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Prevalence and Risk Factors of Asthma and Allergic Diseases Among Working Adolescents: ISAAC Phase III

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ABSTRACT

Working adolescents are exposed to occupational and environmental risk factors that may influence allergic disease development. Epidemiological data on this vulnerable population remain limited. To examine temporal trends in the prevalence of asthma and allergic diseases and identify associated risk factors among working adolescents.

Two repeated cross-sectional surveys were conducted in 2008 (n=353) and 2013 (n=554) at a vocational training center in Istanbul, Türkiye, using the International Study of Asthma and Allergies in Childhood (ISAAC) methodology. Physician-diagnosed asthma, allergic rhinitis, and atopic dermatitis were assessed using the standardized Turkish version of the ISAAC questionnaire. Multivariable logistic regression was used to identify independent risk factors.

Between 2008 and 2013, the prevalence of physician-diagnosed asthma increased from 2.8% to 6.9%, that of allergic rhinitis increased from 2.5% to 9.0%, and that of atopic dermatitis from 3.1% to 8.1%. In multivariable analyses, familial allergy was associated with all 3 conditions and regular smoking was associated with asthma and allergic rhinitis. Male sex was associated with a lower likelihood of asthma and allergic rhinitis. Employment in the hairdressing sector was strongly associated with atopic dermatitis (adjusted odds ratio, 24.05; 95% confidence interval, 3.27–176.74).

The prevalence of allergic diseases increased substantially among working adolescents over 5 years. A family history of allergy, smoking, and hairdressing employment emerged as key risk factors. Targeted preventive strategies addressing modifiable behavioral and occupational exposures are warranted for this vulnerable population.

Keywords: Adolescent; Allergic; Asthma; Atopic; Dermatitis; Occupational exposure; Prevalence; Rhinitis

INTRODUCTION

Working adolescents are individuals younger than

18 years of age who typically engage in jobs within industries, agriculture, trades, crafts, marginal work environments, workplaces, homes, or even on the streets

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to contribute to their family income and acquire professional skills.¹ These adolescents remain particularly vulnerable to environmental exposures due to ongoing physical and biological development. Early entry into the workforce may prolong exposure duration, potentially increasing the risk of developing allergic diseases compared with adults.² Occupational exposure to substances in workplace environments may lead to respiratory symptoms, such as cough, wheeze, and sputum production, and may contribute to chronic conditions, including bronchitis and asthma.³ In addition, these exposures may affect the upper airways, leading to rhinitis, or cause skin conditions, such as irritant or allergic contact dermatitis.⁴

The prevalence of allergic diseases varies across countries and regions. Standardized methodologies are therefore required to allow valid comparisons between populations. The International Study of Asthma and Allergies in Childhood (ISAAC) is one of the largest international initiatives designed to assess the prevalence, severity, and risk factors of asthma, allergic rhinitis, and eczema in children and adolescents.

ISAAC Phase III repeats an earlier ISAAC survey in the same setting at least 5 years later, using the same standardized questionnaire, so that time trends in the prevalence of asthma, allergic rhinitis, and eczema can be determined.⁵⁻⁷ These surveys are conducted in samples drawn from schools, and working adolescents are therefore absent from the ISAAC literature. In Türkiye, several ISAAC Phase I and Phase II studies have been carried out, whereas Phase III data remain limited.⁸⁻¹⁰

An ISAAC Phase II survey had previously been carried out in a group of working adolescents and described the prevalence of allergic diseases at that time.¹¹ We repeated this survey in the same setting after an interval of 5 years. Our aims were to determine how the prevalence of asthma, allergic rhinitis, and atopic dermatitis had changed in this population and to identify the associated risk factors, with particular attention to occupational sector. To our knowledge, this is the first ISAAC Phase III study conducted in working adolescents.

MATERIALS AND METHODS

Study Design and Setting

This study used a repeated cross-sectional design, in accordance with ISAAC methodology, in which a survey is repeated in the same setting after an interval of

at least 5 years. An ISAAC Phase II survey was carried out in 2008 among working adolescents in Kartal County, Istanbul, and the survey was repeated in 2013 as an ISAAC Phase III study. Each survey enrolled the adolescents attending the center at that time, so that the 2 samples comprised different individuals and no participant took part in both surveys. Participants were recruited from the Kartal Vocational Training Center, which provides apprenticeship-based education in trades including hairdressing, motor vehicle repair, lathe operation, and textiles. For analysis, participants were grouped as hairdressing, motor vehicle repair, and lathe operation and other trades (textiles).

Participants

Eligible participants were adolescents who had entered the workforce before age 18 and had been employed for at least 1 year at the time of the survey, so that all participants had a minimum period of occupational exposure. Duration of employment and daily working hours were recorded. A total of 907 adolescents were included in the analysis, comprising 353 participants surveyed in 2008 and 554 participants surveyed in 2013.

Ethical Approval and Consent

The study was approved by the Ethics Committee of Bezmialem Vakif University (Approval No. 36/12, dated April 8, 2013). Additional permissions were obtained from the Kartal County Directorate of National Education and the school administration. Written informed consent was obtained from parents or legal guardians of all participants younger than 18 years of age, and written assent was obtained from the adolescents, in accordance with national regulations governing research involving minors in Türkiye. The study was conducted in accordance with the Declaration of Helsinki.

Questionnaire

The Turkish version of the ISAAC Phase II adolescent questionnaire was used in both surveys to ensure methodological consistency and comparability between the 2 study periods. All questionnaires were administered face to face by a physician to reduce missing data and improve response reliability.

