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Exploring Cross-Reactivity Among Hen, Duck, and Quail Eggs in Children with Hen's Egg Allergy

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ABSTRACT

OBJECTIVE: To investigate cross-reactivity among hen, duck, and quail eggs in children with suspected egg allergy.

METHODS: A cross-sectional study enrolled 20 children with a history consistent with egg allergy. Specific immunoglobulin E levels to hen's egg white and egg yolk, skin prick test (SPT) to fresh raw hen, duck, and quail eggs, and oral food challenges in selected cases were performed for egg allergy evaluation. Thirty children with a clear history of egg tolerance were recruited as a control group. SPT were performed according to standardized protocols by trained personnel. Mean wheal diameter from SPT measured cross-reactivity and Spearman's correlation examined the cross-reactivity pattern.

RESULTS: The median age of participants with suspected egg allergy was 1.1 years and 3.6 years for the control group. Reported allergic reactions when entering the study were primarily to hen eggs, mainly urticaria/angioedema (70%). Anaphylaxis occurred in 20%. Participants with suspected hen's egg allergy were sensitized to at least one of the avian eggs, while controls showed a negative response. Among these participants, SPT positivity rate for quail eggs was high (60% for whites and 55% for yolks), followed by duck eggs (50% for whites and 30% for yolks). Moderate correlations were found between egg whites and egg yolks within each egg type. A negative correlation was found between hen egg whites and duck egg yolks (r = -0.127), and hen and duck eggs showed a weak correlation (r = 0.169–0.259). Patients with multiple egg sensitizations had a higher prevalence of earlier age of first reaction (p = 0.049) and a maternal history of atopy (p = 0.03).

CONCLUSION: This study suggests lower sensitization rates to duck eggs. Evaluating duck egg reactivity could benefit children with suspected hen's egg allergy.

KEYWORDS: avian eggs, cross-reactivity, duck eggs, egg allergy, food hypersensitivity, quail eggs

INTRODUCTION

Egg allergy is a common childhood food allergy worldwide[1-3], including in Thailand where the prevalence of adverse food reactions is approximately 6% with eggs being the second most common causative food[4]. Egg allergies significantly impact the quality of life of the patient and family[5-6]. Eggs provide fundamental nutrition for children's development and growth as they contain all the essential amino acids, good fat, vitamins, and other microelements. Having to manage an egg-free diet poses constraints on caregivers, making it more difficult to provide comparable nutritional intake,

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for instance, hen's egg avoidance leads to reduced vitamin D intake, which is essential to children's bone health[7].

Current international guidelines recommend avoidance of all avian eggs in patients with an egg allergy due to the limited research on the cross-reactivity between the different bird egg types[8-9]. Thai households can find this challenging as Thai cuisine frequently incorporates eggs in complex dishes, making it difficult to differentiate safe foods for children. Moreover, to completely avoid the offending food may lead to social isolation and increased anxiety.

While some studies have suggested potential variations in cross-reactivity, with individuals with hen's egg allergy potentially showing more tolerance to other egg types[10-13], the extent of these differences remains limited. A pioneer study quantified the cross-reactivity protein occurrences among eggs of various avian species and ranked their allergenic activity in relation to hen egg white (HEw) as follows: turkey, duck, goose, and seagull[10]. This suggested that some individuals with hen's egg allergy may exhibit varying sensitivities to different types of eggs.

Although duck and quail eggs are common ingredients in Thai cuisine and are affordable choices for every household, there remains an absence of studies addressing this knowledge gap. Therefore, this study investigated the cross-reactivity patterns among hen, duck, and quail eggs in Thai children with suspected egg allergy. We explored the possibility of alternative dietary options by examining skin test reactivity and the correlation between the egg whites and yolks of each type.

METHODS

This study enrolled children aged 6 months to 15 years with a history of immediate reaction to one of the avian eggs (hen, duck, and quail). Participants were recruited from the Pediatric Outpatient Clinic between January and December 2023. Children who had a history indicating a likely history of egg allergy underwent further clinical assessment to confirm eligibility for the egg allergy group.

