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Environmental tobacco smoke and the risk of eczema symptoms among school children in South Africa: a cross-sectional study

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ABSTRACT

Objective: The aim of this study was to investigate the association between eczema ever (EE) and current eczema symptoms (ES) in relation to exposure to environmental tobacco smoke (ETS).

Design: A cross-sectional study using the International Study of Asthma and Allergies in Childhood questionnaire.

Setting: 16 schools were randomly selected from two neighbourhoods situated in Ekurhuleni Metropolitan Municipality, Gauteng Province, South Africa.

Participants: From a total population of 3764 school children aged 12–14 years, 3468 completed the questionnaire (92% response rate). A total of 3424 questionnaires were included in the final data analysis.

Primary outcome: The prevalence of EE and current ES was the primary outcome in this study.

Results: Data were analysed using Multilevel Logistic Regression Analysis (MLRA). The likelihood of EE was increased by exposure to ETS at home (OR 1.30 95% CI 1.01 to 1.67) and at school (OR 1.26 95% CI 1.00 to 1.60). The likelihood of EE was lower for males (OR 0.66 95% CI 0.51 to 0.84). The likelihood of ES was increased by ETS at home (OR 1.93 95% CI 1.43 to 2.59) and school (1.44 95% CI 1.09 to 1.90). The likelihood of ES was again lower for males (OR 0.56 95% CI 0.42 to 0.76). Smoking by mother/female guardian increased the likelihood of EE and ES, however, this was not significant in the multivariate analysis.

Conclusions: Symptoms of eczema were positively associated with exposure to ETS at home and school. The results support the hypothesis that ETS is an important factor in understanding the occurrence of eczema.

Strengths and limitations of this study

- The use of a validated International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire, which has been used in many studies globally with consistent results.
- Large sample size of over 3000 children.
- The participation rate was high (92%).
- The results of the study might be higher than the actual prevalence since they are based on self-reported answers from the questionnaire and no objective measures were taken at the time of data collection.

BACKGROUND

Eczema (or atopic dermatitis, AD) is a chronic, and the most frequent, inflammatory skin disease; it usually develops in childhood and can persist through to adulthood.[1] It is characterised by dry skin, itchy rash and excoriation,[2 3] and the condition affects 15–30% of children and 2–10% of adults.[3] The term eczema describes skin diseases with common clinical characteristics involving a genetically determined skin-barrier defect. Decreased barrier function leads to increased water loss through the outermost layer of the skin, resulting in a decrease in water content of this particular layer of skin, increased permeability to hydrophilic substances, decreased ceramides in the skin and decreased barrier to infectious agents.[4] Although not life-threatening, the condition may result in secondary infection and damage to the skin. The quality of life for those having the condition, particularly children and their caregivers, may be affected, for example, by lack of sleep and lack of concentration at school as a result of itching at night.[5 6] Families of affected children have an extra financial burden to care for the affected child.[7 8] The prevalence of eczema among children is reported to vary in different countries, with some countries experiencing an increase, and others with high prevalence undergoing a decline.[9–11]

In Cape Town Province, South Africa, Zar *et al*[12] reported an increase in the prevalence of eczema from 11.8% in 1995 to 19.4% in 2002, from two International Study of

Asthma and Allergies in Childhood (ISAAC) studies that were questionnaire based and conducted 7 years apart. The reason for the increase in the prevalence of eczema is not clearly understood. The pathogenesis of eczema is complex, involving an interaction between several factors, which may include, among others, genetics, socioeconomic status, lifestyle, diet, meteorological and living conditions at home, and environmental air pollutants, such as type of fuel used for cooking and heating in homes, and traffic-related air pollution and exposure to environmental tobacco smoke (ETS).[13–16]

Tobacco smoke is one of the most common indoor air pollutants. The literature, as early as in the 1970s, periodically reviewed ETS, or passive smoking and health.[17] Children usually get exposed to tobacco smoke at home due to parents and other family members smoking, but also during transportation and in areas such as schools and restaurants.[18] Although ETS has been considered to be a risk factor for eczema, the relationship between the two has not been sufficiently investigated. Studies have reported that smoking by the mother, or her exposure to smoke during pregnancy, may increase the risk of eczema during childhood.[19]

Many studies focusing on eczema have been mainly reported from studies conducted in developed countries; little is known about the strength of such associations in developing countries such as South Africa. The aim of the study was to investigate the association of eczema ever (EE) and current eczema symptoms (ES) with ETS among children attending schools in urban areas of Tembisa and Kempton Park.