Definitions

Regular smoking was defined as smoking at least 1

cigarette per day for a minimum duration of 6 months. Household smoker was defined as the presence of at least 1 household member who actively smoked indoors. Familial asthma or allergy was defined as physician-diagnosed asthma or allergic disease in a first-degree relative. Heating was categorized as central heating vs other methods (eg, stove or electric heating). Animals referred to the presence of any pet in the household.

Statistical Analysis

All statistical analyses were performed using NCSS 2007 software (NCSS LLC, Kaysville, Utah, USA). Continuous variables were summarized as mean±standard deviation (SD), and categorical variables were expressed as frequencies and percentages. Comparisons between the 2008 and 2013 cohorts were conducted using independent-sample *t* tests for continuous variables and Pearson χ^2 test, the Fisher exact test, or the Yates continuity correction for categorical variables, as appropriate.

Univariate logistic regression analyses were performed to identify potential risk factors associated with allergic diseases. Variables with a $p < 0.25$ in univariate analyses were entered into multivariable logistic regression models, following the screening criterion recommended for logistic regression model building,¹² and the final models were obtained by backward elimination. Variables were retained on statistical grounds alone; none was forced into the models, and interaction terms were not examined. Adjusted odds ratios (aORs) with 95% confidence intervals (CIs) were calculated. A 2-sided $p < 0.05$ was considered statistically significant.

RESULTS

Prevalence of Allergic Diseases

Between 2008 and 2013, a significant increase was observed in the prevalence of physician-diagnosed allergic diseases. The prevalence of asthma increased from 2.8% to 6.9% ($p = 0.013$), that of allergic rhinitis from 2.5% to 9.0% ($p < 0.001$), and that of atopic dermatitis from 3.1% to 8.1% ($p = 0.004$). These changes correspond to a 2.5-fold increase in physician-diagnosed asthma, a 3.6-fold increase in allergic rhinitis, and a 2.6-fold increase in atopic dermatitis. Symptom-based prevalence also increased over time, including lifetime rhinitis (18.1% vs 46.6%; $p < 0.001$), lifetime wheeze

(14.7% vs 37.5%; $p < 0.001$), and lifetime dermatitis (5.4% vs 29.4%; $p < 0.001$) (Figure 1 and Table 1).

In contrast, the prevalence of sleep disturbance due to pruritus decreased significantly between surveys (50.0% vs 16.3%; $p = 0.007$). Emergency department admission due to respiratory symptoms was more frequent in 2013 than in 2008 (2.3% vs 6.5%; $p = 0.006$) (Table 1).

Risk Factors for Allergic Rhinitis

In the 2008 cohort, no independent risk factors were identified for physician-diagnosed allergic rhinitis in multivariable analysis.

In the 2013 cohort, familial allergy (aOR, 2.81; 95% CI, 1.44–5.46; $p = 0.002$) and regular smoking (aOR, 1.98; 95% CI, 1.07–3.66; $p = 0.029$) were identified as significant independent risk factors. In contrast, male sex was found to be protective (aOR, 0.30; 95% CI, 0.15–0.57; $p < 0.001$). Higher paternal education level (high school or above) showed a trend toward a protective effect (aOR, 0.35; 95% CI, 0.12–1.03; $p = 0.056$), although this did not reach statistical significance. Employment in hairdressing was associated with allergic rhinitis in univariate analysis (unadjusted OR [uOR], 2.49; 95% CI, 1.01–6.16; $p = 0.048$) but was not retained in the final model (Table 2).

Risk Factors for Asthma

In the 2008 cohort, regular smoking was the only independent risk factor for physician-diagnosed asthma (aOR, 5.73; 95% CI, 1.20–27.39; $p = 0.029$).

In the 2013 cohort, familial allergy (aOR, 2.70; 95% CI, 1.29–5.64; $p = 0.008$) and regular smoking (aOR, 2.49; 95% CI, 1.24–5.01; $p = 0.010$) were significant independent risk factors, whereas male sex was associated with a reduced risk (aOR, 0.29; 95% CI, 0.14–0.60; $p = 0.001$). Employment in hairdressing was associated with asthma in univariate analysis (uOR, 4.91; 95% CI, 1.46–16.45; $p = 0.010$) but was not retained in the final model (Table 3).

Risk Factors for Atopic Dermatitis

In the 2008 cohort, male sex was protective against physician-diagnosed atopic dermatitis (aOR, 0.15; 95% CI, 0.04–0.59; $p = 0.006$), while higher paternal education level (high school or above) (aOR, 4.75; 95% CI, 1.05–21.36; $p = 0.042$) and familial allergy (aOR, 5.98; 95% CI, 1.03–34.85; $p = 0.047$) were identified as independent risk factors.

In the 2013 cohort, male sex was significantly associated with physician-diagnosed atopic dermatitis in univariate analysis; however, the association lost statistical significance after adjustment for occupational group and other covariates in the multivariable model, which may

reflect confounding or collinearity with occupational group. In contrast, working in the hairdressing sector was identified as a strong occupational risk factor for physician-diagnosed atopic dermatitis (aOR, 24.05; 95% CI, 3.27–176.74; $p=0.002$) (Table 4).

