

Original article

Allergic reactions to insect stings: Results from a national survey of 10,000 junior high school children in Israel

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Background: Insect sting allergy is a medical condition the magnitude of which has not been fully estimated in children. **Objectives:** We sought to evaluate the prevalence of insect stings among schoolchildren in Israel, the rate of allergic reactions, and hospital attendance.

Methods: A self-report questionnaire of the International Study of Asthma and Allergies in Childhood was administered to a national sample of schoolchildren aged 13 to 14 years across Israel. Questions regarding insect stings, allergic reactions, and hospital attendance were added.

Results: Ten thousand twenty-one questionnaires were available for analysis. Most (56.3%) had been stung at least once in their lifetime. Of these, 20.5% had a large local reaction (LLR), 11.6% had a mild (cutaneous) systemic reaction (MSR), and 4.4% had a moderate-to-severe systemic reaction (SSR); 11.5%, 6.5%, and 2.5% of the study group, respectively. Arabs had significantly more allergic reactions of all 3 types than Jews ($P < .0001$). On multivariate analysis, LLR was associated with SSR (odds ratio, 6.25; 95% CI, 4.66-8.41) and MSR (odds ratio, 5.15; 95% CI, 4.24-6.25). More than 10% of the children with an LLR only attended a hospital compared with 7.5% of those with an MSR only and 14.5% with an SSR only. **Conclusions:** The frequency of reported allergic sting reactions in children might be higher than previously estimated. Arab children reported significantly more allergic reactions than Jews. Hospital attendance does not correlate with the severity of the allergic reaction, and only a minority of children with SSRs are treated in hospital.

Clinical implications: The improper care of severe reactions highlights the need for better public and physician education. (J Allergy Clin Immunol 2006;117:1-7.)

Key words: Schoolchildren, insect stings, large local reaction, mild systemic reaction, moderate-to-severe systemic reaction, hospital attendance

The reported prevalence of insect stings and rates of allergic reactions of all types vary among studies,¹⁻⁴ probably because of differences in the age distribution of the studied populations,^{5,6} exposure rates,^{7,8} the insect distributions in various parts of the world, and the presence of other risk factors.⁹⁻¹² Because there is no standard international questionnaire for studying allergic reactions to insect stings, differences in definition add to the variability of the figures.

Insect sting is one of the most common causes of anaphylaxis worldwide.¹³⁻¹⁵ Anaphylaxis frequently goes unrecognized by patients, as well as physicians,¹⁶ and most affected individuals never even seek medical advice.^{1,5} Therefore there is room for improvement in the medical management of insect stings, including education aimed at raising public and clinician awareness of the potential hazards to individuals at risk.

The present study was conducted in Israel, where the order Hymenoptera is common. According to the Ministry of Environment, 4 Hymenoptera genera can be found in Israel, as in other Mediterranean countries¹⁷: honey bee, *Vespa germanica* (yellow jacket), *Polistes dominulus*, and *Vespa orientalis*. Honey bee and yellow jacket account for most of the allergic reactions to insect stings in the country.¹⁸

The aim of the present study was to evaluate the prevalence of insect stings among schoolchildren in Israel and to examine the rate of allergic reactions and hospital attendance.

METHODS

Sampling strategy

The study was conducted as part of the International Study of Asthma and Allergies in Childhood¹⁹ and included a national sample of 13- to 14-year-old schoolchildren in Israel. To obtain a representative sample, 109 schools were chosen at random from a list of all junior high schools by district that was provided by the Ministry of Education. All eighth-grade children in each school selected were included in the study. The number of schools selected from each district was weighted by the total number of eighth graders in that district and

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TABLE I. History of stings by characteristics of the study participants

	Ever stung (%)	1-3 stings (%)	4-10 stings (%)	>10 stings (%)
Total (n = 10,021)	56.3	75.8	20.2	4.0
Sex				
Male (n = 4672)	61.6*	68.2*	25.4*	6.4*
Female (n = 5349)	51.7	84.4	14.2	1.4
Population group				
Arabs (n = 3308)	68.2*	65.2*	28.3*	6.5*
Jews (n = 6449)	50.5	83.7	14.3	2.0
Area of residence†				
Rural (n = 1170)	72.7*	72.8*	23.2*	4.0‡
Urban (n = 8851)	54.2	76.7	19.4	3.9

* $P < .0001$.†Rural, ≤ 2000 population; urban, >2000 population.‡ $P = .05$.*Abbreviations used*

LLR: Large local reaction

MSR: Mild systemic reaction

OR: Odds ratio

SSR: Moderate-to-severe systemic reaction

the number of children attending each school. Because Jews and Arabs generally attend separate schools, sampling was done for each population group separately. For technical reasons, we did not include the specialized school system attended by ultraorthodox Jews, who comprise 5% of the Jewish population in Israel.

