

Are children at high familial risk of developing allergy born into a low risk environment? The PIAMA Birth Cohort Study

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Summary

Background A family history of allergy, reflecting genetic risk factors, increases the risk of developing allergic diseases, but environmental factors, especially those present in early life, also contribute to the actual development of allergic phenomena.

Objective To identify differences in lifestyle between allergic and non-allergic parents, which may influence the prevalence of environmental risk factors in their homes.

Methods Data were collected in a Dutch birth cohort study by postal questionnaire about 2 months before and 3 months after the birth of the child.

Results Of the 3147 infants in the study 1910 (61%) had two non-allergic parents, of 315 infants (10%) only the mother was allergic, of 787 infants (25%) only the father was allergic and 135 (4%) infants had two allergic parents. If both parents were allergic, 53% reported that allergy was taken into consideration when they furnished their home and significantly more of their homes were free of cats and free of cigarette smoke; adjusted odds ratio's for two allergic parents vs. two non-allergic parents were 0.30 (confidence interval (CI) 0.17–0.50) for the presence of cats and 0.46 (CI 0.27–0.75) for smoking in the home. Parental allergy was also associated with having a smooth floor in the baby's bedroom and with postponement of the introduction of fruits and vegetables until the age of 26 weeks. The presence of dogs at home, the prevalence of mothers' smoking during pregnancy and the decision to breast feed were unrelated to parental allergy.

Conclusion We conclude that studies on the relationship between allergy in parents and allergy in their offspring should always consider the home environment as a potential confounder. For allergy prevention our results imply that among allergic parents there is awareness and willingness to take measures that reduce exposure to indoor allergens.

Keywords: infants, parental allergy, allergy risk factors, lifestyle, indoor environment, avoidance

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Introduction

A family history of allergy increases the risk of developing allergic disease, but besides genetic factors, environmental

factors, especially those present in early life, also contribute to the actual development of allergic complaints [1,2]. Avoidance of allergen and tobacco smoke exposure is widely advocated as the best currently available protection against the development of allergic disease [3–5].

In The Netherlands a multicentre birth cohort study is being conducted on Prevention and Incidence of Asthma and Mite Allergy (PIAMA). Children of allergic as well as

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children of non-allergic parents participate in this study and one of the aims of the study is to identify, in both these groups, risk factors for the development of asthma and allergy. In this paper the question is addressed whether the home environment in which children are born and grow up differs for children of allergic and children of non-allergic parents. Do allergic parents have fewer pets, do they smoke less, do they more frequently have smooth floors rather than carpets or rugs and do more of them breast feed? This question is relevant for two reasons. First, it is scientifically relevant to know whether the observed prevalence of allergy in children of allergic parents solely reflects an increased genetic risk, or whether the genetic risk is modified by environmental factors associated with the parents' allergy. Misleading associations between a high prevalence of allergy in children and a low prevalence of environmental risk factors could be found if risk factors were less prevalent in homes of allergic parents. Second, for health care workers giving advice to allergic parents-to-be it is worth knowing to what extent such parents take measures either to reduce their own complaints or to reduce the risk for their children.

Methods

The PIAMA study consists of two parts: a placebo-controlled intervention part in which the effect of mite-impermeable mattress covers is studied, and a natural history part in which no intervention takes place. In this paper only data from the natural history part of the study are presented.

Pregnant women were recruited from the general population with the help of 52 midwife practices and obstetric clinics in three different regions of The Netherlands. Pregnant women ($n = 10\,232$) completed a validated [6] short screening questionnaire on inhalant allergies. Women with any one of the following self-reported complaints—asthma, hay fever, house dust

allergy, house dust mite allergy or pet allergy—were defined as 'allergic' ($n = 2949$, 29%). Women who reported not having any of these complaints were defined as 'non-allergic'. Allergic women ($n = 763$) and 5084 non-allergic women were requested to join the natural history part of the study. Written informed consent was obtained from 3291 pregnant women: 472 allergic (response 62%) and 2819 non-allergic (response 55%) women. The proportion of allergic mothers to be included in the study was determined in the study design and therefore does not reflect the prevalence of allergy among pregnant women in The Netherlands. Allergy of the father was no criterion for inclusion in the study. After the families had agreed to participate, the fathers filled in the same questions as the mothers did in the screening questionnaire and were then classified as 'allergic' or 'non-allergic' using the same criteria as for the mothers. The participating children were born between July 1996 and October 1997 and will be followed until they are at least 8 years old. This will give us the opportunity to relate lifestyle and environment in infancy to clinical manifestations at a later age.

