

Trends in the Exposures to Pesticides in Central Europe

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1. Introduction

The occupational exposures of the humans to pesticides may occur in the gardens, fields, and forests during their dissemination, but also in the course of the preparatory activities, repair of application equipment, and their re-entry, where most symptomatic exposures happened (Meulenbelt & de Vries, 1997). Agricultural workers in several countries in Africa, Asia and South America are at greater risk of pesticide poisoning than non-agricultural workers and there appears a need for heightened efforts to better protect farm workers from pesticide exposure (Litchfield, 2005, Dasgupta et al., 2006, Calvert et al., 2008, Mancini et al., 2009).

Pesticides also became a part of our households and are used for both outdoor and indoor domestic application. As they are considered to be toxic by the general population, they are frequently ingested with the intent to commit a suicide. Globally, agricultural pesticides account for at least 250,000 suicide deaths each year, making pesticides the single most common means of suicide worldwide (Gunnell et al., 2007, Nguyen et al., 2010, Lin et al. 2010, Roberts et al., 2010).

Additionally, children are frequently exposed to any type of pesticide, mostly by ingestion. The exposure of children to pesticides may lead to a different outcome depending on the type of pesticide, geographic location, healthcare system and other variables (Hruskovic et al., 1984, Sudakin & Power, 2009), in South Africa it represents an increasingly important problem and may lead to death (Balme et al., 2010).

Not surprisingly, both home pets and farm animals may come in touch with the pesticides, either accidentally or due to aggressive behavior of some humans, trying to poison them deliberately.

An amount of information has been written on the application of pesticides, their degradation and analyses (Fischer et al., 2011). However, relatively little has been published about the trends in the pesticides use, frequency of exposures and their changing impact on the health in Central Europe.

Therefore, the aim of this chapter is to describe the situation based on the inquiries to the Toxicological Information Centre (TIC) in Prague, which serves to the total Czech population of approximately 10 million inhabitants. Since our last detailed evaluation of the calls 20 years ago (Pelcova et al., 1991) the situation has substantially changed.

2. Methods

Data from the TIC database from the period 1991 to 2010 have been retrospectively evaluated. In all years, the information on the type of pesticide, dose, time, and way of exposure; age and gender of the patient, reason of ingestion, symptoms, and treatment recommended was available. As the electronic recording system started in 1997, the registration of the calls by the physicians – toxicologists in the first period of this study, i.e. in the years 1991-1996, was available only in the hard copy. Based on the electronic recording system in the years 1997-2010, the evaluation of the clinical severity, prognosis, and detailed recommendation for the case management were also available. All intoxications were classified in accordance with the Poisoning Severity Score (Persson et al. 1998).

Additionally, the number of calls due to occupational exposures was compared with the electronic Registry of Occupational Diseases (Urban et al., 2000), which collects all of occupational diseases that were acknowledged and compensated in the Czech Republic. The Registry records the information about the patient, exposure, job, diagnosis, noxious factors; on the other hand, it does not include the acute injuries. Occupational diseases are classified according to the chapters and intoxications with pesticides are recorded separately from skin disorders caused by pesticides.

3. Results

3.1 Total calls due to pesticides

The number of total calls to the TIC continuously increases, as can be seen in Figure 1. In the year 2010 it reached almost 12 thousand per year. Inquiries due to pesticides in the years 1991-2010 amounted total 8530 and accounted for 5.52% of total calls. As shown in Figure 1, the proportion of the calls concerning pesticides slowly decreased from 7.81% in 1991 to 3.75% in 2010.

3.2 Seasonal variation

The calls to the TIC due to pesticides do not have a symmetric distribution throughout the year and they display a seasonal variation, as can be seen in Figure 2. About 79.7% of all exposures occurred in the vegetation period from April to October, during which the occupational and home utilization of pesticides prevailed. Only 20.3% of inquiries were asked in the other months. In the non-vegetation period the proportion of exposures from other reasons, such as suicidal attempts and accidental ingestions of pesticides was more pronounced.

3.3 The population concerned

Among the inquiries concerning pesticides, 44.7% (from 38.0 to 59.4%) concerned adults, 43.1% (36.9-52.1%) children, and 12.0% (2.9-22.3%) animals. The proportion of adults, children, and animals during the years 1997-2010 did not exhibit a certain trend, as can be seen in Figure 3.

As to the gender of the subjects in human exposures, 56.6% of calls involved men; 41.8% women; and the gender was unknown in 1.6%.