The inclusion criteria for the egg allergy group were based on one of the following criteria within the past 6 months: 1. A convincing clinical reaction to eggs (acute skin eruptions/angioedema, persistent vomiting/diarrhea, bronchospasm within 2 hours), supported by positive skin prick test (SPT) to either egg white or egg yolk and/or a level of specific immunoglobulin E to hen's egg white/egg yolk (HEw-sIgE/HEy-sIgE) > 0.35 kU/L. 2. Previous positive oral food challenge (OFC) test to eggs, or 3. The mean wheal diameter (MWD) of SPT or HEw-sIgE exceeding the previous report of 95% positive predictive value for egg allergy diagnosis (MWD of > 5mm, HEw-sIgE > 2 kU/L in patients younger than 2 years, and MWD of > 7 mm in patients older than 2 years)[14]. For the control group, children with a clear history of regular egg consumption with no reaction were invited to participate. Patients who had a history of taking antihistamines within 7 days, on systemic immunosuppressive medications, denied to undergo SPT, having uncontrolled skin disease in the back area, and had developed severe egg anaphylaxis (grade 4-5 according to the World Allergy Organization Anaphylaxis Guideline 2020)[15] were excluded. A sample size of 23 hen egg-allergic patients was calculated to estimate the population proportion of positive SPTs primarily to quail eggs with 80% power and a 5% significance level. This calculation was based on a previous study reporting a cross-reactivity rate of 69.2% between hen and quail eggs[12].

HEw-sIgE and HEy-sIgE were measured using the ImmunoCAP system (Thermo Fisher Scientific, Uppsala, Sweden) with a lower limit of detection of less than 0.35 kU/L. SPTs were performed on the back using fresh raw whites and the yolks of hen, duck, and quail eggs, with a single separate lancet for each allergen. Histamine phosphate (10 mg/ml) and glycerinated saline were used as a positive and negative control, respectively. The wheal diameter was measured 15 minutes after allergen application, and a positive SPT result was defined as a MWD 3 mm larger than the negative control. We also performed SPTs on participants in the control group to serve as a comparison for the specificity of the skin test. To ensure reliability, SPTs were performed by a trained pediatric resident under the supervision of an allergist. The decision to perform an OFC was a shared decision between an allergist (one of the investigators) and the parents. Blood samples were collected in clotted blood tubes and processed within 7 days. The specimen was stored at 2-8°C until analysis.

The study was approved by the Vajira Institutional Review Board on June 15th, 2022 (COA 144/2565). Written informed consent from parents and assent from children older than 7 years of age were obtained. Demographics and reported allergic reaction were recorded.

Statistical analysis involved descriptive statistics for demographic and clinical characteristics, using percentages and mean ± SD or median (IQR) based on Shapiro-Wilk normality testing. Cross-reactivity was reported as a percentage. Group comparisons employed Chi-square test for categorical and Mann-Whitney U test for continuous variables. Spearman's correlation assessed correlations between wheal sizes. All statistical analyses were conducted using the Statistical Package for Social Sciences, version 24 (SPSS Inc., Chicago, Illinois, USA), and a significance level of $p < 0.05$ was considered statistically significant.

RESULTS

Fifty participants were enrolled, with 20 in the egg allergy group and 30 in the control group. Nineteen of the 20 participants met the diagnostic criteria for hen's egg allergy based on a reported allergic reaction and evidence of sensitization through specific IgE testing (n = 14) or SPT (n = 5). Only one participant underwent an OFC to confirm egg allergy. All participants in the egg allergy group reported a history of allergic reactions specifically to hen's egg. Children in the egg allergy group were significantly younger (median age 1.1 years) compared to controls (median age 3.6 years; p-value < 0.001). Sex distribution was similar between the groups (75% male in egg allergy vs. 70% male in control). Atopic dermatitis was more prevalent in the egg allergy group (65%) compared to the control group (10%) (p-value < 0.001). Children in the egg allergy group were more frequently without siblings (p = 0.02), resided in urban environments (p = 0.02), and were exclusively breastfed (p = 0.034).

