

Original article

Does my partner cause my allergy?

Background: The study of partners can help to understand the impact of environmental influences on the development of allergies. We aimed to test the hypothesis that subjects whose partners have hay fever are at increased risk for the same disease and that the risk increases with the time subjects live together with an affected partner.

Methods: A nested unmatched case–control study was performed in a random sample of 4261 inhabitants, aged 25–74 years, of the City of Augsburg, Germany, and two adjacent counties. Using standardized computer-assisted face-to-face interviews, we determined the risk of doctor-diagnosed hay fever in subjects who lived together with a partner having the same disease as opposed to subjects living with an unaffected partner. Furthermore, the risk of doctor-diagnosed hay fever depending on the time the subjects had lived together with an affected partner was calculated.

Results: After adjustment for age, sex, parental predisposition and social status, the risk of hay fever was more than double in subjects who lived together with a partner having the same disease (odds ratio, $OR_{adj.}$, 2.41; 95% confidence interval, CI, 1.48–3.92). If subjects lived together with an affected partner, the risk of developing the disease increased with the time the partners lived together (1–11 years, OR 1; 12–23 years, OR 1.8; 24–35 years, OR 7.4; 36–54 years, OR 13.7).

Conclusion: The risk of developing hay fever is significantly elevated in subjects who live together with a partner having the same disease. The risk further increases with the time the partners live together. This points to important shared environmental influences or behaviours and raises speculations on a transmissible cause.

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Allergies are a major public health problem. Seasonal allergic rhinoconjunctivitis – hay fever – constitutes the most frequent allergy in adults. Frequency estimates for 20–44-year-old individuals from various European countries range from 12 to more than 30% (1). Furthermore, there is good evidence that atopic diseases, including hay fever, have increased significantly over the past decades (2, 3). Genetic factors have great impact on the manifestation of these diseases and are in the focus of current genome searches (4). Numerous studies in families and twins have demonstrated that allergies largely run in families and have estimated the attributable risk of having a genetic predisposition (5, 6). The increase of allergies, however, cannot be explained by genetic factors, i.e. a change of these (7). This has directed the attention and research to the study of environmental influences. Several such factors from early infection to individual lifestyle habits and atmospheric pollution have been identified as contributing factors modulating the manifestation of allergies (8–11). The study of partners would be ideal to investigate influences of a shared environment

independent of genetic associations. The identification of such environmental factors may have an impact on the development of prevention strategies and make these more effective if they are targeted on couples.

An earlier population-based study showed associations for the occurrence of specific cancer types and non-Hodgkin's lymphoma between husbands and wives (12). Studies based on linkages of medical records of patients from general practitioners revealed significant associations between married couples in the occurrence of common diseases and symptoms such as hypertension, hyperlipidaemia, peptic ulcer, depression and also asthma (13, 14).

We hypothesized that the risk for hay fever, the most prevalent allergy in adults, would be increased in persons who live together with an affected partner and tested this association on a large population basis. We further speculated that, if this association would be of clinical relevance, the risk would increase in a dose-dependent manner with the time period a subject had been living together with an affected partner.

Subjects and methods

Study design and subjects

A nested unmatched case-control study was carried out in a representative population-based adult sample. The study was performed in the City of Augsburg (Bavaria, Germany) as part of a series of surveys within the health research project KORA (Kooperative Gesundheitsforschung im Raum Augsburg), thereby taking advantage of the epidemiological framework, which was established by the WHO MONICA studies since 1984 (15, 16). Our study base consisted of all registered residents, aged 25–74 years, of the City of Augsburg and two surrounding counties. A random cross-sectional sample stratified for age and gender of 6640 subjects, representing 1.5–2% of the eligible population, was drawn. After excluding those who had died or moved out of the area ($n = 256$), 6384 subjects were invited to participate by an informative letter. Several attempts were made to approach nonresponders, by reminder letters, telephone calls and personal home visits to those who were not accessible by phone. Finally, 4261 subjects (response 67%) participated in the study between September 1999 and April 2001.

From all participants, a written and informed consent was obtained prior to the beginning of the study after the federal ethical committee (Landesärztekammer Bayern) had approved the study in accordance with the Declaration of Helsinki as revised in 1996.

