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Lifestyle factors and sensitization in children – the ALADDIN birth cohort

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Abstract

Background: Several cross-sectional studies indicate that an anthroposophic lifestyle reduces the risk of allergy in children. We initiated the Assessment of Lifestyle and Allergic Disease During Infancy (ALADDIN) birth cohort to elucidate the role of specific factors supposed to mediate this effect. The aims of this study are to describe the ALADDIN cohort and to report patterns of exposure and allergic sensitization during the first years of life.

Methods: The ALADDIN study is a prospective birth cohort study of 330 children from families with an anthroposophic, partly anthroposophic, or nonanthroposophic lifestyle. The children and their parents were following an extensive data collection scheme, including repeated questionnaires and biological samples. Blood samples were collected from the parents and from the child at birth as well as at 6, 12, and 24 months of age.

Results: Several lifestyle factors differed between the groups, such as diet, medication, and place of delivery. Children of families with an anthroposophic lifestyle had a markedly decreased risk of sensitization during the first 2 years of life compared with children of nonanthroposophic families with adjusted OR 0.25 (95% CI 0.10–0.64) and *P*-value 0.004. A similar situation held true for children from families with a partly anthroposophic lifestyle, adjusted OR 0.31 (95% CI 0.15–0.54), and *P*-value 0.002.

Conclusions: The anthroposophic lifestyle comprises several factors of interest for allergy development and is here shown to be associated with reduced risk of IgE sensitization already in infancy. Identifying the factors responsible for this association would be of significant clinical importance.

The prevalence of IgE-associated allergic diseases has increased in many parts of the world during the last decades, especially in the Western world (1). However, in areas where the prevalence is high, there now appears to be stabilization (2). Environmental and lifestyle factors must be responsible for the comparatively rapid changes in the prevalence of allergic diseases (3). Exposures occurring prenatally or during the first years of life may be influential for the development of allergic diseases in children (3, 4). For example, exposure to cigarette smoking *in utero* or in early infancy is a risk factor for developing recurrent wheezing (5) and increases the risk of IgE sensitization to allergens (6). Exposure to traffic-related air pollution in infancy affects children's lung function and is associated with sensitization to common allergens (7). Some factors, however, are related to a lower prevalence of allergic diseases, like maternal exposure during pregnancy to a farm environment (8) as well as visits to stables and consumption of farm milk or fish during the first year of life (9, 10).

We have previously shown that the anthroposophic lifestyle is associated with a lower prevalence of allergic diseases (11), which has been confirmed in a multicenter European study (12, 13). The anthroposophic lifestyle is characterized, for example, by home deliveries, an organic diet, restricted use of antibiotics, antipyretics, and vaccinations as well as by

several other features that may influence the allergy risk. The previous studies (11–13) were performed on school children (5–13 years) and were of cross-sectional design, which complicates assessments of causal relationships. Thus, it still remains to assess the timing of the lower prevalence of allergic diseases and to disentangle certain lifestyle factors within the anthroposophic lifestyle that explain this effect. The Assessment of Lifestyle and Allergic Disease During Infancy (ALADDIN) birth cohort was initiated to prospectively, by the collection of biological samples already during the pre- and postnatal period, elucidate the role and timing of the anthroposophic lifestyle for the development of allergic disease in childhood.

The aims of this article are to describe the study design and to report on exposure characteristics during pregnancy and infancy in children of families with an anthroposophic lifestyle. In addition, we have analyzed the risk of IgE sensitization to common food and inhalant allergens among infants during the first 2 years of life.

Methods

Study population

Assessment of Lifestyle and Allergic Disease During Infancy is a prospective birth cohort study where children from anthroposophic and conventional Maternal-Child Health Centers (M-CHCs) are followed from the fetal period, in this report up to 24 months of age. Couples expecting a child were consecutively recruited between September 2004 and November 2007 from anthroposophic M-CHCs in Järna and Stockholm as well as from two conventional M-CHCs in the Järna area. Järna is a countryside village outside Stockholm with a community of anthroposophic followers. In the second trimester of pregnancy, parents were asked by their midwife whether they wanted information about the study. Families who, after getting information from the study team, agreed to participate were recruited in the third trimester of pregnancy. The children were born at delivery clinics in the area or by homebirth. The study was approved by the Research Ethical Committee at Huddinge University Hospital, Stockholm, Sweden, and written informed consent was obtained from all families.