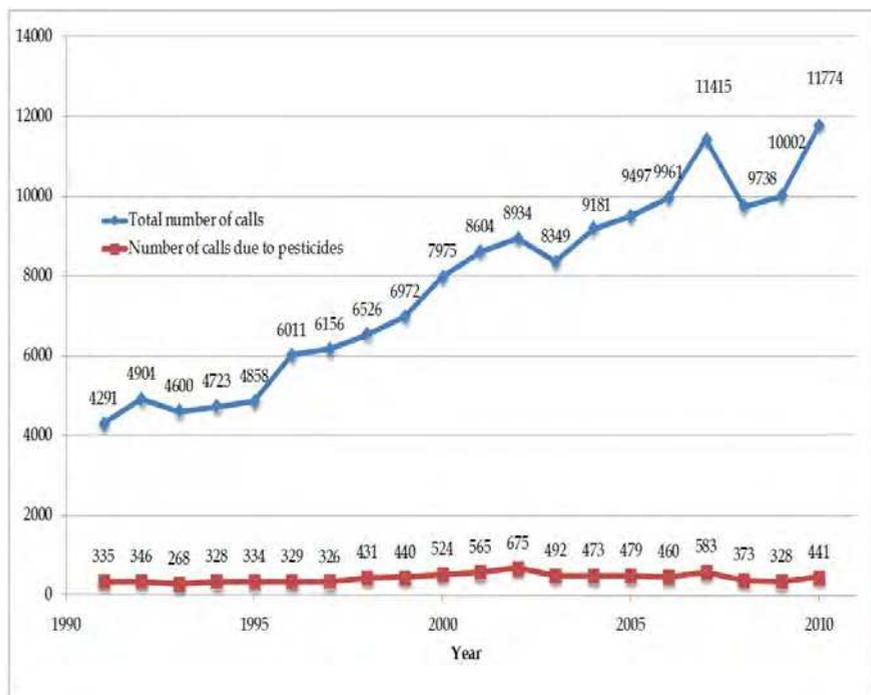


Fig. 1. Total number of calls to the TIC of the Czech Republic and the number of calls due to pesticides in the years 1991-2010

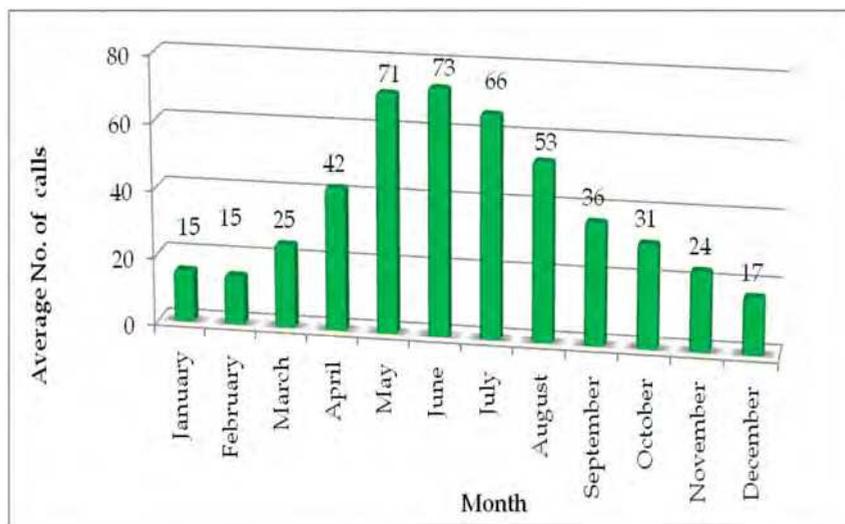


Fig. 2. Average number of calls to the TIC concerning pesticides throughout the months of the year.

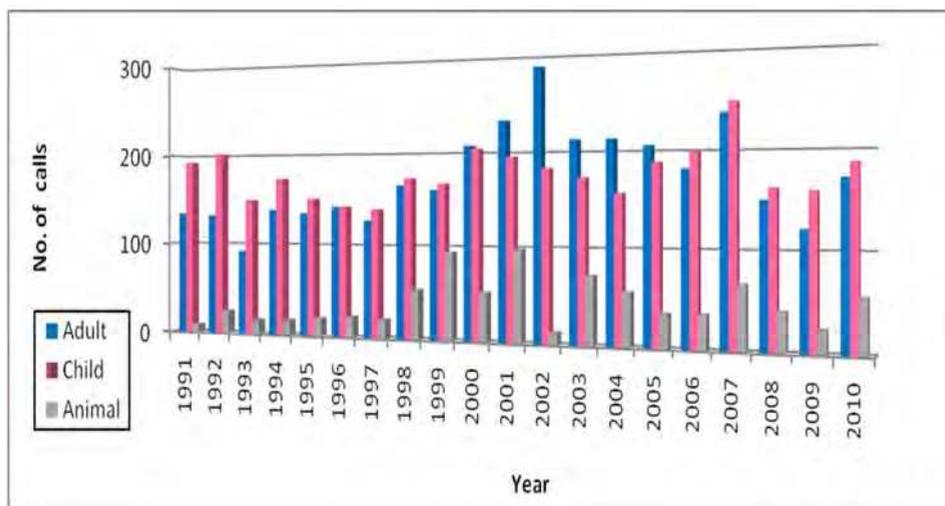


Fig. 3. The population in the calls to the TIC concerning pesticides in the years 1997-2010

3.4 The reason of exposure

Pesticide exposures occurred predominantly accidentally (including house work, wrong use and children exposures), which was the case in 90.5% of the calls due to pesticides in the years 1997-2010. In total, only 5.9% exposures were suicidal, 2.7% occupational and 0.7% due to aggressive behavior. The percentage of other or unknown reasons amounted to about 2.9%.

