Original Article

A prospective clinical study of allergy progression in identical and fraternal twin pairs of children

Jing Wang[1,2,3], Li Wang[4], Shuang Liu[5], Yuling Han[2,3], Darryl J. Adamko[6], Lu Cheng[2,3], Jingjing Gao[1], Yun Zhang[2,3], Xiang Ma[2,3], Aihua Cao[1]

[1]Department of Pediatrics, Qilu Hospital of Shandong University, Jinan, China; [2]Department of Respiratory, Children's Hospital Affiliated to Shandong University, Jinan, China; [3]Department of Respiratory, Jinan Children's Hospital, Jinan, China; [4]Obstetrics Department, Qianfoshan Hospital Affiliated to Shandong First Medical University, Jinan, China; [5]Department of Obstetrics, Jinan Fifth People's Hospital, Jinan, China; [6]Department of Pediatric Respirology, University of Saskatchewan, Saskatoon, Saskatchewan, Canada

Contributions: (I) Conception and design: J Wang, A Cao; (II) Administrative support: X Ma, A Cao; (III) Provision of study materials or patients: L Wang, S Liu; (IV) Collection and assembly of data: Y Han, L Cheng; (V) Data analysis and interpretation: Y Zhang; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Xiang Ma, MD. Department of Respiratory, Children's Hospital Affiliated to Shandong University, Jinan, China; Department of Respiratory, Jinan Children's Hospital, No. 23976 Jingshi Road, Jinan 250022, China. Email: maxiang0176@126.com; Aihua Cao, MD. Department of Pediatrics, Qilu Hospital of Shandong University, No. 107 Wenhua West Road, Jinan 250000, China. Email: qlyyebk@163.com.

Background: Understanding the factors leading to the development of allergic disease is a critical area of research. We studied the development of allergic disease in identical and fraternal twins to identify potential differences in environment versus genetic factors.

Methods: Twins aged up to 4 years were selected for inclusion in this long-term follow-up study. Regular questionnaire results, allergen levels, and other indicators were examined.

Results: A total of 80 twins were included in this study. Over time, the incidence of atopic dermatitis (AD) decreased, and the incidence of rhinitis and wheezing increased. The incidence of AD, rhinitis, and food allergy was significantly higher in identical twins than fraternal twins. The consistency of positive inhaled allergens and positive food allergens was significantly higher in the identical twins than fraternal twins. The factors influencing allergic diseases were analyzed. In the identical twins, AD was more frequent in males, those with a birth weight <2,500 g, and having siblings; rhinitis was more frequent in those living in a bungalow style home, having pets, and carpeting; and wheezing was more frequent in males, having a birth weight <2,500 g, and having siblings. In the fraternal twins, AD was more frequent in those born <37 weeks gestation, and having flowers and plants in the house; rhinitis was more frequent in those born <37 weeks gestation, those with a history of neonatal asphyxia, and having a household smoking; and wheezing was more frequent in those born <37 weeks gestation, those with a history of neonatal asphyxia, with central heating, and household smoking. No factors were found to affect the occurrence of food allergy.

Conclusions: Allergic diseases in children have a strong genetic predisposition, but are also influenced by environmental factors. The environmental factors affecting the occurrence of allergic diseases in identical and fraternal twins differ.

Keywords: Children; atopic dermatitis; allergic rhinitis (AR); asthma

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Introduction

The prevalence of allergic diseases in children, including atopic dermatitis (AD), allergic rhinitis, food allergies, and asthma, has increased considerably worldwide (1). These allergic diseases are not independent and tend to correlate over time (2). The typical time course of allergic disease is called the "atopic march". It usually begins with AD in infancy 1–2 months after birth, and is often associated with food allergies, most commonly, allergies to milk and eggs (3). The incidence of asthma peaks in pre-school age, while the incidence of rhinitis peaks at school age (4).