METHODS

Study area

The study was conducted in Tembisa and Kempton Park areas, situated in the northern region of the Ekurhuleni Metropolitan Municipality (EMM), located in the eastern region of Gauteng Province, South Africa. Tembisa is the second largest township in Gauteng Province, with both formal and informal housing; it is home to mainly African ethnic groups. Kempton Park is a suburban area and the residents are predominantly Caucasian; it has only been in recent years, after the 1994 democratic elections, that some, mostly middle income, African ethnic families have moved into the area.

Study design, population and sample selection

A cross-sectional epidemiological study was conducted between February and June 2012, following the ISAAC Phase I protocol.[20] The ISAAC was designed as a multicentre study to investigate the epidemiology of asthma, rhinitis and AD among children, using standardised definitions, thus allowing comparisons worldwide.[20] A list of all schools (primary and secondary) in EMM was provided by the Gauteng Department of Education. All primary schools were excluded and 16 high schools were randomly selected from the list. Each school was contacted and requested to participate in the study. Following the approval of the study by the principal and governing body in each school, all eligible children between the ages of 13 and 14 years and in grade 8 were requested to participate. An appointment was scheduled with the school to deliver the consent forms for the children 2 weeks prior to the study and the children were requested to return them within 3 days. The study population consisted of 3764 children, based on the numbers given by each school prior to data collection. Data were collected using the English versions of ISAAC written and video questionnaires. The questionnaires were completed by the children in the classroom under the supervision of the data collectors, who were specifically trained and briefed to avoid explanations that could interfere in the participant's answers.

Health outcomes

In this study, we estimated health outcomes on the basis of positive answers from the written ISAAC questionnaire. Answers to written questions were self-reported by children.

1. Have you ever had an itchy rash that was coming and going for the past 6 months? (Yes\No)
2. Have you had this itchy rash at any time in the past 12 months? (Yes\No)
3. Has this itchy rash at any time affected any of the following places: the folds of the elbow, behind the knees, in front of the ankles, under the buttocks, or around the neck, ears, or eyes? (Yes\No)
4. Current ES were defined as those children who, according to the written questionnaire, responded positively to questions 1, 2 and 3.
5. EE: have you ever had eczema? (Yes\No)

Air pollution sources and potential confounding variables

Air pollution sources included: ETS exposure at home in the past 30 days (yes/no), ETS exposure at school in the past 30 days (yes/no), tobacco smoking by participant (yes/no), mother/father smoking tobacco (yes/no), any other person smoking at home other than participant (yes/no). The following potential confounding variables were included in the study, similar to other ISAAC studies,[21] age, sex (male/female) and type of house (brick, mud, corrugated iron, combination); the children were asked to select the most frequently used energy source at home: for cooking (electricity, gas, paraffin, open fires) and for heating (electricity, gas, paraffin, open fires). The children were asked about the mode of transport to school (walking, taxi/bus, car, combination of car/taxi or train), the frequency of trucks passing near residences on weekdays (never, seldom, frequently through the day, almost all day). Other variables included in the questionnaire and reported in the descriptive analysis included: period lived in the residential area (<6 months, 6–12 months, 1–2 years, ≥3 years), being born in Tembisa/Kempton Park (yes/no) and availability of running water (yes/no).

Data management and statistical analysis

The data were entered into a database set up in EpiInfo V.3.5.3 and Stata V.12 was applied for the data analysis. Prevalence rates for the each health outcome and proportion of risk factors under investigation were calculated by dividing the number of participants who responded affirmatively to a particular question, by the number of questionnaires completed. Observations marked as 'do not know', 'not stated' or 'other responses' were set as missing. This resulted in each question having a slightly different sample size. Crude and adjusted OR and 95% CI were calculated with Multilevel Logistic Regression Analysis (MLRA) with random effect to estimate the likelihood of having EE and current ES given ETS exposure variable.