Table 1. Demographic characteristics and prevalence of allergic symptoms among working adolescents in 2008 and 2013

Characteristic	2008 (n=353)	2013 (n=554)	<i>p</i>	
Age, mean±SD, y	16.89±1.25	17.67±1.33	<0.001 ^a	
Total working time, mean±SD, y	2.63±1.11	2.70±1.80	0.449 ^a	
Daily working hours, mean±SD, h	11.89±1.99	11.64±2.04	0.057 ^a	
Sex, No. (%)			0.703 ^b	
Female		54 (15.3)	90 (16.2)	NA
Male		299 (84.7)	464 (83.8)	NA
Occupational group, No. (%)			0.737 ^b	
Lathe + other trades (textiles)		98 (27.8)	143 (25.8)	NA
Motor repair		79 (22.4)	134 (24.2)	NA
Hairdressing		176 (49.9)	277 (50.0)	NA
Lifetime rhinitis		64 (18.1)	258 (46.6)	<0.001 ^b
Rhinitis in the past 12 months		63 (17.8)	216 (39.0)	<0.001 ^b
Physician-diagnosed rhinitis		9 (2.5)	50 (9.0)	<0.001 ^c
Lifetime wheezing		52 (14.7)	208 (37.5)	<0.001 ^b
Wheezing in the past 12 months		42 (11.9)	184 (33.2)	<0.001 ^b
Sleep interrupted by wheezing ^d		9 (21.4)	62 (33.7)	0.173 ^e
Difficulty speaking with wheezing ^d		9 (21.4)	63 (34.2)	0.154 ^e
Physician-diagnosed asthma		10 (2.8)	38 (6.9)	0.013 ^c
Wheezing with exercise		41 (11.6)	180 (32.5)	<0.001 ^b
Nighttime coughing		34 (9.6)	147 (26.5)	<0.001 ^b
Emergency department admission due to respiratory symptoms		8 (2.3)	36 (6.5)	0.006 ^c
Lifetime dermatitis		19 (5.4)	163 (29.4)	<0.001 ^c
Dermatitis in the past 12 months		14 (4.0)	135 (24.4)	<0.001 ^c
Sleep interruption due to pruritus ^d		7 (50.0)	22 (16.3)	0.007 ^c
Physician-diagnosed dermatitis		11 (3.1)	45 (8.1)	0.004 ^c
Familial asthma		34 (9.6)	120 (21.7)	<0.001 ^b
Familial allergy		19 (5.4)	98 (17.7)	<0.001 ^c
Regular smoker		149 (42.2)	238 (43.0)	0.824 ^b
Household smoker		266 (75.4)	382 (69.0)	0.037 ^b

^aIndependent-samples *t* test. ^bPearson χ^2 test. ^cFisher exact test. ^dPercentages for symptom-severity items are calculated among participants reporting the corresponding symptom in the past 12 months. ^e χ^2 test with Yates continuity correction. ^fNA: not applicable; SD: standard deviation.

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Table 2. Risk factors for physician-diagnosed allergic rhinitis among working adolescents in 2008 and 2013

Variable	2008 (n=353)				2013 (n=554)					
	No. (%)	uOR (95% CI)	p		No. (%)	uOR (95% CI)	p	aOR (95% CI)	p	
Occupational group										Removed from final model
Motor repair	1 (1.3)	1 [Reference]	NA	6 (4.5)	1 [Reference]	NA	NA	NA	NA	
Lathe + other trades (textiles)	4 (4.1)	3.32 (0.36–30.31)	0.288		15 (10.5)	2.50 (0.94–6.65)	0.066	NA	NA	
Hairdressing	4 (2.3)	1.81 (0.20–16.50)	0.597		29 (10.5)	2.49 (1.01–6.16)	0.048	NA	NA	
Sex										
Female	2 (3.7)	1 [Reference]	NA		19 (21.1)	1 [Reference]	NA	1 [Reference]	NA	
Male	7 (2.3)	0.62 (0.13–3.08)	0.562		31 (6.7)	0.27 (0.14–0.50)	<0.001	0.30 (0.15–0.57)	<0.001	
Maternal education										
Elementary school	8 (2.4)	1 [Reference]	NA		47 (9.4)	1 [Reference]	NA	NA	NA	
High school and above	1 (4.5)	1.92 (0.23–16.10)	0.547		3 (5.8)	0.59 (0.18–1.97)	0.394	NA	NA	
Paternal education										
Elementary school	7 (2.3)	1 [Reference]	NA		46 (9.8)	1 [Reference]	NA	1 [Reference]	NA	
High school and above	2 (4.7)	2.11 (0.42–10.51)	0.361		4 (4.8)	0.47 (0.16–1.34)	0.156	0.35 (0.12–1.03)	0.056	
Family income										
Low	6 (2.5)	1 [Reference]	NA		10 (10.1)	1 [Reference]	NA	NA	NA	
Middle	3 (2.7)	1.06 (0.26–4.33)	0.931		40 (8.8)	0.86 (0.41–1.78)	0.680	NA	NA	

Table 2. Continued...

Variable	2008 (n=353)			2013 (n=554)				
	No. (%)	uOR (95% CI)	<i>p</i>	No. (%)	uOR (95% CI)	<i>p</i>	aOR (95% CI)	<i>p</i>
Household members				Removed from final model				
≤3	2 (4.2)	1 [Reference]	NA	5 (4.9)	1 [Reference]	NA	NA	NA
≥4	7 (2.3)	0.54 (0.11–2.68)	0.451	45 (10.0)	2.14 (0.83–5.55)	0.117	NA	NA
Number of rooms								
≤3	5 (2.3)	1 [Reference]	NA	23 (8.6)	1 [Reference]	NA	NA	NA
≥4	4 (2.9)	1.27 (0.33–4.81)	0.726	27 (9.5)	1.12 (0.62–2.00)	0.705	NA	NA
Heating								
Central	3 (2.1)	1 [Reference]	NA	40 (9.4)	1 [Reference]	NA	NA	NA
Other	6 (2.9)	1.37 (0.34–5.58)	0.658	10 (7.9)	0.83 (0.40–1.70)	0.606	NA	NA
Animals in household								
No	7 (2.3)	1 [Reference]	NA	41 (9.4)	1 [Reference]	NA	NA	NA
Yes	2 (3.8)	1.68 (0.34–8.32)	0.525	9 (7.5)	0.78 (0.37–1.65)	0.511	NA	NA
Familial asthma								
No	9 (2.8)	1 [Reference]	NA	37 (8.5)	1 [Reference]	NA	NA	NA
Yes	0 (0)	[†] _b	NA	13 (10.8)	1.30 (0.67–2.54)	0.436	NA	NA
Familial allergy								
No	9 (2.7)	1 [Reference]	NA	32 (7.0)	1 [Reference]	NA	1 [Reference]	NA
Yes	0 (0)	[†] _b	NA	18 (18.4)	2.98 (1.60–5.60)	0.001	2.81 (1.44–5.46)	0.002