Data on aspects of the infant's home environment that may influence the development of allergy were collected by postal questionnaire on two occasions: during the last trimester of pregnancy and around 3 months after the birth of the child. For the analyses, data were used of 3147 infants. Data of 144 infants were excluded from the analyses because no data on the father's allergy were available or because either the prenatal or the postnatal questionnaire was not completed. We focused on aspects of the home environment that can be influenced by the parents if they choose to do so. Two types of questions were asked. Most questions referred to the actual situation in the home, enquiring about the presence of pets, smooth floors, smoking and feeding practices. In addition, participants were asked whether they had taken allergy of a family member into account when they furnished their home. A positive answer to this question would not necessarily mean

Table 1. Characteristics of the study population

Characteristics	Study population $n = 3147$
Mother's age (years, mean (SD))	30.4 (3.9)
Father's age (years, mean (SD))	32.8 (4.7)
First child (%)	48.8
Gender (% boys)	52.0
Birth weight (g, mean (SD))	3516 (537)
Mother's educational level:	
primary, lower vocational and lower general (%)	23.4
senior high school and intermediate vocational (%)	41.9
higher vocational and university (%)	34.6

Table 2. Prevalence of lifestyle factors by parental allergy

	Both parents not allergic (<i>n</i> = 1910)	Only mother allergic (<i>n</i> = 315)	Only father allergic (<i>n</i> = 787)	Both parents allergic (<i>n</i> = 135)
Mother smoked during pregnancy (%)	16.0	15.0	11.3*	13.4
Allergy taken into account when furnishing home (%)	3.9	38.7**	32.8**	53.3**
Cat present after birth (%)	37.2	29.8*	31.4*	16.5**
Dog present after birth (%)	16.6	21.0	14.4	16.7
Smoking in the home (%)	32.5	29.4	22.5**	20.7*
Smooth floor in baby's bedroom (%)	38.9	44.9	45.3*	47.9
Ever breast fed (%)	80.7	83.3	83.7	86.6
Children with infant feeding data (<i>n</i>)	1256	221	535	86
Breast fed for ≥ 26 weeks (%)	29.9	31.3	32.8	38.6
No juice, fruits and vegetables until 27th week (%)	8.4	10.8	10.8	22.2**

P-values for difference compared to the group 'Both parents not allergic'.

**P* < 0.01.

***P* < 0.001.

that effective measures were taken, but was interpreted as an indicator of parents' awareness that allergy avoidance is possible and may be beneficial. In addition to the two questionnaires, parents were asked to keep a record of the

child's feeding during the entire first year of life and then, after the child's first birthday, to return these records to the researchers. For a number of specified foods, they were asked to record the child's age (in weeks) when they

Table 3. Relationship between parental allergy and lifestyle

Dependent variable	Only mother allergic		Only father allergic		Both parents allergic	
	OR ¹	95% CI ¹	OR ¹	95% CI ¹	OR ¹	95% CI ¹
Mother smoked during pregnancy ² (<i>n</i> = 3129)	0.94	0.65–1.37	0.77	0.59–1.01	0.72	0.40–1.32
Cat present after birth ³ (<i>n</i> = 3127)	0.69	0.52–0.92	0.82	0.68–0.99	0.30	0.17–0.50
Dog present after birth ³ (<i>n</i> = 3102)	1.34	0.96–1.87	0.97	0.75–1.24	0.93	0.54–1.61
Smoking in the home ³ (<i>n</i> = 3132)	0.97	0.72–1.29	0.68	0.55–0.84	0.46	0.27–0.75
Smooth floor in baby's bedroom ³ (<i>n</i> = 2711)	1.33	1.01–1.76	1.30	1.08–1.58	1.42	0.95–2.12
Ever breast fed ⁴ (<i>n</i> = 3126)	1.17	0.81–1.71	1.09	0.85–1.40	1.30	0.75–2.27
Breast fed for ≥ 26 weeks ⁴ (<i>n</i> = 2048)	1.08	0.79–1.51	1.12	0.89–1.43	1.84	1.12–3.03
No juice, fruits and vegetables until 26th week ⁴ (<i>n</i> = 1931)	1.47	0.88–2.46	1.35	0.93–1.96	3.81	2.08–6.99

¹Adjusted odds ratio's (OR) and 95% confidence intervals (CI) vs. households with two non-allergic parents.

