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Adolescent pesticide exposures reported to Texas poison centers

Abstract

Background: Pesticides, particularly when misused, can cause serious morbidity and mortality. There is limited literature on pesticide exposures among adolescents.
Objective: The purpose of this study was to describe adolescent pesticide exposures reported to poison centers and compare them to adult exposures.
Subjects: Pesticide exposures reported to Texas poison centers during 2000–2013 where the patient was age 13 years or greater.
Methods: Cases were divided into adolescents (13–19 years) and adults (20 years or more). The distribution of the cases was determined for various factors, and comparisons were made between the two age groups.
Results: There were 2772 adolescent and 33,573 adult pesticide exposures. The most common types of pesticide among adolescent and adult cases, respectively, were insecticides (71% vs. 76%), herbicides (6% vs. 9%), repellents (11% vs. 8%), and rodenticides (10% vs. 5%). Adolescent patients were 56% male and 43% female; adult patients were 45% male and 55% female. The most common exposure routes among adolescent and adult cases, respectively, were dermal (29% vs. 38%), inhalation (22% vs. 33%), ingestion (47% vs. 29%), and ocular (14% vs. 13%). The exposure reason for adolescent and adult exposures, respectively, were unintentional (82% vs. 89%), intentional (13% vs. 7%), adverse reaction (2% vs. 3%), and other/unknown (3% vs. 1%).
Conclusion: Compared to adult exposures, adolescent pesticide exposures were more likely to involve repellents and rodenticides, involve males, occur by ingestion, and be intentional.

Keywords: management; pesticide; poison center.

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Introduction

Pesticides have a variety of uses. They can increase agricultural production, preserve produce, and combat infestations of insects and other pests. Approximately 1.1 billion pounds of pesticide active ingredients are used annually in the United States (1). Over 20,000 pesticide products are marketed in the U.S. (1). Pesticide sales in the U.S. totaled $12.5 billion in 2007, accounting for 32% of total world sales (2).

Pesticides, particularly when misused, can cause morbidity and mortality. The U.S. Environmental Protection Agency (EPA) estimates that 10,000–20,000 pesticide poisonings occur among the roughly two million agricultural workers nationally each year (1). Over 88,000 pesticide exposures were reported to U.S. poison centers in 2012, making them the tenth most common substance reported in 2012. At least 16 of these exposures resulted in death (3).

The literature contains relatively little information on pesticide exposures among adolescents. This may partially be due to higher proportions of potentially adverse pesticide exposures occurring among young children and adults. Of 82,916 single-substance exposures to pesticides reported to U.S. poison centers in 2012, 36,056 involved patients aged 5 years or less, 4016 aged 6–12 years, and 32,563 aged 20 years or more, whereas only 2675 involved patients aged 13–19 years (3). The EPA has created plans for reducing the risk of pesticide exposures in school settings (4). However, children may be exposed to pesticides outside of school. A study of exposures among patients aged 6–19 years reported to Texas poison centers during 1998–2002 found 2.6% of non-school exposures involved pesticides. In contrast, pesticides were not included in the top 15 substances reported among school exposures in this age group (5).

The objective of this investigation was to describe adolescent pesticide exposures that were reported to a large poison center system. Moreover, the pattern of adolescent

exposures was compared to adult exposures to determine whether there were any differences in pesticide exposures between the two age groups.

Materials and methods

This retrospective study used data collected by the Texas Poison Center Network (TPCN), which comprises six poison centers that together service the entire state. According to the 2010 Census, there were over 2.6 million persons aged 13–19 years in Texas. All of the TPCN centers use a common electronic database to collect information on all exposures in a consistent manner. The data variables and allowable codes in this database were standardized by the American Association of Poison Control Centers (AAPCC) (6). The Texas Department of State Health Services institutional review board considers this analysis exempt from ethical review.

Cases were all pesticide exposures reported to the TPCN during 2000–2013 where the patient was aged 13 years or more. Exposures involving substances in addition to the pesticide were included. Cases not followed to a final medical outcome also were included because these comprised a large portion of the total cases. Exposures reported from outside of Texas were excluded.