The multilevel data included 16 schools within two residential areas (Kempton Park and Tembisa) at level 1. ETS and confounding variables were added in a stepwise manner, starting with the most significant from the univariate analysis. Each time a new potential confounder was added to the model, if the effect estimate between the exposure of interest and respiratory outcome already in the models changed by more than 5%, the additional variable was retained in the final multiple MLRA, otherwise, the variable was removed and a different one was added.[22] The most parsimonious multiple MLRA models were reported, that is, those with variables having a p value <0.05.[22]

Ethical considerations

The Gauteng Department of Education, Ekurhuleni North District, school principals and governing bodies were approached, and gave approval and cooperation for the study. Parents of participants were sent a letter explaining the study details and its nature, and requested to give consent to allow their children to participate in the study. All information was kept confidential.

RESULTS

The study population consisted of 3764 children from 16 schools; 3468 completed the modified ISAAC questionnaire at the schools (92% response rate). The study focused only on those children who were present at the time of fieldwork; therefore, 296 learners did not participate. The teachers gave assurance that most of the children were present. School attendance was high during the study, therefore bias, which may have been introduced by non-response rate, was assumed to be relatively low. Forty-four questionnaires were excluded during the data capturing due to incomplete information. A total of 3424 questionnaires were finally included in the data analysis.

Table 1 summarises the frequencies and percentages for general characteristics and living conditions. 53% of the children were born within the study areas and more than three-quarters had been living in the study areas for longer than 3 years (76%). Girls accounted for 52% of the children.

The majority of the children lived in formal housing structures (86%) and fewer than 20% lived in houses without running water. Ten per cent of the children had a mother or female guardian who was a smoker, 27% a father or male guardian who was a smoker, or lived with someone who other than their parents, who was a smoker (44%). Forty-two per cent were exposed to tobacco smoke at home, while 34% were exposed at school. A small percentage of children reported gas most frequently (5%) and paraffin most frequently used (5%) for cooking at home, while the majority most frequently used electricity (88%).

Twelve per cent most frequently used gas for heating, 18% used paraffin, 7% used open fires (wood and coal), while the remaining 52% used electricity. Just over half of the children walked to school (51%), while the remainder used other modes of transport (cars, taxi, buses and train). Truck traffic passing near residences almost all day was reported by 35% of the children. The prevalence of health outcomes is summarised in table 2. Twenty-one per cent of the children reported having a rash that was coming and going for at least 6 months, the prevalence of ever having a rash in the past 12 months was 17% and the prevalence of ever having rash in the flexures was 10.2%. EE was reported by 14% and current ES 9.6%. ES were more prevalent among girls (table 2).

Table 3 summarises the results of the MLRA for EE set at level 1 for residential areas. After adjusting for potential confounding variables, it was found that the likelihood of EE increased with exposure to: ETS at home (OR 1.30 95% CI 1.01 to 1.67) and at school (OR 1.26 95% CI 1.00 to 1.60). Smoking by mother/female guardian increased the likelihood of EE, however, the association was not significant. Among the confounding variables, significant association was observed for sex, the likelihood of EE was lower for males (OR 0.66 95% CI 0.51 to 0.84), gas frequently used for heating at home (OR 1.76 95% CI 1.28 to 2.43) and frequency of truck passing near residences on weekdays, frequently throughout the day (OR 1.60 95% CI 1.03 to 2.51) and almost all day (OR 1.70 95% CI 1.13 to 2.54). The use of the motor car as mode of transport to school was significant in the univariate analysis, however, it was not significant in the multivariate analysis. No association was observed for age and type of house.

