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Prevalence and risk factors of allergic rhinitis in children in Bangkok area

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Abstract

Background: Allergic rhinitis (AR) is a disease with a high global disease burden and significant morbidity and expense. Risk factors are not well understood.

Objective: The objective of our project is to study the prevalence and risk factors of AR in children living in the Bangkok area.

Methods: A cross-sectional, multi-center survey using new GAN core questionnaires on current AR and risk factors was completed by 3,074 parents of children aged 6–7 years and by 3,217 children aged 13–14 years, directly.

Results: The prevalence of current AR in children aged 6–7 years and 13–14 years was 15.0% (95% confidence interval [CI]:13.8–16.3%) and 17.5% (95% CI: 16.2–18.8%), respectively. The prevalence of severe AR in children aged 6–7 years and 13–14 years was 1.0% (95% CI: 0.6–1.3%) and 1.9% (95% CI: 1.4–2.4%), respectively. Co-morbidity with asthma and eczema was 27.1% and 24.6%, respectively. Significant factors associated with AR include parental history of asthma ($p = 0.025$), parental history of AR ($p < 0.001$), parental history of eczema ($p < 0.001$), lower respiratory tract infection in the first year of life ($p < 0.001$), breastfeeding ($p = 0.019$), current use of paracetamol ($p < 0.001$), exercise ($p < 0.001$), current cat exposure ($p = 0.008$), and truck traffic on the street of residence (< 0.001).

Conclusion: AR is a common disease among children residing in Bangkok. This study confirms that a family history of atopy (asthma, AR, and eczema), antibiotics given in the first year of life, current paracetamol use, exercise, current cat exposure, and truck traffic on the street of residence are important and significant risk factors for AR symptoms.

Key words: allergic rhinitis, atopy, asthma, ISAAC, GAN

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Introduction

Allergic rhinitis (AR) is characterized by paroxysms of sneezing, rhinorrhea, and nasal obstruction, often accompanied by itching of the eyes, nose, and palate. Postnasal drip, cough, irritability, and fatigue are other common symptoms.[1,2] AR is associated with significant morbidity and expense.[3,4]

The increase in the prevalence of AR began to attract attention from epidemiologists in the late 1980s. The International Study of Asthma and Allergies in Childhood (ISAAC) was initiated to establish the prevalence of allergic diseases in 257,800 school children aged 6–7 years and in 463,801 children aged 13–14 years using standardized and validated questionnaires.[7] Phase I of ISAAC, which began to enroll patients in 1992, sought to establish prevalence rates in nearly 60 countries on every continent; phase II investigated variables contributing

to AR (e.g., environmental exposures); and phase III provided follow-up data on the patients at least five years after entry into the study. In phase I, prevalence rates for AR collected across all centers ranged from 0.8% to 14.9% (median, 6.9%) in the 6–7-year-olds and from 1.4% to 39.7% (median, 13.6%) in the 13–14-year-olds.[5] The highest prevalence rates for AR were observed in parts of Western Europe, North America, and Australia, whereas the lowest rates were found in parts of Eastern Europe and South and Central Asia. The phase III analyses revealed that the prevalence rates had increased, with 12-month prevalence rates of 1.8% to 24.2% in children aged 6–7 years (median, 8.5%) and 1.0% to 45% (median, 14.6%) in children aged 13–14 years.[6] These findings strongly indicate that the prevalence of AR has increased over a relatively short period of time, mostly in Westernized countries with a higher standard of living.

According to phase I of ISAAC in Bangkok (1995–1999), the prevalence of AR was 10.0% in the children aged 6–7 years and 15.4% in the children aged 13–14 years.[7] In phase III of the study in Bangkok (2001), the prevalence of AR in children aged 6–7 years and 13–14 years was 13.4% and 23.9%, respectively.[8] There was an increase in the prevalence of rhinitis in both age groups.

Phase III of ISAAC included new questions on risk factors that identified several environmental associations.[9] Risk factors for AR include paracetamol, antibiotics, truck traffic, breast-feeding, farm animals, cats and dogs, air pollution, tobacco, body mass index (BMI), diet, cooking fuels, birth weight, migration, and siblings. Despite the considerable research efforts, the risk factors of AR remain poorly understood. A family history of atopic diseases seems to be a major risk factor, but various environmental factors and lifestyle are also considered important elements in the evolution of the disease.[3,10]

The objective of our project is to study the prevalence and risk factors of AR in children living in Bangkok, Thailand.

