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INDOOR ALLERGENS IN SETTLED DUST FROM KINDERGARTENS IN CITY OF ŁÓDŹ, POLAND

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Abstract
Objectives: The main objective of the study was to determine the levels of house dust mite (Der p1), dog (Can f1), cat (Fel d1) and cockroach (Bla g2) allergens in kindergartens localized in an urban agglomeration. **Material and Methods:** A quantitative analysis of allergens was carried out in settled dust samples collected by vacuuming the floor surface in three kindergartens (N = 84) and children's clothing (N = 36). The samples were collected in spring-summer and autumn-winter periods as well as at the beginning and end of the week. The allergen dust concentration was determined by enzyme-linked immunoenzymatic assay (ELISA). **Results:** The mean geometric concentrations (±geometric standard deviations) of allergens Der p1, Can f1, Fel d1 and Bla g2 determined in kindergartens were: 0.02±3.21 μg/g of dust; 0.97±4.49 μg/g of dust; 0.30±4.43 μg/g of dust and 0.01±3.08 μg/g of dust, respectively. Younger classrooms (children aged from 3 to 4 years) were characterized by almost twice higher mean concentration of allergen Fel d1, as compared to older classrooms (children aged from 5 to 6 years) ($p < 0.05$). A significant impact of seasonality on the level of dog allergen Can f1 was found ($p < 0.05$). No significant weekly variation was found in average concentrations of the allergens. Children who had a dog and/or cat at home were characterized by high concentrations of allergens Can f1 and Fel d1 on their clothes (59.2±5.39 μg Can f1/g of dust; 3.63±1.47 μg Fel d1/g of dust), significantly higher than concentrations of allergens in children who did not have any pets ($p < 0.001$). **Conclusions:** Special attention should be paid to keeping the kindergarten rooms tidy and clean and to an appropriate choice of furnishings and fittings which would prevent the proliferation of the house dust mite and accumulation of allergens.

Key words:
Indoor allergens, Settled dust, Environmental exposure, Allergen transportation, Kindergartens, Children

INTRODUCTION

Kindergartens, apart from the home environment, constitute a significant place of the children's contact with biological agents including allergens. As the children spend in kindergartens a considerable amount of the time (approximately 30 h weekly), it is extremely important to ensure conditions that are appropriate and advantageous for their health and development. The results of the published studies indicate that the indoor allergen concentrations determined in kindergartens often reach levels comparable to those in home environments and also exceed threshold concentrations which in sensitive individuals may produce allergic symptoms, including bronchial asthma [1–4]. The main allergens determined in the air and settled dust collected in kindergartens (floors, carpets, beds, soft toys) comprise the house dust mite allergens,

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fur-covered animal (mainly the dog and the cat) allergens transported on clothing by the staff and children who have pets at home, as well as the cockroach allergens [5–14].

In Poland, the scientific information about the concentration of indoor allergens present in the place where the children live and stay is very limited and refers mainly to the house dust mite allergens [15–18], and recently also to cat and dog allergens [19].

The main objective of the study was to determine the levels of allergens of the house dust mite (Der p1), dog (Can f1), cat (Fel d1) and cockroach – *Blatella germanica* (Bla g2) in kindergartens of different characteristics, localised in a big urban agglomeration, as well as to confirm their possible transport on children's clothing. The performed study was aimed at reconnaissance only and constituted the first stage of the project which comprises a comprehensive evaluation of the environmental (daily) exposure of the 3- to 6-year children to indoor allergens.

MATERIAL AND METHODS

Study area

The study was carried out in city of Łódź, Poland. Of the list of 149 kindergartens registered at the Department of Education, The City of Lodz Office, selected for the studies were three facilities:

- facility A – 9 classrooms, 225 children, representing big kindergartens;
- facility B – 4 classrooms, 92 children, representing medium-sized kindergarten;
- facility C – 3 classrooms, 60 children, representing small kindergartens.