The egg introduction behavior of Thai households was also explored. We found that egg introduction was initiated at a median age of 6 months. The median age of initial reaction in the allergy group was also 6 months. Fifty-eight percent of the introductions were with isolated egg yolks, and the predominant cooking method for egg introduction was hard-boiled (94%), with only 6% having consumed fried egg products. There was no significant difference in terms of the timing of egg introduction, the egg component initially introduced, or the egg cooking method used between the 2 groups. Table 1 presents a detailed comparison of all the demographic characteristics. Reported allergic reaction to eggs are demonstrated in Table 2, with urticarial/angioedema being the most common (70%).

Table 1 Demographic data of study participants (n = 50)

Characteristic	Total (n = 50)	Egg allergy (n = 20)	Control (n = 30)	P-value
Age (years), median (IQR)	2.5 (1-5)	1.1 (0.9-1.5)	3.6 (2.8-6.3)	< 0.001
Male sex, n (%)	36 (72)	15 (75)	21 (70)	0.70
No sibling, n (%)	24 (48)	13 (65)	11 (36.7)	0.02
Allergy in mother, n (%)	17 (34)	11 (55)	6 (20)	0.01
Allergy in father, n (%)	16 (32)	9 (45)	7 (23.3)	0.11
Urban living environment, n (%)	43 (86)	20 (100)	23 (76.7)	0.02

Table 1 Demographic data of study participants (n = 50) (continued)

Characteristic	Total (n = 50)	Egg allergy (n = 20)	Control (n = 30)	P-value
Atopic comorbidities				
Atopic dermatitis, n (%)	17 (34)	14 (65)	3 (10)	< 0.001
Recurrent wheezing, n (%)	18 (36)	7 (35)	11 (36.7)	0.90
Multiple food allergy, n (%)	20 (40)	7 (35)	13 (43.3)	0.21
Exclusive breast feeding, n (%)	41 (82)	18 (90)	23 (76.7)	0.034
Egg ingestion during pregnancy (yes), n (%)	47 (94)	20 (100)	27 (90)	0.15
Maternal frequency of egg ingestion during pregnancy (days/week)	3 (3-5.5)	3 (3-7)	3 (3-4)	0.19
Egg introduction				
Age of first introduction (month), median (IQR)	6 (6-6)	6 (6-7)	6 (6-7)	0.69
Age of first reaction (month), median (IQR)	-	6 (6-7.8)	-	N/A
Egg component first introduced				
Egg white, n (%)	0	0	0	N/A
Egg yolk, n (%)	29 (58)	12 (60)	17 (56.7)	0.82
Whole egg, n (%)	21 (42)	8 (40)	13 (43.3)	0.82
Cooking method				
Boil, n (%)	47 (94)	18 (9)	29 (96.7)	0.34
Steam, n (%)	0	0	0	N/A
Fried, n (%)	3 (6)	2 (10)	1 (3.3)	0.34
Baked, n (%)	0	0	0	N/A

Abbreviations: IQR, interquartile range; n, number; N/A, not applicable (used for data not collected, relevant in the control group) Values are expressed as mean ± SD or median (IQR), as appropriate. Comparisons between groups were performed using the Mann Whitney U test for continuous variables and the Chi-square test (or Fisher's Exact test where applicable) for categorical variables. P-value < 0.05 was considered statistically significant.