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Table 2. Continued...

Variable	2008 (n=353)				2013 (n=554)				
	No. (%)	uOR (95% CI)	p		No. (%)	uOR (95% CI)	p	aOR (95% CI)	p
Regular smoker									
No	5 (2.5)	1 [Reference]	NA		23 (7.3)	1 [Reference]	NA	1 [Reference]	NA
Yes	4 (2.7)	1.10 (0.29–4.16)	0.891		27 (11.3)	1.63 (0.91–2.92)	0.101	1.98 (1.07–3.66)	0.029
Alcohol use									
No	9 (2.6)	1 [Reference]	NA		47 (8.9)	1 [Reference]	NA	NA	NA
Yes	0 (0)	^a _‡ ^b	NA		3 (12.0)	1.40 (0.40–4.85)	0.597	NA	NA
Household smoker									
No	1 (1.1)	1 [Reference]	NA		17 (9.9)	1 [Reference]	NA	NA	NA
Yes	8 (3.0)	2.67 (0.33–21.63)	0.358		33 (8.6)	0.86 (0.47–1.60)	0.636	NA	NA

^aLogistic regression analysis was performed using backward elimination. ^bOdds ratios could not be calculated due to zero cell counts. ^caOR: adjusted odds ratio; CI: confidence interval; NA: not applicable; uOR: unadjusted odds ratio.

Table 3. Risk factors for physician-diagnosed asthma among working adolescents in 2008 and 2013

Variable	2008 (n=353)					2013 (n=554)				
	No. (%)	uOR (95% CI)	p	aOR (95% CI)	p	No. (%)	uOR (95% CI)	p	aOR (95% CI)	p
Occupational group									Removed from final model	
Motor repair	0 (0)	1 [Reference]	NA	NA	NA	3 (2.2)	1 [Reference]	NA	NA	NA
Lathe + other trades (textiles)	4 (4.1)	‡ ^b	0.997	NA	NA	7 (4.9)	2.25 (0.57–8.88)	0.248	NA	NA
Hairdressing	6 (3.4)	‡ ^b	0.997	NA	NA	28 (10.1)	4.91 (1.46–16.45)	0.010	NA	NA
Sex										
Female	1 (1.9)	1 [Reference]	NA	NA	NA	15 (16.7)	1 [Reference]	NA	1 [Reference]	NA
Male	9 (3.0)	1.64 (0.20–13.25)	0.640	NA	NA	23 (5.0)	0.26 (0.13–0.52)	<0.001	0.29 (0.14–0.60)	0.001
Maternal education									Removed from final model	
Elementary school	9 (2.7)	1 [Reference]	NA	NA	NA	31 (6.2)	1 [Reference]	NA	NA	NA
High school and above	1 (4.5)	1.70 (0.21–14.09)	0.621	NA	NA	7 (13.5)	2.36 (0.98–5.67)	0.054	NA	NA
Paternal education										
Elementary school	8 (2.6)	1 [Reference]	NA	NA	NA	30 (6.4)	1 [Reference]	NA	NA	NA
High school and above	2 (4.7)	1.84 (0.38–8.97)	0.450	NA	NA	8 (9.6)	1.57 (0.69–3.55)	0.281	NA	NA
Family income										
Low	6 (2.5)	1 [Reference]	NA	NA	NA	6 (6.1)	1 [Reference]	NA	NA	NA
Middle	4 (3.5)	1.43 (0.40–5.17)	0.585	NA	NA	32 (7.0)	1.17 (0.48–2.88)	0.729	NA	NA
Household members										
≤3	1 (2.1)	1 [Reference]	NA	NA	NA	5 (4.9)	1 [Reference]	NA	NA	NA
≥4	9 (3.0)	1.43 (0.18–11.54)	0.738	NA	NA	33 (7.3)	1.53 (0.58–4.01)	0.390	NA	NA
Number of rooms									Removed from final model	
≤3	5 (2.3)	1 [Reference]	NA	NA	NA	23 (8.6)	1 [Reference]	NA	NA	NA
≥4	5 (3.6)	1.60 (0.45–5.63)	0.465	NA	NA	15 (5.3)	0.59 (0.30–1.16)	0.130	NA	NA
Heating				Removed from final model						
Central	7 (4.9)	1 [Reference]	NA	NA	NA	31 (7.3)	1 [Reference]	NA	NA	NA
Other	3 (1.4)	0.28 (0.07–1.11)	0.070	NA	NA	7 (5.5)	0.74 (0.32–1.73)	0.495	NA	NA

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Table 3. Continued...