Outcome assessment

Standardized computer-assisted face-to-face interviews were performed by trained and certified interviewers. Several measures were taken to assure the validity of the interviews including the implementation of question-related instructions to the interviewer, supervision and comparisons of tape recordings and data entry. Besides basic sociodemographic characteristics, we asked detailed questions on the personal history of hay fever (personal history of self-reported and doctor-diagnosed hay fever, age of onset and duration). We most likely have covered allergic and intermittent type rhinitis based on the most recent classification (17–19). To account for a parental predisposition, we obtained data on a doctor's diagnosis of atopic diseases (hay fever, asthma and atopic eczema) in the parents. As proxy for socioeconomic status, the years of school education at the highest level of graduation of the study subjects were classified into five categories (no graduation, graduation after 8, 10, 13 or >13 years). The smoking status was recorded as a further potential confounder. The interview included questions on the marital status, whether the subject lived together with a partner, and for how long. Furthermore, it was asked whether a doctor had diagnosed hay fever in the partner.

Statistical analyses

Sample size calculation. Based on a power of 80% and a two-sided significance level of 5%, it was calculated that we would need a sample of 2680, assuming a reported frequency of doctor-diagnosed hay fever of 15% in the subjects and 10% in their partners, to detect a 60% relative risk increase.

Besides descriptive parameters, *P*-values of chi-square tests or odds ratios (ORs) and 95% confidence intervals (CIs) are reported as parameters of association and stability. The correlation of the social status (school education) of the study subjects and their partners was expressed by a kappa value. The time period the subjects had lived together with their partners was transformed into a categorical variable according to quartiles. Multiple logistic regression analyses were performed taking actual doctor-diagnosed

hay fever as the dependent variable. We included sex, age (25–34, 35–44, 45–54, 55–64 and 65–74 years), school education and parental predisposition as confounders. The first model investigated the association between hay fever in the study subjects and their partners and was restricted to hay fever cases that had their onset within the time period the subjects lived together with their partners. The second model tested the association between hay fever and the duration the subjects lived together with an affected partner in a categorical fashion (1–11, 12–23, 24–35 and 36–45 years). This analysis was therefore restricted to subjects who lived together with an affected partner and had either no hay fever or hay fever that manifested within the time period the subjects lived together with their partners. All calculations were performed using the statistical software package spss 11.0.

Results

According to the study design, roughly half of the 4261 adult participants were of female gender (51.0%) and the population sample had a mean age of 49 years (range 25–74 years). Every fifth participant (19.6%) reported hay fever at some time in their lives and the majority (63.5%) of them still noticed symptoms at the time of investigation. The duration of hay fever was estimated to be on average 12.9 years (SD 11) and ranged between 1 and 70 years. The age of onset was on average 26 years (SD 14.5; range 1–70). In one-fourth of all hay fever cases, symptoms started after the age of 35. Figure 1 illustrates the distribution of the age of onset.

In 13.7% of all the study subjects, a doctor had diagnosed hay fever. Cases tended to be younger and of female gender. A positive parental history of

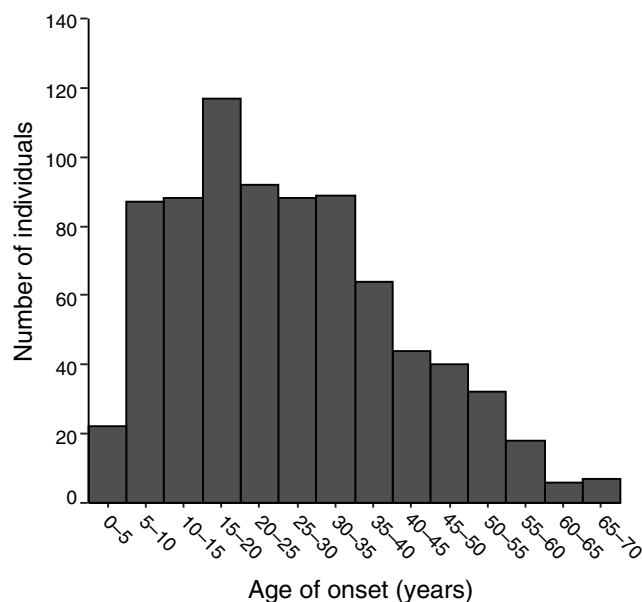


Figure 1. Age of onset (years) in 794 adults with self-reported hay fever out of a population-based sample of 4261 subjects (mean 26 years).

doctor-diagnosed atopic diseases was given in 18.3%. Doctor-diagnosed hay fever was much more frequent in those with a positive parental history (23.4%) as compared to those without predisposition (11.4%) (OR 2.38, CI 1.95–2.90). Furthermore, a significant trend of increasing hay fever prevalence with increasing length of school education was observed in the study subjects. Those who graduated after 8 years of school exhibited a prevalence of 9.6%, whereas 19.2% of those, finishing school after 13 years, had hay fever (P -trend < 0.001). A total of 25.8% of the study population was smoking actively. Smoking, however, was not associated with a history of hay fever and therefore not included as confounder in the regression models. Detailed information on confounders, contrasting subjects with and without a history of hay fever are given in Table 1.