Characteristics of kindergartens

The kindergartens were described by virtue of the information obtained during a local inspection of the facilities. Two of the three kindergartens included into the studies (A, B) were built in the 80-s in direct vicinity of residential buildings. The third kindergarten (C) was located in an over 90-year old tenement house in the city centre, next to the traffic route. The building was characterised by slight defects which required some minor repairs, as well as traces of flood (no mould was found in the rooms).

In all classrooms of the investigated facilities the floors were covered by synthetic carpets (60–80% of the surface). The classrooms were mainly equipped with furniture made of plywood, basically low shelves. The walls were decorated with ornaments made of paper, fabrics and dried plants. Soft toys constituted from 10 to 30% of all toys available in classrooms for the youngest children. There were no animals in any of the kindergartens. The kindergartens were cleaned on average 3 times a week, mainly by vacuuming of the floors. The observations made during the measurement cycles revealed in one of the kindergartens (B) frequent signs of neglect in keeping the classrooms clean and tidy, i.e. fragments of solid debris in floor carpets, dust in classrooms' corners, on window sills and shelves. The studied facilities were provided with gravity ventilation. The kindergartens showed some differences as to airing the classrooms at daytime. Most frequently aired were classrooms of kindergarten A, actually every day from Monday to Friday, whereas the least frequently aired were classrooms of kindergarten C (on average twice a week). Frequent airing of the kindergarten was prevented by direct neighbourhood of a busy street (noise, dust, traffic fumes).

Strategy and methods of dust collection

Settled dust samples collected from floors in the classrooms (N=84) served as the basis for evaluation of exposure to indoor allergens occurring in kindergarten environment. Settled dust collection was carried out simultaneously in all three kindergartens in the morning, before the onset of classes with the children. The samples were collected during one year, in spring-summer and autumn-winter seasons (four measurement series), twice a week (Monday and Friday). Moreover, in one of the kindergartens (A),

samples of dust were collected once from the clothes of random-selected children (N = 36).

Dust samples from the covered floors were collected for 6 min, by vacuuming 1 m^2 of the classroom's area (central part), using portable vacuums (1600 W) equipped with ALK-sampler (Alk-Abello, Denmark) heads with cellulose filters = 70 mm, Grade 41 (prod. Whatman, USA).

Samples from the children's clothes (both sides, outer and inside) were collected in the morning, before the child entered the classroom, using the measurement equipment described above and 2-min. collection time. This measurement was made in the presence of the child's parents, from whom information was obtained whether or not the child had a cat or a dog at home.

Filters for collection of samples were weighed before and after each measuring series, and then they were transferred into tight sterile containers. Before analyses, the samples were stored at a constant temperature of –20°C.

During every measurement series in classrooms two parameters of microclimate, the temperature and relative humidity of air were measured using the multifunctional microclimate measuring instrument Testo 432 (Testo, Germany). Furthermore, the number of children was recorded (on average 17 children in the classroom); no statistically significant differences ($p > 0.05$) were found between the classrooms within individual kindergartens and between the investigated kindergartens within the number of children present on the measurement day).

Sample extraction and allergen analysis

The collected dust was not sieved; however, large solid fragments were removed before extraction. The dust samples were extracted using pyrogen-free water (Lonza, USA) with 0.05% Tween 20 (Sigma, Poland) added at a volume dependent on the weight of dust collected on the filter (5 ml: $m_{dust} < 500$ mg; 10 ml: 500 mg $\leq m_{dust} < 1000$ mg; 20 ml: 1000mg $\leq m_{dust} < 2000$ mg; 40 ml: $m_{dust} \geq 2000$ mg). All samples were precipitated for 60 min and subsequently centrifuged at 1000×G for 15 min. From the prepared samples, 10% of eluate was collected for further analyses to check the presence of endotoxins and (1→3)-β-D-glucans which constitute a subject of the second stage of studies. PBS solution (Sigma, Poland) was added to the samples for allergen analysis; the resultant mixture was then precipitated for 60 min and centrifuged at 2000×G for 15 min [20]. The concentrations of allergens in dust samples were measured using spectrophotometer SpectraMax Plus348 (Molecular Devices, USA). Allergen levels were determined by the immunoenzymatic method, using commercial kits of ELISA reagents (Indoor Biotechnologies Ltd., UK). The limits of detection and quantification for each allergen were as follows: 0.488 ng Der p1/ml, 0.977 ng Can f1/ml and 0.254 ng Fel d1/ml and 0.391 ng Bla g 2/ml. The concentrations of allergens were expressed in terms of μg/g of settled dust.