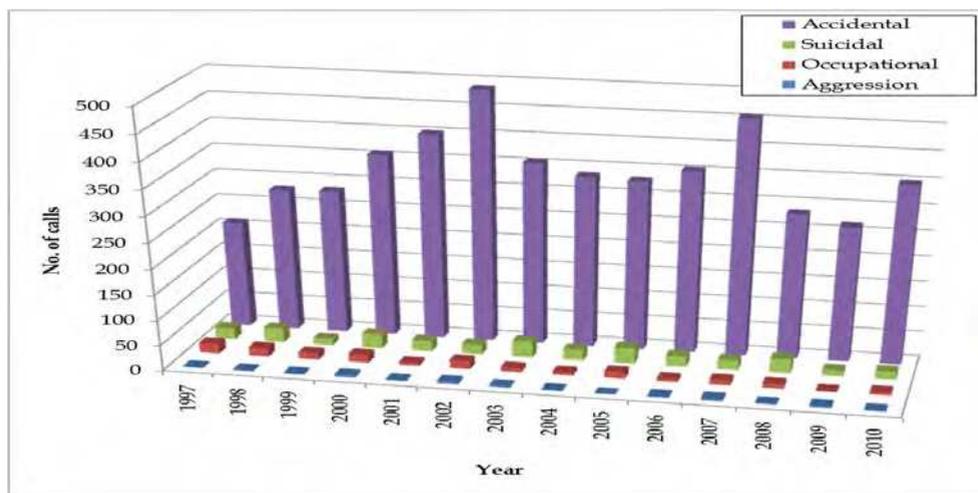


Fig. 4. The reason of exposure in the calls, concerning pesticides to the TIC in the years 1997-2010

A detailed analysis of the causes of exposure was possible in the past 6 years and can be seen in Figure 5. Again, most common was the unintentional exposure; the second most

frequent reason of exposure was the house work with pesticides. As can be seen, the suicidal exposure slightly decreased. Another new item, wrong use, appeared in the statistic.

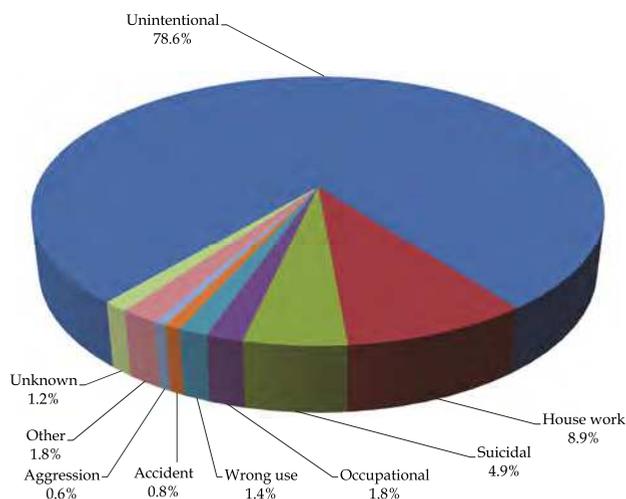


Fig. 5. Detailed reasons of exposure in the calls to the TIC in the years 2005-2010

The percentage of inquiries due to occupational exposures dropped in the last 6 years from 2.7% to 1.6%.

Accordingly, the data of the Registry of Occupational Diseases shows a low number of occupational diseases.

The poisonings with pesticides during past 20 years involved only 2 workers, occupationally exposed to synthetic pyrethrins, as can be seen in Figure 6.

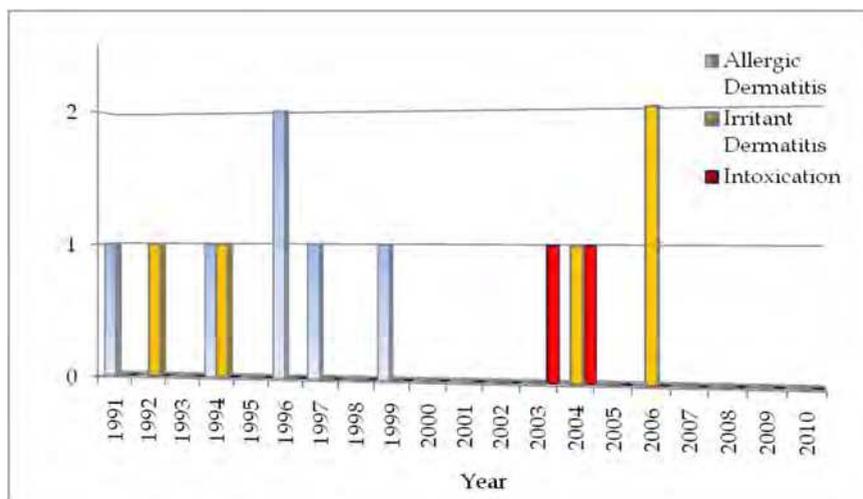


Fig. 6. Occupational diseases due to pesticides according to the Registry of Occupational Diseases in the Czech Republic in the years 1991-2010.