Methods

Study Design

This study has a cross-sectional, multi-center design.

Participants

Seven primary schools and six secondary schools in Bangkok were randomly mapped, stratified, and chosen to represent the population of the entire Bangkok metropolitan area. Subjects were selected in the same manner as ISAAC phase III.[9] The same age groups were recruited: 13–14-year-old children (self-completed questionnaires) and 6–7-year-old children (parental completed questionnaires). Of 6,834 questionnaires sent to children, 6,291 were completed (95.05%). There were 3,074 (86.49%) questionnaires of children aged 6–7 years and 3,217 (98.08%) questionnaires of children aged 13–14 years available for analysis. The study was approved by the Human Research Ethics Committee of Thammasat University (054/2560) and the Human Research Ethics Committee of Bhumibol Adulyadej Hospital. The clinical trial number was MTU-EC-ES-4-013/60. Informed consents/assents were obtained from the children and parents.

GAN Core Questionnaires

GAN 2016 standardized written core questionnaires for AR modifying from ISAAC questionnaires were used in this study.[11,12] The questionnaires were translated and back-translated into the Thai language by three independent linguistic -proficient individuals. Demographic questions included the participant's name, age, date of birth, school (for the adolescents and children), sex, and date of interview. Questionnaires were coded by using a unique number for each center, school, and participant to ensure confidentiality and to link the questionnaires between the adults and children.[13] The written core questionnaires, used in GAN, had a question about doctor-diagnosed asthma, rhinitis, and eczema added. The core questions were both sensitive and specific, and they had good content, construct, concurrent, and predictive validity.[14] The environmental risk factor questionnaires, developed for ISAAC phase III, were expanded for use in this study. Height and weight measurements were taken by the fieldworkers in schools.

Definitions of AR, Rhinitis, and Hay Fever

The standardized core symptom questionnaire was the same as that used in ISAAC phase I and comprised of six questions on symptoms relating to rhinitis or rhinoconjunctivitis.[11,12] These questions were as follows:

1. Have you (has your child) ever had a problem with sneezing or a runny or blocked nose when you (he or she) DID NOT have a cold or "the flu"?
2. In the past 12 months, have you (has your child) had a problem with sneezing or a runny or blocked nose when you (he or she) DID NOT have a cold or "the flu"?
3. In the past 12 months, has this nose problem been accompanied by itchy/watery eyes?
4. In which of the past 12 months did this nose problem occur? (Month names listed)
5. In the past 12 months, how much did this nose problem interfere with your (child's) daily activities? (Not at all, a little, a moderate amount, a lot)
6. Have you (has your child) ever had hay fever?

Question 2 was used to estimate the prevalence of current rhinitis; question 3 was used to estimate the prevalence of current conjunctivitis; and question 6 was used to estimate the prevalence of "hay fever ever." Questions 2 and 3 were combined to assess current rhinoconjunctivitis symptoms or current AR. Questions 2 and 3 and the answer "A LOT" to question 5 were used to assess the prevalence of severe rhinoconjunctivitis symptoms or severe AR.

Sample Size

A sample size of 2,654 is needed to estimate the prevalence of questionnaire-based AR of 10% for children of each age group with margin errors of ± 1.5% and type one error of 0.01. The total sample size of 6,834 was accounted for the non-response rate of 30%.

Data Collection and Analysis

Data were collected from July 2017 to February 2018. Statistical analyses were carried out using STATA/SE software (Stata/SE 14 for Windows, StataCorp LP, College Station, TX, USA). Binomial confidence intervals (CIs) on proportions with rhinitis and rhinoconjunctivitis were calculated. The multivariable logistic regression model was used to conduct exploratory analysis for risk factors of AR. The model included age, sex, family history of allergy, birth weight, paracetamol, antibiotics, truck traffic, breastfeeding, farm animals, cat and dog exposure, air pollution, tobacco, BMI, diet, cooking fuels, migration, and number of older and younger siblings to estimate the magnitude of the association by calculating adjusted odds ratios with their 95% CIs.