At the time of investigation, the majority of the study subjects ($n = 3273$, 76.9%) lived together with a partner. Most of them did so as married couples ($n = 2929$, 89.2%). On an average, the subjects lived together with the same partner since 23 years (SD 14, 1–54). Doctor's diagnosis of hay fever was reported in 8.2% of these partners. The length of school education correlated significantly between partners (kappa 0.34, $P < 0.001$). Women with partners were somewhat younger (48 years) than men (51 years), which turned out to be significant on a bivariate level. Gender-related differences were also observed for social status as men tended to have a longer school education.

We observed a crude association of doctor-diagnosed hay fever in the study subjects and their partners. When the partner did not suffer from hay fever, 13.1% of the study subjects were affected, whereas 19.6% had hay fever when the partner also had a positive diagnosis (OR 1.61, CI 1.22–2.14). We further tested this association in a multiple logistic regression model. In order to assure a proper time sequence of exposure and disease, the analysis was restricted to cases of hay fever that occurred

after the study participants had started to live together with their partners. After control for age, sex, parental predisposition and school education, there was an even higher risk of hay fever for those who lived together with a partner having the same disease (OR 2.41, CI 1.48–3.92) (Table 2).

In order to test a dose–response relationship of this association, the duration of living together with a partner was categorized according to quartiles (11, 23, 36 years). We restricted the analyses to subjects whose partners had a positive history of hay fever and compared cases who developed hay fever after they had started to live with their partner to subjects with a negative history of doctor-diagnosed hay fever. According to this model, the risk of developing hay fever increased steadily and, in part, significantly with increasing time periods the subjects had been living together with an affected partner (Table 3).

Table 2. Multiple logistic regression for actual doctor-diagnosed hay fever (occurring after the start of living together with a partner) and living together with a partner with hay fever in 3855 adults from the general population

Variable (n)	OR*	95% CI†	P
Age (25–34 years, 700; 35–44 years, 784; 45–54 years, 820; 55–64 years, 847; 65–74 years, 734)	0.96	0.84–1.10	0.54
Female sex (1979)	1.65	1.14–2.40	0.01
Parental predisposition (673)	1.60	1.06–2.41	0.02
Length of school education (no graduation, 33; 8 years, 2117; 10 years, 886; 13 years, 313; >13 years, 536)	0.95	0.79–1.13	0.53
Hay fever in partner (319)	2.41	1.48–3.92	<0.001

* OR: odds ratio.

† CI: confidence interval.

Table 3. Multiple logistic regression for actual doctor-diagnosed hay fever (occurring after the start of living together with a partner) and duration of living together with a partner with hay fever in 315 adults from the general population

Variable (n)	OR*	95% CI†	P
Age (25–34 years, 85; 35–44 years, 91; 45–54 years, 66; 55–64 years, 49; 65–74 years, 24)	0.53	0.24–1.20	0.13
Female sex (145)	1.55	0.62–3.89	0.35
Parental predisposition (70)	1.48	0.53–4.09	0.46
Length of school education (no graduation, 2; 8 years, 136; 10 years, 74; 13 years, 36; >13 years, 67)	0.67	0.41–1.07	0.09
Living together with an affected partner (years)			
1–11 (120)	1		
12–23 (88)	1.80	0.44–7.35	0.41
24–35 (69)	7.44	1.01–55.21	0.049
36–54 (38)	13.73	0.78–241.95	0.07

* OR: odds ratio.

† CI: confidence interval.

Table 1. Characteristics of 567 individuals with a history of doctor-diagnosed hay fever compared to 3584 controls: results of a population-based study in adults

	Hay fever	No hay fever	OR* (CI†)	P
Mean age (years)	42.4	50.3		<0.001 (t-test)
Female gender	56.1%	50.3%	1.26 (1.06–1.51)	
School graduation				
No graduation	0.9%	0.8%		
8 years	37.0%	55.3%		
10 years	31.9%	22.1%		
13 years	11.8%	7.9%		
>13 years	18.3%	13.8%		<0.001 (trend)
Parental history of atopic diseases	32.1%	16.6%	2.38 (1.95–2.90)	
Active smoking	23.5%	26.1%	0.87 (0.70–1.07)	

* OR: odds ratio.

† CI: confidence interval.

Discussion

In this population-based, nested case-control study, the risk for hay fever was more than double in persons who lived together with a partner having the same disease. Furthermore, the risk increased with the time the subjects had been living together with an affected spouse.