Statistical analysis

The results were reported as geometric means (GM) together with geometric standard deviations (GSD). All independent variables were not normally distributed according to Shapiro-Wilk statistic, thus nonparametric tests were used. Allergen concentrations in kindergartens/classrooms were compared with the use of Kruskall-Wallis test and Mann-Whitney U-test was applied to check seasonal/weekly variation as well as allergen concentrations on children's clothes. For assessment of relationships between variables the Spearman rank correlation was calculated. In all analyses the level of significance was set at a p value of 0.05. All statistical analyses were calculated using the STATISTICA software (StatSoft, USA).

RESULTS

Concentrations of allergens in kindergartens

The mean concentration of the settled dust collected from the floors in kindergartens was 1.03 g/m^2 with the geometric standard deviation 2.52 and range 0.03–4.93 g/m^2.

Significant differences ($p < 0.01$) were found between the kindergartens within the mean values of the levels of settled dust collected from floors in the classrooms: A) 1.21±2.41 g (0.06–4.93); B) 1.30±32.14 g (0.18–4.20); C) 0.62±2.68 g (0.03–1.65).

Over 93% of dust samples were characterised by allergen concentrations above the detection level. For most of the dust samples (70%) the concentrations of allergens did not exceed the threshold levels (allergic sensitization) established for sensitized persons: 2 μg/g of dust for Can f1 and Der p1,1 μg/g of dust for Fel d1, and 0.08 μg/g of dust (= 2 Units/g) for Bla g2 [21]. Table 1 specifies the results of determinations of the mean geometric concentrations of allergens Der p1, Fel d1, Can f1 and Bla g2 in settled dust and their respective geometric standard deviation and concentration range values for kindergartens and individual classrooms. The highest mean concentration was determined for the dog allergen Can f1 (0.97±4.49 μg/g of dust), whereas the lowest concentration was noted for the cockroach allergen Bla g2 (0.01±3.08 μg/g of dust). The mean level of the other allergens, cat Fel d1 and house dust mite Der p1, were 0.30±4.43 μg/g of dust and 0.02±3.21 μg/g of dust, respectively.

The analysis of variance indicated a significant difference ($p < 0.01$) between kindergartens in terms of the house dust mite allergen levels Der p1. The highest mean concentration of Der p1 was obtained for kindergarten C (0.04±3.21 μg/g of dust) and it was twice higher than the mean concentration recorded for kindergarten A. The studied facilities differed significantly also in the mean concentrations of allergen Can f1 in settled dust ($p < 0.05$). No differences were noted between the kindergartens for the levels of allergen Fel d1.

Table 1. Mean concentrations of allergens Der p1, Fel d1, Can f1 and Bla g2 determined in settled dust collected from the floors in investigated kindergartens and in individual classes within the facilities