Occupational skin disorders were more frequent and involved 6 cases of contact allergic dermatitis. The diseases occurred due to the exposure to propoxur, cypermethrin, mancozeb. Other 5 subjects developed the contact irritant dermatitis (due to permethrin, triadimefon, metiram, sulfur, copper oxychloride, methyl and benzisothiazolinone). As can be seen in Figure 6, last occupational disorders were acknowledged in 2006.

3.5 The route of exposure

Ingestion was the most frequent scenario of exposure and accounted for 85.1%, inhalation for 12.4% and skin contamination for 2.5% of the calls due to pesticides.

Obviously, ingestion was the most common way of exposure in children and in adults committing suicide; on the other hand, the inhalation played a role in exposure almost exclusively in adults during their domestic or occupational work with pesticides in the house, garden or field.

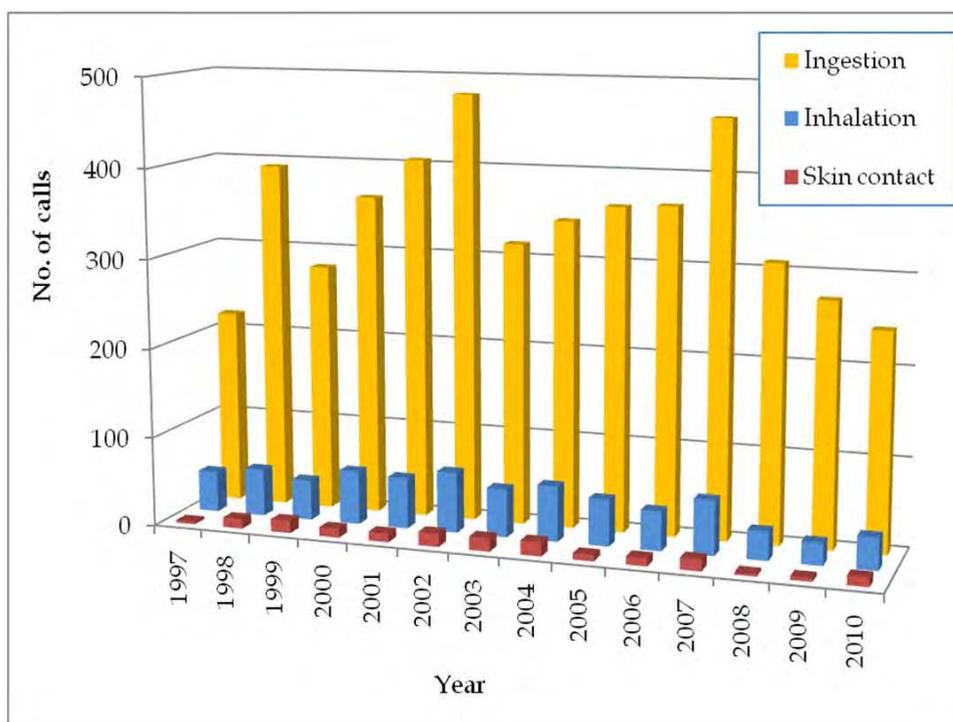


Fig. 7. The route of exposure to pesticides in the calls to the TIC in the years 1997-2010

3.6 The symptoms

The symptoms of intoxication in all inquiries due to all pesticides in the years 1997-2010 were absent in 69.7% of subjects, including the animals. About 23.6% of subjects had mild symptoms, 4.2% medium, and 0.6% severe; the symptoms at the time of the call were unknown in the rest of the cases. Consultation of a decrease concerning a pesticide was the reason of the phone call in 0.1% of cases only.

The severity of symptoms was not the same in the group of cholinergic pesticides, in the group of rodenticides and other pesticides (fungicides, herbicides, molluscocides, etc.).

The differences in the frequency of symptoms due distinct groups of pesticides at the time of the inquiry can be seen in Figure 8 (for organophosphates and carbamates), Figure 9 (for rodenticides), and Figure 10 (for other pesticides).

No lethal case was recorded due to exposure to a rodenticide, inclusive the suicide attempts during the past 14 years. In humans, symptoms of bleeding developed after a repeated exposure, including skin exposure due to a contaminated bed in the hayloft. In other subjects, the exposure to rodenticides has not been proven and was merely considered in differential diagnosis. The symptoms occurred mostly in animals, especially dogs, where repeated exposures could not be excluded.