Procedure

The study was carried out during the last 2 weeks of May 2003. The parents of the children in the selected schools received an explanatory letter with a reply slip that served as informed consent. The parents were asked to return the slip to the school if they did not want their child to participate in the study. Children who were absent from school on the day of the study were asked to complete the questionnaire on a specified day during the following month.

Questionnaire

Six questions regarding history of bee and wasp stings and allergic reactions were added to the International Study of Asthma and Allergies in Childhood standard core questionnaire for asthma and allergic diseases.¹⁹ Questions on demographic and social factors were also added. The children were asked if they had ever been stung by an insect, how many times, and whether they had ever experienced one or more of the following reactions: a large local reaction (LLR), defined as an induration contiguous to the sting site that was estimated to be greater than 5 cm and persisted for more than 2 days; a mild systemic reaction (MSR), defined as a reaction occurring within 1 hour of the sting and consisting of an isolated cutaneous manifestation, such as generalized hives or angioedema; or a moderate-to-severe systemic reaction (SSR), defined as a reaction occurring within 1 hour of the sting and consisting of difficulties in breathing, asthma attack, abdominal pain, or loss of consciousness. There was one question regarding hospital attendance. All items required a yes/no response, except the item about history of stings, to which the response was given in numbers.

The questionnaire was completed on an anonymous basis in the children's native language (Arabic or Hebrew) in class. The teachers were instructed not to help the children with their responses.

Statistical analysis

Statistical analyses were done with SAS package 8.2 (SAS Institute Inc, Cary, NC). χ^2 Tests were used to determine the statistical significance of differences in distributions of categorical variables. A multiple logistic regression model was fitted to the data to evaluate the association between the allergic reactions and the various risk factors. A P value of less than .05 was considered significant.

RESULTS

Response rate

The sampling process yielded a study population of 14,603 schoolchildren from 109 schools. Twelve of the schools (total of 1403 children) refused to take part in the study, leaving a final sample of 13,200 schoolchildren from 97 schools (8469 Jews and 4731 Arabs). Of these, 11,255 children filled out the questionnaire, for an overall response rate of 82.9%. An additional 1234 questionnaires were later excluded because the responses were incomplete. Thus the questionnaires of 10,021 children were available for analysis: 5349 (53.4%) female subjects and 4672 (46.6%) male subjects; 6449 (66.1%) Jews and 3308 (33.9%) Arabs.

History of stings

Of the 10,021 children, 5644 (56.3%) reported ever having been stung in their lifetime; 59.9% of them were stung more than once, and 12.2% were stung more than 5 times. The prevalence rates of stings by the characteristics of the study participants are given in Table I. Male subjects reported significantly more stings than female subjects, and Arabs reported significantly more stings than Jews. Children living in rural areas were stung more often than those from urban areas. On multiple logistic regression analysis, male subjects, Arabs, and children living in rural areas were at a higher risk of having been stung (odds ratio [OR] of 1.5 and 95% CI of 1.4-1.7 for male subjects; OR of 2.3 and 95% CI of 2.1-2.6 for Arabs; and OR of 2.9 and 95% CI of 2.5-3.3 for children living in a rural area).

Allergic reactions to stings

The children were asked to reply yes or no to each of the reactions described (LLR, MSR, and SSR) to evaluate allergic reactions to stings.

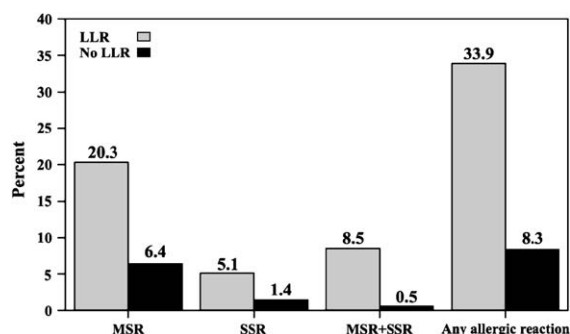


FIG 1. Prevalence of systemic reactions in patients with and without an LLR.

Of the children who had ever been stung, 20.5% (11.5% of the whole study group) reported having an LLR, 11.6% (6.5% of the study group) reported having an MSR, and 4.4% (2.5% of the study group) reported having an SSR.

An LLR only was reported by 13.6% of the children who had been stung (7.6% of the study group), an MSR only was reported by 5.1% (2.9% of the study group), and an SSR only was reported by 1.1% (0.63% of the study group). Sixty-four percent of the children who reported an SSR also reported an LLR. There was a significant association between the presence of an LLR and systemic reactions (Fig 1). Specifically, 33.9% of those who reported an LLR had systemic reactions of any kind compared with only 8.3% of those who did not report an LLR ($P < .0001$).