Sampling site	Samples (n)	Der p1 (μg/g of dust)			Fel d1 (μg/g of dust)			Can f1 (μg/g of dust)			Bla g2 (μg/g of dust)		
		GM	GSD	min.–max	GM	GSD	min.–max	GM	GSD	min.–max	GM	GSD	min.–max
Kindergarten A	42	0.02	2.77	0.005–0.10	0.40	3.20	0.020–3.61	1.22	4.11	0.01–10.39	0.01	4.30	0.004–0.680
class I	10	0.02	2.57	0.007–0.07	0.60	2.12	0.110–1.19	1.08	5.09	0.11–2.68	0.01	4.01	0.050–0.130
class II	10	0.02	3.38	0.006–0.10	0.65	2.49	0.200–3.27	2.44	2.34	0.84–7.87	0.01	7.93	0.050–0.680
class III	12	0.01	2.41	0.005–0.05	0.20	1.86	0.070–0.43	0.74	1.51	0.01–2.54	0.08	1.19	0.004–0.090
class IV	10	0.02	2.80	0.005–0.06	0.77	2.82	0.150–3.61	2.07	2.09	0.86–10.39	0.01	1.25	0.004–0.100
Kindergarten B	24	0.03	3.48	0.005–0.16	0.26	3.10	0.020–1.26	0.95	1.91	0.27–2.45	0.01	1.31	0.004–0.010
class I	6	0.09	1.66	0.040–0.16	0.55	2.16	0.170–1.26	0.76	2.16	0.27–1.59	0.004	1.18	0.004–0.006
class II	6	0.04	3.71	0.006–0.11	0.50	1.43	0.280–0.81	0.97	1.92	0.30–1.82	0.005	1.24	0.004–0.007
class III	6	0.03	3.97	0.005–0.12	0.36	1.62	0.160–0.71	1.19	2.08	0.38–2.45	0.007	1.36	0.004–0.010
class IV	6	0.01	2.60	0.005–0.05	0.50	1.84	0.020–0.12	0.62	2.01	0.27–1.94	0.005	1.23	0.004–0.007
Kindergarten C	18	0.04	3.21	0.005–0.13	0.22	8.60	0.004–1.89	0.73	8.26	0.02–6.73	0.01	1.85	0.004–0.070
class I	6	0.03	3.45	0.005–0.10	0.52	4.40	0.050–1.89	1.12	4.75	0.09–3.75	0.005	1.23	0.004–0.007
class II	6	0.03	3.69	0.006–0.10	0.46	1.54	0.250–0.74	2.11	1.82	1.09–6.02	0.006	1.26	0.004–0.008
class III	6	0.07	2.98	0.007–0.13	1.21	1.27	0.950–1.77	3.81	1.51	2.38–6.73	0.006	1.18	0.004–0.007
Total	84	0.02	3.21	0.005–0.16	0.30	4.43	0.004–3.61	0.97	4.49	0.01–10.39	0.01	3.08	0.004–0.680

Der p1 – mite allergen; Fel d1 – cat allergen; Can f1 – dog allergen; Bla g2 – cockroach allergen.
GM – geometric mean; GSD – geometric standard deviation; min.–max – minimal and maximal values.

A comparative analysis of preschooler classes did not indicate any significant differences in the values of allergens. After aggregation of the classes into 2 groups: I–II (children aged from 3 to 4 years; N = 44) and III–IV (children aged from 5 to 6 years; N = 40) a statistically significant difference was found to occur between the groups only for the concentrations of allergen Fel d1 in the settled dust collected from floors in the investigated facilities ($p < 0.05$). The mean concentration of allergen Fel d 1 in lower classes (I–II) was 0.55±2.25 μg/g of dust, almost twice higher than the mean level determined in the dust collected in higher classes (III–IV). No differences between the classes were found for the other allergens, or for the settled dust.

Seasonal and weekly variation

The mean concentrations of the settled dust collected from the floors of kindergartens in winter (1.13±1.37 g; 0.03–4.93) were significantly higher than those for the samples collected in the same rooms in summer (0.89±1.56 g; 0.21–1.63) ($p < 0.01$).

A significant impact of season was determined only for the mean level of the dog allergen Can f1, that was almost twice higher than that in samples of dust collected from the classroom floors in the autumn-winter period (1.29±2.14 μg/g of dust), as compared to the mean level of that allergen obtained for samples collected in the spring-summer period (0.80±7.87 μg/g of dust) ($p < 0.05$) (Table 2).

The effects of microclimate and cleanliness of rooms on the concentration of allergens

The analysis of microclimate did not show any differences within the temperatures inside the classrooms. The average temperature in both winter and summer was maintained at the level of 22°C. Instead, significant differences between the kindergartens were found for the average relative humidity of air in the rooms (29% facility A , 41% facilities B and C; $p < 0.001$).

