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Article type : Brief Communication

Hen's egg allergen in house and bed dust is significantly increased after hen's egg consumption – a pilot study

Short title: hen's egg allergen in house and bed dust

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This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1111/all.13303

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Abstract

Environmental exposure to food allergens may be a risk factor for cutaneous sensitization. Previous studies could detect peanut allergen in house dust. In this pilot study, we wanted to investigate whether hen's egg allergen is detectable in house dust collected from different household areas and whether levels are increased after intentional hen's egg consumption. Hen's egg protein levels of dust samples were measured using ELISA. In 8/8 households, hen's egg was detectable in dust samples of eating area and bed. 48 hours after intentional hen's egg consumption, hen's egg protein levels were significantly increased in both. Still, further research is necessary to investigate whether hen's egg allergen in house and bed dust plays a role in sensitization via skin.

Key words: cutaneous sensitization; environmental exposure; food allergens; house dust; hen's egg allergy.

Introduction

Sensitization to food allergens is often found in infants with moderate to severe atopic dermatitis, leading to the hypothetical conclusion that cutaneous exposure to food allergens might be an important way of sensitization (1, 2). A high household consumption of peanut was found to be a possible risk factor for the development of peanut allergy (3). Furthermore, peanut protein was found in house dust (4-7). In a prior investigation, we could show that a single, intentional consumption of roasted peanuts leads to significantly increased levels of peanut protein in house dust (4). Up to now, there is only little data on the environmental exposure of other food allergens. Hen's egg allergy rates among the most

common food allergies in Europe and is the most common food allergy in early infancy (8, 9). In the daily diet hen's egg plays a more important role compared to peanut in European countries. Therefore, high exposure to hen's egg allergen in house dust might also be a possible risk factor for cutaneous sensitization, especially in small infants with atopic dermatitis. However, whether there is a distribution of hen's egg allergen among different household areas has not yet been shown. Therefore, we wanted to investigate whether hen's egg protein is detectable in the house and bed dust and whether the preparation and consumption of a dish made from hen's egg increase hen's egg protein levels.

Methods

Eight voluntary households from Berlin, Germany, were included into the study. Each of the recruited households included at least one child. The participants were asked to complete a standardized questionnaire on general aspects of the household (number of adults and children, number and location of bedrooms) and the frequency of consumption of hen's egg and hen's egg containing products (listed as examples) over the last 4 weeks (never, 1-2 times/month, 1-2 times/week, ≥ 3 times/week, daily). Dust samples were collected at home using a special device for the vacuum cleaners (MITEST dust collector; Indoor Biotechnologies LTD, Cardiff, UK). Prior to the first collection of dust samples, the families were asked not to change their usual eating habits regarding hen's egg, not to vacuum clean for at least 72 hours and to keep the same bed sheets on the child's bed for at least 7 days. Baseline dust samples were collected from the habitual eating area (kitchen, dining room) and the child's bed sheets. At least 48 hours after baseline sampling, all participating households were asked to prepare scrambled eggs using two hen's eggs in the kitchen and to consume it in their usual eating area (kitchen or dining room). After 48 hours dust

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samples were taken again from the habitual eating area as well as from the child's bed sheets. Hen's egg protein was extracted from the dust samples and levels of hen's egg protein were measured with a commercially available ELISA (RIDASCREEN® FAST hen's egg; R-Biopharm, Darmstadt, Germany) coated with antibodies specific to the major allergens of hen's egg ovalbumin and ovomucoid. The range of quantification was 0.25 to 6.62 µg/g dust (detection limit 0.05 µg/g). Samples with hen's egg protein levels above the range of the standard curve were further diluted. Wilcoxon rank test was used to compare hen's egg protein level at baseline and 48 hours after the intentional hen's egg consumption.

Results

According to the questionnaire, all of the included households (8/8) reported to consume hen's egg or hen's egg containing products at least 1-2 times per week; 5/8 even at least 3 times per week. At baseline, hen's egg protein was detectable in all households in the eating area as well as on the child's bed sheet (Figure 1). The median hen's egg protein level was 13.1 µg/g dust (range 6.5-14.8 µg/g) in the eating areas and 12.9 µg/g dust (range 2.0 to 13.8 µg/g) on the child's bed sheets. 48 hours after the intentional preparation and consumption of scrambled eggs increased values of hen's egg protein were measured in all participating households in a very wide range (Figure 2). Median levels of hen's egg protein were significantly increased compared to baseline in the eating area with a median level of 214.0 µg/g dust (range 17.0-2,409.4 µg/g, $p < 0.05$) as well as on the child's bed sheets with a median level of 50.34 µg/g dust (range 5.9-247.0 µg/g, $p < 0.05$). In household number 8 with the lowest hen's egg protein levels on bed sheets at both time points the child's bed room was located on another floor than the eating area. The two households with the second lowest hen's egg levels (number 5 and 2) the child's bed rooms were on the same floor but

not adjacent to the eating area, whereas in household number 1 with the highest hen's egg levels on the bed sheet the child's bedroom was directly adjacent to the eating area.