A number of cohort studies have shown the existence of the atopic march, and confirmed that childhood allergic disease is a dynamic development process (5-9). The occurrence of allergic diseases is multi-factorial between genetics and the environment. The genetics of allergic diseases is complex. Numerous environmental factors play a role in the occurrence of allergic diseases in children (10) while other study has shown that genes play an important role (11).

Twins have served as important research subjects in assessing the influence of genetic and environmental factors on the development of disease. In addition, twins share a common (or family) environment with family-related factors (e.g., home environment), all of which make twins more similar. Both types of twins share their unique environments, but some factors influence twins differently from each other; for example, different teachers, friends, or special experiences. Therefore, if the consistency of an allergic disease is higher in monozygotic twins than dizygotic twins, we can conclude that genetic factors influence the occurrence of disease.

This study administered a questionnaire to gather data about identical and fraternal twins and the development of allergic disease. Similar to previous studies, our findings could be helpful for early intervention of allergic diseases in children. We present this article in accordance with the STROBE reporting checklist (available at https://tp.amegroups.com/article/view/10.21037/tp-2024-615/rc).

Highlight box

Key findings

- The consistency of allergic diseases in identical twins was significantly higher than that in fraternal twins.
- The factors affecting allergic diseases in identical and fraternal twins differ.

What is known, and what is new?

- Allergic diseases in children have typical atopic march.
- The occurrence of allergic diseases in children is influenced by environmental factors.

What is the implication, and what should change now?

- In addition to genetic factors, attention should be paid to the influence of environmental factors in allergic diseases.

Methods

Subjects

Identical and fraternal twins born between January 1, 2019 and July 31, 2020 were selected for inclusion in this study. All the children lived in Jinan City. All the enrolled participants were followed up for more than 4 years. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee of Jinan Children's Hospital (No. ETYY-2018014) and informed consent was taken from all the patients' guardians.

Questionnaire

The guardians of the twins were surveyed immediately after birth, and at 6, 12, 24, and 48 months after birth. The questionnaire included questions related to the twins' birth and feeding history (gestational age, birth method, birth age, maternal weight/height at birth, birth weight, feeding method, asphyxia history, and underlying diseases), living environment (father's education, father's income, mother's education, mother's income, alien residence history, home environment, heating method, household smoking, pet feeding, pet feeding type, siblings, flower planting, and home carpeting), family allergy history, and allergic disease assessment.

Allergen determination

The European Union (EU) allergen detection system was used to determine inhalation and ingestion allergens. The operating principle of the allergen determination is enzyme-linked immunoassay. Inhalation allergens included trees, ragweed, mugwort, dust mites, animal dander, cockroaches, mold, and *Humulus scandens*. Ingestion allergens included egg white, milk, peanuts, soybeans, beef, lamb, sea fish combination, shrimp, and crab.

Table 1 Basic information form for twin children

Basic information	Identical twins (n=12)	Fraternal twins (n=46)	χ^2 value	P value	Effect sizes
Gender					
Male	4	23	1.063	0.35	0.135
Female	8	23	1.063	0.35	0.135
Gestational age					
<28 weeks	2	4	0.652	0.59	0.106
28–37 weeks	6	16	0.936	0.51	0.127
≥38 weeks	4	26	2.049	0.20	0.188
History of asphyxia					
Yes	2	6	0.105	0.67	0.043
No	10	40	0.105	0.67	0.043
Feeding method					
Formula feeding	2	4	0.652	0.59	0.106
Mixed feeding	8	42	0.652	0.59	0.106
Birth weight (g)	2,457.92±303.29	2,322.39±595.13	0.760	0.45	0.115

Data are presented as case number or mean ± standard deviation if not otherwise specified.

Assessment of airway inflammation

Fractional exhaled nitric oxide (FeNO) levels were analyzed using the chemiluminescence method with a SUNVOU instrument (12).