Variable	2008 (n=353)					2013 (n=554)				
	No. (%)	uOR (95% CI)	p	aOR (95% CI)	p	No. (%)	uOR (95% CI)	p	aOR (95% CI)	p
Animals in household										
No	8 (2.7)	1 [Reference]	NA	NA	NA	31 (7.1)	1 [Reference]	NA	NA	NA
Yes	2 (3.8)	1.46 (0.30–7.10)	0.635	NA	NA	7 (5.8)	0.80 (0.34–1.88)	0.616	NA	NA
Familial asthma										
No	8 (2.5)	1 [Reference]	NA	NA	NA	22 (5.1)	1 [Reference]	NA	NA	NA
Yes	2 (5.9)	2.43 (0.49–11.93)	0.274	NA	NA	16 (13.3)	2.88 (1.46–5.68)	0.002	NA	NA
Familial allergy										
No	9 (2.7)	1 [Reference]	NA	NA	NA	24 (5.3)	1 [Reference]	NA	1 [Reference]	NA
Yes	1 (5.3)	2.00 (0.24–16.71)	0.520	NA	NA	14 (14.3)	3.00 (1.49–6.04)	0.002	2.70 (1.29–5.64)	0.008
Regular smoker										
No	2 (1.0)	1 [Reference]	NA	1 [Reference]	NA	15 (4.7)	1 [Reference]	NA	1 [Reference]	NA
Yes	8 (5.4)	5.73 (1.20–27.39)	0.029	5.73 (1.20–27.39)	0.029	23 (9.7)	2.15 (1.10–4.21)	0.026	2.49 (1.24–5.01)	0.010
Alcohol use										
No	8 (2.3)	1 [Reference]	NA	NA	NA	34 (6.4)	1 [Reference]	NA	NA	NA
Yes	2 (18.2)	9.28 (1.72–50.03)	0.010	NA	NA	4 (16.0)	2.77 (0.90–8.54)	0.075	NA	NA
Household smoker										
No	1 (1.1)	1 [Reference]	NA	NA	NA	12 (7.0)	1 [Reference]	NA	NA	NA
Yes	9 (3.4)	3.01 (0.38–24.12)	0.299	NA	NA	26 (6.8)	0.97 (0.48–1.98)	0.941	NA	NA

^aLogistic regression analysis was performed using backward elimination. ^bOdds ratios could not be calculated due to zero cell counts. ^caOR: adjusted odds ratio; CI: confidence interval; NA: not applicable; uOR: unadjusted odds ratio.

Table 4. Risk factors for physician-diagnosed atopic dermatitis among working adolescents in 2008 and 2013

Variable	2008 (n=353)					2013 (n=554)				
	No. (%)	uOR (95% CI)	p	aOR (95% CI)	p	No. (%)	uOR (95% CI)	p	aOR (95% CI)	p
Occupational group										
Motor repair	1 (1.3)	1 [Reference]	NA	NA	NA	1 (0.7)	1 [Reference]	NA	1 [Reference]	NA
Lathe + other trades (textiles)	2 (2.0)	1.62 (0.14–18.26)	0.694	NA	NA	2 (1.4)	1.90 (0.17–21.21)	0.602	1.90 (0.17–21.21)	0.602
Hairdressing	8 (4.5)	3.71 (0.46–30.21)	0.220	NA	NA	42 (15.2)	24.05 (3.27–176.74)	0.002	24.05 (3.27–176.74)	0.002
Sex										
Female	5 (9.3)	1 [Reference]	NA	1 [Reference]	NA	14 (15.6)	1 [Reference]	NA	NA	NA
Male	6 (2.0)	0.20 (0.06–0.68)	0.010	0.15 (0.04–0.59)	0.006	31 (6.7)	0.39 (0.20–0.76)	0.006	NA	NA
Maternal education										
Elementary school	10 (3.0)	1 [Reference]	NA	NA	NA	37 (7.4)	1 [Reference]	NA	NA	NA
High school and above	1 (4.5)	1.53 (0.19–12.51)	0.692	NA	NA	8 (15.4)	2.28 (1.00–5.21)	0.049	NA	NA
Paternal education										
Elementary school	8 (2.6)	1 [Reference]	NA	1 [Reference]	NA	37 (7.9)	1 [Reference]	NA	NA	NA
High school and above	3 (7.0)	2.83 (0.72–11.11)	0.136	4.75 (1.05–21.36)	0.042	8 (9.6)	1.25 (0.56–2.79)	0.584	NA	NA
Family income										
Low	7 (2.9)	1 [Reference]	NA	NA	NA	7 (7.1)	1 [Reference]	NA	NA	NA
Middle	4 (3.5)	1.22 (0.35–4.26)	0.754	NA	NA	38 (8.4)	1.20 (0.52–2.77)	0.673	NA	NA
Household members										
≤3	3 (6.3)	1 [Reference]	NA	NA	NA	12 (11.8)	1 [Reference]	NA	NA	NA
≥4	8 (2.6)	0.40 (0.10–1.58)	0.193	NA	NA	33 (7.3)	0.59 (0.29–1.19)	0.140	NA	NA
Number of rooms										
≤3	7 (3.2)	1 [Reference]	NA	NA	NA	21 (7.8)	1 [Reference]	NA	NA	NA
≥4	4 (2.9)	0.90 (0.26–3.13)	0.866	NA	NA	24 (8.4)	1.09 (0.59–2.00)	0.791	NA	NA
Heating										
Central	4 (2.8)	1 [Reference]	NA	NA	NA	39 (9.1)	1 [Reference]	NA	NA	NA
Other	7 (3.3)	1.20 (0.34–4.17)	0.776	NA	NA	6 (4.7)	0.49 (0.20–1.19)	0.117	NA	NA

Allergic Diseases in Working Adolescents

Table 4. Continued...