Discussion

Only a few studies investigated the detection of food allergens in house dust, most of them focusing on peanut protein (4-7, 10-12). In the present study, hen's egg allergen was found in every household (100%) not only in the eating area where all participating households reported to consume hen's egg or hen's egg containing products but also on child's bed sheets where those products are usually not consumed. This indicates also a relevant distribution of hen's egg allergens within the household as it could be observed for peanut proteins (4, 5). In contrast to our data on baseline levels of peanut protein which were detectable in a wide range in the house dust of different households, hen's egg protein was distributed in low to moderate amounts in every household. On the one hand that could be due to a more similar eating behavior concerning hen's egg compared to peanut, on the other hand, the stability of these two different allergens may play a role. Peanut allergens are known to be extremely stable and therefore they might persist for a longer period of time in the environment than hen's egg (13, 14).

Furthermore, we could show that the preparation and consumption of a dish made from hen's egg lead to a significant increase of hen's egg protein levels in different household areas including the child's bed. Concerning the route of allergen spreading into the home environment after consumption, it could be shown for peanut protein that there might be a possible transfer via saliva or hands (5, 11). Whether these findings can be transferred to the distribution of hen's egg protein still needs further research. However, the wide range of detectable hen's egg protein after consumption in the eating area and on bed sheets

between households despite similar baseline levels might have been influenced by factors as different behaviors in surface cleaning after preparation or washing hands after consumption.

Two other studies determined the presence and baseline levels of hen's egg allergens in house dust (10, 12). A study from Norway detected hen's egg allergen among other food allergens in 22% of the mattress dust samples of 143 households using semi-quantitative dot blot analyses (12). They showed that the allergen level of mattress dust samples was higher if the bedroom and the kitchen were located on the same floor. In our analysis we included a much smaller sample size, however, we observed a similar trend 48 h after hen's egg consumption with higher protein levels on bed sheets when the bed room was adjacent to the eating area and the lowest protein level when the bedroom and the kitchen were on a different floor. Due to the small sample size, we could not perform any correlation with regard to hen's egg protein levels between different areas within the household. Another small study from the Netherlands investigating the level of ovomucoid and β -lactoglobulin in house dust reported that the amount of ovomucoid found in house dust, comparable with our baseline levels, might probably be sufficient to cause sensitization to hen's egg (10).

Recently it was shown that the exposure to peanut allergens in house dust augments the risk for peanut sensitization most notably in children with severe atopic dermatitis (7). In a similar way, hen's egg allergen found in bed dust might be a relevant source for the development of sensitization to hen's egg especially in small infants with an impaired skin barrier who spent most of the time in bed. In the current analysis only bed dust samples of the child's bed were taken. Probably even more food allergen would be found in the parent's bed, actually preparing the food at home and children would have been exposed even to higher doses of the food allergen when sleeping in the parent's bed. In future

investigations with a larger study population of children with atopic dermatitis, we therefore aim to collect additional dust samples of the parent's bed sheets as well as sleeping habits of the children.

In conclusion, hen's egg protein was found in house and bed dust with high levels following hen's egg consumption, indicating a potential risk factor for the development of a sensitization to hen's egg. Nevertheless, further research is necessary to proof whether hen's egg allergens in house and bed dust can cause sensitization and whether there is a correlation between allergen levels and the level of sensitization.

Acknowledgements

We would like to thank Alexander Rohrbach and Gabriele Schulz for their assistance in the laboratory.

Author contributions

Valérie Trendelenburg, Bodo Niggemann and Kirsten Beyer designed the study, Valérie Trendelenburg conducted the study, Valérie Trendelenburg and Sebastian Tschirner performed the statistics, Sebastian Tschirner wrote the first draft of the manuscript, all authors reviewed the manuscript and approved the final version.

Conflict of interest

The authors have no conflict of interest to declare.

Declaration of funding

This work has been supported by institutional funds. A discount for the ELISA was received from R-Biopharm, Darmstadt, Germany.

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Figure legends

Figure 1 Hen's egg protein levels in house and bed dust samples of 8 households at baseline.

Figure 2 Hen's egg protein levels in house and bed dust samples at baseline and 48 hours after preparation and consumption of scrambled eggs in the eating area and on bed sheets (n=8). Numbers in boxes are representing the household identification numbers.