Table 4 summarises the results of the MLRA for current ES. The likelihood of current ES was significantly increased by exposure to ETS at home (OR 1.93 95% CI 1.43 to 2.59) and school (1.44 95% CI 1.09 to 1.90). Smoking by mother/female guardian increased the likelihood of current ES, however, this was not significant in the multivariate analysis. Among confounding variables, the likelihood of ES was lower for boys (OR 0.56 95% CI 0.42 to 0.76). The use of taxi/bus as the mode of transport to school (OR 1.79 95% CI 1.27 to

Table 1 Demographic characteristics and household conditions of the study participants (n=3424)

Variable	Total	Percentage
Age (years)		
12	111	3.2
13	1582	46.2
14	1731	50.6
Sex of child		
Female	1790	52.3
Male	1634	47.7
Residential area		
Kempton Park	1117	32.6
Tembisa	2301	67.2
Missing	6	0.2
Period lived in the residential area		
<6 months	253	7.4
6–2 months	216	6.3
1–2 years	346	10.1
≥3 years	2609	76.2
Born in the areas of Tembisa and Kempton Park		
Yes	1812	52.9
No	1609	47.0
Missing	3	0.1
Type of house		
Brick	2938	85.8
Mud	45	1.3
Corrugated iron	184	5.5
Combination	126	3.7
Missing	126	3.7
ETS exposure at residence in the past 30 days		
Yes	1452	42
No	1460	43
Missing	512	15
ETS exposure at school in the past 30 days		
Yes	1177	34.4
No	1452	42.4
Missing	755	23.2
Residential cooking fuel type most frequently used		
Electricity	2995	87.5
Gas	179	5.2
Paraffin	200	5.8
Open fires (wood, coal)	30	0.9
Missing	20	0.6
Residential heating fuel type most frequently used		
Electricity	2041	59.6
Gas	426	12.4
Paraffin	631	18.4
Open fires (wood, coal)	270	7.9
Missing	56	1.64
Mode of transport to school		
Walk	1728	50.5
Informal taxi/Bus	708	20.1
Car	683	20.
Combination car and informal taxi	201	5.9
Train	100	2.9
Missing	4	0.1
Frequency of trucks passing near homes on weekdays		
Never	563	16.4
Seldom	1033	30.2
Frequently through the day	580	16.9
Almost every day	1212	35.4
Missing	36	1.1

ETS, environmental tobacco smoke.

2.53) and the frequency of trucks passing near residences almost all day on weekdays (OR 1.95 95% CI 1.19 to 3.20). No association was observed for the age and type of house. Smoking by participant was not significant in either the univariate or the multivariate analysis, in the stepwise analysis; the inclusion of smoking by participant did not have an effect on the final model and was therefore left out.

DISCUSSION

The aim of the study was to investigate the association of EE and current ES with ETS among children attending schools in urban areas of Tembisa and Kempton Park, EMM. The prevalence of current ES in this study was 9.6%. In a cross-sectional study of centres participating in the ISAAC, the prevalence of eczema was from <1% in Albania to more than 17% in Nigeria for the age range of 13–14 years. High prevalence of ES was reported in Australia and Northern Europe, and lower prevalences were reported in Eastern and Central Europe, and Asia. Similar patterns were seen for symptoms of severe eczema.[9] Some centres in Africa were reported to be among those with the highest prevalence of eczema.[23] In Brazil, Porto Neto reported a prevalence of 13.6% for eczema in a study conducted among 2948 school children aged 13–14 years following the ISAAC methodology.[24] The prevalence of current ES in this study is lower than that reported by the study conducted in Polokwane (17%) and the two studies conducted in Cape Town, 11.8% in 1995 and 19.4% in 2002.[12 21] The slightly lower prevalence for this study might be attributable to the fact that the study area was situated in the Highveld region, with a higher altitude than Polokwane, which is in the Lowveld, while Cape Town is located on the coast.

The study found that EE and ES were positively associated with ETS exposure at home and school. For current ES, the risk of exposure appears to be much higher at home than at school (OR 1.93 at school vs 1.42 at home) as 42% of the children were exposed to tobacco smoke at home, while 34% were exposed at school. For ETS at home, the likelihood of ES was much higher in the adjusted model, OR 1.93 versus 1.33.