Table 2 Characteristic of egg allergic reactions

Characteristics	Egg allergy (n = 20)
Anaphylaxis, n (%)	4 (20)
Non-anaphylaxis, n (%)	16 (80)
Skin, n (%)	20 (100)
Acute Atopic dermatitis flare up, n (%)	6 (30)
Urticaria/angioedema, n (%)	14 (70)
Respiratory symptoms, n (%)	1 (5)
Gastrointestinal symptoms, n (%)	3 (15)

Abbreviation: n, number

All participants in the egg allergy group demonstrated sensitization to at least one avian egg. This was confirmed by positive SPT, with hen egg white (HEw) eliciting the largest MWD (7.5 mm, 5-14 mm). MWD for other egg components were: hen egg yolk (HEy): 2 mm (0–4 mm), duck egg white (DEw): 3 mm (1–8 mm), duck egg yolk (DEy): 1.8 mm (0–4 mm), quail egg white (QEw): 4.5 mm (1–7.5 mm), and quail egg yolk (QEy): 3.5 mm (2–7.5 mm). Consistent with the SPT findings, specific IgE levels also showed the highest value for HEw with a median of 1.25 kU/L (0.2-4.1 kU/L). The median HEy-sIgE level was 0.30 kU/L (0.1-0.7 kU/L). In contrast, none of the participants in the control group showed positive skin reactions.

SPT results among participants in the egg allergy group revealed a pattern of sensitization towards other avian eggs. QEw showed the highest SPT positivity rate (60%), followed by QEy at 55%, DEw at 50%, and lastly DEy at 30% (figure 1A). Notably, positive SPTs were more frequent for egg whites compared to yolks across all tested avian eggs. We also investigated the rate of cross-reactivity pairwise between egg components. The study found that the cross-reactivity rates between hen's egg components and quail's egg components are higher than the duck's egg counterparts (figure 1B), with HEw-QEw being the highest (60%). The cross-reactivity between HEw-DEw was lower at 40%. The cross reactivity rates involving HEy components yielded lower rates with the lowest being HEy-DEy (15%).