Data collection

An overview of the data collection procedures in the ALADDIN study is provided in Table 1. Demographic and exposure data as well as information on signs and symptoms of allergic disease were obtained by previously used questionnaires, health diaries, and interviews and by physical examinations (11–13). Classification of the participating families into lifestyle groups was based on the choice of M-CHCs and parental responses to three questionnaire questions: (i) 'What kind of preschool/school will your newborn child probably go to?', (ii) 'Has any of the parents, no matter which type of school you have planned for your child, an anthroposophic view of life?', and (iii) 'Is the family's everyday life influenced by an anthroposophic view of life?'. Families answering 'anthroposophic school' to question 1 and 'yes' to questions 2 and 3, and also attending anthroposophic M-CHCs were defined as 'anthroposophic'. Families answering conventional

Table 1 Events in families participating in the Assessment of Lifestyle and Allergic Disease During Infancy study from pregnancy until the age of 24 months of the child

	Pregnancy	Prior delivery	Delivery	3–6 days	3 weeks	2 months	6 months	12 months	18 months	24 months
Questionnaire	X†		X‡			X§			X¶	X§
Blood mother + father	X									
Feces mother		X				X				
Dust bed		X					X		X	
Cord blood			X							
Placenta			X††							
Vernix			X							
Feces child				X	X	X	X	X	X	X
Breast milk				X		X				
Health diary						X	X	X	X	X
Examination + interview						X	X	X	X	X
Blood child							X	X		X
Saliva child, mother, father‡‡							X	X		X
Skin prick test child										X

†Sense of Coherence Scale (20).
‡Delivery Fear Scale (21).
§Demographic and exposure data.
¶Social network.
††Placenta (22).
‡‡Salivary cortisol (23).

or any other nonanthroposophic type of school to question 1, 'no' to questions 2 and 3, and going to conventional M-CHCs were defined as 'nonanthroposophic'. Any other combination of answers was defined as 'partly anthroposophic'.

Determination of sensitization

Blood samples were obtained from the parents when the family was included in the study, from the child at delivery by aspiration from cord blood, and at the age of 6, 12, and 24 months. The samples were collected in heparin tubes and plasma stored at −20°C. Parental IgE sensitization was defined by ImmunoCAP Phadiatop® (Phadia AB, Uppsala, Sweden) containing a mix of 11 inhalant allergens. Cord blood was analyzed for total IgE (Phadia AB). Blood from the children at the age of 6, 12, and 24 months was analyzed by ImmunoCAP® (Phadia AB) for total IgE and for IgE to seven common allergens (hen's egg, cow's milk, peanut, cat, dog, birch, and timothy). A study subject was classified as IgE-sensitized if IgE levels were ≥0.35 kU_A/l, for the parents in Phadiatop and for the children in at least one of the seven allergens (14). Analyses were also performed using a cutoff level of 0.70 kU_A/l.

Statistics

Statistical analyses were conducted using PASW 18.0 software (SPSS, Chicago, IL, USA) and Stata 11.1 (StataCorp, College Station, TX, USA). Linear analyses for trend (for categorical variables) and ANOVA (for comparison of means for continuous variables) were used for the comparison of lifestyle factors between the groups. Generalized estimating equations were used to estimate odds ratios (OR) for the association between lifestyle groups and sensitization, which was measured at 6, 12, and 24 months of age. Median regression was used for total IgE because it showed a skewed distribution. To adjust for the dependence of total IgE within each child, cluster bootstrap was used to estimate standard errors. Data were adjusted for the following baseline variables: sex of the child, parental sensitization, maternal smoking during pregnancy, number of siblings or other children living with the family, exclusive breastfeeding at 6 months of age, family living on a farm with animals during pregnancy, and parental education. A P-value < 0.05 was regarded as statistically significant.

Results

The recruitment process and the flow of participants in the cohort are shown in Fig. 1. Of all potentially eligible families, 65.4% (189 of 289) from the anthroposophic M-CHCs and 70.1% (141 of 201) from the conventional M-CHCs were included in the study (n = 330). Six families were excluded after inclusion: four because of preterm delivery (< 36 gestational week) and two because of miscarriage. Further, before categorization into lifestyle groups (at 2 months of age), 17 families did not continue in the study for various reasons: nine because of stressful situations, two because of disease other than allergy of the child or mother, three because of moving, and three for unknown reasons. Five families did not answer the questions used for categorization into lifestyle groups and were therefore excluded from this report. Thus, after categorization, the study included 82 families with anthroposophic, 120 with partly anthroposophic, and 100 with nonanthroposophic lifestyle. After 2 months of age, an additional five families left the study until the age of 24 months: two because of disease other than allergy of the child, one because of moving, and two for unknown reasons.