The prevalence rates of local and systemic reactions by the number of stings (in categories) are shown in Table II. Allergic reactions of all types were more common in those who were stung more frequently.

On univariate analyses, there were no significant differences between male and female subjects in the rates of MSRs and SSRs, although female subjects had more LLRs ($p = 0.004$). Arab children had significantly more allergic reactions of all 3 types (LLR, MSR, and SSR) than Jewish children ($P < .0001$ for all).

Table III provides the results of the multiple logistic regression analysis. After adjustment for various potential risk factors, having been stung more than once was a risk factor for all 3 types of allergic reactions. Arab children had more allergic reactions, mainly MSRs (OR, 4.34; 95% CI, 3.46-5.34). An LLR was a risk factor for an MSR (OR, 5.15; 95% CI, 4.24-6.25) and an SSR (OR, 6.26; 95% CI, 4.66-8.41). The results were similar when this analysis was limited to children who were stung more than 5 times.

Hospital attendance

The emergency department was visited by 5.8% of the children who were ever stung. Hospital attendance was significantly more common in those who were stung more times (Table II). The rate of attendance varied by the type of allergic reaction, being 10.4% for those with an LLR only, 7.5% for those with an MSR only, and 14.5% for those with an SSR only.

On multivariate analysis, LLRs, MSRs, and SSRs were significantly associated with hospital attendance after stings (OR of 4.8 and 95% CI of 3.62-6.39, OR of 2.81 and 95% CI of 2.04-3.86, and OR of 4.71 and 95% CI of 3.25-6.83, respectively). Patient sex, population group, area of residence, and number of stings (≥ 2 vs 1) did not retain statistical significance (Table III).

DISCUSSION

To the best of our knowledge, this is the first study to provide information on the nationwide prevalence of allergic reactions to insect stings among 13- to 14-year-old schoolchildren. We found that 56.3% of the children had been stung once or more by Hymenoptera species. In 2 previous studies of older populations (16-65 years old), the reported cumulative lifetime sting rates were 61% and 94.5%, respectively.^{2,4} The relatively high prevalence rate in the present study is probably related to the long hours Israeli children spend outdoors because of the good weather (mostly sunny with a short rainy season). This might also explain the significantly greater number of stings reported by male subjects, Arabs, and those living in rural areas.

The risk of sting allergies increases with the degree of exposure, and therefore some professions are associated with more frequent insect stings and systemic reactions (beekeepers and forestry workers).^{7,8,20} In the present study those who were stung more times were at a significantly higher risk of having an allergic reaction. Data on the prevalence of allergic reactions to stings among children are very limited. Two studies from the 1970s reported that 0.35% to 0.4% of girl and boy scouts aged 11 to 16 years in the United States had a history of systemic reactions.^{21,22} However, the findings were based on the health cards of the scouts who attended summer camp. This might have led to an underestimation of the prevalence of allergic reactions because many affected children would not have attended camp. Furthermore, health cards might not reveal the history in many cases because even routine medical histories can often miss the diagnosis. A more recent study from Italy found that 19.4% of 1175 primary-school children had a local reaction and 0.34% had both local and systemic reactions.¹⁰ However, the authors defined local reaction as redness, itching, or swelling at the site of the sting, without specifying its size or the time it persisted, which could account for the high prevalence. In neither of these studies was information on sting rate provided.

In the present study 11.5% of 10,021 children had LLRs, 6.5% had MSRs, and 2.5% had SSRs. These figures are similar to those reported in older populations.^{1,4,5} The high prevalence of LLR might be attributable to our relatively broad definition. Although this definition was used previously in children,²³ it might be too sensitive and insufficiently specific. The differences in results from the limited published studies in children could be due to dissimilarities in the questionnaires, which were based on various definitions of the reactions (as mentioned above), and the resolution of the questions. Differences in risk

TABLE II. Prevalence of allergic reactions and hospital attendance by number of stings

No. of stings	Individuals (%)	LLR (%)	MSR (%)	SSR (%)	Hospital attendance (%)
Ever stung	100 (56.3*)	20.5 (11.5*)	11.6 (6.5*)	4.4 (2.5*)	5.8 (3.3*)
1-3	75.8	17.3	9.25	3.5	4.9
4-10	20.2	27.6	16.1	4.7	7.0
>10	4.0	34.3	32.0	16.0	12.4
		$P < .001$	$P < .0001$	$P < .0001$	$P < .0001$

*Percentage of the whole study population.