A negative correlation was found between the air temperature in classrooms and concentration of allergen Der p1. A positive correlation was detected between the concentration of settled dust (index of rooms' cleanliness) and the level of allergen of dog Can f1 as well as cat Fel d1, however, significant negative correlation was found between settled dust and level of cockroach Bla g2 (Table 3).

Table 3. Spearman's correlation coefficients between the microclimate factors, settled dust and allergen concentrations in kindergartens

Variables	Allergens			
	Der p1	Fel d1	Can f1	Bla g2
Settled dust	0.15	0.52**	0.24*	–0.24*
Temperature	–0.27*	–0.06	–0.18	0.07
Relative humidity	0.19	–0.01	–0.02	0.05

Abbreviations as in Table 1.
* Statistically significant ($p < 0.05$).
** Statistically significant ($p < 0.001$).

Table 2. Seasonal and weekly variation within the mean concentrations of allergens Der p1, Fel d1, Can f1 and Bla g2 in the settled dust collected from kindergarten floors

Factor (μg/g of dust)	Winter (N = 48)		Summer (N = 42)		p	Monday (N = 45)		Friday (N = 44)		p
	GM±GSD	min.–max	GM±GSD	min.–max		GM±GSD	min.–max	GM±GSD	min.–max	
Der p1	0.03±2.82	0.005–0.16	0.02±1.37	0.005–0.13	0.877	0.02±3.00	0.005–0.130	0.03±3.29	0.005–0.16	0.125
Fel d1	0.41±3.03	0.004–3.61	0.25±1.89	0.005–1.89	0.187	0.30±4.44	0.005–3.610	0.31±4.50	0.004–3.27	0.897
Can f1	1.29±2.14	0.010–10.39	0.80±7.87	0.020–7.87	0.019	0.86±5.39	0.010–10.39	1.10±3.67	0.020–7.87	0.462
Bla g2	0.01±1.21	0.004–0.13	0.01±3.14	0.004–0.68	0.833	0.01±3.10	0.004–0.680	0.01±3.10	0.004–0.58	0.645

Abbreviations as in Table 1.

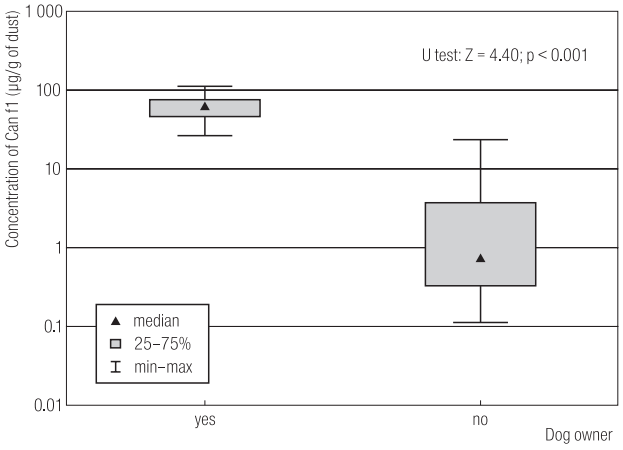

Fig. 1. The effects of the presence of a dog in the house environment on the concentration of allergen Can f1 on the clothes of children attending the kindergarten

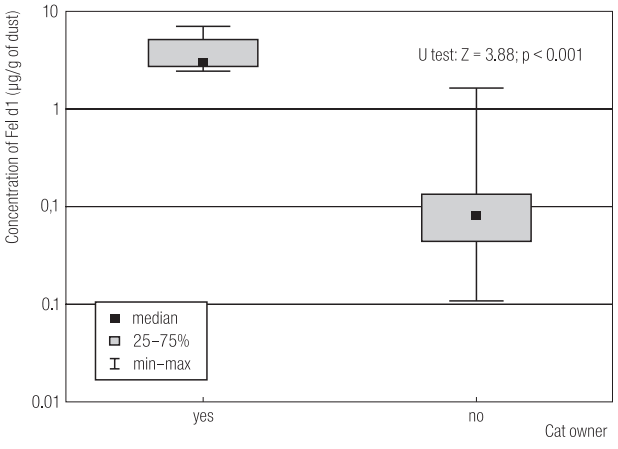

Fig. 2. The effects of the presence of a cat in the house environment on the level of allergen Fel d1 on the clothes of children attending the kindergarten