Demographic and allergy-related data in the families are shown in Table 2. In all lifestyle groups, the majority of parents were born in Scandinavia. However, in the anthroposophic group, parents to a higher extent were born abroad, mostly in another European country. The education level of the parents was similar between the three groups. Families with nonanthroposophic lifestyle more often lived in private houses as compared with the other groups. Parental allergic sensitization and reported symptoms of allergy-related disease in the families did not differ significantly between the three lifestyle groups. In total, 27.2% of the mothers were IgE-sensitized and 43.0% of the fathers. However, many lifestyle factors differed markedly between the groups during pregnancy, delivery, and the first 2 months of age of the children (Tables 3 and 4), for example concerning diet, place of delivery, and medication. Children in anthroposophic families were to a higher extent exclusively breastfed at 2 and 6 months of age as compared with children in the other groups. Further, children in anthroposophic families were less often given AD vitamin supplement, more commonly wore wool closest to the skin, and lived on a farm with animals.

Parental blood was analyzed from all of the mothers and from 96.4% of the fathers. Cord blood was obtained for analyses from a total of 85.8% of the children (82.9% in the anthroposophic group, 85.8% in the partly anthroposophic group, and 88.0% in the nonanthroposophic group). Blood samples were obtained from a total of 91.4% of the children on at least one of the three time points of blood sampling (82.9% in the anthroposophic group, 90.9% in the partly anthroposophic group, and 99.0% in the conventional group).

The level of total IgE in cord blood and during the first 2 years of life did not differ significantly between the three lifestyle groups (Table 5). At each follow-up – 6, 12, and 24 months of age—sensitization was most prevalent in the nonanthroposophic group (Table 5). At 6 months of age, 23 children were sensitized, and of them, 20 children (87%) were still sensitized at 12 months of age and 18 (78%) at 24 months of age. At 12 months of age, 38 children were sensitized, and of them, 29 (76%) were still sensitized at 24 months of age.

Children from families with an anthroposophic lifestyle had an overall decreased risk of sensitization during the first 2 years of life compared with children from nonanthroposophic families with an OR of 0.25 (95% CI 0.10–0.64), P-value 0.004, adjusted for sex of the child, parental sensitization, mother smoking during pregnancy, number of siblings or other children living with the family, exclusive breastfeeding at 6 months of age, family living on a farm with animals