The findings were in line with other studies that identified ETS as one of the most common indoor air pollutants; the home being the most important site of such exposure. The association between eczema and ETS exposure has been reported previously.[25] The likelihood of current ES was also associated with smoking by

Table 2 Self-reported prevalence of eczema symptoms (ES) among boys and girls aged 12–14 years (n=3424)

ES	Total	Females	Males
Ever had recurrent itchy rash in the past 6 months	714 (20.9)	418 (23.4)	296 (18.2)
Itchy rash in the past year	575 (16.8)	349 (74.9)	226 (67.3)
Ever had this rash in flexures	343 (10.2)	224 (12.5)	119 (7.3)
Eczema ever	481 (14.1)	289 (16.2)	192 (11.8)
Current eczema (ES)	329 (9.6)	214 (12.0)	115 (7.0)

mother/female guardian. Yi *et al*[19] found AD to be highly correlated with ETS among children whose mothers had smoked during pregnancy and/or in the first year after birth, in a study conducted in Korea among 7030 children between 6 and 13 years of age.

In a cross-sectional study conducted among 3153 Lebanese adolescents 13–14 years of age, females and passive smokers were at a 1.5 times risk of having eczema than their counterparts.[26] An ecological analysis of ISAAC Phase I data from 463 801 children aged 13–14 years in 155 countries and in 257 800 children aged

Table 3 The prevalence of ever having had EE among the participants along with crude and adjusted ORs

Variable	Total*	EE (%)	Crude OR (95% CI)†	p Value	Adjusted OR (95% CI)†	p Value
Age (years)						
12	111	16.2	1		1	
13	1577	13.8	0.80 (0.47 to 1.36)	0.430	0.88 (0.43 to 1.77)	0.721
14	1726	14.1	0.85 (0.50 to 1.44)	0.561	1.09 (0.54 to 2.20)	0.804
Sex						
Female	1784	16.2	1		1	
Male	1630	11.8	**0.69 (0.56 to 0.83)**	**0.000**	**0.66 (0.51 to 0.84)**	**0.001**
Type of house						
Brick	2928	14.11	1		1	
Mud	45	15.56	1.16 (0.51 to 2.62)	0.716	0.81 (0.23 to 2.75)	0.738
Corrugated iron	189	15.34	1.19 (0.78 to 1.80)	0.406	1.22 (0.71 to 2.12)	0.459
Combination	126	12.70	0.85 (0.49 to 1.45)	0.560	0.74 (0.39 to 1.39)	0.352
ETS exposure at home in the past 30 days						
No	1453	12.6	1		1	
Yes	1449	16.2	**1.36 (1.10 to 1.68)**	**0.003**	**1.30 (1.01 to 1.67)**	**0.038**
ETS exposure at school in the past 30 days						
No	1447	12.99	**1**		**1**	
Yes	1175	16.34	**1.29 (1.04 to 1.61)**	**0.019**	**1.26 (1.00 to 1.60)**	**0.050**
Mother/female guardian smoke cigarettes						
No	3028	13.38	**1**			
Yes	342	20.18	**1.55 (1.16 to 2.08)**	**0.003**	**1.18 (0.80 to 1.73)**	**0.394**
Fuel frequently used for heating at home						
Electricity	2033	12.7	1		1	
Gas	425	19.5	**1.62 (1.23 to 2.13)**	**0.001**	**1.76 (1.28 to 2.43)**	**0.000**
Paraffin	631	14.3	1.25 (0.95 **to** 1.65)	0.104	1.22 (0.85 **to** 1.75)	0.273
Open fires	270	16.3	1.43 (1.01 **to** 2.03)	0.043	1.40 (0.90 **to** 2.18)	0.127
Mode of transport to school						
Walk	1723	12.71	1		1	
Taxi/bus	705	14.18	1.13 (0.87 to 1.46)	0.329	1.11 (0.80 to 1.54)	0.511
Motor car	683	17.13	1.42 (1.11 to 1.81)	0.005	1.24 (0.84 to 1.85)	0.271
Combination	200	14.00	1.12 (0.73 to 1.71)	0.587	0.97 (0.57 to 1.68)	0.930
Train	99	17.17	1.44 (0.83 to 2.47)	0.186	1.48 (0.77 to 2.85)	0.232
Frequency of trucks passing near homes on weekdays						
Never	562	12.28	**1**		**1**	
Seldom	1030	14.08	1.10 (0.81 to 1.51)	0.519	1.21 (0.81 to 1.81)	0.347
Frequently through the day	578	15.05	1.28 (0.91 to 1.08)	0.151	**1.60 (1.03 to 2.51)**	**0.037**
Almost all day	1208	14.57	1.27 (0.94 to 1.72)	0.114	**1.70 (1.13 to 2.54)**	**0.010**

*Total for each risk factor is different due to difference in missing values.
†Model adjusted for all the variables.
Values that are statistically significant at less than 0.02 for the crude OR and less than 0.05 for the adjusted OR are in bold font.
EE, eczema ever; ETS, environmental tobacco smoke.