A recent study from the UK has demonstrated that married couples are at increased risk for the same common diseases like diabetes, hypertension, depression, hyperlipidaemia and also asthma (14). It is speculated that shared environmental influences including diet and allergen exposure and a shared lifestyle including certain health behaviours like physical exercise account for that association.

Strength and limitations

We could consider some aspects of the design as strengths of the study. This study is based on a random population sample that can be regarded as representative. Therefore, the data should be valid for a broader adult population. The British study was based on medical records that relied on a selection process with respect to the patient status and could introduce a bias, as consultations of married couples at general practitioners are likely to be dependent events.

We could include data on 3273 study subjects who lived together with a partner. This could be considered as large sample size and allows for robust analyses, although the study from the Nottingham area included a large number with 8386 couples.

The study was designed to analyse the question at hand and did not rely on secondary, i.e. retrospective data. Several attempts were made to assure a valid data assessment. We obtained data on the length of time that subjects lived together with their partners as well as on the onset of the disease. We could therefore restrict the analysis to cases that occurred after the onset of exposure, i.e. within the shared time period and thereby reduce temporal ambiguity.

Recall bias is always an issue in cross-sectional studies and can also not be ruled out in this study. It is likely that people report symptoms of their partners more frequently due to higher awareness when they have experienced the symptoms themselves. As we have based our analyses not on self-reported disease or symptoms, but on cases of study subjects or their partners with a diagnosis confirmed by a doctor, we believe that the influence of such a bias would be reduced.

In this study, we focussed on the primary outcome of seasonal allergic rhinoconjunctivitis, which, due to the rather high prevalence of 13.7%, allowed for appropriate statistical analyses. From a clinical point of view, it would have been interesting to also analyse data on asthma or the comorbidity of both inhalative allergies. The prevalence of doctor-diagnosed asthma, however, was much

lower than that of hay fever in the study subjects (6.1%) and their spouses (3.4%). Only 2.6% of the participants and 1.5% of their partners suffered from both asthma and allergic rhinitis. We analysed the association between asthma in the study subjects and their partners, but could not, given the small sample size, establish a significant association. In the earlier study from Hippisley-Cox et al. (13), however, which was based on a much larger sample, a significant association for asthma was observed.

It can be argued that restricting the analyses to cases of hay fever, which occurred after the subjects had started to live together with their partners in order to assure a proper time sequence, does not take into account the variability of phenotypes of hay fever by age. As we do not have data to characterize further the phenotypes of hay fever, the results should primarily be interpreted with respect to hay fever occurring in these age groups.

When following a hypothesis based on influences of a shared environment, it would have been especially interesting to study perennial, i.e. persistent, allergic rhinitis as a clinical outcome. This, however, would have been associated with the problem of a presumably lower frequency and therefore a lower statistical power and the difficulty to obtain a reliable diagnosis in an epidemiological study.

A similarity and convergence of phenotypes in partners has been frequently reported. However, it is discussed whether this is a consequence of a convergence process or due to selective mating (20). It is well known that people tend to mate with partners of a similar social, ethnic and educational background. Thus, homogamy may explain the reported association as allergies are associated with social status (21). We have, in contrast to others, however, obtained data on school education as proxy for social status of the study subjects and their partners. Confirming somehow the assumption of selective mating, the length of school education correlated well between partners. After control for social status in multiple logistic regression analyses, the association, however, remained stable. We therefore conclude that the association at hand cannot be explained by disease-relevant similarities between partners, at least as far as their association with social status is concerned.

A likely explanation for the association of hay fever in partners might be found in the shared environment. Thus, differential exposure to the causal pollen allergens is not a likely explanation, because pollen exposure is largely independent of individual environmental characteristics. However, there is increasing evidence that other individual and lifestyle factors such as home environment, allergen and air pollutant exposure, smoking, diet or infection contribute to the manifestation of allergies (8, 22). Some of these factors might be shared by couples and explain the concomitant occurrence.

Further, rather speculative explanations follow the fact that the epidemiological pattern as described here might also apply to transmissible diseases. It was reported that

the risk of infection with, e.g. *Helicobacter pylori*, is greater in spouses (23). Furthermore, a transfer of genetic material seems to be possible, at least in smaller organisms (24). There is, however, no evidence so far supporting the idea of an infectious agent or a transfer of genetic material being responsible for the manifestations of allergies in partners.

Conclusion

In this large population-based study in adults, subjects with a history of doctor-diagnosed hay fever could be characterized as being younger, better educated and belonging in higher percentage to the female gender group than persons with a negative history.

After control for important confounders, the risk of present doctor-diagnosed hay fever was more than double

in subjects who lived together with a partner suffering from the same allergy. Furthermore, there was indication that this risk increased with the time the partners had been living together.

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