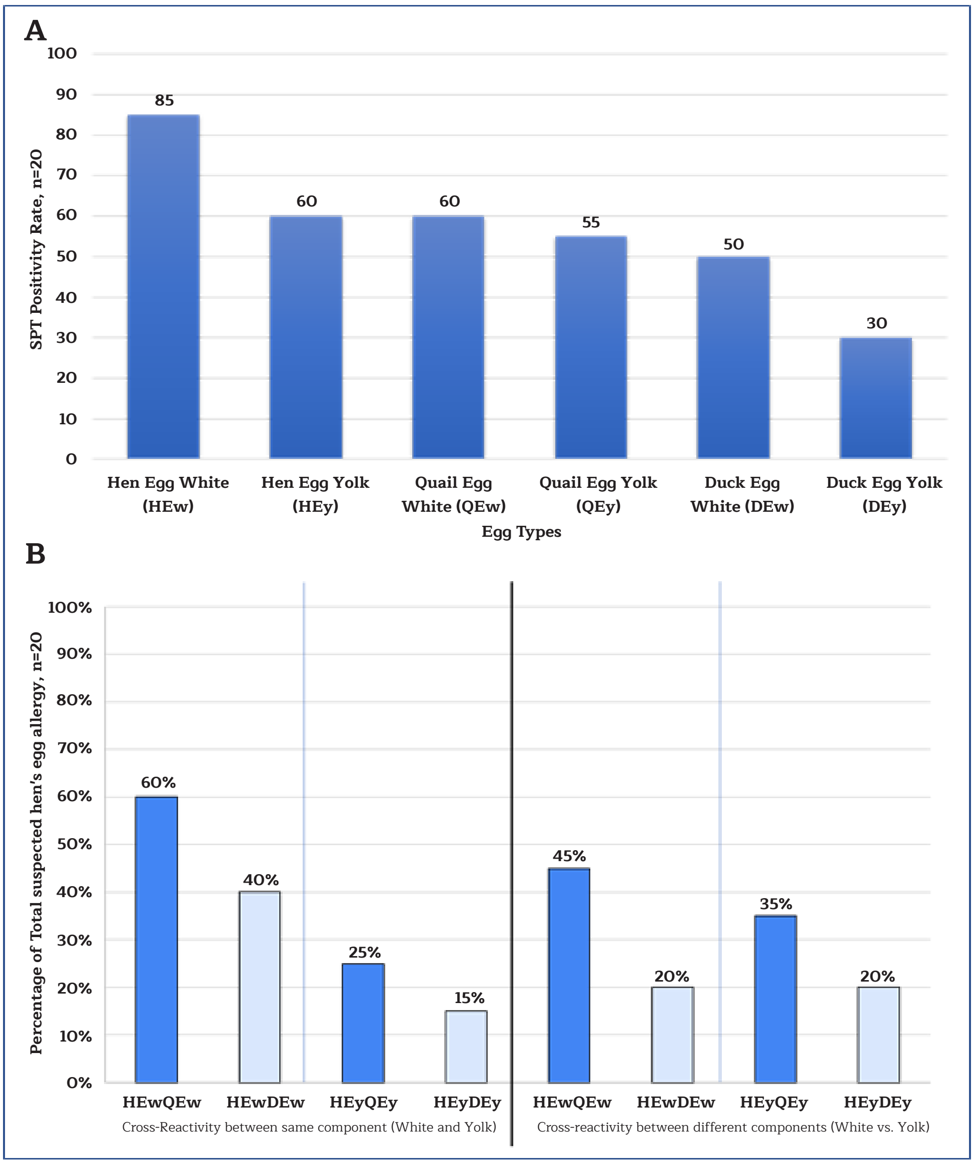

Figure 1 (A) SPT positivity rate (B) Cross-reactivity among egg components of three avians by skin prick test (n = 20)

Abbreviations: DEw, duck egg white; DEy, duck egg yolk; HEw, hen egg white; HEy, egg yolk; QEw, quail egg white; QEy, quail egg yolk

Spearman's correlation analysis revealed significant positive correlations ($p < 0.05$) between the MWD of egg whites and egg yolks within each bird species. Moderate correlations were found between the components of duck-quail eggs (QEw-DEw, r = 0.581, p = 0.009, QEy-DEw, r = 0.544, p = 0.016, and QEw-DEy, r = 0.528, p = 0.02), and quail-HEy (QEw-HEy, r = 0.522, p = 0.022 and QEy-HEy, r = 0.528, p = 0.02). In contrast, weak correlations between duck and hen egg components were found (DEw–HEw, r = 0.185, p = 0.434, DEy–HEy, r = 0.169, p = 0.475 and DEw–HEy, r = 0.259, p = 0.271). A negative correlation was found between HEw and DEy, r = -0.127, p = 0.594, although this was not statistically significant (figure 2).

Participants in the egg allergy group were further subclassified into: 1. The 'pan-egg sensitization' group (n = 9), including children sensitized to all 3 eggs, and 2. The "mono or dual egg sensitization" group (n = 11), including children sensitized to one or two types of eggs. A significantly higher proportion of participants in the pan-egg sensitization group had a history of maternal atopic disease (77.8% versus 36.3%, p = 0.03), and an earlier age of first egg reaction (6 months versus 6.5 months, p = 0.049) compared to the mono or dual sensitization group. Details are provided in Table 3.