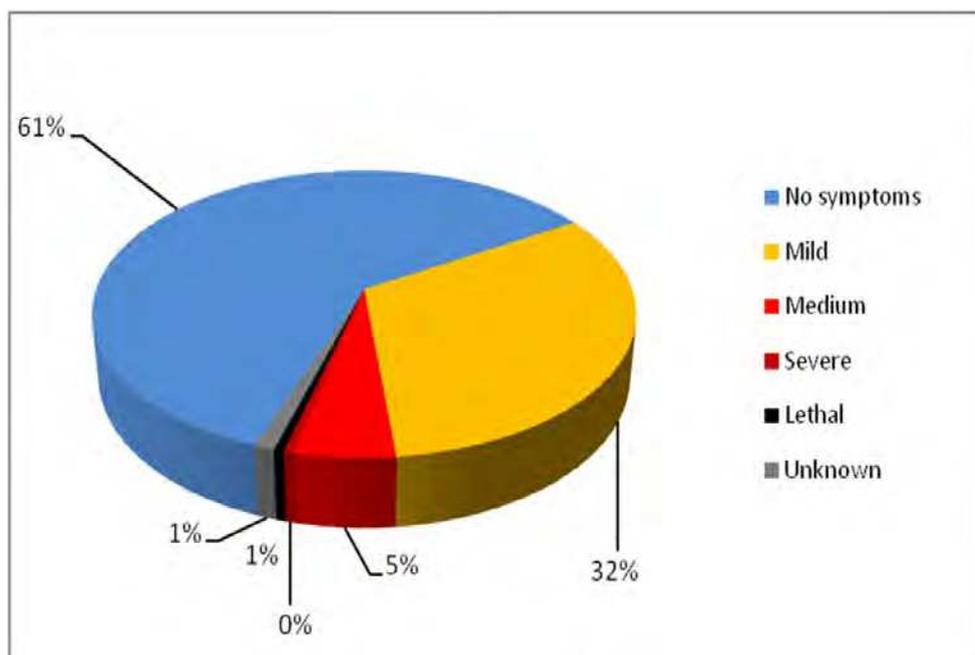


Fig. 8. Symptoms due to cholinergics (organophosphates and carbamates) during the call to the TIC in the years 1997-2010

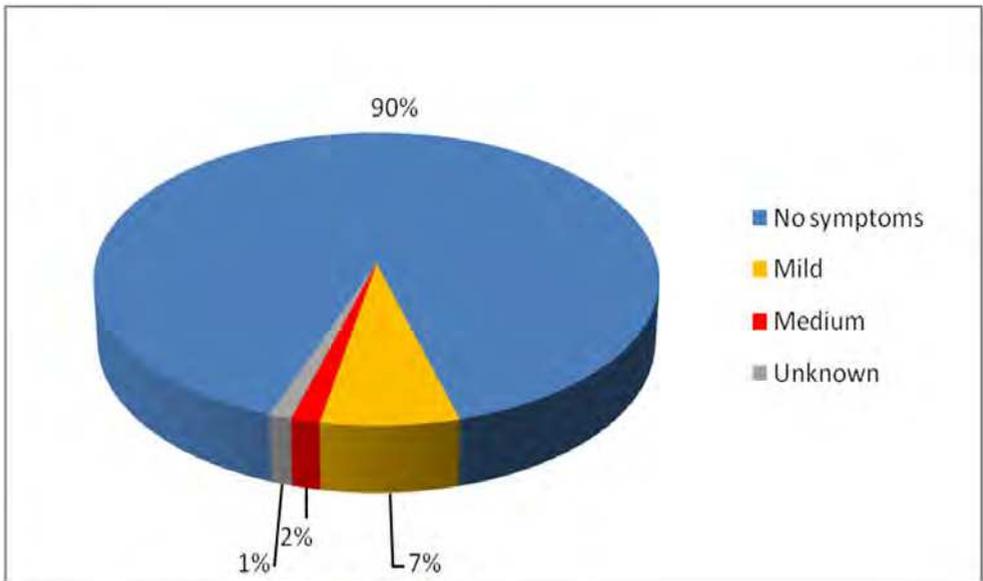


Fig. 9. Symptoms due to rodenticides during the call to the TIC in the years 1997-2010

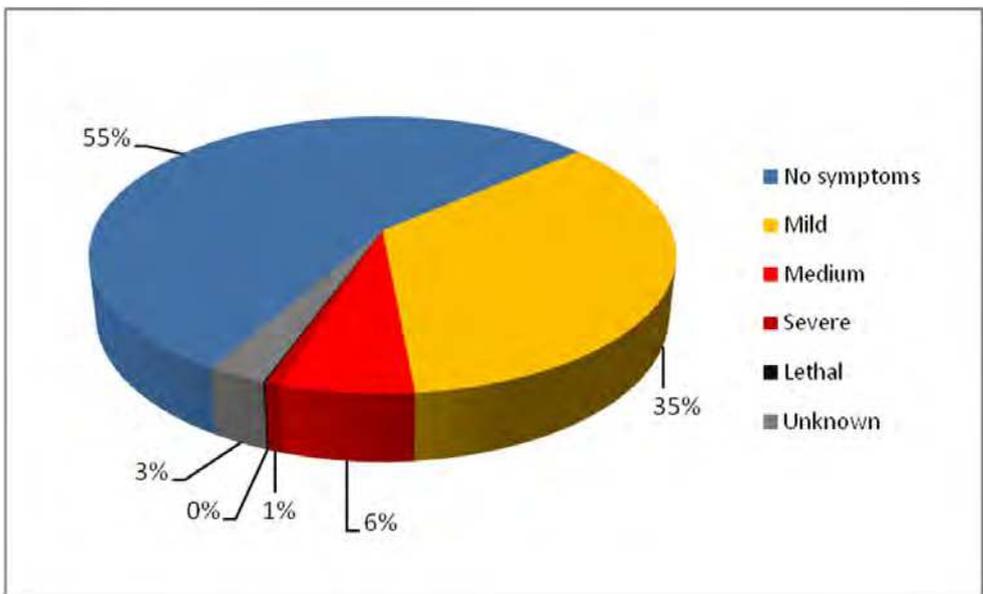


Fig. 10. Symptoms due to other pesticides during the call to the TIC in the years 1997-2010
Symptomatic exposures to other pesticides concerned most frequently the dogs, exposed to molluscocides.