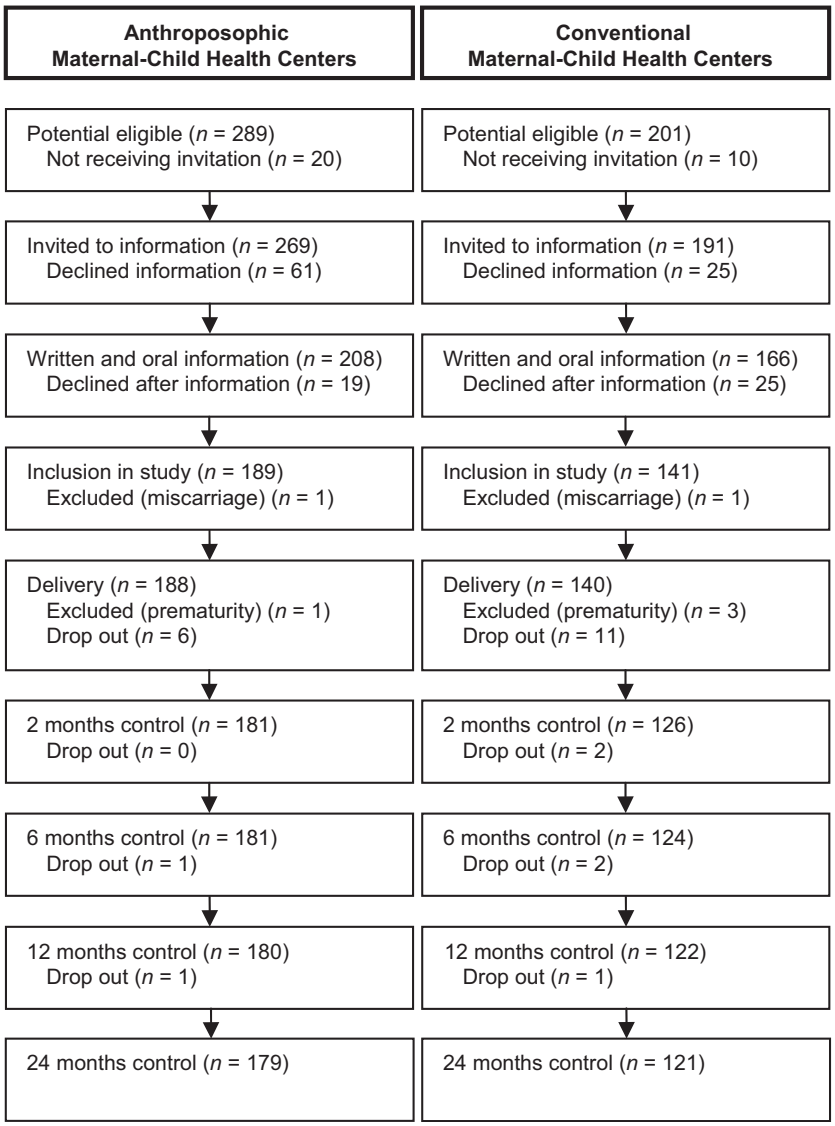

Figure 1 Flow chart of the recruitment process and the flow of participants during the first 24 months of the Assessment of Lifestyle and Allergic Disease During Infancy study. *n*, number of families at each stage.

during pregnancy, and parental education. Children from families with a partly anthroposophic lifestyle also showed a decreased risk compared with children from the nonanthroposophic families, adjusted OR 0.31 (95% CI 0.15–0.54), *P*-value 0.002, and did not differ significantly compared with children from anthroposophic families. The differences between the groups persisted when the IgE cutoff level was raised to 0.70 kU_A/l.

Discussion

This article provides an overview of the design of the prospective birth cohort study ALADDIN and describes the distribution of demographic and environmental factors in families with anthroposophic lifestyle and in comparison groups. We also show that the risk of IgE sensitization to common allergens was lower among children of families with an anthroposophic lifestyle and that this was obvious already at 6 months of age.

Like in previous studies (11–13), we saw that several lifestyle factors were associated with the anthroposophic lifestyle (Tables 2–4) and some of them previously assessed in relation to the development of allergic diseases, such as family size, diet, and living on a farm (8, 9, 15). Also, our findings of an association between the anthroposophic lifestyle and allergic sensitization are in accordance with earlier results (11–13), which however were cross-sectional and did not focus on infancy. The observed effect of lifestyle factors on the development of sensitization is in line with other cohorts where exposure early in life to tobacco smoke, pollution from traffic,

Table 2 Demographic data including allergy and sensitization in families with an anthroposophic, partly anthroposophic, and nonanthroposophic lifestyle. [Categorical variables: *n*/*N* (%). Continuous variables: mean ± SD]