The cases were divided into two age groups: (1) adolescents (patients age 13–19 years or classified as "adolescent") and (2) adults (patients age 20 years or more or classified as "adult"). For both age groups, the distribution of cases was determined for pesticide category, time period, patient gender, exposure route, circumstances of (reason for) the exposure, exposure site, management site, medical outcome, and most commonly reported adverse clinical effects.

For examination by time period, annual trends were examined by grouping the cases into two seven-year time periods (2000–2006 and 2007–2013) and seasonal trends by grouping into three four-month periods (January–April, May–August, and September–December). For exposure reason, the major categories were unintentional (i.e., accidental), intentional (i.e., suspected attempted suicide, intentional misuse or abuse), adverse reaction to the product (occurred with normal, prescribed, labeled, or recommended use of the product), other, and unknown.

The medical outcome or severity of an exposure is assigned by the poison center staff and is based on the observed or anticipated adverse clinical effects. Medical outcome is classified according to the following criteria: no effect (no symptoms due to exposure), minor effect (some minimally troublesome symptoms), moderate effect (more pronounced, prolonged symptoms), major effect (symptoms that are life-threatening or cause significant disability or disfigurement), and death. A portion of exposures are not followed to a final medical outcome because of poison center resource constraints or the inability to obtain subsequent information on the patient. In these instances, the poison centers' staff record the expected outcome of the exposure. These expected outcomes are grouped into the following categories: not followed but judged to be a nontoxic exposure (symptoms not expected); not followed but minimal symptoms possible (no more than minor symptoms possible); unable to follow but judged as a potentially toxic exposure. Another medical outcome category is unrelated effect, where the exposure was probably not responsible for the symptoms. An analysis of medical outcome was performed for these specific outcomes as well as grouping the outcomes into those known or expected to have no effects (no effect, not followed, and judged nontoxic), known or expected to have minor effects (minor effect, not followed, and judged minimal effects), and those known or expected to be serious (moderate effect, major effect, death, unable to follow, and potentially toxic).

Any observed differences in the distribution of adolescent and adult pesticide exposures were evaluated for statistical significance by calculating the rate ratio of the adolescent and adult percentages for each subgroup and 95% confidence interval (CI) by the Newcombe-Wilson method without continuity correction. The rate ratios were considered statistically significant if the 95% CI excluded 1.00, and p-Values were not calculated.

Results

Out of 95,611 total pesticide exposures reported to the TPCN during 2000–2013, 2772 involved adolescents, and 33,573 involved adults. Of the adolescent cases, 2588 (93.4%) involved a single pesticide product and no other substances, 58 (2.1%) involved more than one pesticide product, and 140 (5.1%) involved other substances besides pesticides. Of the adult cases, 31,484 (93.8%) involved a single pesticide product and no other substances, 943 (2.8%) involved more than one pesticide product, and 1264 (3.8%) involved other substances besides pesticides. Of the adolescent cases, the number of patients tended to increase with patient age (Table 1).

Table 2 presents the distribution of cases by pesticide category. For both age groups, the most common pesticides were insecticides. Among adolescents, the next most common pesticides were repellents followed by rodenticides and then herbicides. Among adults, the next most common pesticides were herbicides followed by repellents and rodenticides. For these four pesticide categories, as well as for fungicides, the differences in percentages between the two age groups were statistically significant.

Table 3 shows the circumstances and demographics of the pesticide exposures. Approximately equal proportions

Table 1: Age distribution of adolescent pesticide exposures reported to the Texas Poison Center Network during 2000–2013.

Age, years	Number	%
13	351	12.7
14	357	12.9
15	357	12.9
16	353	12.7
17	378	13.6
18	459	16.6
19	455	16.4
Unknown	62	2.2
Total	2772	

Table 2: Comparison of adolescent and adult pesticide exposures reported to the Texas Poison Center Network during 2000–2013 by pesticide category.