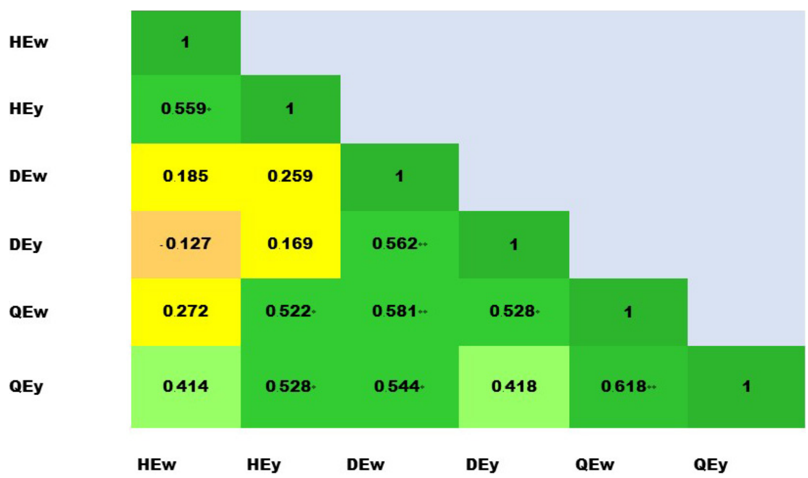

Figure 2 Correlations coefficients of skin prick test wheal sizes of hen, duck, and quail eggs in egg allergy participants (n = 20)

Correlation coefficients were calculated using Spearman's rank correlation test. P-value <0.05 is considered statistical significant

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Abbreviations: DEw, duck egg white; DEy, duck egg yolk; HEw, hen egg white; HEy, egg yolk; QEw, quail egg white; QEy, quail egg yolk

Table 3 Comparison of patients with pan-egg sensitization and with mono- or dual egg sensitization

Characteristics	Pan-egg sensitization (n = 9)	Mono or dual egg sensitization (n = 11)	P-value
Male sex, n (%)	7 (77.8)	8 (72)	0.645
Age (years), median (IQR)	1.1 (0.9-1.9)	1 (0.8-1.5)	0.710
Atopic dermatitis, n (%)	6 (66.7)	8 (72.3)	0.609
Recurrent wheezing, n (%)	3 (37.5)	4 (33.3)	1.000
Maternal atopic disease, n (%)	7 (77.8)	4 (36.3)	0.03
Paternal atopic disease, n (%)	5 (55.6)	4 (36.3)	0.273
Anaphylaxis, n (%)	3 (33.3)	1 (9)	0.14
Age of egg first introduction (months), median (IQR)	6 (6-6.5)	6 (6-8)	0.915
Age of egg first reaction, median (IQR)	6 (6-6)	6.5 (6-8)	0.049
HEw-sIgE (kU/L), mean ± SD	3.2 ± 3.2	1.7 ± 1.9	0.620
HEy-sIgE (kU/L), mean ± SD	0.7 ± 0.9[a]	0.3 ± 0.3	0.409
MWD HEw (mm), mean ± SD	9.7 ± 5.1	8.1 ± 5.9	0.868
MWD HEy (mm), mean ± SD	4.3 ± 4.1	2.2 ± 1.7	0.405

Abbreviations: HEw-sIgE, specific immunoglobulin E to hen egg white; HEy-sIgE, specific immunoglobulin E to hen egg yolk; IQR, interquartile range; kU/L, kilounits per liter; mm, millimeter; MWD, mean wheal diameter; n, number; SD, standard deviation
Values are expressed as mean ± SD or median (IQR), as appropriate. Comparisons between groups were performed using the Mann-Whitney U test for continuous variables and the Chi-square test (or Fisher's Exact test where applicable) for categorical variables. P-value < 0.05 was considered statistically significant
a: Missing data for HEy-sIgE in 1 patient

Of those 20 patients with suspected hen's egg allergy, 3 consented to undergo OFC to the egg type with the lowest SPT reactivity, aiming to minimize the risk of severe allergic reactions. All patients displayed an elevated HEw-sIgE level. Patient 1., despite negative SPT result to duck egg, experienced two lesions of urticaria at 2 hours post-challenge, followed by generalized urticaria requiring intravenous antihistamine and systemic corticosteroid. Patient 2. exhibited mild urticaria while approaching the full portion of a hen's egg, and Patient 3. tolerated the quail egg challenge without adverse reaction. Details of the patient characteristics who were underwent OFC are presented in Table 4.