	Anthro	Partly anthro	Nonanthro	*P**
N = 302	82	120	100	
Age mother at birth of child, years	32.5 ± 6.4	31.7 ± 5.0	31.7 ± 4.3	0.51
Age father at birth of child, years	35.9 ± 7.8	34.8 ± 6.6	33.8 ± 8.5	0.19
Mothers place of birth				
Scandinavia	56/82 (68.3)	106/120 (88.3)	92/100 (92.0)	<0.001
Other european country	23/82 (28.0)	9/120 (7.5)	7/100 (7.0)	<0.001
Non-european country	3/82 (3.7)	5/120 (4.2)	1/100 (1.0)	0.27
Fathers place of birth				
Scandinavia	57/82 (69.5)	96/120 (80.0)	89/99 (89.9)	0.001
Other european country	21/82 (25.6)	17/120 (14.2)	6/99 (6.1)	<0.001
Non-european country	4/82 (4.9)	7/120 (5.8)	4/99 (4.0)	0.76
Mother attended Steiner School	36/82 (43.9)	30/120 (25.0)	3/99 (3.0)	<0.001
Father attended Steiner School	32/82 (39.0)	15/119 (12.6)	3/98 (3.1)	<0.001
Mother highest education				
Gymnasium	30/82 (36.6)	50/120 (41.7)	51/100 (51.0)	0.048
University	37/82 (45.1)	57/120 (47.5)	38/100 (38.0)	0.30
Father highest education				
Gymnasium	36/82 (43.9)	49/117 (41.9)	56/99 (56.6)	0.085
University	30/82 (36.6)	46/117 (39.3)	28/99 (28.3)	0.20
Having older siblings	61/80 (76.3)	74/118 (62.7)	65/94 (69.1)	0.36
No. of siblings or other children living with the family	1.11 ± 1.0	0.74 ± 0.8	0.86 ± 0.8	0.01
Size of living area (m^2)	100 ± 52	99 ± 45	133 ± 50	<0.001
Living in apartment	36/82 (43.9)	61/120 (50.8)	18/100 (18.0)	<0.001
Child's room recently painted	16/82 (19.5)	24/120 (20.0)	23/100 (23.0)	0.55
Wall-to-wall carpeting	3/82 (3.7)	3/120 (2.5)	2/100 (2.0)	0.50
Condensation inside windows regularly	16/80 (20.0)	15/119 (12.6)	11/100 (11.0)	0.034
Insulated windows	27/82 (32.9)	44/119 (37.0)	56/100 (56.0)	0.001
Mother reported				
Eczema	22/82 (26.8)	34/120 (28.3)	25/100 (25.0)	0.76
Asthma	5/82 (6.1)	12/119 (10.1)	12/100 (12.0)	0.18
Allergic rhinoconjunctivitis	21/80 (26.3)	30/112 (26.8)	25/96 (26.0)	0.97
Reactions to food	24/82 (29.3)	39/120 (32.5)	24/99 (24.2)	0.42
Father reported				
Eczema	18/82 (22.0)	20/116 (17.2)	16/97 (16.5)	0.36
Asthma	9/81 (11.1)	13/117 (11.1)	14/99 (14.1)	0.52
Allergic rhinoconjunctivitis	27/78 (34.6)	40/112 (35.7)	37/96 (38.5)	0.59
Reactions to food	19/80 (23.8)	25/115 (21.7)	21/99 (21.2)	0.69
Siblings reported†				
Eczema	19/61 (31.1)	20/74 (27.0)	17/65 (26.2)	0.54
Asthma	4/61 (6.6)	3/74 (4.1)	8/65 (12.3)	0.21
Allergic rhinoconjunctivitis	8/61 (13.1)	5/74 (6.8)	7/65 (10.8)	0.68
Reactions to food	19/61 (31.1)	15/74 (20.3)	16/65 (24.6)	0.41
Mother sensitized	19/82 (23.2)	35/120 (29.2)	28/100 (28.0)	0.49
Father sensitized	34/80 (42.5)	51/114 (44.7)	40/97 (41.2)	0.84

*Categorical variables: *P* for trend; continuous variables: *P* for comparisons of means.
†Computed among those having older siblings.

Table 3 Environmental factors during pregnancy and delivery and for the infant during the neonatal period, in families with an anthroposophic, partly anthroposophic, and nonanthroposophic lifestyle. [Categorical variables: *n*/*N* (%). Continuous variables: mean ± SD]