3.7 The dose of the pesticide

The level of the pesticide exposure, evaluated by the physician at the time of the call, is shown in Figure 11; the most frequent evaluation was "Low".

The difficulty to make an exact estimate of the dose is seen in the high percentage of the "Unknown" classification, which includes especially oral exposures of the children and animals on one hand, and inhalational and skin exposures in all subjects at the other hand.

3.8 Prognosis of the exposure

Prognosis of the pesticide exposure, evaluated individually in every patient at the time of the call, is presented in Figure 11. The decision was based on several parameters, able to influence further development of the exposure/intoxication. To the most important parameters belonged especially the dose of the pesticide, time interval since the exposure, the symptoms of the patient, and the availability of the antidote or other efficient treatment.

It can be seen that the counts are relatively stable and prognosis is relatively favorable.

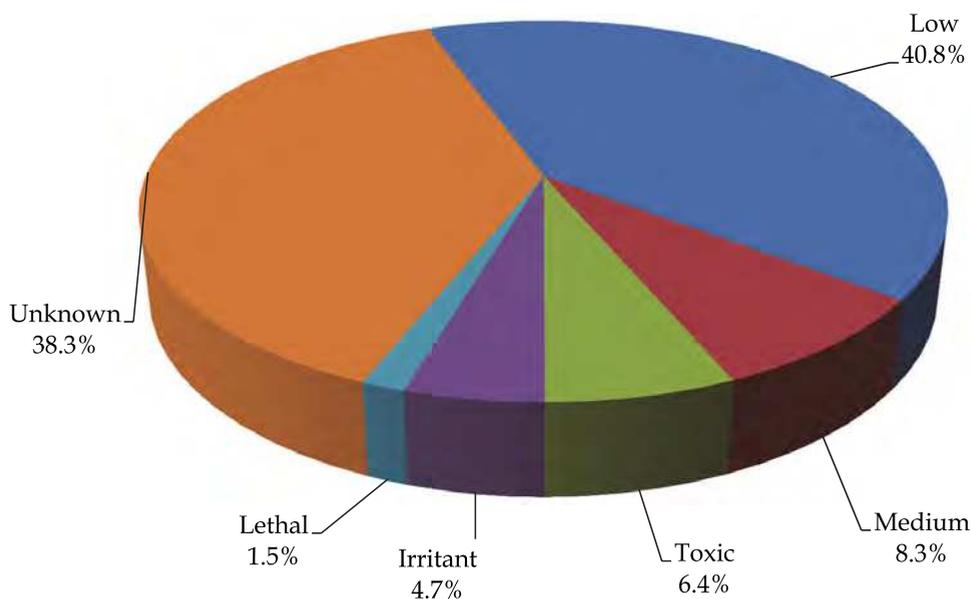


Fig. 11. Dose of the pesticide, evaluated at the time of the call to the TIC in the years 2005-2010

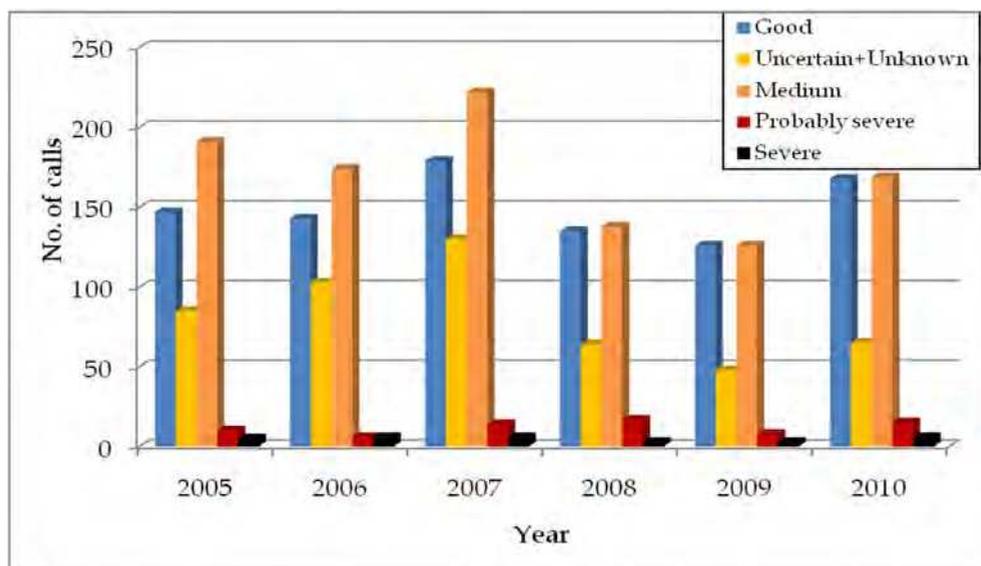


Fig. 12. Prognosis of the exposure, evaluated at the time of the call to the TIC in the years 2005-2010

3.9 Trends in the types of pesticides

The decrease in the number of calls since the 90ies can be seen especially in the group of insecticides. In spite of the increasing number of total calls, the number of inquiries due to pesticides remained mostly stable during the years, even with 10year's intervals, as can be seen in Table 1.