Results

The prevalence of questionnaire-based symptoms of rhinitis stratified by age group is shown in **Table 1**. The prevalence of current rhinitis in children aged 6–7 years and 13–14 years was 38.2% (95%CI: 36.5–39.9%) and 48.8% (95%CI: 47.0–50.5%), respectively. The prevalence of current rhinitis in all children was 43.6% (95%CI: 42.4–44.8%). Concomitant eye symptoms were reported at 16.3%. The prevalence of current AR in children aged 6–7 years and 13–14 years was 15.0% (95%CI: 13.8–16.3%) and 17.5% (95%CI: 16.2–18.8%), respectively. The prevalence of current AR in all children was 16.3% (95%CI: 15.4–17.2%).

Although the term so-called "hay fever" does not exist in the Thai language, 27.4% indicated that they suffered from "allergy to the air," a common term denoting hay fever in Thailand. Patterns of rhinitis symptoms of children in Bangkok were of the perennial type. The prevalence of severe AR in children aged 6–7 years and 13–14 years was 1.0% (95%CI: 0.6–1.3%) and 1.9% (95%CI: 1.4–2.4%), respectively. The prevalence of severe AR in all children was 1.5% (95%CI: 1.2–1.7%). There were strong associations with other allergic diseases: 27.1% of children with AR had asthma and 24.6% had eczema.

A parental history of atopy including asthma ($p = 0.025$, OR = 1.50, 95%CI = 1.05–2.13), AR ($p < 0.001$, OR = 1.43, 95%CI = 1.10–1.71), and eczema ($p < 0.01$, OR = 1.56, 95%CI = 1.29–1.88) was significantly related to current AR. Current use of paracetamol was associated with current AR ($p < 0.001$, OR = 1.64, 95%CI = 1.30–2.08). Exercise was associated with current AR ($p < 0.001$, OR = 1.49, 95%CI = 1.29–1.71). Only current cat exposure was associated with current AR ($p = 0.008$, OR = 1.28, 95%CI = 1.07–1.54). The frequency of truck traffic on the street of residence was positively associated with current AR; comparison of both the occasional truck traffic group ($p = 0.002$, OR = 1.28, 95%CI = 1.10-1.50) and the always truck traffic group ($p < 0.001$, OR = 1.73, 95%CI = 1.41-2.11) to the never truck traffic group is shown in **Tables 2 and 3**.

Concerning the age group of 6–7 years, parental history of AR and eczema was significantly related to current AR (AR: $p < 0.001$, OR = 1.71, 95%CI = 1.35–2.17; eczema: $p < 0.001$, OR = 1.83, 95%CI = 1.42–2.35). Lower respiratory tract infection (LRTI) in the first year of life was positively associated with current AR ($p < 0.001$, OR = 1.86, 95%CI = 1.34–2.59). Parental reported breastfeeding (six months) was positively associated with current AR ($p = 0.019$, OR = 1.28, 95%CI = 1.04–1.57). The frequency of truck traffic on the street of residence was positively associated with the prevalence of current AR for both the occasional truck traffic group ($p = 0.007$, OR = 1.39, 95%CI = 1.09–1.76) and the always truck traffic group ($p < 0.001$, OR = 1.92, 95%CI = 1.42–2.58), as shown in **Tables 2 and 3**.

In the children aged 13–14 years, parental history of atopy was not significantly related to an increased risk of current AR. Current use of paracetamol, however, was associated with increased risk of current AR ($p = 0.004$, OR = 1.57, 95%CI = 1.16–2.14). Only current cat exposure was associated with increased risk of current AR ($p = 0.015$, OR = 1.32, 95%CI = 1.05–1.64). The frequency of truck traffic on the street of residence was also positively associated with the prevalence of current AR in both the occasional truck traffic group ($p = 0.032$, OR = 1.25, 95%CI = 1.02–1.54) and the always truck traffic group ($p < 0.001$, OR = 1.62, 95%CI = 1.24–2.13), as shown in **Tables 2 and 3**.

Table 1. Prevalence of questionnaires-based symptoms of rhinitis stratified by age group

Symptoms	All (n = 6,291)		6-7 years (n = 3,074)		13-14 years (n = 3,217)	
	N	Prevalence 95%CI	N	Prevalence 95%CI	N	Prevalence 95%CI
Current AR or ARC	1,042	16.3% (15.4%, 17.2%)	462	15.0% (13.8%, 16.3%)	580	17.5 (16.2%, 18.8%)
Current rhinitis	2,744	43.6% (42.4%, 44.8%)	1,175	38.2% (36.5%, 39.9%)	1,569	48.8% (47.0%, 50.5%)
Hay fever (allergic to air)	1,722	27.4% (26.3%, 28.5%)	754	24.5% (23.0%, 26.1%)	968	30.1% (28.5%, 31.7%)
Severe AR	91	1.5% 1.2%, 1.7%)	30	1.0% (0.6%, 1.3%)	61	1.9% (1.4%, 2.4%)