Allergens on children's clothes

The mean geometric concentration of dust collected from children's clothes (N = 36, kindergarten A) was 0.03±2.51 g (0.003–1.60). The levels of allergens Der p1, Fel d1 and Can f1 were 0.16±2.83 (0.02–1.32), 0.16±5.30 (0.01–7.13) and 2.17±8.08 (0.11–113.8) µg/g of dust, respectively.

The children who had a dog and/or cat at home were characterized by high concentrations of allergens Can f1 and Fel d1 on their clothes (59.2±5.39 µg Can f1/g of dust; 3.63±1.47 µg Fel d1/g of dust), significantly higher than the concentrations of allergens determined in children who did not have and were not in permanent contact with pets ($p < 0.001$) (Figures 1 and 2).

DISCUSSION

Given the fact that airborne allergens in public buildings are characterised by low concentrations, often below the determinability threshold [21–23], quantitative analysis of allergens, similarly as in other studies of this type, was carried out in samples of settled dust collected from classroom floors and children's clothing [1].

It was found that children attending the kindergartens were exposed to low levels of allergens, while mean geometric concentrations of the allergens in settled dust did not exceed the threshold levels established for sensitized people [21]. However, in the light of the published data, it seems reasonable to assume that low levels of exposure to allergens do not exclude the development of allergic reactions. Exposure to the low levels causes merely that the time to develop the allergic reaction is longer, while the allergens continue to be a potential risk to sensitive children's health [11,24,25].

The level of allergens in kindergartens is determined by a number of factors, the best described of which are: geographic-climatic conditions, season, technical condition of the building, microclimate of rooms, type of ventilation, equipment of rooms, intensity and effectiveness of cleaning and tidying up, as well as the presence of fur-bearing pets in dwellings of the kindergartens' staff and children [1,6,26,27].

The obtained results of the mean concentration of allergen Der p1 in settled dust collected from floors in the investigated facilities (0.02–0.04 µg/g) were comparable to the results of studies carried out in seven municipal kindergartens localised in south-western Poland (0.056 µg Der p1/g) [18], as well as in Scandinavian countries characterised by cold and dry climate [9,14]. However, they were lower

than results from French (0.05–1.90 μg/g) [28] or Turkish (0.00–2.70 μg/g) [29] kindergartens.

The published results indicate that the levels of house dust mite allergens are usually slightly lower in kindergartens than in the house environment [11]. In case of our studies the concentration of allergen Der p1 in kindergartens was approx. 10 times lower than in dwellings localised in the same urban agglomeration (Łódź city) [30]. Because of the classrooms relative humidity of air below 45%, the investigated kindergartens did not constitute an advantageous environment for living and development of the house dust mite [31], which was reflected in a low level of allergen Der p1 determined in the collected dust. On the other hand, it was found out that one of the kindergartens localised in the oldest building showing some traces of flood and requiring some renovation was characterised by an increased concentration of allergen Der p1, as compared to the other facilities. Similarly to Zuraimi et al. [6], the effects of microclimate on the level of indoor allergens were examined, indicating a negative correlation between the air temperature in classrooms and concentration of allergen Der p1 in the settled dust collected from floors.

Of the determined allergens, the lowest mean concentration in the settled dust collected from floors in kindergartens, which did not exceed 0.01 μg/g, was obtained for cockroach allergen Bla g2. Analysis of the results of studies carried out in kindergartens and schools mainly in the United States indicated a high span within the mean concentrations of allergens Bla g1 and Bla g2 in dust from the value below 0.01 μg/g of dust to the levels exceeding 5 μg/g of dust [1]. However, Stelmach et al. [32] in homes from Łódź region showed that the range of Bla g2 levels found in the houses was 0.1–389.26 μg/g of dust. That was considerably higher than in our current study. They also revealed that concentrations of cockroach allergen in homes were strongly related to the houses' characteristics. In our study, no significant differences were found between the kindergartens and individual classrooms, as well as the seasonal and weekly variation within the mean concentrations of allergen Bla g2 in dust.