Year	1988	1989	1998	1999	2008	2009
Insecticides	180	128	180	189	134	132
Rodenticides	110	77	140	105	114	69
Herbicides	41	36	50	68	49	52
Fungicides	24	20	44	51	25	22
Other pesticides	20	14	17	27	50	49
TOTAL	375	275	431	440	372	324

Table 1. The types of pesticides in the calls to the TIC in selected years during two decades

In the electronic recording of the structured format of the calls in the past decade, the mean percentage of the calls due to rodenticides amounted 26.6%, cholinergic insecticides 13.0%, other insecticides, mostly pyrethrin-based 18.4%.

Herbicides reached 16.3%, among them, glyphosate took the first place with a slowly decrease from 12.2%, 10.2%, 10.8%, 10.8% to 7.2% in the years 2006, 2007, 2008, 2009 and 2010, respectively. The proportion of molluscocides and fungicides was 6.0% and 8.6%, respectively.

When the trends in the participation of different groups of pesticides were evaluated, only fungicides displayed a minor decrease of the calls since 2000, as can be seen in Figure 13.

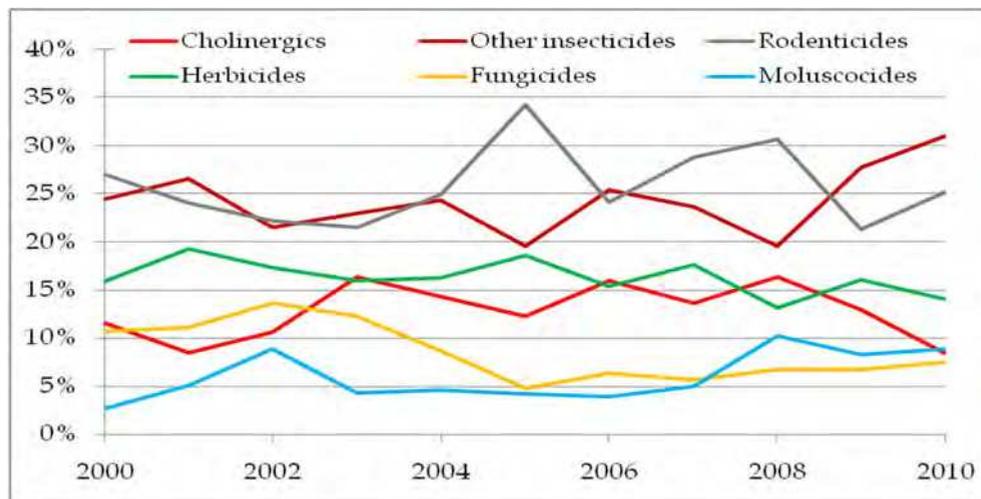


Fig. 13. Trends in the percentage of calls due to different groups of pesticides in the calls in the years 2000-2010

3.10 Exposures in animals

Veterinary calls in the 20 year's period represented 0.6% of the total calls to the TIC. In the last decade the percentage mildly increased and lies in the range of 0.8-1.9%. However, calls concerning animals reached 12.0% of the calls due pesticides, i.e. 2-3 times more than the humans. Exposures with a higher severity were registered for pyrethrins, wrongly used as insecticides in cats. On the other hand, carbofuran was given to the dogs or birds supposedly with the intent to damage or kill them by the neighbors. Moluscocide metaldehyde in pellets, appearing attractive to the dogs, carbofuran, and glyphosate belonged to the most frequent causes of symptomatic exposures.

3.11 Selected case reports of exposures

3.11.1 Unintentional ingestions

2 years-old male drank organophosphate metathion from a bottle in the garden. His father immediately induced vomiting and brought him to the hospital, where the boy vomited again. Gastric lavage was performed and charcoal given. The patient received atropine; however, the symptoms appeared 3.5 hours later - fasciculations, diarrhea, and bradycardia. The condition slowly improved after repeated atropine injections and resolved within 20 hours without sequels (April 1991).

46 years-old female took by mistake 7 ml of liquid organophosphate diazinon instead of antitussic drops. Within few minutes she began to vomit spontaneously, experienced cholinergic symptoms, weakness and muscle fasciculations. She was treated with atropine in infusion. Cholinesterase on admission was 6.0 $\mu\text{kat/l}$, further decreased to 0.5 $\mu\text{kat/l}$ and on discharge within 8 days it increased to 13.3 $\mu\text{kat/l}$. Normal level is 87-190 $\mu\text{kat/l}$. (September 1999).