	Anthro	Partly anthro	Nonanthro	*P**
Pregnancy				
Mother				
Gainful employment	66/82 (80.5)	96/120 (80.0)	89/100 (89.0)	0.11
Having disease	27/82 (32.9)	50/118 (42.4)	32/100 (32.0)	0.81
Medication	35/81 (43.2)	57/120 (47.5)	49/100 (49.0)	0.45
Antibiotics	9/82 (11.0)	19/120 (15.8)	14/100 (14.0)	0.59
Serious event for the family	16/82 (19.5)	26/120 (21.7)	16/99 (16.2)	0.54
Vegetarian diet	18/82 (22.0)	21/119 (17.6)	2/90 (2.0)	<0.001
Organic/biodynamic diet	65/81 (80.2)	67/117 (57.3)	5/99 (5.1)	<0.001
Major change in diet	24/82 (29.3)	44/120 (36.7)	25/97 (25.8)	0.55
Consuming fish	64/82 (78.0)	107/120 (89.2)	91/100 (91.0)	0.01
Butter on bread	38/82 (46.3)	25/120 (20.8)	1/100 (1.0)	<0.001
Olive oil as main cooking fat	69/82 (84.1)	89/120 (74.2)	50/100 (50.0)	<0.001
Nature cure medicine	70/80 (87.5)	85/118 (72.0)	16/100 (16.0)	<0.001
Living on farm with animals	15/81 (18.5)	8/118 (6.8)	10/98 (10.2)	0.10
Regular animal contact	47/82 (57.3)	66/120 (55.0)	65/100 (65.0)	0.30
Regularly in barn	8/80 (10.0)	10/117 (8.5)	10/97 (10.3)	0.92
Smoking	7/82 (8.5)	6/120 (5.0)	9/100 (9.0)	0.84
Snuffing	3/81 (3.7)	2/116 (1.7)	0	0.06
Father smoking	17/82 (20.8)	23/117 (19.7)	14/99 (14.1)	0.16
Delivery				
Home delivery	34/82 (41.5)	29/120 (24.2)	0	<0.001
Vacuum extraction	2/82 (2.4)	7/120 (5.8)	1/99 (1.0)	0.52
Acute cesarean section	8/82 (9.8)	4/120 (3.3)	10/99 (10.1)	0.10
Elective cesarean section	4/82 (4.9)	4/120 (3.3)	10/99 (10.1)	0.12
Anesthesia	29/82 (35.4)	61/119 (51.3)	91/99 (91.9)	<0.00
Antibiotics	11/82 (13.4)	4/120 (3.3)	10/98 (10.2)	0.53
Midwife from Health Centre assisting	43/81 (53.1)	52/120 (43.3)	0	<0.001
Infant during the neonatal period				
Sex (female)	39/82 (47.6)	60/120 (50.0)	54/100 (54.0)	0.68
Birth weight (kg)	3.6 ± 0.6	3.6 ± 0.6	3.6 ± 0.5	0.71
Birth height (cm)	50.8 ± 2.3	51.0 ± 2.1	50.7 ± 2.2	0.64
Birth head circumference (cm)	35.4 ± 2.0	35.2 ± 1.5	35.3 ± 1.3	0.55
Child admitted to neonatal care	2/48 (4.2)	8/93 (8.6)	4/98 (4.1)	0.74
Days at hospital† (days)	3.8 ± 3.2	3.0 ± 2.3	2.6 ± 1.0	0.015
Cow's milk formula during first week	10/80 (12.5)	18/120 (15.0)	25/99 (25.3)	0.023
Use of skin cream first week	51/80 (63.8)	64/119 (53.8)	48/96 (50.0)	0.72
First clothing of wool	43/82 (52.4)	23/117 (19.7)	0	<0.001
Age at first wash of whole body (days)	19.2 ± 12.5	15.9 ± 15	7.6 ± 6.5	<0.001
Antibiotics (first 2 months)	1/76 (1.3)	5/118 (4.2)	3/99 (3.0)	0.57
Naturecure medicine (first 2 months)	15/76 (19.7)	17/118 (14.4)	0	<0.001
Antipyretics (first 2 months)	2/76 (2.6)	7/118 (5.9)	3/99 (3.0)	0.98

*Categorical variables: *P* for trend; continuous variables: *P* for comparisons of means.
†Computed among those born at hospital.

and exposure to farming animals during fetal period have been related to allergy development (6–8). Our results on a difference in sensitization are largely explained by the difference in proportion of IgE sensitization to food allergens, which constitutes the most common type of sensitization during the first year of life (16). Allergic diseases are strongly influenced by parental allergy, but this was similarly distributed in the three lifestyle groups and not responsible for the differences observed in sensitization of the children. Also, total IgE was similarly distributed. Its predictive value is poor for allergic sensitization and atopic disease, especially regarding asthma (16, 17). Allergen-specific IgE sensitization is a precursor of later allergic manifestations and if combined with other risk factors, a predictor of allergic disease (16).