Current AR or Allergic rhinoconjunctivitis (ARC)- positive to question number 2 and 3
Current rhinitis - positive to question number 2
Hay fever ever- positive to question number 6
Severe AR - positive to question number 2 and 3 and the answer "A LOT" to question 5

Table 2. Characteristics of children with AR stratified by age group

Factors		Total (n = 6,291)			6-7 Years old (n = 3,074)			13-14 Years old (n = 3,217)		
		N	n (%)	P-value	N	n (%)	P-value	N	n (%)	P-value
Age (years)				0.009						
6-7		3,074	462 (15.0)		-	-	-	-	-	-
13-14		3,217	562 (17.5)		-	-	-	-	-	-
Sex				0.143			0.023			0.760
Female		3,013	468 (15.6)		1,559	211 (13.6)		1,454	257 (17.7)	
Male		3,278	555 (16.9)		1,515	250 (16.5)		1,763	305 (17.3)	
BMI				0.137			0.172			0.445
< P85		5,360	857 (16.0)		2,619	384 (14.7)		2,471	473 (17.3)	
≥ P85		931	167 (17.9)		455	78 (17.1)		476	89 (18.7)	
Paternal allergy history										
Asthma	No	6,107	976 (16.0)	< 0.001	2,965	434 (14.6)	0.002	3,142	542 (17.3)	0.034
	Yes	184	48 (26.1)		109	28 (25.7)		75	20 (26.7)	
AR	No	5,234	775 (14.8)	< 0.001	2,442	303 (12.4)	< 0.001	2,792	472 (16.9)	0.031
	Yes	1,057	249 (23.6)		632	159 (25.2)		425	90 (21.2)	
Atopic	No	5,434	811 (14.9)	< 0.001	2,595	331 (12.8)	< 0.001	2,839	480 (16.9)	0.021
	Yes	857	213 (24.9)		479	131 (27.3)		378	82 (21.7)	
Sibling	No	2,013	327 (16.2)	0.961	1,034	140 (13.5)	0.100	979	187 (19.1)	0.107
	Yes	4,278	697 (16.3)		2,040	322 (15.8)		2,238	375 (16.8)	
Only 6-7 Years old										
LBW	No	-	-	-	2,830	423 (14.9)	0.664	-	-	-
	Yes	-	-	-	224	39 (16.0)		-	-	-
Breast Feeding (6 months)	No	-	-	-	1,810	246 (13.6)	0.008	-	-	-
	Yes	-	-	-	1,264	216 (17.1)		-	-	-
Antibiotics (first 1 year)	No	-	-	-	1,936	225 (11.6)	< 0.001	-	-	-
	Yes	-	-	-	1,138	237 (20.8)		-	-	-
Paracetamol (first 1 year)	No	-	-	-	1,099	138 (29.9)	0.004	-	-	-
	Yes	-	-	-	1975	324 (70.1)		-	-	-
LRTI (first 1 year)	No	-	-	-	2,383	286(12%)	< 0.001	-	-	-
	Yes	-	-	-	691	176 (25.5%)		-	-	-
Farm animal	No	-	-	-	2,962	435(14.7%)	0.006	-	-	-
	Yes	-	-	-	112	27 (24.1)		-	-	-
Paracetamol	No	893	99 (11.1)	< 0.001	415	40 (9.6)	0.001	478	59 (12.3)	0.001
	Yes	5,398	925 (17.1)		2,659	422 (15.9)		2,739	503 (18.4)	
Exercise	No	4,032	558 (13.8)	< 0.001	2,264	308 (13.)	< 0.001	1,768	250 (14.1)	< 0.001
	Yes	2,259	466 (20.6)		810	154 (19.0)		1,449	312 (21.5)	
Parent Smoke	No	6,025	982 (16.3)	0.826	2,927	438 (15.0)	0.652	3,098	544 (17.6)	0.493
	Yes	266	42 (15.8)		147	24 (16.3)		119	18 (15.1)	
Pet										
Dog Now	No	4,275	728 (15.)	0.030	2,477	366 (15.0)	0.978	2,248	362 (16.5)	0.020
	Yes	1,566	283 (18.1)		597	90 (15.1)		969	193 (19.9)	
Cat Now	No	5,317	813 (15.5)	< 0.001	2,759	403 (14.8)	0.271	2,558	410 (16.3)	0.001
	Yes	974	197 (20.2)		315	54 (17.1)		659	143 (21.7)	
Truck Traffic				< 0.001			<0.001			<0.001
Never		3,410	459 (13.5)		1,988	251 (12.6)		1,422	208 (14.6)	
Sometime		2,114	384 (18.2)		751	131 (17.4)		1,363	253 (18.6)	
Always		767	181 (23.6)		335	80 (23.9)		432	101 (23.4)	
Fire Cooking	No	6,036	979 (16.2)	0.545	2,928	442 (15.1)	0.645	3,108	537 (17.3)	0.126
	Yes	255	45 (17.6)		146	20 (13.7)		109	25 (22.9)	
Env Factors										
Cockroach	No	4,273	664 (15.5)	0.021	1,973	281 (14.2)	0.102	2,300	383 (16.7)	0.053
	Yes	2,018	360 (17.8)		1,101	181 (16.4)		917	179 (19.5)	
Air Conditioner	No	3,993	619 (15.5)	0.028	1,820	259 (14.2)	0.136	2,173	360 (16.6)	0.052
	Yes	2,298	405 (17.6)		1,254	203 (16.2)		1,044	202 (19.3)	
Tree or Flower	No	2,238	343 (15.3)	0.129	796	106 (13.3)	0.116	1,442	237 (16.4)	0.164
	Yes	4,053	681 (16.8)		2,278	356 (15.6)		1,775	325 (18.3)	
Perfume	No	3,591	557 (15.5)	0.058	1,536	199 (13.0)	0.001	2,055	358 (17.4)	0.923
	Yes	2,700	467 (17.3)		1,538	263 (17.1)		1,162	204 (17.6)	
School Type				0.575			0.763			0.207
Public		4,170	671 (16.1)		1,957	125(10.5)		1,370	226 (16.5)	
Private		2,121	353 (16.6)		1,117	165 (14.8)		1,004	188 (18.7)	

