr/wk)	0	0	2100	0	0	1750	0.924
Kefir (mL/wk)	0	0	3500	0	0	3500	0.243
Pickles (gr/wk)	140	0	700	0	0	2100	0.119
Fermented Sausage (gr/wk)	410	0	3500	210	0	2100	0.183

gr/wk: Gram/week; mL/wk: Mililitre/week

To our knowledge, no studies in the literature have evaluated the relationship between egg allergy and FDP consumption habits. In this respect, our study aims to fill a critical gap in the field and highlights the need for larger-scale and prospective studies to better understand the potential effects of FDP consumption during pregnancy and lactation on the development of egg allergy. Considering the potential protective effects of FDP diversity against allergic diseases, future high-quality studies in this area are expected to make valuable contributions to the literature.

In our study, the gestational age and maternal weight gain during pregnancy were similar for both the case and control groups. This similarity suggests that we excluded the effects of these two factors from the results, and other variables might be more decisive. While factors like gestational age and maternal weight gain during pregnancy have been studied in relation to pregnancy and allergic diseases, their specific association with egg allergy has not been addressed in the literature. This highlights our study's potential to fill a significant knowledge gap in this area and contribute uniquely to the field.

The case and control groups in our study were also statistically similar regarding gender. No differences were found between the groups regarding the presence of food allergies, asthma, allergic rhinitis, and respiratory allergies in the fam-

ily, as well as for other factors. However, maternal education level showed a significant difference between the groups ($p=0.044$). No significant differences were observed for other variables. In a similar study on FDP consumption during pregnancy, CMPA was found to be more prevalent in male children. The risk of CMPA was higher in children of parents with a history of asthma and allergic rhinitis, and it was also greater in mothers with higher education levels. Moreover, maternal smoking during pregnancy and having pets in the household during the child's first year were linked to a decreased risk of CMPA in children.^[20] The lack of gender-based differences in our study suggests that gender does not play a significant role in the development of egg allergy. Furthermore, the absence of differences between groups regarding family histories of food allergy, asthma, allergic rhinitis, atopic dermatitis, and respiratory allergies indicates that these factors do not directly influence the development of egg allergy. The significant difference in maternal education levels suggests that higher education levels in mothers may be associated with differences in allergy and dietary habits in their children. This finding aligns with previous studies that link higher education levels with increased allergy risks and more conscious dietary choices by mothers. Given the limited data in the literature, broader research is needed to fill this gap and provide valuable insights into this field.

Our study also showed no statistical differences between the case and control groups regarding delivery method and maternal smoking during pregnancy. In another study on children with allergic proctocolitis, vaginal delivery and maternal smoking during pregnancy were more prevalent in the allergic proctocolitis group compared to the control group.^[21] These findings suggest that our results were not influenced by demographic factors, making them more reliable. The association of maternal smoking with both allergic proctocolitis and other allergic diseases is a common finding in the literature. Smoking is proposed to influence the fetal immune system, predisposing it to allergic diseases. However, the lack of an association between these factors and allergic reactions (specifically egg allergy) in our study suggests that the impact of maternal smoking on allergic diseases may not be uniform across all disease groups. For instance, specific diseases like egg allergy may be less sensitive to the effects of maternal smoking, or these effects may manifest differently. This underscores the complexity of the etiology of allergic diseases and the need for an integrated evaluation of genetic, environmental, and immunological factors.

In our study, no differences were found between groups regarding a family history of atopic dermatitis. In a study of 2,371 participants, it was observed that mothers who consumed yogurt in the later stages of pregnancy had infants with a lower incidence of eczema at 3–6 months and a reduced risk of recurrent eczema during the first 6 months.^[22] The absence of a significant difference between groups concerning a family history of atopic dermatitis suggests that genetic predisposition is not a decisive factor in this context. Instead, environmental or nutrition-based factors, particularly maternal-related variables, might play a more significant role in the development of eczema and atopic dermatitis in infants, providing a novel perspective on the etiology of these conditions. Consequently, specific dietary interventions during pregnancy, such as yogurt and other fermented food consumption, could be considered potential protective factors against the development of atopic dermatitis in infants.

The statistical similarity of the case and control groups regarding gestational age, maternal weight gain during pregnancy, gender, family history of allergic diseases, and maternal smoking enabled an independent evaluation of our results, emphasizing the significance of nutrition-based factors. Despite the lower yogurt consumption during pregnancy in the case group, the lack of a significant difference and the absence of differences during the lactation period contribute to an underexplored area in the literature. Additionally, maternal environmental and nutrition-based factors appear to

play a more decisive role in the development of egg allergy than genetic factors. Although our study is one of the initial investigations into the link between FDP consumption during pregnancy and breastfeeding and egg allergy, it underscores the importance of conducting large-scale studies to explore the possible impact of FDP on allergic conditions.

CONCLUSION

The findings demonstrate that maternal consumption patterns of fermented foods during pregnancy and lactation among mothers of children diagnosed with egg allergy did not differ significantly from those observed in the control group. These results do not support a potential association between the intake of fermented foods and the development of egg allergy in offspring. Although our study did not establish a clear relationship between the consumption of fermented foods during pregnancy and the development of egg allergy in children, previous literature has shown that fermented foods rich in probiotics may reduce the overall risk of allergies. Due to their potential to decrease the development of certain allergic conditions, particularly atopic dermatitis, the consumption of such foods during pregnancy can still be considered a recommended approach. It is believed that consuming at least one serving (150–200 grams) of yogurt or kefir per day during pregnancy may be beneficial in terms of general probiotic support. However, it should be clearly stated that this recommendation is not supported by sufficient evidence specifically regarding egg allergy and, therefore, should not replace current diagnostic or therapeutic approaches. There is a need for future descriptive and interventional studies with larger sample sizes, designed prospectively and utilizing validated dietary intake questionnaires. Such studies would allow for a more accurate evaluation of the impact of maternal nutrition during pregnancy on the development of childhood allergies.

Among the limitations, the single-center nature of the study restricts the generalizability of the findings. The relatively small sample size may affect the statistical power, and reliance on self-reported dietary habits introduces a risk of recall bias. Additionally, the study focused solely on fermented dairy products, excluding other potential dietary factors, and did not comprehensively evaluate variables such as socioeconomic status or environmental influences.

Nevertheless, the study also has significant strengths. Being one of the pioneering studies to investigate the relationship between fermented dairy consumption during pregnancy and lactation and the development of egg allergy highlights its originality in this field. The similarity of the case and con-

trol groups regarding key variables such as gestational age, maternal weight gain, gender, and smoking status enhances the reliability of the results. Furthermore, by focusing on a topic that has not been adequately addressed in the literature, the study provides a unique and valuable contribution to the field. It underscores the potential role of maternal nutrition in the development of allergic diseases and paves the way for more comprehensive future research on this subject.

Mothers may have difficulty recalling their dietary habits from previous months, which could lead to systematic bias.

Disclosures

Ethics Committee Approval: The study was approved by the University of Health Sciences, Ümraniye Training and Research Hospital Ethics Committee (No: 287, Date: 05/09/2024).

Informed Consent: Written informed consent forms were obtained from the patients, as this was a prospective study.

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