Table 4 The prevalence of current ES among the participants along with crude and adjusted ORs

Variable	Total*	ES (%)	Crude OR (95% CI)†	p Value	Adjusted OR (95% CI)†	p Value
Age (years)						
12	111	16.22	1		1	
13	1582	10.24	0.58 (0.34 to 0.99)	0.046	0.67 (0.33 to 1.38)	0.289
14	1731	8.61	0.48 (0.28 to 0.82)	0.007	0.63 (0.31 to 1.30)	0.219
Sex						
Female	1790	12.0	1		1	
Male	1634	7.0	**0.55 (0.43 to 0.70)**	**0.000**	**0.56 (0.42 to 0.76)**	**0.000**
Type of house						
Brick	2938	9.98	1		1	
Mud	45	8.89	0.89 (0.31 to 2.50)	0.829	0.62 (0.14 to 2.72)	0.529
Corrugated iron	189	8.99	0.90 (0.54 to 1.50)	0.699	0.67 (0.31 to 1.42)	0.301
Combination	126	5.56	0.53 (0.24 to 1.16)	0.115	0.44 (0.17 to 1.12)	0.088
ETS exposure at home in the past 30 days						
No	1460	7.5	**1**		**1**	
Yes	1452	12.4	**1.73 (1.34 to 2.22)**	**0.000**	**1.93 (1.43 to 2.59)**	**0.000**
ETS exposure at school in the past 30 days						
No	1452	8.6	1		1	
Yes	1177	11.6	**1.40 (1.08 to 1.80)**	**0.010**	**1.44 (1.09 to 1.90)**	**0.009**
Mother/female guardian smoke cigarettes						
No	3037	9.10	1		1	
Yes	343	13.12	1.48 (1.06 to 2.08)	**0.020**	1.48 (0.97 to 2.26)	0.067
Mode of transport to school						
Walk	1728	8.2	1		1	
Taxi/bus	708	12.3	**1.56 (1.18 to 2.08)**	**0.002**	**1.79 (1.27 to 2.53)**	**0.001**
Motor car	683	9.8	1.21 (0.89 to 1.65)	0.207	1.12 (0.75 to 1.66)	0.576
Combination	201	10.5	1.31 (0.80 to 2.12)	0.273	1.29 (0.72 to 2.30)	0.389
Train	100	12.0	1.55 (0.83 to 2.92)	0.166	0.94 (0.39 to 2.26)	0.892
Frequency of trucks passing near homes on weekdays						
Never	563	7.3	1		1	
Seldom	1033	9.5	1.33 (0.91 to 1.95)	0.135	1.46 (0.89 to 2.41)	0.132
Frequently through the day	580	9.3	1.30 (0.85 to 1.99)	0.219	1.35 (0.77 to 2.36)	0.293
Almost all day	1212	11.1	**1.59 (1.10 to 2.29)**	**0.012**	**1.95 (1.19 to 3.20)**	**0.008**

*Totals for each risk factor are different due to difference in missing values.
†Model adjusted for all the variables.
Values that are statistically significant at less than 0.02 for the crude OR and less than 0.05 for the adjusted OR are in bold font.
ES, eczema symptoms; ETS, environmental tobacco smoke.

6–7 years in 91 centres in 38 countries, found an association between several factors including smoking by women and the symptom prevalence of three conditions (asthma, rhinoconjunctivitis and eczema).[27] In South Africa, in the study that was conducted in Polokwane Province, Wichmann *et al*[21] reported that the likelihood of having ES was significantly increased by 43% in rural areas and by 54% when exposed to tobacco smoke at home. The current study was conducted in Gauteng Province, 10 years after the Polokwane study; seemingly, exposure to tobacco smoke is still a problem in different communities in South Africa, with the home still the main environment where children are exposed to tobacco. This study was conducted in an urban setting where the majority of the children lived in formal housing, which may be one of the reasons for the lower prevalence than that in the Polokwane study.