Pesticide category	Adolescent		Adult		RR[a]	95% CI[b]
	No.	%	No.	%		
Total	2722		33,573			
Insecticides	1.956	70.6	25,543	76.1	0.93	0.90–0.95
Herbicides	169	6.1	2930	8.7	0.70	0.60–0.81
Repellents	312	11.3	2602	7.8	1.45	1.30–1.62
Rodenticides	270	9.7	1776	5.3	1.84	1.63–2.08
Fungicides	23	0.8	454	1.4	0.61	0.40–0.93
Fumigants	13	0.5	135	0.4	1.17	0.66–2.06
Miscellaneous	37	1.3	325	1.0	1.38	0.98–1.93

Adolescent, 13–19 years; adult, ≥20 years. An exposure may involve pesticides in more than one category. [a]RR, rate ratio (ratio of adolescent percentage to adult percentage); [b]CI, confidence interval. Interval not including 1.00 is considered to be statistically significant.

of adolescent exposures were reported during the first and second halves of the 14-year time period. However, a higher proportion of adult exposures were reported during the second 7-year period, with the difference between the two age groups being statistically significant. The seasonal patterns of adolescent and adult exposures were similar with roughly half of the exposures reported during May–August. Whereas the majority of adolescent exposures involved males, the majority of adult exposures involved females; the differences in percentages by patient gender were statistically significant.

Almost half of the adolescent exposures involved ingestion, with the next most frequent routes being dermal contact and inhalation. Dermal contact was the most frequent route of adult exposures followed by inhalation and ingestion. The differences in percentages for these three routes were statistically significant between

Table 3: Comparison of adolescent and adult pesticide exposures reported to the Texas Poison Center Network during 2000–2013 by selected demographic factors and circumstances of the exposure.

Variable	Adolescent		Adult		RR[a]	95% CI[b]
	No.	%	No.	%		
Total	2772		33,573			
Time period						
2000–2006	1369	49.4	15,691	46.7	1.06	1.02–1.10
2007–2013	1403	50.6	17,882	53.3	0.95	0.91–0.99
Seasonal period						
January–April	660	23.8	7709	23.0	1.04	0.97–1.11
May–August	1409	50.8	17,303	51.5	0.99	0.95–1.02
September–December	703	25.4	8561	25.5	0.99	0.93–1.06
Patient gender						
Male	1562	56.3	15,158	45.1	1.25	1.21–1.29
Female	1204	43.4	18,324	54.6	0.80	0.76–0.83
Unknown	6	0.2	91	0.3	0.80	0.35–1.82
Route (most common)[c]						
Dermal	808	29.1	12,857	38.3	0.76	0.72–0.81
Inhalation	611	22.0	10,937	32.6	0.68	0.63–0.73
Ingestion	1292	46.6	9,726	29.0	1.61	1.54–1.68
Ocular	379	13.7	4,474	13.3	1.03	0.93–1.13
Exposure reason						
Unintentional	2281	82.3	29,809	88.8	0.93	0.91–0.94
Intentional	363	13.1	2403	7.2	1.83	1.65–2.03
Adverse reaction	56	2.0	906	2.7	0.75	0.57–0.98
Other	58	2.1	292	0.9	2.41	1.82–3.18
Unknown	14	0.5	163	0.5	1.04	0.60–1.79
Exposure site (most common)						
Own residence	2351	84.8	30,075	89.6	0.95	0.93–0.96
Other residence	111	4.0	786	2.3	1.71	1.41–2.08
Workplace	128	4.6	1849	5.5	0.84	0.70–1.00
School	71	2.6	19	0.1	45.26	27.32–74.98
Public area	46	1.7	333	1.0	1.67	1.23–2.27

Adolescent, 13–19 years; adult, ≥20 years. [a]RR, rate ratio (ratio of adolescent percentage to adult percentage); [b]CI, confidence interval. Interval not including 1.00 is considered to be statistically significant; [c]An exposure may have occurred by multiple routes.

the age groups. Among both adolescents and adults, most of the exposures were unintentional, with the next most frequent exposure reason being intentional; however, the unintentional rate was significantly lower and the intentional rate significantly higher among adolescents. The preponderance of exposures among both age groups occurred at the patient's own residence. Nevertheless, the proportion of exposures that occurred at another residence, school, or public area was substantially higher among adolescents and the proportion that occurred in the workplace was higher among adults.

With respect to the management site (Table 4), most of the adolescent and adult patients were managed on site (i.e., outside of a healthcare facility), although the percentage was significantly higher among adults. A significantly higher percentage of adolescent patients were already at or en route to a healthcare facility when the poison center was contacted. Of the 821 adolescent patients already at, en route to, or referred to a healthcare facility, 466 (56.8%) were treated or evaluated and released, 158 (19.2%) were admitted, and 197 (24.0%) refused referral, were lost to follow-up, or left against medical advice. Of the 8721 adult patients already at, en route to, or referred to a healthcare facility, 4480 (51.4%) were treated or evaluated and released, 1400 (16.1%) were admitted, and 2841 (32.6%) refused referral, were lost to follow-up, or left against medical advice. The majority of exposures among both age groups were not serious or expected to be serious.