Statistical methods

SPSS17.0 statistical software was used to establish a database of the basic information of the study cases and the allergen detection results. A descriptive analysis was performed on the number and positive rate of allergens, and allergic diseases in the children. The Chi-squared test was used to compare the positive rates of food and inhalation allergens between the two groups of twins, the positive rates of allergic diseases between the two groups of twins, and the factors affecting allergic diseases between the two groups of twins. A P value <0.05 was considered statistically significant. After conducting the Chi-squared test, we further calculated Cramér's V as a measure of effect size. The classification criteria for the effect size of Cramér's V are as follows: small effect (0< V ≤0.1); medium effect (0.1< V ≤0.3); large effect (0.3< V ≤0.5); very large effect (V >0.5).

Results

Basic characteristics in the perinatal period

A total of 80 twins were initially enrolled in this study, but after 4 years only 58 children' guardians completed the 48-month questionnaire. There were 12 cases of identical twins and 46 cases of fraternal twins; the number of male in identical and fraternal twins was 5 *vs.* 25. There was no statistically significant difference between monozygotic twins and dizygotic twins in terms of gender, gestational age, history of asphyxia, feeding methods, and birth weight (*Table 1*). Bronchopulmonary dysplasia occurred in 2 identical twins and 10 fraternal twins.

Incidence of allergic disease in each group of twins

The incidence of AD, food allergy, rhinitis and wheezing in the identical and fraternal twins were analyzed at different follow-up points (*Tables 2,3*). The presence of AD in identical twins was 100%, and that in fraternal twins was 16.7% (2/2 *vs.* 2/12, P<0.001). The presence of rhinitis in identical twin was 100% and 20% in fraternal (2/2 *vs.* 4/20, P<0.001). Wheezing was 80% in identical and 83.3% in fraternal (4/5 *vs.* 10/12, P>0.05). Food allergy was 100%

Table 2 Analysis of allergic progression in identical twins

Allergic diseases	6 months (n=20)	12 months (n=18)	24 months (n=12)	48 months (n=12)
AD	16 (80.0)	13 (72.2)	8 (66.7)	2 (16.7)
Food allergies	6 (30.0)	5 (27.8)	3 (25.0)	0
Rhinitis	1 (5.0)	2 (11.1)	4 (33.3)	2 (16.7)
Wheezing	2 (10.0)	4 (22.2)	5 (41.7)	5 (41.7)

Data are presented as case number (%). AD, atopic dermatitis.

Table 3 Analysis of allergic progression in fraternal twins

Allergic diseases	6 months (n=60)	12 months (n=58)	24 months (n=56)	48 months (n=46)
AD	30 (50.0)	25 (43.1)	13 (23.2)	12 (26.1)
Food allergies	15 (25.0)	13 (22.4)	16 (28.6)	15 (32.6)
Rhinitis	2 (3.3)	4 (6.9)	13 (23.2)	20 (43.5)
Wheezing	0 (0)	2 (3.4)	7 (12.5)	12 (26.1)

Data are presented as case number (%). AD, atopic dermatitis.

Table 4 Consistency analysis of allergic diseases in identical and fraternal twins

Allergic diseases	Identical twins (n=12)			Fraternal twins (n=46)			χ^2 value	P value	Effect sizes
	Numbers	Same family	Consistency (%)	Numbers	Same family	Consistency (%)			
AD	2	2	100	12	2	16.7	141.88	<0.001	1.564
Rhinitis	2	2	100	20	4	20	133.3	<0.001	1.516
Wheezing	5	4	80	12	10	83.3	0.298	0.36	0.072
Food allergies	0	0	100	15	4	26.7	114.96	<0.001	1.408

Data are presented as case number if not otherwise specified. AD, atopic dermatitis.

in identical and 26.7% in fraternal (0/0 *vs.* 4/15, P<0.001) (*Table 4*).

Inhaled and food allergen data in identical vs. fraternal twins

The presence of positive inhaled allergen result was 100% in identical twins and 80% in fraternal (6/6 *vs.* 16/20, P<0.05). In addition, the presence of food allergen testing was 86% in identical and 57% in fraternal twins (6/7 *vs.* 12/21, P<0.001). The results are shown in *Table 5*.