Table 3. Factor Associate with AR of all children

	All				6-7 Years old				13-14 Years old			
	Crude Odds Ratio		Adjusted Odds Ratio		Crude Odds Ratio		Adjusted Odds Ratio		Crude Odds Ratio		Adjusted Odds Ratio	
	Point (95%CI)	P Value	Point (95%CI)	P Value	Point (95%CI)	P Value	Point (95%CI)	P Value	Point (95%CI)	P Value	Point (95%CI)	P Value
Age (years)												
6-7	Ref.	-	Ref.	-	-	-	-	-	-	-	-	-
13-14	1.20 (1.05, 1.37)	0.009	1.11 (0.96 1.29)	0.155	-	-	-	-	-	-	-	-
Sex Male	1.11 (0.97, 1.26)	0.143	-	-	1.26 (1.03, 1.54)	0.023	1.21 (0.98, 1.48)	0.084	0.97 (0.81, 1.17)	0.760	-	-
Paternal allergy history												
Asthma	1.86 (1.33, 2.60)	< 0.001	1.50 (1.05, 2.13)	0.025	2.02 (1.30, 3.14)	0.002	1.41 (0.88, 2.26)	0.157	1.74 (1.04, 2.93)	0.034	1.58 (0.91, 2.72)	0.102
Allergic rhinitis	1.77 (1.51, 2.08)	< 0.001	1.43 (1.20, 1.71)	< 0.001	2.37 (1.91, 2.95)	< 0.001	1.71 (1.35, 2.17)	< 0.001	1.32 (1.03, 1.70)	0.031	1.18 (0.90, 1.57)	0.236
Atopic dermatitis	1.89 (1.59, 2.24)	< 0.001	1.56 (1.29, 1.88)	< 0.001	2.58 (2.04, 3.25)	< 0.001	1.83 (1.42, 2.35)	< 0.001	1.36 (1.05, 1.77)	0.021	1.18 (0.93, 1.64)	0.146
Only 6-7 Years old												
Antibiotics (first 1 year)	-	-	-	-	1.31 (1.07, 2.44)	< 0.001	1.17 (1.45, 2.20)	0.304	-	-	-	-
Paracetamol (first 1 year)	-	-	-	-	1.37 (1.10-1.69)	0.004	0.97 (0.76, 1.23)	0.794	-	-	-	-
LRTI (first 1 year)	-	-	-	-	2.50 (2.03, 3.09)	< 0001	1.86 (1.34, 2.59)	< 0.001	-	-	-	-
Farm animal	-	-	-	-	1.85 (1.18, 2.88)	0.006	1.42 (0.89, 2.27)	0.142	-	-	-	-
Breast feeding	-	-	-	-	1.31 (1.07, 1.60)	0.008	1.28 (1.04, 1.57)	0.019	-	-	-	-
Paracetamol Now	1.66 (1.33, 2.07)	< 0.001	1.64 (1.30, 2.08)	< 0.001	1.77 (1.26, 2.49)	0.001	1.44 (1.01, 2.05)	0.039	1.60 (1.20, 2.13)	0.001	1.57 (1.16, 2.14)	0.004
Exercise	1.62 (1.41, 1.85)	< 0.001	1.49 (1.29, 1.71)	< 0.001	1.49 (1.21, 1.84)	< 0.001	1.29 (1.03, 1.61)	0.025	1.67 (1.39, 2.00)	< 0.001	1.64 (1.36, 1.97)	< 0.001
Pet												
Dog Now	1.18 (1.02, 1.38)	0.030	1.07 (0.91, 1.26)	0.389	1.00 (0.78, 1.29)	0.978	-	-	1.26 (1.04, 1.53)	0.020	1.17 (0.96, 1.44)	0.119
Cat Now	1.38 (1.16, 1.64)	< 0.001	1.28 (1.07, 1.54)	0.008	1.19 (0.87, 1.63)	0.271	-	-	1.42 (1.15, 1.76)	0.001	1.32 (1.05, 1.64)	0.015
Truck Traffic												
Never	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-
Sometime	1.43 (1.23, 1.66)	< 0.001	1.28 (1.10, 1.50)	0.002	1.46 (1.16, 1.84)	0.001	1.39 (1.09, 1.76)	0.007	1.33 (1.09, 1.63)	0.005	1.25 (1.02, 1.54)	0.032