Table 4 Environmental factors at 2 months of age in children of families with an anthroposophic, partly anthroposophic, and nonanthroposophic lifestyle. [Categorical variables: *n*/*N* (%). Continuous variables: mean ± SD]

	Two months of age			
	Anthro	Partly anthro	Nonanthro	*P**
Mother				
Breastfeeding				
Exclusively	73/76 (96.1)	105/118 (89.0)	72/99 (72.0)	<0.001
Partly	2/76 (2.6)	10/118 (8.5)	18/99 (18.2)	0.001
During breastfeeding				
Diet organic/biodynam.	67/75 (89.3)	69/115 (60.0)	7/90 (7.8)	<0.001
Particular diet	49/75 (65.3)	60/115 (52.2)	38/89 (42.7)	0.004
Medication	19/75 (25.3)	39/115 (33.9)	30/86 (34.9)	0.20
Antibiotics	5/75 (6.7)	10/115 (8.8)	8/90 (8.9)	0.62
Nature cure medicine	57/75 (76.0)	72/115 (62.6)	37/90 (41.1)	<0.001
Consuming fish	52/75 (69.7)	96/115 (83.5)	77/89 (86.5)	0.007
Butter on bread	30/75 (40.0)	25/115 (21.7)	1/90 (1.1)	<0.001
Olive oil in food	61/75 (81.3)	84/115 (73.0)	39/90 (43.3)	<0.001
Regularlyin barn	4/75 (5.3)	9/114 (7.9)	10/89 (11.2)	0.17
Regular animal contact	20/75 (26.7)	30/111 (27.0)	32/87 (36.8)	0.15
Child				
Having AD vitamins	4/76 (5.3)	29/118 (24.6)	84/99 (84.8)	<0.001
Sleeping outdoors day	22/76 (28.9)	52/118 (44.1)	36/99 (36.4)	0.40
Mother smoking	4/76 (5.3)	3/118 (2.5)	9/98 (9.2)	0.20
Father smoking	11/75 (14.7)	18/116 (15.5)	7/96 (7.3)	0.12
Sleeping in parents bed	52/76 (68.4)	74/118 (62.7)	52/99 (52.5)	0.03
Wool closest to skin	56/76 (73.7)	38/118 (32.2)	4/99 (4.0)	<0.001
Use of pacifier	24/76 (31.6)	42/118 (35.6)	50/99 (50.5)	0.009
Body wash 1/week or less	69/76 (90.7)	92/118 (78.0)	54/98 (55.1)	<0.001
Skin cream use regularly	68/76 (89.5)	99/118 (83.9)	86/99 (86.9)	0.53
Lying on sheep skin daily	48/76 (63.2)	60/118 (50.8)	17/99 (17.2)	<0.001
Wearing a cap indoors	52/75 (69.3)	43/118 (36.4)	3/99 (3.0)	<0.001
Pets in household	35/41 (46.1)	47/118 (39.8)	46/99 (46.5)	0.88
Other contact with animals	20/76 (26.3)	25/118 (21.2)	32/99 (32.3)	0.30
Living on farm with animals	15/76 (19.7)	5/118 (4.2)	9/99 (9.1)	0.036
Outdoors (mean, h/day)	2.1 ± 1.5	2.4 ± 1.7	2.2 ± 1.7	0.32

*Categorical variables: *P* for trend. Continuous variables: *P* for comparisons of means.

Thus, our results suggest that differences will occur in the development of allergic disease in the cohort also over the coming years, allowing further assessment of associations with certain lifestyle exposures in the anthroposophic lifestyle.

Some issues have to be considered in the interpretation of our findings. Information on some exposure characteristics for an anthroposophic lifestyle was collected by questionnaires, health diaries, and interviews, which may lead to bias. However, the prospective design in which the baseline information was received already during pregnancy and neonatal period and thus before allergy-related symptoms were expressed or test results available should minimize risks of disease-related modification of exposure. The recruitment rate was fairly high (65–70% at both anthroposophic and conventional M-CHCs) indicating that the cohort could be representative for the populations targeted for investigation. The fact that anthroposophic parents were born to a higher degree in non-Scandinavian European countries may raise the question whether different genetic differences could explain the results. However, because the allergy prevalence and sensitization did not differ between the parents in the three lifestyle groups, it seems unlikely that genetic factors could explain the lower prevalence of sensitization in children in the anthroposophic group. Parental sensitization was also included as a control variable in the statistic models and did not have any significant influence on the results. Further, the representativeness of the reference group appears high because their prevalence of allergic sensitization was similar to that seen in other studies of children at the same age (18). The prevalence of reported allergic rhino conjunctivitis, a fairly valid indicator of sensitization to air-borne allergens, was in mothers of all lifestyle groups close to the prevalence in a large questionnaire survey of adults in the Stockholm area (19). Fathers in our cohort generally reported such symptoms more often, however, similarly in all three lifestyle groups.