Analysis of environmental factors influencing allergic diseases in identical and fraternal twins

The factors influencing the occurrence of allergic diseases in the identical and fraternal twins were analyzed. Regarding identical twins, being male, a birth weight <2,500 g were the factors increasing the occurrence of AD and wheezing (all P<0.05) while having siblings was the protective factor in the occurrence of wheezing (all P>0.05). Home environment did show significance. Bungalow living style, pet feeding, and home carpeting were the factors increasing rhinitis (all P<0.05). Regarding fraternal twins, the results showed that a gestational age <37 weeks was the factor increasing the occurrence of AD, rhinitis and wheezing (all P<0.05), while a history of neonatal asphyxia, and a household smoking were factors increasing the occurrence of rhinitis and wheezing (all P<0.05). The planting of flowers and plants in the home were a protective factor in the occurrence of AD (P<0.05); while central heating was

Table 5 Consistency analysis of allergen positivity in identical and fraternal twins

Allergen positivity	Identical twins (n=12)			Fraternal twins (n=46)			χ^2 value	P value	Effect sizes
	Numbers	Same family	Consistency (%)	Numbers	Same family	Consistency (%)			
Combined with same inhaled allergen positive	6	6	100	20	16	80	22.2	<0.001	0.619
Combined with the same food allergen positive	7	6	86	21	12	57	20.64	<0.001	0.597

Data are presented as case number if not otherwise specified.

Table 6 Analysis of factors affecting AD in identical twins

Influencing factors	AD (N=8)	Non-AD (N=4)	χ^2 value	P value	Effect sizes
Boys	6	0	6.0	0.03	0.707
Gestational age <37 weeks	6	4	1.2	0.42	0.316
Birth weight <2,500 g	8	0	12	0.002	1
History of asphyxia	2	0	1.2	0.42	0.316
Father's education ≤ senior high school	6	2	0.75	0.41	0.25
Father's income <100,000 yuan	6	2	0.75	0.41	0.25
Mother's education ≤ senior high school	4	2	0.0	1.0	0
Mother's income <100,000 yuan	4	2	0.0	1.0	0
Non-central heating	4	4	3.0	0.14	0.5
Bungalow	0	2	4.8	0.09	0.632
Per living area <30 m^2	4	2	0.0	1.0	0
Alien residence history	2	0	1.2	0.42	0.316
Household smoking	4	0	3.0	0.14	0.5
Pet feeding	2	0	1.2	0.42	0.316
Flower planting	6	2	0.75	0.41	0.25
Home carpeting	2	0	1.2	0.42	0.316
Family history of allergies	4	0	3.0	0.14	0.5
Siblings	8	0	12	0.002	1

Data are presented as case number if not otherwise specified. AD, atopic dermatitis.

the protective factor in the occurrence of wheezing (P<0.05). The results are shown in *Tables 6-12*.

Measurement of allergen sensitization

Of the total group, only 13 identical twins and 30 fraternal twins underwent allergen detection within the 24-month follow-up period. Inhaled and food allergen sensitization was similar in identical and fraternal twins. No statistically significant differences in the positive rates of inhalation and ingestion allergens were found between the identical and fraternal twins (all P>0.05). The results are shown in *Tables 13,14*.

FeNO measurements

The mean FeNO levels of the 13 identical and 30 fraternal twins were 12.18±4.5 and 13.91±6.2 parts per billion (ppb),