Always	1.99 (1.64, 2.41)	< 0.001	1.73 (1.41, 2.11)	< 0.001	2.17 (1.63, 2.88)	< 0.001	1.92 (1.42, 2.58)	< 0.001	1.78 (1.36, 2.33)	< 0.001	1.62 (1.24, 2.13)	0.001
Env Factors												
Cockroach	1.18 (1.03, 1.36)	0.021	1.11 (0.88, 1.41)	0.385	1.19 (0.97, 1.45)	0.102	-	-	1.21 (1.00, 1.48)	0.053	1.06 (0.76, 1.47)	0.743
Air Conditioner	1.17 (1.02, 1.34)	0.028	1.05 (0.83, 1.32)	0.705	1.16 (0.95, 1.42)	0.136	-	-	1.21 (1.00, 1.46)	0.052	1.14 (0.83, 1.57)	0.424
Perfume	1.14 (1.00, 1.30)	0.058	1.07 (0.93, 1.23)	0.371	1.21 (0.95, 1.52)	0.116	-	-	1.14 (0.95, 1.37)	0.164	-	-

*** Multivariable logistic regression mod**
Point: Point Estimate

Discussion

The results from our study showed the prevalence of current AR in the children aged 6–7 years to be 15.0%. When compared to ISAAC phase III in the Bangkok area at 13.4%, there was a slightly but significantly increased prevalence in the younger age group (p = 0.006). In this study, the prevalence of current AR in the 13–14-year age group was 17.5%. This decrease was significant when compared to ISAAC phase III in Bangkok (23.9%, p = 0.006). The mean global prevalence of current AR in both age groups was 9.1% and 16%, respectively, in which the Asia-Pacific prevalence was 5.8% and the ISAAC phase III prevalence was 14.5%. The results of our study so far show a higher percentage in both prevalences.

Our study confirms that parental atopy is a risk factor for the development of AR. These results are consistent with the findings of other studies.[15,16] Both genetic and environmental factors play important roles in the etiology of AR. It is likely that there is a multilevel interaction between genetic and environmental factors.[17]

This study did not find any association between antibiotic use in the first year of life and later AR. We found a positive relation between current consumption of paracetamol and the prevalence of current AR. There is a dose-related association between acetaminophen use and AR in children.[18] The association of paracetamol with allergic disease is possible due to the depletion of glutathione. This is a result of the pharmacokinetics of this drug, leaving the respiratory mucosa with inadequate antioxidant protection.[19] This mechanism could explain the possible association between paracetamol consumption and the prevalence of the symptoms of rhinitis in our patients.