²OR adjusted for mother's age, father's age, mother's educational level, presence of siblings and region.

³OR adjusted as for ² and for child's gender and child's age.

⁴OR adjusted as for ³ and for birth weight and Hospital admission after birth.

introduced this food for the first time. They were also asked to record the age of the child the last time it was breast fed and the first time it was formula fed. These infant feeding records were completed and returned for 2102 (64%) of the children in this study. They were used to assess the duration of breast feeding and the time of introduction of solids.

Logistic regression analysis was used to assess the relationship between the various lifestyle factors and having an allergic mother, having an allergic father or having two allergic parents compared with having two non-allergic parents. Crude odds ratio's (OR) were estimated as well as ORs adjusted for mother's age, father's age, the presence of siblings in the family, region and mother's education. ORs of the lifestyle factors assessed post-natally were also adjusted for the child's gender and the child's age (in weeks) when the postnatal questionnaire was completed. The OR for breast feeding was also adjusted for the child's birth weight and for Hospital admission after birth.

Results

Of the 3147 infants in the study 1910 (61%) had two non-allergic parents, of 315 infants (10%) only the mother was allergic, of 787 infants (25%) only the father was allergic and 135 (4%) infants had two allergic parents. The disparity in the numbers of infants with only an allergic mother and with only an allergic father is a result of the study design, as non-allergic mothers were over sampled in the natural history part of the study.

Table 1 shows some basic characteristics of the study population. Table 2 shows the (unadjusted) prevalences of the lifestyle factors studied in the four parental allergy groups (both parents not allergic, only mother allergic, only father allergic, both parents allergic). Table 3 shows the adjusted ORs for the association between parental allergy and the lifestyle factors studied. As the adjusted ORs hardly differed from the unadjusted ORs, the latter are not shown in this Table.

The largest differences between the four parental allergy groups in the prevalence of lifestyle factors were observed for items directly related to allergen avoidance. If both parents-to-be were allergic 53% reported in the prenatal questionnaire that allergy of a family member was taken into consideration when they furnished their home. If they mentioned specific measures, these were mostly related to type of floor covering and sometimes to the type of furniture. This does not necessarily mean that in these homes allergen levels were effectively reduced, but indicates the level of awareness about allergen avoidance among allergic parents. Data from the postnatal questionnaire showed adjusted ORs significantly lower than 1 for the presence of cats in families with one or two allergic parents compared with the families with two non-allergic

parents. Of the allergic parents without cats between 42% (only father allergic) and 53% (both parents allergic) reported that the reason for not having a cat was an allergic family member. Adjusted ORs were significantly higher than 1 for smooth floors in the baby's bedroom in families with an allergic father or mother. The prevalence of smoking in the home (defined as 'yes' if any smoking in the home, by the parents or others, occurred on average at least once a week) ranged from 21% in families with two allergic parents to 33% in families with two non-allergic parents, but the adjusted ORs were significantly lower than 1 only for having an allergic father and for having two allergic parents. The percentages of mothers who smoked during pregnancy were similar in the four parental allergy groups (11–16%). Also the decision to breast feed was not related to parental allergy. Over 80% of the mothers started breast feeding after birth, irrespective of parental allergy. Breast feeding for at least 26 weeks, however, as well as not introducing either fruit juice, fruits or vegetables before the age of 26 weeks were both significantly associated with having two allergic parents.

Discussion

The infants of allergic parents in our study were born in a home environment that differed from that of infants of non-allergic parents. Infants of allergic parents were more likely than other infants to be born in a home free of cats and free of cigarette smoke. They were more likely to have a smooth floor in their bedroom and, if they had two allergic parents, less likely to be exposed to newly introduced foods at an early age.