DISCUSSION

This study investigated avian egg cross-reactivity and the characteristics of patients with pan-egg sensitization in Thai children (median age 1 year) with a history of suspected hen's egg allergy. An evaluation of a relatively young age group captured a population where an egg allergy is less likely to have been outgrown compared to studies with older children[11-13]. We prioritized duck and quail eggs due to their culinary importance in Thailand.

Table 4 Clinical and immunological characteristics of patients undergone OFC

No	Age (Year)	Sex	Clinical history of allergy in hen egg	HEw sIgE (kU/L)	HEy sIgE (kU/L)	Comorbidity	Maternal history of atopy	Age of first introduction (months)	Age of first reaction (months)	SPT Mean wheal diameter, mm.								OFC (heated)		
										HEw	HEy	DEw	DEy	QEw	QEy	Histamine	Glycerin	Hen	Duck	Quail
1	1	M	AD flare up	3.46	0.29	AD	No	6	6	7.5	3	2	0	3.5	5	4	0	ND	Urticaria after 2 hours	ND
2	1.2	M	Urticaria	6.14	0.44	AD	No	6	6	6.5	0	13.5	4.5	7.5	3	2	0	Urticaria	ND	ND
3	1.5	M	AD flare up	3.79	0.9	AD	No	6	6	6.5	0	3.5	0	0	0	3	0	ND	ND	Pass

Abbreviations: AD, atopic dermatitis; DEw, duck egg white; DEy, duck egg yolk; HEw, hen egg white; HEy, hen egg yolk; kU/L, kilounits per liter; M, male; ND, not done; OFC, oral food challenge; QEw, quail egg white; QEy, quail egg yolk; SPT, skin prick test

Our study observed a young age of egg allergy onset, often upon first exposure. Skin and gastrointestinal symptoms were predominant with rare respiratory issues. These findings align with previous reports[2,8,16]. Additionally, known risk factors of egg allergy development such as atopic dermatitis[17], a familial history of atopy[18], and the absence of siblings[18] were found more common in our egg allergy group. The high prevalence of atopic dermatitis in our study population suggests a potential link between skin barrier dysfunction and the development of food allergies. This is supported by the concept of the 'dual-allergen exposure' hypothesis, where pre-existing cutaneous sensitization predispose individuals to allergic reactions upon subsequent oral exposure to the same allergen[17]. Despite the limitations of the study design to establish these factors as true risk factors, the observed differences between the egg-allergy group and the control group warrant further investigation in larger prospective studies. The observed egg introduction practices in our study followed the national dietary recommendations and align with the findings of previous studies, including an egg cohort of Thai children commencing with hard-boiled egg yolk at 6 months of age[19-20]. This approach is in contrast with the reports from Australia, where introduction usually commences after 10 months with cooked egg white. This approach was found to be associated with higher allergy risks[21]. This suggests the need for future research that explores the potential benefits of earlier egg yolk introduction in the Thai context.

Compared to an Iranian study[11], our participants showed lower cross-reactivity with duck and quail eggs, and the overall MWD was also smaller. This difference potentially resulted from the younger age of our study group, as the skin reactions were less pronounced in children below 2 years[22], and the regional dietary differences. Notably, QEw displayed the highest cross-reactivity rate, followed by duck egg components. The pattern of SPT results aligns with the observed moderate correlations between quail egg components and duck eggs and HEys, but with a weaker correlation between duck and hen eggs. This suggests that quail egg proteins might share some similarities with both duck and hen eggs, while duck egg proteins might have a more distinct reactivity profile compared to hen eggs. This finding aligns with previous research suggesting DEw might have specific allergenic determinants distinct from HEw[10], identifying duck ovalbumin as the potentially responsible protein with specific antigenic determinants[23-25].

The distinctness of duck egg protein may be explained by avian phylogenetic relationships. Chickens and quails are closely related as they belong to the Galliformes order, while ducks, belonging to the Anseriformes, suggesting a more distant relationship to chickens and quails[26]. While evolutionary relationships may influence allergen structure, further investigation using immunoblotting and component-resolved diagnosis is warranted in order to identify the major allergens responsible for the observed cross-reactivity[27].