Table 7 Analysis of factors affecting rhinitis in identical twins

Influencing factors	Rhinitis (n=2)	Non-rhinitis (n=10)	χ^2 value	P value	Effect sizes
Boys	2	4	2.4	0.23	0.447
Gestational age <37 weeks	2	8	0.48	0.68	0.2
Birth weight <2,500 g	2	2	4.8	0.09	0.632
History of asphyxia	0	2	0.48	0.68	0.2
Father's education ≤ senior high school	2	6	1.2	0.42	0.316
Father's income <100,000 yuan	0	4	1.2	0.42	0.316
Mother's education ≤ senior high school	2	2	4.8	0.09	0632
Mother's income <100,000 yuan	2	4	2.4	0.23	0.447
Non-central heating	0	8	4.8	0.09	0.632
Bungalow	2	0	12	0.02	1
Per living area <30 m^2	0	6	2.4	0.23	0.447
Alien residence history	0	2	0.48	0.68	0.2
Household smoking	0	4	1.2	0.42	0.316
Pet feeding	2	0	12	0.01	1
Flower planting	2	6	1.2	0.42	0.316
Home carpeting	2	0	12	0.01	1
Family history of allergies	0	4	1.2	0.42	0.316
Siblings	2	8	0.48	0.68	0.2

Data are presented as case number if not otherwise specified.

Table 8 Analysis of factors affecting wheeze in identical twins

Influencing factors	Wheezing (n=5)	Wheezing (n=7)	χ^2 value	P value	Effect sizes
Boys	5	1	8.57	0.008	0.845
Gestational age <37 weeks	5	5	1.714	0.32	0.378
Birth weight <2,500 g	4	0	8.4	0.01	0.837
History of asphyxia	2	0	3.36	0.15	0.529
Father's education ≤ senior high school	5	3	4.286	0.07	0.598
Father's income <100,000 yuan	1	3	0.686	0.42	0.239
Mother's education ≤ senior high school	3	1	2.743	0.15	0.478
Mother's income <100,000 yuan	3	3	0.343	0.5	0.169
Non-central heating	2	6	2.743	0.15	0.478
Bungalow	2	0	3.36	0.15	0.529
Per living area <30 m^2	3	3	0.343	0.5	0.169
Alien residence history	0	2	1.714	0.32	0.378
Household smoking	2	2	0.171	0.58	0.119

Table 8 (*continued*)

Table 8 (*continued*)

Influencing factors	Wheezing (n=5)	Wheezing (n=7)	χ^2 value	P value	Effect sizes
Pet feeding	2	0	3.36	0.15	0.529
Flower planting	5	3	4.286	0.07	0.598
Home carpeting	2	0	3.36	0.15	0.529
Family history of allergies	3	1	1.071	0.15	0.299
Siblings	0	7	12	0.001	1

Data are presented as case number if not otherwise specified.

Table 9 Analysis of factors affecting AD in fraternal twins

Influencing factors	AD (n=38)	Non-AD (n=8)	χ^2 value	P value	Effect sizes
Boys	21	4	0.074	0.54	0.04
Gestational age <37 weeks	10	6	6.905	0.02	0.387
Birth weight <2,500 g	20	4	0.018	0.60	0.019
History of asphyxia	4	2	1.221	0.28	0.163
Father's education ≤ senior high school	13	3	0.032	0.58	0.026
Father's income <100,000 yuan	10	3	0.408	0.40	0.094
Mother's education ≤ senior high school	14	2	0.409	0.42	0.094
Mother's income <100,000 yuan	17	6	2.421	0.12	0.229
Non-central heating	31	5	1.414	0.23	0.175
Bungalow	7	1	0.161	0.57	0.059
Per living area <30 m^2	6	2	0.390	0.43	0.092
Alien residence history	8	2	0.061	0.58	0.036
Household smoking	16	4	0.168	0.49	0.06
Pet feeding	3	1	0.177	0.55	0.062
Flower planting	28	6	6.905	0.02	0.387
Home carpeting	10	2	0.006	0.66	0.011
Family history of allergies	7	1	0.161	0.57	0.059
Siblings	17	3	0.141	0.51	0.055

Data are presented as case number if not otherwise specified. AD, atopic dermatitis.

respectively. No statistically significant difference was found between the two groups (P>0.05).