Table 5 Total IgE in cord blood and sensitization to common allergens and total IgE at 6, 12, and 24 months of age in children of families with an anthroposophic, partly anthroposophic, and nonanthroposophic lifestyle. [Sensitization *n*/*N* (%). Total IgE: median kU/l]

	Anthro	Partly anthro	Nonanthro
Cord blood			
Total IgE	0.32	0.16	0.18
6 months			
Sensitization	1/51 (2.0)	6/84 (7.1)	16/82 (19.5)
Egg	1/56 (1.8)	3/97 (3.1)	6/86 (7.0)
Milk	0/57	0/97	10/87 (11.5)
Peanut	0/56	1/96 (1.0)	0/86
Cat	0/52	2/88 (2.3)	1/82 (1.2)
Dog	0/51	0/84	2/82 (2.4)
Timothy	0/53	0/87	0/83
Birch	0/54	0/86	0/83
Total IgE	3.6	4.0	5.2
12 months			
Sensitization	2/47 (4.3)	10/87 (11.5)	26/83 (31.3)
Egg	2/53 (3.8)	5/92 (5.4)	16/91 (17.6)
Milk	0/53	3/91 (3.3)	12/91 (13.2)
Peanut	0/51	2/90 (2.2)	4/89 (4.5)
Cat	0/50	1/88 (1.1)	4/81 (4.9)
Dog	0/46	0/87	3/81 (3.7)
Timothy	0/50	0/86	1/81 (1.2)
Birch	0/51	0/88	1/85 (1.2)
Total IgE	6.6	6.8	7.3
24 months			
Sensitization	9/59 (15.3)	11/89 (12.4)	24/90 (26.7)
Egg	1/59 (1.7)	3/92 (3.3)	13/92 (14.1)
Milk	6/59 (10.2)	7/93 (7.5)	13/92 (14.1)
Peanut	0/59	4/92 (4.3)	4/92 (4.3)
Cat	1/59 (1.7)	0/92	4/91 (4.4)
Dog	0/59	0/90	4/90 (4.4)
Timothy	0/59	2/89 (2.2)	5/91 (5.5)
Birch	2/59 (3.4)	4/90 (4.4)	4/91 (4.4)
Total IgE	15.0	15.0	14.5
OR*	0.25 (0.10–0.64)	0.31 (0.15–0.54)	1.0 (reference)
P-value	0.004	0.002	–
OR†	1.0 (reference)	1.24 (0.46–3.33)	4.03 (1.57–10.4)
P-value	–	0.66	0.004

*Overall OR adjusted (95% CI) for sensitization with nonanthroposophic group as reference.
†Overall OR adjusted (95% CI) for sensitization with anthroposophic group as reference.

The loss to follow-up was very small in all lifestyle groups, minimizing risk of such bias. In all the lifestyle groups, blood samples were available in more than 80% of the children from at least one time point, even though this proportion was smaller in children from anthroposophic families than from the other two groups. Some part of the missing blood values was explained by failure by the nurse to receive blood, and this was equally distributed between the groups. The choice of not giving blood was made by the parents at a time point when they had not received any results of their own or the child's blood sample analyses. All families received their results of the blood samples after the last child had turned 24 months of age. We believe that the choice of not giving blood was more related to lifestyle-associated attitude.

In conclusion, several lifestyle factors that have been related to the development of allergic diseases differed between families with an anthroposophic, partly anthroposophic, and nonanthroposophic lifestyle during pregnancy, delivery, and the first 2 years of life of the child. We also show that the anthroposophic lifestyle is associated with a reduced risk of allergic sensitization during this period. The cohort, which is now being expanded, will be followed over time, including assessment of the development of allergic symptoms and the influence of specific lifestyle factors.

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Author contributions

FS, JS, GL, MBor, GP, AS, and JA were all involved in the planning of the study, the study design, and data analysis. The clinical part of the study including patient contact was handled by FS. Pediatric aspects, including allergy, were dealt with by FS, JA, GL, and MBor. AS was handling matters related to immunology. Epidemiological and statistical issues were primarily handled by GP and MBot. FS wrote the article; all other authors critically reviewed it and approved the final version.

Conflict of interest

MBor is affiliated to Phadia AB, Uppsala, Sweden. FS, JS, GL, MBot, GP, AS, and JA reported no conflict of interest.

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