The data show that a considerable proportion of the allergic parents in our study were aware of the possibility and usefulness of taking measures to avoid contact with allergens. The percentages of allergic parents who reported that they took allergy of a family member into consideration when furnishing their home and the percentage of allergic parents reporting that they had no cat because of allergy in the family reflect this awareness. With respect to breast feeding no differences were observed between the four parental allergy groups. Breast feeding is widely recommended by health professionals to allergic parents, but also to all other parents. Our data show that being allergic provides no additional motivation on top of other considerations to breast feed. Similarly, all pregnant women are advised not to smoke during pregnancy. The relatively small group of women who do smoke during pregnancy is likely to consist of those who are either not reached or not motivated by anti-smoking messages and those who are unable to quit. The large majority of women in the study (85%) did not smoke during pregnancy and being allergic or having an allergic husband only marginally

increased the prevalence of non-smoking. Official Dutch guidelines to health workers, published in 1998 [7], recommend that parents of children with a high allergy risk (defined as having two allergic parents or having one allergic parent and an allergic sibling) be advised not to feed their children any solids until they are 6 months old. At the time the infants in this study were born this was, however, not yet part of the standard advice given to parents. Late introduction of fruits and vegetables was significantly associated with having two allergic parents, but in absolute terms there were still only few parents who postponed the introduction of these foods, indicating that either the advice was mostly not given to parents or that parents were unwilling or unable to follow the advice.

We cannot exclude the possibility that selection bias has influenced our results. The allergic parents who agreed to participate in the PIAMA study may know more or care more about allergy prevention than the allergic parents who were unwilling to join the study. If this is the case, this would imply that differences between allergic and non-allergic parents in the general population would be smaller than they were in the study population. Even if selection bias were extreme, however, our results still indicate that a considerable proportion of the infants of allergic parents are born in an environment that differs from the home environment of infants of non-allergic parents.

We have also considered the possibility that reporting bias may have contributed to these results in the sense that allergic parents might, consciously or unconsciously, tend to give more 'desirable' answers about their lifestyle and behaviour. Recall bias cannot have played a role as questions were asked about the present situation, but the possibility that allergic parents perceive or report their own behaviour differently from other parents cannot be excluded. We assume that perception and reporting bias are small for questions on such straightforward matters as having a cat or having a smooth floor. Questionnaire data on smoking and infant feeding, however, might suffer from biased perception or biased reporting by the parents. The questionnaire data on smoking were compared with measurements of nicotine in the air in a sample of the study population [8]. The reported smoking habits and the nicotine measurements were found to agree very well, indicating that the questionnaire data on smoking in the home can be considered valid. For the infant feeding data no such comparison with a more objective measurement was available. The response rate on the infant feeding questionnaire was 70% for children with only an allergic mother compared with 66% for children with two non-allergic parents and 64% for children with two allergic parents. This observation has no implications for the validity of the answers given by allergic and non-allergic parents, but at least indicates that the motivation to keep

infant feeding records was independent of parental allergy. Altogether we feel confident to conclude that if reporting bias has contributed to our observations, this contribution was relatively small and that real lifestyle differences exist between allergic and non-allergic parents in our study. Dust samples were collected in a subsample of the homes when the children were 3 months old. When results of the allergen determinations in these samples are available, they will enable us to assess the effect of differences in lifestyle on the levels of indoor allergens.

An earlier Dutch study on the relationship between pet ownership and respiratory allergy among 3344 children aged 6–12 years revealed, like our study, an association between allergy and the absence of pets, in particular cats. Fifty-seven percent of all reported pet allergy and 38% of all doctor-diagnosed asthma in that study were found in the 12% of the study population who had removed pets from their home [9]. Our results differ from those obtained in a Canadian study among 194 postpartum women [10]. In this study no differences were observed in behaviour of families with high-risk and low-risk infants with respect to the presence of pets, carpeting, introduction of solids and parental smoking.

Based on our results, however, we would recommend that studies on the relationship between allergy in parents and allergy in their offspring should always consider the home environment as a potential confounder. Similarly, we recommend that studies on allergen exposure and allergic symptoms always consider the possibility that low allergen levels may be more prevalent in homes of genetically high-risk children. Neglecting this possibility may lead to misinterpretation of observed associations between absence of risk factors and a high incidence of symptoms.

We conclude that among the allergic parents in our study there was considerable awareness and willingness to take measures specifically directed at reduction of exposure to indoor allergens and that the prevalences of a number of environmental risk factors were lower in the homes of infants at high familial risk than in other homes. On the other hand, our results show that, even of the infants with two allergic parents, 13% were exposed *in utero* to tobacco smoke, 21% were exposed after birth to tobacco smoke and 17% had a cat at home, indicating that in many families there is still ample scope for improvement of the home environment.

In a number of years, results of the PIAMA study will provide more insight into the effects of the lifestyle factors described here on the development of allergic disease in both high-risk and low-risk children.

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