Variable	2008 (n=353)					2013 (n=554)				
	No. (%)	uOR (95% CI)	p	aOR (95% CI)	p	No. (%)	uOR (95% CI)	p	aOR (95% CI)	p
Animals in household				Removed from final model						
No	8 (2.7)	1 [Reference]	NA	NA	NA	33 (7.6)	1 [Reference]	NA	NA	NA
Yes	3 (5.8)	2.24 (0.57–8.74)	0.245	NA	NA	12 (10.0)	1.35 (0.67–2.70)	0.397	NA	NA
Familial asthma									Removed from final model	
No	9 (2.8)	1 [Reference]	NA	NA	NA	29 (6.7)	1 [Reference]	NA	NA	NA
Yes	2 (5.9)	2.15 (0.45–10.40)	0.340	NA	NA	16 (13.3)	2.15 (1.12–4.10)	0.021	NA	NA
Familial allergy										
No	9 (2.7)	1 [Reference]	NA	1 [Reference]	NA	35 (7.7)	1 [Reference]	NA	NA	NA
Yes	2 (10.5)	4.25 (0.85–21.21)	0.078	5.98 (1.03–34.85)	0.047	10 (10.2)	1.37 (0.65–2.86)	0.407	NA	NA
Regular smoker										
No	6 (2.9)	1 [Reference]	NA	NA	NA	26 (8.2)	1 [Reference]	NA	NA	NA
Yes	5 (3.4)	1.15 (0.34–3.83)	0.825	NA	NA	19 (8.0)	0.97 (0.52–1.79)	0.917	NA	NA
Alcohol use										
No	11 (3.2)	1 [Reference]	NA	NA	NA	43 (8.1)	1 [Reference]	NA	NA	NA
Yes	0 (0)	‡ ^b	NA	NA	NA	2 (8.0)	0.98 (0.22–4.31)	0.982	NA	NA
Household smoker										
No	5 (5.7)	1 [Reference]	NA	1 [Reference]	NA	15 (8.7)	1 [Reference]	NA	NA	NA
Yes	6 (2.3)	0.38 (0.11–1.27)	0.116	0.28 (0.08–1.06)	0.061	30 (7.9)	0.89 (0.47–1.70)	0.730	NA	NA

^aLogistic regression analysis was performed using backward elimination. ^bOdds ratios could not be calculated due to zero cell counts. ^caOR: adjusted odds ratio; CI: confidence interval; NA: not applicable; uOR: unadjusted odds ratio.

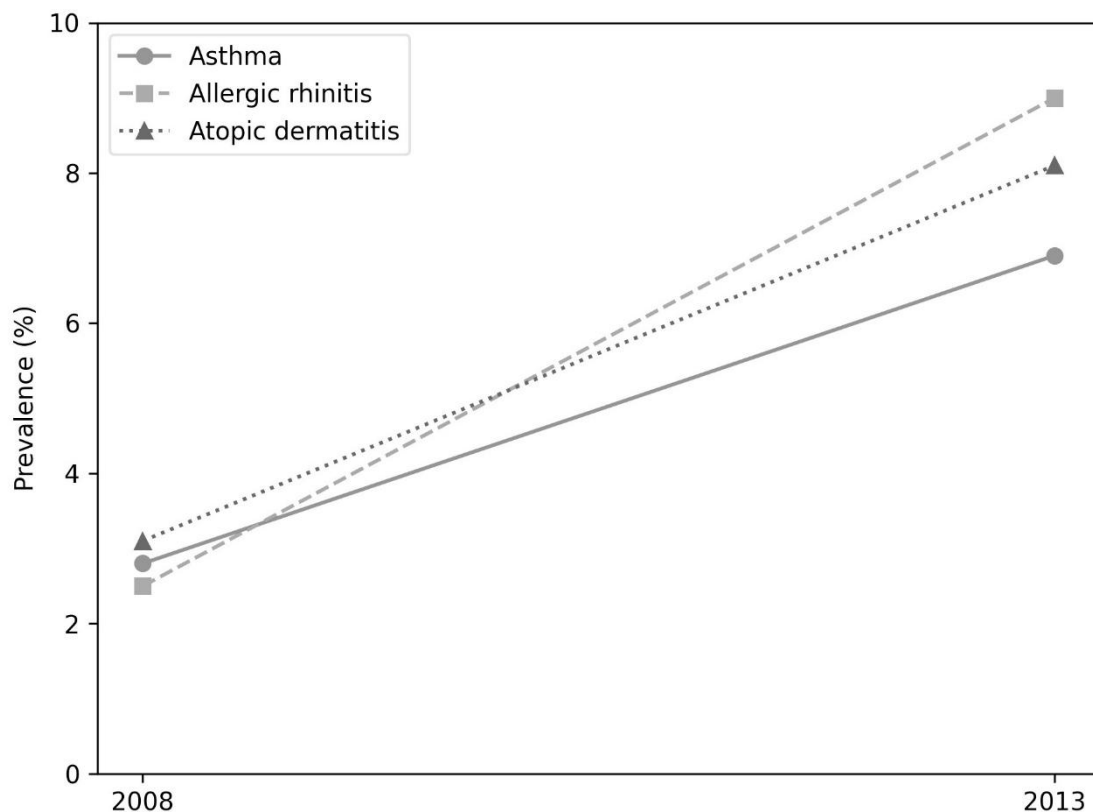


Figure 1. Prevalence of physician-diagnosed allergic diseases among working adolescents in 2008 and 2013.

Data are from 2 repeated cross-sectional surveys carried out in the same vocational training center 5 years apart using the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire (2008, n=353; 2013, n=554). The y-axis shows prevalence as a percentage of the participants surveyed in each year, and the x-axis shows the survey year. All 3 conditions became more frequent over the interval: asthma increased from 2.8% to 6.9%, allergic rhinitis increased from 2.5% to 9.0%, and atopic dermatitis increased from 3.1% to 8.1%.