Discussion

According to the World Health Organization, allergic diseases are the fourth most common disease in the world, and are expected to affect more than half of the population by 2025 (13). The "allergic march" begins with infantile AD at 1–3 months after birth, is usually associated with food allergies, and becomes increasingly pronounced during the first year of life (14,15). A birth cohort study in Canada has found that early persistent atopic dermatitis is significantly associated with atopic sensitization (16). Research on pediatric allergic diseases in China indicates that the occurrence of eczema in early life is correlated with

Table 10 Analysis of factors affecting food allergy in fraternal twins

Influencing factors	Food allergy (n=9)	Nonfood allergy (n=37)	χ^2 value	P value	Effect sizes
Boys	5	20	0.007	0.62	0.012
Gestational age <37 weeks	2	14	0.778	0.32	0.13
Birth weight <2,500 g	6	18	1.835	0.17	0.199
History of asphyxia	0	6	1.678	0.25	0.191
Father's education ≤ senior high school	3	13	0.010	0.62	0.015
Father's income <100,000 yuan	7	19	2.057	0.15	0.211
Mother's education ≤ senior high school	3	13	0.010	0.62	0.015
Mother's income <100,000 yuan	7	29	0.002	0.64	0.007
Non-central heating	7	29	0.002	0.64	0.007
Bungalow	2	6	0.182	0.50	0.063
Per living area <30 m^2	2	6	0.182	0.50	0.063
Alien residence history	3	7	0.884	0.30	0.139
Household smoking	4	16	0.004	0.62	0.009
Pet feeding	0	4	1.066	0.41	0.152
Flower planting	7	27	0.087	0.57	0.044
Home carpeting	3	9	0.305	0.43	0.081
Family history of allergies	3	5	1.979	0.18	0.207
Siblings	4	16	0.004	0.62	0.009

Data are presented as case number if not otherwise specified.

the development of asthma and rhinitis by the age of 7 (17). Among children with mild atopic dermatitis, the prevalence of asthma is approximately 20%, but it escalates to over 60% in those with severe atopic dermatitis (18). In children diagnosed with allergic asthma (AA), approximately 74–81% also experience allergic rhinitis (AR) (19). Our study conducted a prospective investigation for up to 4 years, and as expected found the incidence of AD in children decreased, the incidence of rhinitis and wheezing gradually increased, in both identical twins and fraternal twins. We know that allergic diseases are interconnected and can manifest in episodic exacerbations. Altaş *et al.* conducted a case-control study to investigate the levels of skin moisture and sebum in children with a house dust mite allergy but without skin symptoms, and found that these children had lower levels of skin moisture and sebum (20). The reduction in skin moisture and sebum levels can increase the occurrence of eczema symptoms.

Twins facilitate the assessment of genetic relationships between phenotypes and the interrelationships between heredity and environment. Spaich *et al.* found that the consistency of allergic diseases was higher in identical twins than fraternal twins (21). Regarding AD, a twin study revealed that identical twins had a higher incidence of AD than fraternal twins, and if one of the identical twins had AD, the incidence of AD in the other sibling was 86% (22). In addition to genetic factors that can lead to differences in allergic diseases, environmental factors are also important causes of allergic diseases. A study on the severity of asthma symptoms showed that, after eliminating other confounding factors, genetic factors accounted for 24%, while environmental factors could have as high as a 76% impact on the severity of asthma (10). We analyzed the consistency of allergic diseases in identical and fraternal twins, and found that similar to previous data the consistency of AD, rhinitis, and food allergy was significantly higher in the identical twins than fraternal twins, which provided further evidence of the strong influence of genes on these allergic