To provide an alternative diet option, and share-decision making with the caregivers, we performed OFC to the egg type with the lowest skin reaction from SPT in 3 patients. Despite observing moderate cross-reactivity between hen and quail eggs, we successfully introduced quail eggs into the diet of a 1.5-year-old male participant with hen's egg allergy (table 4, patient 3). Due to constant maternal anxiety, the patient underwent extensive food avoidance, leading to nutritional deficiencies. SPT confirmed hen egg sensitization but was negative for quail eggs, allowing us to perform an OFC to quail eggs, which the patient successfully passed. The safe introduction of quail eggs into the child's diet expanded his dietary options. This case aligns with a study from Japan that reported successful quail egg OFC in 55% of children with a hen's egg allergy[12].

Conversely, Patient 1. developed mild urticaria at 2 hours with a progression to systemic symptoms, despite a negative SPT result on duck eggs. Although a delayed reaction and progression of symptoms is not typical, this characteristic of the reactions after a food challenge has been reported even without further allergen intake[28]. While acute urticaria has various causes, the patient's history indicated no alternative explanations. We therefore recommended continuing duck egg avoidance until later confirmatory testing.

We hypothesized that individuals exhibiting cross-reactivity to all 3 egg types might develop antibodies against the shared proteins existing in those avian eggs, which are responsible for the cross-reaction among those eggs[9]. However, the absence of molecular-level analysis in this study limited our ability to confirm this hypothesis. Nevertheless, we observed the differences in the clinical characteristics between the patients with sensitization to all 3 eggs compared to those with sensitization to fewer egg types. It is important to note that the classification of patients based solely on SPT results may not accurately reflect the true extent of cross-reactivity.

This study has some important limitations. Firstly, the small number of participants affects the generalizability of the findings to a broader population. A larger sample size would enhance the study's reliability. Secondly, while the inclusion of a control group was essential for establishing the specificity SPT in detecting egg allergies, the potential for selection bias cannot be excluded. The requirement for an invasive procedure might have influenced the characteristics of the control group, leading to discrepancies in age between the 2 groups. Additionally, a matched case-control design would have been ideal for establishing robust associations between risk factors and egg allergies. Future studies employing this design are warranted in order to further explore these relationships. Finally, the limited number of participants (n = 3) undergoing OFC significantly restricted out ability to establish definitive IgE-mediated cross-reactivity.

In any future research, an expansion of the sample size and the inclusion of OFC as a confirmatory step would enhance the robustness and reliability of the data. Additionally, incorporating a more detailed analysis of past and current egg consumption patterns in a longitudinal study might offer further understanding of how dietary habits influence the development of cross-reactivity. Moreover, an exploration of the protein composition of avian eggs could unveil the key molecular components influencing allergic responses and clinical cross-reactivity.

CONCLUSION

This study provides preliminary insights into cross-reactivity patterns among hen, duck, and quail eggs in children with a suspected hen's egg allergy. We observed lower sensitization rates and weaker cross-reactivity between duck and hen eggs, suggesting the potential for duck eggs as a dietary alternative for some children with hen's egg allergy. However, the small sample size and limited number of OFCs necessitate a cautious interpretation of these findings. While one participant successfully tolerated quail eggs, further research with a larger cohort is required to confirm this observation and to fully understand the complexity of cross-reactive patterns. Incorporating SPT with the fresh eggs of hens, ducks, and quails, alongside hen egg-specific IgE testing, could be a valuable tool for evaluating children with suspected egg allergy and identifying potential dietary alternatives.

CONFLICT OF INTEREST

The authors report no conflict of interest for this article.

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DATA AVAILABILITY STATEMENT

All of the data generated and analyzed during this study are included in this article. Further enquiries can be directed to the corresponding author.

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