DISCUSSION

This repeated cross-sectional study demonstrated a significant increase in the prevalence of asthma, allergic rhinitis, and atopic dermatitis among working adolescents over a 5-year period. As in other ISAAC Phase III surveys, the 2 samples comprised different individuals, and the differences reported therefore describe change at the population level.

Our results are in line with previous Turkish ISAAC studies. Öneş et al reported an upward trend in asthma prevalence among schoolchildren between 1995 and 2004, and Duksal et al reported increases in allergic rhinitis between 2003 and 2013 and in asthma symptoms and physician-diagnosed asthma over a 6-year period.⁸⁻¹⁰ Doğruel et al in a repeated cross-sectional study in southern Turkey spanning 20 years, found a significant increase in physician-diagnosed asthma, allergic

rhinitis, and atopic dermatitis despite a concurrent fall in parent-reported wheezing, indicating a divergence between diagnostic and symptom trends.¹³ Karadağ et al reported a significant increase in physician-diagnosed asthma and allergic bronchitis in the general pediatric population over 2 decades, whereas changes in allergic rhinitis and atopic dermatitis symptoms did not reach significance.¹⁴ In our cohort, all 3 conditions increased significantly, which may reflect an additional contribution from early occupational exposure.

Internationally, the Hong Kong ISAAC study between 1995 and 2015 showed marked increases in wheezing, rhinitis, and eczema symptoms, particularly among those with a parental history of atopy,¹⁵ whereas a survey from Quito, Ecuador, reported falling asthma and eczema prevalence with rising rhinitis, illustrating the influence of regional and environmental factors.¹⁶

Several explanations should be considered for the increase observed between the 2 surveys. Wider access to healthcare, greater awareness of allergic symptoms among adolescents and their families, and changes in diagnostic practice during this period may all have contributed to the higher prevalence of physician-diagnosed disease, and a repeated cross-sectional design cannot separate these influences from a true rise in disease frequency. Two observations argue against increased recognition being the only explanation. First, symptom-based prevalence rose at least as steeply as physician-diagnosed prevalence: lifetime rhinitis increased from 18.1% to 46.6%, lifetime wheezing from 14.7% to 37.5%, and lifetime dermatitis from 5.4% to 29.4%. Second, comparable increases in physician-diagnosed allergic disease have been reported in school-based Turkish populations over the same period,^{8–10,13,14} and rising symptom prevalence has been documented in many ISAAC centers worldwide,¹⁷ indicating that working adolescents follow rather than diverge from these wider trends.

The clinical implications of this increase deserve consideration. Emergency department admission due to respiratory symptoms rose from 2.3% to 6.5% between the 2 surveys, indicating that the change was not confined to reported diagnoses but was accompanied by acute episodes requiring urgent care. Wheezing that begins early frequently persists into adult life, and persistent disease is accompanied by impaired lung function that is already established by early adulthood.¹⁸ Asthma in adolescents is also associated with poorer school performance and with more days of school absence than other allergic conditions,¹⁹ which is relevant in a group that combines formal education with long working days. In the workplace, hand dermatitis restricts tasks requiring repeated contact with water and chemicals, and skin and respiratory disease are recognized reasons for young workers to change or leave their trade.²⁰ Disease that begins during apprenticeship may therefore affect both health and occupational trajectory, which makes early recognition and treatment particularly important in this group.

A key finding of this study was the association between employment in the hairdressing sector and physician-diagnosed atopic dermatitis in 2013. This association is biologically plausible, as hairdressing apprentices are frequently exposed to irritant and sensitizing substances, including hair dyes, bleaching products, and cleaning chemicals. Previous

occupational health studies have similarly reported increased prevalence of hand eczema and allergic contact dermatitis among hairdressing trainees and young professionals.^{21,22} The confidence interval around this estimate was wide (95% CI, 3.27–176.74), which reflects the small number of adolescents with physician-diagnosed atopic dermatitis in the comparison occupational groups. The lower bound indicates that an association was present, but its magnitude cannot be estimated with precision, and the finding is best regarded as exploratory and in need of confirmation in larger samples.

In 2013, hairdressing was associated with asthma (uOR, 4.91; 95% CI, 1.46–16.45) and with allergic rhinitis (uOR, 2.49; 95% CI, 1.01–6.16) in univariate analysis, but neither association persisted after adjustment, whereas the association with atopic dermatitis remained. Several factors may explain this gradient. In hairdressing, skin exposure may be more direct and repetitive, whereas airborne exposure may vary with the products used and with workplace ventilation. The 2 groups of disease may also develop over different timescales, since irritant contact dermatitis can appear within months of beginning regular contact with irritant substances,²¹ whereas occupational asthma and rhinitis usually have a longer latency; the mean duration of employment in this cohort was less than 3 years. Statistical power was also limited, as physician-diagnosed asthma and rhinitis were uncommon and the corresponding confidence intervals were wide. Finally, all outcomes were questionnaire-based, and early airway changes, such as increased bronchial responsiveness, cannot be detected by this method; such changes have been demonstrated in apprentices exposed to metalworking fluids using objective testing.²³ A true absence of respiratory effect therefore cannot be distinguished from an effect that the present design was unable to detect.

Adolescents who had already left their trade were not surveyed, since at least 1 year of employment was required for eligibility. Skin and respiratory disease are among the reasons apprentices leave their occupation,²⁰ so those remaining in the more hazardous trades may be the ones who tolerate the exposure. This selection is likely to have weakened rather than strengthened the occupational associations we report.