Our results show that LRTI in the first year of life was positively associated with current AR. Respiratory infections are among the major causes of hospitalization and pediatric medical consultation, and they are directly associated with mortality in children.[20] Allergic children showed a significantly higher number of respiratory infections in comparison with the non-allergic group.[21] Epidemiological studies have investigated significant relationships between AR and LRTI.[22]

In phase III of ISAAC, there was no consistent association between breastfeeding in the first year of life and rhinoconjunctivitis in 6–7-year-old children. However, breastfeeding was associated with reduced prevalence of current symptoms of severe rhinoconjunctivitis.[23] Our results suggest that breastfeeding (six months) was associated with current AR. Several studies have shown that breastfeeding in developing countries is associated with protection against infections, particularly gastric infection and diarrhea.[24] The immunological properties of breast milk are significant contributing factors to infant health in poor countries. Breastfeeding is therefore rightly promoted by authorities such as the World Health Organization.[25]

ISAAC phase III showed that early-life exposure to cats is a risk factor for symptoms of rhinoconjunctivitis in 6–7-year-old children. Current exposure to cats and dogs combined, and only to dogs, is a risk factor for symptom reporting by 13–14-year-old adolescents worldwide.[26] The Melbourne Atopy Cohort study (MASC) showed no evidence that exposure to cats and dogs at birth increases the risk of allergic disease in high-risk children.[27] The Childhood Origins of ASThma (COAST) showed associations between allergen-specific sensitization and rhinitis. At one year, sensitization to cats was the only aeroallergen associated with an increased risk of rhinitis at 6 years of age. At age 6 years, sensitization to all allergens tested except cockroach was associated with concurrent rhinitis.[28]

In this study, we found a positive global relationship between childhood symptoms of current AR and self-reported frequency of truck traffic on the street of residence. The associations were remarkably similar in different parts of the world in the two age groups studied and when using a self-completed questionnaire and a parent-completed questionnaire for 6–7-year-old children.[29] A recent study from Italy found that self-reported traffic density in the area of residence was clearly associated with nitrogen dioxide, which was 39 μg/m^3 when self-reported traffic was "absent," 44 μg/m^3 when "low," 48 μg/ m^3 when "intermediate," and 52 μg/m^3 when "high."[30] First, there are now several published studies that have used objective measures of exposure and effect and found similar relationships between truck traffic exposure or other measures of exposure to vehicular traffic and respiratory and allergic symptoms in children.[31,32] Second, these studies were conducted mostly in Western Europe and North America, and in ISAAC phase III the associations found in these regions were not different from those found in other parts of the world. One could argue that concern about possible adverse effects on respiratory health by traffic fumes is different in different parts of the world, so one would not expect to see a universal association if responder bias played much of a role. Third, the associations were similar for the 13–14-year-olds and the 6–7-year-olds, despite the fact that the teenagers completed the questionnaires themselves, whereas the parents completed the questionnaires for the 6–7-year-olds. We can only speculate about what factors influence the remaining heterogeneity of exposure–response relationships between participating centers. There is experimental evidence to support that diesel particles may enhance allergic sensitization to common inhalant allergens.[33]

The major strengths of our study included standardized written core questionnaires (GAN 2016) for AR modified from ISAAC questionnaires, a well-established and standardized protocol, and a high response rate. One limitation of our study is that it is cross-sectional, which limits our ability to determine causation. Another limitation is that symptoms of AR were self-reported in the questionnaire; therefore, we could not confirm with physical examination and laboratory investigations.

In conclusion, our study shows that the prevalence of AR remained high in both age groups. Our data confirm that a family history of atopy, LRTI in the first year of life, breastfeeding (six months), current paracetamol use, exercise, current cat exposure, and truck traffic on the street of residence are important and significant risk factors for AR symptoms. This study may serve as evidence-based health education for parents to reduce the prevalence of AR by proper management of common disease (current use of paracetamol, LRTI in the first year of life, asthma, eczema) and environmental control (pets and truck traffic on the street of residence). More detailed studies are needed on the risk factors of AR.

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