As in case of the studies carried out in other countries, it was indicated that allergens of dog Can f1 and cat Fel d1 were common in the kindergarten environment, exhibiting higher mean concentrations in the settled dust than the house dust mite allergens Der p1, Der f1 or cockroach allergens Bla g1, Bla g2 [7,8]. Unlike with the results obtained by Instanes et al. [9], a significant correlation was found between the concentration of the settled dust collected from the surface of floors, which was acknowledged as an indirect indicator of the rooms cleanliness, and the level of pets' allergens. The highest levels of Can f1 found in kindergarten A resulted probably from its localization. This facility was placed in a big residential district with many green spaces, which favoured keeping a dog.

Furthermore, a significant effect of the season on the level of dog allergen Can f1 was found, its higher mean concentration having been determined in the settled dust collected in winter, as compared to the level obtained in summer. Occurrence of this phenomenon is most likely caused by type of activity of children as well as dogs. Previous studies [23,33] have revealed that dogs, in contrast to cats, spend more time on the floor than on the soft furniture. This determines higher concentrations of allergen Can f1 on carpets, where children have their place for playing. However, this model of spending time is characteristic mainly for autumn-winter seasons, when outdoor fun of children is limited. Analysing individual classrooms in respect of the level of pet allergens in the settled dust collected from floors, a significantly higher mean concentration was found of allergen Fel d1 in lower classes (children aged from 3 to 4 years), as compared to higher classes (children aged from 5 to 6 years), with a comparable number of children who have a cat at their dwelling place. This fact may be accounted for by the fact that younger children more often

play on the floor which is a place where dust settles down and which is a reservoir of allergens, thereby accumulating more allergen Fel d1 on their clothes, as compared to older children.

A significant part of the study was devoted to the determination of the levels of allergens Der p1, Can f1 and Fel d1 on clothing of randomly selected children and comparison of the mean concentrations of pet allergens obtained from clothing of children who had or did not have any dog or cat in the house environment. The results confirm the mechanism of pet allergen transportation, by their owners, to the kindergarten environment [13,26]. However, there is still limited scientific information about the clothing as a source of exposure to sensitizing agents. Siebers et al. [34] while analysing the clothing of children aged from 7 to 9 years determined the mean geometric concentration of allergen Der p1 at the level of 2.77 μg/g of dust, at the average amount of dust reaching 0.06 g. Patchett et al. [35] in the same age group of children indicated that having a cat at home increases over 7 times the concentration of allergen Fel d1 on children's clothes (78.7 μg/g). Furthermore, the authors demonstrated that woollen clothes were characterised by a higher concentration of allergens, as compared to the clothes made of polyester or cotton.

The results obtained in our study, both in case of the average amount of dust collected from clothes and the mean concentrations of pet allergens determined in dust were significantly lower, which may be associated with the examined children's age group (3–6 years), smaller surface of the clothes they wore and a different frequency of washing the clothes. Nevertheless it was indicated that the children having a dog and/or a cat in the house environment were characterised by a 14-times and 18-times higher mean concentration of allergen Can f1 and Fel d1, respectively, on their clothes as compared to the children who did not have any pets at home.

CONCLUSIONS

Kindergartens, apart from the dwellings, constitute a potential place of the children's contact with indoor allergens. To reduce children's exposure to allergens, special attention should be paid mainly to removing from kindergartens' furnishings those elements which constitute a reservoir of dust and allergens, i.e. mainly carpets, including wall-to-wall carpets, upholstered furniture and soft toys. Aiming at a reduction of the level of fur-bearing pet allergens in kindergartens (mainly the dog and the cat allergens), it is important to familiarize the parents with the problem of pet allergen transportation on the children's clothes and providing every day changed clean clothes to children who attend kindergartens.

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