Regular smoking was reported by more than 40% of participants in both surveys and was independently associated with asthma and allergic rhinitis. Several

mechanisms may contribute. Cigarette smoke increases the permeability of the airway epithelium, impairs mucociliary clearance, and induces oxidative stress with release of pro-inflammatory cytokines; it also shifts the lymphocyte balance toward a T helper 2 (T_H2) profile and is associated with higher circulating immunoglobulin E (IgE) concentrations.²⁴ Given how common smoking was in this population, it is reasonable to ask whether it confounded the occupational associations. Smoking was independently associated with asthma and allergic rhinitis and was retained in the final models for both outcomes; occupational group, however, was not retained in these models, so no independent occupational association remained after adjustment. Smoking was not associated with atopic dermatitis in either survey. Because the distribution of smoking across occupational groups was not examined, residual confounding of the occupational findings by smoking cannot be completely excluded.

Male sex was associated with a lower likelihood of physician-diagnosed asthma and allergic rhinitis in 2013 and of atopic dermatitis in 2008. Reports from childhood populations generally describe a higher prevalence of wheeze and asthma in boys, whereas a shift toward higher rates in girls has been described during adolescence; hormonal changes and sex-specific differences in environmental exposure have been proposed as possible explanations.²⁵ The participants in the present study were adolescents, so the direction of the association we observed is compatible with this pattern.

These findings have practical implications for vocational training centers, which see adolescents at the start of working life. Preventive measures are most useful at the beginning of an apprenticeship rather than after symptoms appear. These include instruction in the safe handling of workplace chemicals, the provision and routine use of protective gloves and clothing, and respiratory protection where airborne exposure is expected. Adequate ventilation of work areas and, where feasible, substitution of the most hazardous products would further reduce exposure.²⁶ Smoking prevention and cessation programs would be a further component of health promotion in these centers. Periodic health surveillance during apprenticeship would allow skin and respiratory symptoms to be identified early, at a stage when a change of task or improved protection may still alter the course.

This study has several limitations. Both surveys were carried out in a single vocational training center in

Istanbul, and adolescents attending it may differ from working adolescents elsewhere in socioeconomic background, in the trades available, in the enforcement of workplace regulations, and in ambient environmental exposures, so the findings may not be generalizable to other settings. As in ISAAC surveys generally, all information was obtained by questionnaire^{7,17}; reported diagnoses were not verified against medical records and symptoms were recalled, and face-to-face administration by a physician cannot remove recall or reporting bias. The design was cross-sectional, so no causal inference can be drawn, and because eligibility required at least 1 year of employment, the healthy worker effect discussed above may have influenced both the prevalence estimates and the risk factor analyses. The 2 samples also differed modestly in age, with participants in 2013 being older on average, so differences in sample composition may have contributed in part to the observed temporal changes.

Occupational exposure was defined only by sector: neither survey recorded the products used, the frequency of contact with them, or the use of protective equipment, and the chemicals used in these trades may have changed between the surveys. Sector is therefore a proxy for the exposures actually encountered, and the associations reported describe occupational sectors rather than specific substances. Outdoor air pollution, dietary factors, and domestic allergen levels were not measured, so residual confounding cannot be excluded. The multivariable models were built by backward elimination, and collinearity diagnostics, interaction terms, and goodness-of-fit statistics were not examined. Because several variables entered were closely related—most participants in hairdressing were girls—and physician-diagnosed disease was uncommon, some models were based on very few outcome events and may therefore be unstable; the confidence intervals for these estimates are wide, particularly those relating to sex, since girls made up about 15% of participants. The adjusted odds ratios should therefore be read as indicating direction and approximate strength rather than precise effects.

In this repeated cross-sectional survey of working adolescents, the prevalence of asthma, allergic rhinitis, and atopic dermatitis increased significantly over a 5-year period. Familial allergy was associated with all 3 conditions and regular smoking was associated with asthma and allergic rhinitis, while sex-related associations varied across outcomes and survey years.

Importantly, employment in the hairdressing sector was identified as a notable occupational risk factor for atopic dermatitis, underscoring the potential impact of early occupational exposures on skin-related allergic diseases. These findings highlight the importance of monitoring the health of working adolescents and support the introduction of protective equipment training, smoking prevention programs, and periodic health surveillance in vocational training centers.

Several directions for future research follow. Prospective cohorts that follow apprentices from the start of employment would separate incident disease from disease already present and would establish the sequence between exposure and onset. Exposure should be assessed objectively rather than by sector, through workplace air sampling, biological monitoring of the chemicals used, and structured recording of contact frequency and protective equipment use. Clinical and laboratory assessment would detect airway and sensitization changes that a questionnaire cannot. Multicenter studies across a wider range of trades and regions would improve generalizability and provide adequate statistical power.

These questions matter because of when the exposure occurs. Adolescents who enter the workforce meet occupational hazards at an age when most of their peers are still at school, and at the start of a working life that may last decades. Attention to this group is therefore likely to have effects that extend well beyond adolescence.

STATEMENT OF ETHICS

This study was performed in line with the principles of the Declaration of Helsinki. Ethical approval was granted by the Ethics Committee of Bezmialem Vakif University (Approval No. 36/12, dated April 8, 2013). Written informed consent was obtained from parents or legal guardians of all participants younger than 18 years of age, and written assent was obtained from all participating adolescents.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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Not applicable.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author on reasonable request.

AI ASSISTANCE DISCLOSURE

Artificial intelligence (AI) was used solely for language editing and grammar correction. No generative AI tool was used to generate the scientific content of this manuscript.

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