Time spent in the school environment is second to the time children spend at home, and seems to be another area where children are exposed to tobacco smoke. Children start experimenting with cigarettes while in their early teens and rates of tobacco use among school children aged 13–15 years are high (WHO).[28] The Global Tobacco Surveillance System Collaborative group has analysed a sample of 747 603 adolescents from different countries and continents, and report that the frequency of current tobacco use varies from 11.4% in the Western Pacific Region to 22.2% in the Americas, with a global average of 17.3%. In general, girls were reported to smoke less than boys both in the Americas and Europe, while in the leading regions the frequency is almost the same between genders.[29]

In a study conducted in Israel, to investigate the association of smoking and exposure to ETS with prevalence of atopic eczema in a national sample of 10 298 children aged 13–14 years, Graif *et al*[1] reported a dose–response association between smoking and atopic eczema compared to those not smoking. Furthermore, tobacco smoking has been proposed to promote hand eczema; a large population-based study in Sweden reported an

association between heavy smoking and 1 year prevalence of hand eczema, and a dose–response relation was also indicated.[30]

Conversely, studies such as those by Fedortsiv *et al*,[31] Ciaccio *et al*,[32] Schafer *et al*,[33] and Strachan and Cook[34] did not observe any association between atopic eczema and tobacco smoke. The debate as to whether exposure to tobacco smoke is associated with atopic eczema warrants further investigation, as the aetiology of the disease may differ from one country to another due to other risk factors. While research on the matter still continues, policies that are currently available to protect the public and children against exposure to the harmful effects of tobacco smoke should be implemented and enforced. Health education programmes on the harmful effects of tobacco smoke should be strengthened with more resources allocated to such programmes; these should focus on school children.

Limitations of the study

Certain limitations should be taken into account in the interpretation of the results, which should be interpreted as a whole. First, the study had a cross-sectional epidemiological design, as in all ISAAC studies. Cross-sectional studies are weak in providing causation as they are subject to difficulties in interpreting the temporal sequence of events since health status and determinants are measured simultaneously. However, our findings are supported by other studies, as discussed previously. Second, the results of the study might be higher than the actual prevalence since they are based on self-reported answers from the questionnaire and no allergy testing was performed at the time of data collection.

Third, no quantitative exposure assessment was conducted as part of the study; the number of cigarettes smoked was not included. Fourth, only age, sex, type of house, mode of transport to school, fuel frequently used for cooking and heating at home, and the frequency of trucks passing near residences, were included as confounding variables, of which most were highly significant in the final multilevel model. This supports the hypothesis that the development of eczema is associated with many other factors, therefore, studies on ETS should explore the co-existence of such factors in the development and exacerbation eczema. Despite these limitations, this study will contribute to the existing literature because very little data are available on the prevalence of eczema specifically in Gauteng Province, South Africa. The strength of our study is mainly the use of a validated ISAAC questionnaire, which has been used in many studies globally, with consistent results. Furthermore, cross-sectional studies are important indicators of health problems occurring in communities and serve as a baseline for further analytical and experimental investigation. The study had a large sample size and the participation rate was very high, which eliminated the risk of selection bias.

CONCLUSION

The study found that eczema was associated with ETS at home and in school. In the literature, most studies investigating eczema in relation to tobacco smoke were cohort studies following children from birth up to the ages of 6–7 years; there are limited studies focusing on the age group of 13–14 years. Studies have also suggested that ETS is associated with increased health symptoms during infancy and that the effect diminishes with the increasing age of the child, however, the results of this study suggest the condition may persist until teenage years through to adulthood. Most epidemiological studies have been conducted in developed countries. The aetiology of the disease may differ from that of children in other parts of the country or children in developed countries. The results of this study will add to the number of limited studies in developed countries, such as South Africa. The baseline data will serve as a benchmark for future epidemiological studies to build more evidence on the effect of ETS on eczema, in order to inform and influence policy decisions and to protect the public against the harmful effects resulting from exposure to tobacco smoke.

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