TABLE III. Adjusted ORs (95% CIs) for allergic reactions and hospital attendance*

Factor	LLR	MSR	SSR	Hospital attendance
Sex				
Female	1.36 (1.17-1.58)	1.02 (0.82-1.22)	1.26 (0.94-1.69)	1.18 (0.9-1.54)
Male	$P < .001$	$P = .9$	$P = .11$	$P = .24$
Population group				
Arabs	1.25 (1.07-1.58)	4.34 (3.46-5.34)	1.43 (1.04-1.92)	1.1 (0.81-1.48)
Jews	$P = .005$	$P < .01$	$P = .027$	$P = .55$
Area of residence†				
Rural	1.51 (1.2-1.89)	1.33 (0.93-1.89)	1.06 (0.66-1.69)	1.04 (0.68-1.59)
Urban	$P = .0003$	$P = .11$	$P = .81$	$P = .86$
No. of stings				
1	1.69 (1.44-1.97)	1.47 (1.17-1.84)	1.57 (1.11-2.22)	0.91 (0.67-1.22)
>1	$P = .001$	$P = .0008$	$P = .001$	$P = .52$
LLR	—	5.15 (4.24-6.25), $P < .0001$	6.26 (4.66-8.41), $P < .0001$	4.80 (3.62-6.39), $P < .0001$
MSR	—	—	—	2.81 (2.04-3.86), $P < .0001$
SSR	—	—	—	4.71 (3.25-8.83), $P < .0001$

*Adjusted for all other factors listed in the table.

†Rural, ≤ 2000 population; urban, > 2000 population.

factors (eg, age at first sting and number of stings in childhood) might also have contributed.

We found that 33.9% of the children with LLRs also had systemic reactions. Although LLRs were reported in one study to be a frequent occurrence after insect sting, future stings resulted in systemic reactions in only 2% of subjects.²³ A recent study found that 7% of children with LLRs had systemic reactions to a subsequent sting.²⁴ In the present study the reactions were not reported in temporal sequence, and therefore we could not estimate the type of reaction in subsequent stings. Nevertheless, our findings indicated that those who reported systemic reactions often described a noticeable local reaction.

Arab children had more allergic reactions of all types. Because asthma, allergic rhinitis, and atopic eczema are less prevalent in Arabs than Jews,^{25,26} this observation is probably not related to an atopic background. It could be explained by a younger age at first sting; a higher frequency of stings in the Arab population, whose lifestyle is associated with more exposure to insects from early childhood; or both. These issues were beyond the scope of the present study and require further investigation. Although we are unaware of any published data about differences in allergic reactions to insect stings by ethnicity, it is possible that the high rate observed in this study is related to genetic factors.

Almost 6% of the children who were ever stung attended a hospital. The most prominent factors associated

with hospital attendance were LLR and SSR; sex, population group (Jew/Arab), and area of residence were not predictors for this parameter. There are no published data about hospital attendance after stings in children, and data in adults are inconsistent. Researchers recommend that all patients with a severe reaction to an insect sting should be hospitalized for observation for at least 24 hours.²⁷ However, although one study reported that 9.3% of subjects visited an emergency department after being stung,³ others found that most victims of an insect sting never sought medical advice.^{1,5}

The present study showed that most of the children with SSRs did not attend a hospital, whereas almost the same percentage of children with LLRs did. It is possible that because LLRs usually last for several days, parents perceive them as being more hazardous than other reactions. Accordingly, a multicenter study from the United States, recently published in this Journal,²⁸ reported that 58% of those who attended an emergency department for insect stings had local reactions, and 31% had multisystem organ involvement or hypotension. It is also important to note that in Israel most acute conditions are treated in hospitals, which are very accessible to the public. Together, these findings emphasize the low percentage of children with SSRs getting the recommended medical treatment on the one hand and the relatively high percentage of children with nonemergency LLRs who attend hospitals on the other hand.

We are aware that the present study was limited by our use of children's self-reports. Children's reporting of allergic reactions depends on the definitions that are used and their preconceptions of allergic reactions. However, earlier studies found that children's self-reports on respiratory symptoms were valid²⁹ and that school-age children can report effectively on their own general health and well-being.³⁰

Because this was a nationwide anonymous study, we could not validate the findings with physicians or with specific IgE measurements. This could have contributed to some overestimation of the prevalence of allergic reactions. It is well recognized that the history and diagnostic tests are imperfectly correlated. The dilemma of negative skin test results in patients with a convincing history and a reaction on subsequent stinging has been discussed in the literature.^{31,32}

In conclusion, the frequency of reported allergic sting reactions in Israeli children is higher than previously reported in this age group and is consistent with the rate in adults. Arab children appear to have significantly more allergic reactions than Jews, independent of the number of stings. However, it is possible that our figures might be overestimated because of the methodology used and the lack of confirmation by detailed history, diagnostic tests, or both. As in other countries and despite good access to care, Israeli children with moderate-to-severe allergic sting reactions do not seek the medical attention that they should. Standardized international studies might contribute to a better understanding of this medical issue and help clinicians to set guidelines for prevention, education, and therapy.

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