Table 5 presents the distribution of the 14 most commonly reported adverse clinical effects. Only four (ocular irritation/pain, vomiting, red eye, abdominal pain) were more frequently reported among adolescents, with the differences in rates being statistically significant for vomiting and abdominal pain. Of the remaining ten clinical effects, the rates were substantially higher among adults for seven (dermal irritation/pain, cough/coke, headache, throat irritation, dizziness/vertigo, dyspnea, and diarrhea).

Discussion

Only 2772 adolescent exposures were reported during the 14-year period of this study. And of these exposures, only 12% were known or expected to have serious outcomes. Taken together, this information suggests that potentially adverse pesticide exposures among adolescents are relatively uncommon, at least in Texas. And of those exposures that do occur, the majority will have no or minor health effects.

Table 4: Comparison of adolescent and adult pesticide exposures reported to the Texas Poison Center Network during 2000–2013 by management site and medical outcome.

Variable	Adolescent		Adult		RR[a]	95% CI[b]
	No.	%	No.	%		
Total	2722		33,573			
Management site						
On site (non-HCF)	1907	68.8	24,377	72.6	0.95	0.92–0.97
Already at/en route to HCF	629	22.7	6290	18.7	1.21	1.13–1.30
Referred to HCF	192	6.9	2431	7.2	0.96	0.83–1.10
Other	34	1.2	359	1.1	1.15	0.81–1.63
Unknown	10	0.4	116	0.3	1.04	0.55–1.99
Medical outcome						
No effect	449	16.2	4069	12.1	1.34	1.22–1.46
Minor effect	634	22.9	6828	20.3	1.12	1.05–1.21
Moderate effect	148	5.3	1982	5.9	0.90	0.77–1.06
Major effect	19	0.7	188	0.6	1.22	0.76–1.96
Death	0	0.0	17	0.1	0.00	–
Not followed – nontoxic	153	5.5	1707	5.1	1.09	0.92–1.27
Not followed – judged minimal	1057	38.1	13,873	41.3	0.92	0.88–0.97
Not followed – potentially toxic	150	5.4	1801	5.4	1.01	0.86–1.19
Unrelated effect	162	5.8	3108	9.3	0.63	0.54–0.74
Serious[c]	317	12.1	3988	13.1	0.93	0.83–1.03

Adolescent, 13–19 years; adult, ≥20 years. HCF, healthcare facility; [a]RR, rate ratio (ratio of adolescent percentage to adult percentage); [b]CI, confidence interval. Interval not including 1.00 is considered to be statistically significant; [c]Moderate effect, major effect, death, not followed but potentially toxic.

Table 5: Comparison of adolescent and adult pesticide exposures reported to the Texas Poison Center Network during 2000–2013 by most common adverse clinical effects.

Adverse clinical effects	Adolescent		Adult		RR[a]	95% CI[b]
	No.	%	No.	%		
Total	2722		33,573			
Ocular irritation/pain	310	11.2	3449	10.3	1.09	0.98–1.21
Nausea	246	8.9	3185	9.5	0.94	0.83–1.06
Vomiting	283	10.2	2669	7.9	1.28	1.14–1.44
Dermal irritation/pain	149	5.4	2403	7.2	0.75	0.64–0.88
Cough/choke	137	4.9	2295	6.8	0.72	0.61–0.86
Headache	122	4.4	1936	5.8	0.76	0.64–0.91
Throat irritation	104	3.8	1604	4.8	0.79	0.65–0.95
Dizziness/vertigo	86	3.1	1560	4.6	0.67	0.54–0.83
Dyspnea	64	2.3	1310	3.9	0.59	0.46–0.76
Red eye	119	4.3	1254	3.7	1.15	0.96–1.38
Erythema/flushed	67	2.4	952	2.8	0.85	0.67–1.09
Abdominal pain	110	4.0	892	2.7	1.49	1.23–1.81
Diarrhea	45	1.6	933	2.8	0.58	0.43–0.79
Rash	61	2.2	769	2.3	0.96	0.74–1.24

Adolescent, 13–19 years; adult, ≥20 years. [a]RR, rate ratio (ratio of adolescent percentage to adult percentage); [b]CI, confidence interval. Interval not including 1.00 is considered to be statistically significant.