Table 11 Analysis of factors affecting rhinitis in fraternal twins

Influencing factors	Rhinitis (n=4)	Non-rhinitis (n=42)	χ^2 value	P value	Effect sizes
Boys	1	24	1.521	0.24	0.182
Gestational age <37 weeks	4	12	8.214	0.01	0.423
Birth weight <2,500 g	4	20	4.016	0.07	0.295
History of asphyxia	4	2	29.206	<0.001	0.797
Father's education ≤ senior high school	2	14	0.447	0.43	0.099
Father's income <100,000 yuan	2	24	0.076	0.59	0.041
Mother's education ≤ senior high school	2	14	0.447	0.43	0.099
Mother's income <100,000 yuan	2	34	2.057	0.20	0.211
Non-central heating	2	34	2.057	0.20	0.211
Bungalow	2	6	3.242	0.13	0.265
Per living area <30 m^2	0	8	0.922	0.45	0.141
Alien residence history	0	10	1.217	0.36	0.163
Household smoking	4	16	5.695	0.03	0.352
Pet feeding	0	4	0.417	0.69	0.095
Flower planting	4	30	1.546	0.28	0.183
Home carpeting	0	12	1.546	0.28	0.183
Family history of allergies	2	6	3.242	0.13	0.265
Siblings	0	20	3.370	0.09	0.271

Data are presented as case number if not otherwise specified.

diseases. The consistency of airway reactivity was reported higher in identical twins than fraternal twins (15); however, this result has not been confirmed in all studies, and we also found that the consistency of wheezing was higher in the fraternal twins than identical twins. This might be related to the relatively small number of enrolled cases, and the proportion of our premature infants with a low birth weight and infants with bronchopulmonary dysplasia was higher in fraternal twins than identical twins. As such, the high degree of inconsistency in asthma between identical twins might suggest that environment has a greater influence on asthma development than genetics.

Timing of allergen sensitization is important. Children are sensitized earlier to food allergens than to inhalation allergens (23). In our study, the identical and fraternal twins had similar rates of 60–80% for inhalation allergens at the age of 2 years. Serum total immunoglobulin E (IgE) values are strongly associated with considerable co-sensitization between food and inhalation allergens, suggesting that elevated IgE levels caused by sensitization to multiple allergens may lead to severe allergic reactions and increase the risk of atopic diseases (24).

Childhood allergic diseases are caused by a combination of genetic and environmental factors. A prospective study of 1,224,243 mothers of children showed that if the mother had AD, the child was 59% more likely to develop AD than if the mother did not have AD (25). An important determinant of the development of allergic disease appears to be the allergy history of the parents, especially the mother. About 30% of children of mothers with allergies develop allergic sensitization in childhood, and research has shown that genes involved in regulating epithelial barrier function and T-cell responses influence children's susceptibility to developing allergic diseases (1).

In contrast, our prospective study found that a family history of allergy had no effects on AD, allergic rhinitis, and wheezing between the twin groups. Instead, environmental factors influenced the development of allergic diseases. Being male, having a low birth weight, and having siblings were factors affecting the occurrence of allergic diseases

Table 12 Analysis of factors affecting wheeze in fraternal twins

Influencing factors	Wheezing (n=7)	Non-wheezing (n=39)	χ^2 value	P value	Effect sizes
Boys	3	22	4.39	0.40	0.309
Gestational age <37 weeks	6	10	9.442	0.005	0.453
Birth weight <2,500 g	3	17	0.001	0.65	0.005
History of asphyxia	6	0	38.443	<0.001	0.914
Father's education ≤ senior high school	4	12	1.82	0.18	0.199
Father's income <100,000 yuan	5	21	0.747	0.33	0.127
Mother's education ≤ senior high school	4	12	1.82	0.18	0.199
Mother's income <100,000 yuan	5	31	0.227	0.48	0.07
Non-central heating	2	34	11.982	0.003	0.510
Bungalow	2	6	0.718	0.35	0.125
Per living area <30 m^2	2	6	0.718	0.35	0.125
Alien residence history	0	10	2.293	0.16	0.223
Household smoking	6	14	5.992	0.02	0.361
Pet feeding	0	4	0.786	0.50	0.131
Flower planting	6	28	0.596	0.40	0.114
Home carpeting	0	12	2.914	0.10	0.252
Family history of allergies	2	5	1.141	0.29	0.158
Siblings	1	19	2.863	0.10	0.249

Data are presented as case number if not otherwise specified.

Table 13 Comparison of the distribution of the positive rates of inhalation allergens between identical and fraternal twins

Allergens	Identical twins (n=13)	Fraternal twins (n=30)	χ^2 value	P value	Effect sizes
Combined trees	0	1 (3.3)	0.44	0.70	0.101
Ragweed	1 (7.7)	5 (16.7)	0.61	0.40	0.119
Mugwort	1 (7.7)	4 (13.3)	0.28	0.52	0.081
Dust mite	4 (30.8)	10 (33.3)	0.03	0.58	0.026
Animal dander	6 (46.2)	11 (36.7)	0.34	0.40	0.089
Cockroach	3 (23.1)	11 (36.7)	0.76	0.31	0.133
Mold	1 (7.7)	2 (6.7)	0.02	0.67	0.022
Scandent hop	0	1 (3.3)	0.44	0.70	0.101

Data are presented as case number (%) if not otherwise specified.

in the identical twins. A low gestational age and planting of flowers and plants in the house were the main factors affecting the occurrence of AD in the fraternal twins. A history of neonatal asphyxia, household smoking were the main factors affecting the occurrence of rhinitis and wheezing in the fraternal twins. Our data may support a previous study where genetic factors accounted for only 24% of asthma severity, while the effect of environmental

Table 14 Comparison of the distribution of the positive rates of food allergens between identical and fraternal twins

Allergens	Identical twins (n=13)	Fraternal twins (n=30 cases)	χ^2 value	P value	Effect sizes
Egg white	4 (30.8)	13 (43.3)	0.60	0.34	0.118
Milk	6 (46.2)	11 (36.7)	0.34	0.40	0.089
Peanut	4 (30.8)	7 (23.3)	0.26	0.44	0.078
Soya beans	2 (15.4)	12 (40.0)	2.5	0.18	0.241
Beef	1 (7.7)	6 (20.0)	1.01	0.30	0.153
Mutton	1 (7.7)	3 (10.0)	0.06	0.65	0.037
Marine fish	2 (15.4)	2 (6.7)	0.82	0.35	0.138
Shrimp	1 (7.7)	4 (13.3)	0.28	0.52	0.081
Crab	0	3 (10.0)	1.40	0.62	0.181

Data are presented as case number (%) if not otherwise specified.

factors was as high as 76% (10).

Our study had several limitations. First, the number of identical twins was less than that of fraternal twins, and the analysis of factors affecting allergic diseases in twins may cause deviation. In this study, due to the small sample size, we may not be able to fully detect some smaller but potentially important effects. For example, when analyzing the impact of certain genetic or environmental factors on specific traits, the small sample size may make it difficult for us to distinguish between random variation and true effects, thereby leading to some meaningful differences not being significantly detected. In addition, the estimation of effect sizes may also be less stable, which could affect our interpretation and generalization of the study results. While birth weight and the presence of bronchopulmonary dysplasia does increase the risk of asthma-like presentation, whether it can affect allergic inflammation is unknown. We plan to re-evaluate these data in future. In addition, this study used the EU allergen detection system, this is a semi-quantitative method for detecting allergens, based on enzyme-linked immunosorbent assay (ELISA). It detects the presence of allergens through the specific binding of antibodies to allergen proteins. The system is easy to operate and provides quick results. However, its sensitivity and specificity can be affected by sample processing and the specificity of the antibodies used, with the potential for cross-reactions.

Conclusions

All children showed allergic progression, such that with age, the incidence of AD decreased, and the incidence of rhinitis and wheezing increased. The incidence of AD, rhinitis, and food allergy was significantly higher in the identical twins than the fraternal twins, but there was no significant difference in the incidence of wheezing. The consistency of homogenic inhalation and food allergen positivity was significantly higher in the identical twins than the fraternal twins. The occurrence of allergic diseases in children is not only related to genes, but also influenced by environmental factors, and the influencing factors of allergic diseases in identical and fraternal twins are not the same.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://tp.amegroups.com/article/view/10.21037/tp-2024-615/rc

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee of Jinan Children's Hospital (No. ETYY-2018014) and informed consent was taken from all the patients' guardians.

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