When adolescent pesticide exposures were compared to adult pesticide exposures, a number of statistically significant differences were found between the two age groups. Although insecticides were the most commonly reported pesticide among both age groups, the next most common pesticides among adolescents were repellents followed by rodenticides and herbicides, whereas among adults, herbicides were followed by repellents and rodenticides. Due to their age and opportunities, it may be relatively easier for adolescents to have access to repellents and rodenticides and more difficult to have access to herbicides when compared to adults.

Adolescent exposures were substantially more likely to involve males, whereas adult exposures were substantially more likely to involve females. The most common route of exposure among adolescents was ingestion followed by dermal contact and inhalation; among adults, the most common route was dermal contact followed by inhalation and then ingestion, differences that were statistically significant. Like adult exposures, the majority of adolescent exposures were unintentional; however, the intentional exposures percentage was almost twice as high among adolescents, a difference that was statistically significant. Whereas the majority of exposures among both age groups occurred at the patient's own residence, substantially higher proportions of adolescent exposures occurred at another residence, school, or public area. Although most of the exposures among the two age groups were managed outside of a healthcare facility, this percentage was significantly higher among adults. Moreover, a substantially higher proportion of adolescent patients were already at or en route to a healthcare facility when the poison center was contacted.

Of the 14 most commonly reported adverse clinical effects, vomiting and abdominal pain were reported substantially more often among adolescent exposures, whereas dermal irritation/pain, cough/coke, headache, throat irritation, dizziness/vertigo, dyspnea, and diarrhea were substantially more often reported among adults. These divergent patterns of clinical effect may at least partially be related to differences between the two age groups with respect to the particular circumstances of the pesticide exposures (i.e., type of pesticide, route of exposure, exposure reason).

Despite all of these differences in pesticide exposures between the two age groups, the proportion of adolescents and adults with outcomes known or suspected to be serious were similar (12% and 13%, respectively).

The results of this investigation suggest that these differences between adolescent and adult pesticide exposures may need to be taken into consideration when creating education, prevention, and management activities and guidelines for reducing adolescent pesticide exposures and when treating those potentially adverse exposures that occur. As pesticide exposures among adults are not necessarily the same as those that occur among adolescents, such policies designed for the former may not be directly applicable to the latter. It should be mentioned

that actions that reduce the overall use of pesticides in society might be expected to decrease both adolescent and adult potentially adverse pesticide exposures.

Of particular note is the observation that <3% of the adolescent exposures occurred at school, which might indicate that plans for reducing the risk of pesticide exposures in school settings, such as those implemented by the EPA (4), might not greatly affect the majority of potentially adverse pesticide exposures among adolescents.

There are limitations to this study. The data were obtained from the poison centers in a single state, albeit one with a population of over 25 million. The pattern of pesticide exposures in Texas may not be similar to those in the rest of the United States or other countries. The analysis used data only from Texas poison centers; the main purpose of these centers is to manage potentially adverse exposures and not data collection for research. The reporting of potentially adverse pesticide exposures to Texas poison centers is strictly voluntary. Thus, all such exposures are not likely to be reported, and it follows that those exposures that are reported may not be representative of all such exposures that occur in the state. Furthermore, pesticide exposure often was based solely on the report of the caller and was not necessarily clinically confirmed. This is particularly true for those exposures managed outside of a healthcare facility. In addition, there was no follow-up into the root causes of the exposures.

In conclusion, adolescent pesticide exposures reported to Texas poison centers most often involved insecticides followed by repellents, rodenticides, and herbicides. The exposures most frequently occurred during May–August. The majority of patients were male. The exposure route was most often ingestion, dermal contact, or inhalation. The preponderance of adolescent pesticide exposures were unintentional and occurred at the patient's own residence. Most of the exposures were managed on site and did not result in serious outcomes. The pattern of adolescent exposures differed in a number of ways from adult exposures.

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