3.11.2 Suicidal attempts

57 years-old female ingested 250 g of grey powder of warfarin rodenticide. Gastric lavage revealed rests of the rodenticide, she was given phytomenadione and transferred to psychiatry department. Coagulation parameters stayed within the normal range (December 1997).

30 years-old male ingested about 250 ml of pirimicarb with an unknown amount of alcohol beverage, then vomited repeatedly, had gastric lavage, was treated with atropin at the intensive care unit. He was anesthetized and cooled and completely improved within 24 hours. However, on the following day he took another unknown dose of pirimicarb at home and died (September 2005).

29 years-old male committed a suicide using intravenous injection of an unknown dose of pyrethrin. He was found dead 5 days later (January 2007).

3.11.3 Animal exposures

A young dog ingested metaldehyde granules in neighbor's garden and was found dead. During the autopsy, high amount of blue content, proven as metaldehyde was found. (August 2006).

Police was solving a problem of illegal bait containing carbofuran in eggs and a lethal poisoning of a fox, raven, and marsh harrier; all animals were discovered dead in one place in the forest. High concentrations of carbofuran were found both in the eggs and in the carcasses (July 2008).

4. Discussion

It can be concluded that the development of inquiries to the TIC in the Czech Republic in the past two decades concerning pesticides is favorable and there is a relative decline of calls due to pesticides comparing to the calls to other agents.

Interestingly, the proportion of different groups of pesticides was relatively stable and did not change very much especially in the past decade, only the proportion of fungicides slightly decreased.

Some poisonings with pesticides, such as cholinergic pesticides organophosphates and carbamates, display typical clinical signs and symptoms. Based on the symptoms in the relevant time interval after the suspected exposure, these intoxications may be confirmed or excluded. Less specific symptoms are caused by glyphosate. A prospective study focusing on the self-poisonings with glyphosate-containing herbicides was performed in Sri Lanka. Gastrointestinal symptoms, respiratory distress, hypotension, altered level of consciousness, and oliguria were observed in fatal cases. Death was strongly associated with higher age, larger ingestions, and high plasma glyphosate concentrations on admission ($>734 \mu\text{g/ml}$). However despite treatment in rural hospitals with limited resources, the mortality was as low as 3.2% (Roberts et al., 2010), i.e. lower than that reported in previous case series. This is in agreement with our study, as the symptoms caused by glyphosate were relatively rare.

The decrease in the severity and prognosis of exposures can be explained by new formulas of pesticides, especially insecticides that have been substituted by synthetic pyrethrins with low toxicity for the mammals. The situation is even more favorable in the group of rodenticides. In the Czech Republic, solely warfarin or superwarfarin based rodenticides are

available on the market, which explains the asymptomatic course of most exposures after human ingestions of these products (Rakovcova et al., 2007).

The comparison with our data from the years 1988-1989 shows that the proportion of suicidal attempts using pesticides decreased from mean 11.5% to 3.8%. Additionally, also the severity of exposures substantially decreased. According to our survey (Pelcova et al., 1991), during two years 1988 and 1989, as much as 14 fatalities have been recorded. Among them, the reason for 7 persons was a suicide, and for 7 subjects a fatal mistake after drinking a pesticide from a soft-drink bottle.

In the past 20 years, on the other hand, death was recorded only exceptionally. The main difference is that the pesticides, which caused most deaths in the 80ies, such as metathion, paraquat, diquat and sodium chlorate, almost disappeared from the households. In phone inquiries to the TIC, suicide attempts were involved in less than in 1 case per year. Similarly in Poland, northern neighbor country of the Czech Republic, with the population over 38 million of inhabitants, 4 lethal cases were registered in 2002, among them 3 cases due to suicidal attempts (Przybylska, 2004).

The Slovak Republic, another neighbor country with the population of 5 million inhabitants, displays a similar spectrum of groups of pesticides in the calls to the National Toxicological Information Centre to Bratislava (Caganova et al., 2010). The proportion of calls due to insecticides is comparable; however the number of lethal exposures, 24 deaths in 15 years, is more than threefold than in the Czech Republic.

The proportion of suicide deaths attributable to pesticide self-poisoning varies considerably across the world: in Europe and the Americas fewer than 5% of suicide deaths involve pesticides; in the Eastern Mediterranean, African, and Southeast Asian regions 20%-25% involve pesticides; and in the Western Pacific region and in Sri Lanka, more than half of all suicides are pesticide related (Gunnell et al., 2007, Dawson et al., 2010). In aggregate, pesticide poisoning is involved in one-third of all suicides (Miller & Bhalla, 2010).

The low number of inquiries to the TIC in the Czech Republic due to occupational exposures is in agreement with the data from the Registry of Occupational Diseases and confirms the negligible incidence of occupational intoxications with pesticides. The situation is favorable also in Slovakia (Batora & Grellneth, 2008). In addition, the course of intoxication was frequently life-threatening, with severe symptoms or lethal. Ingestions of molluscocides led to more severe course of intoxication.

The efficiency of Czech legislation for pesticides appears satisfactory and there is no problem of the registration, labeling or unlicensed outlets. The production, import, handling, transportation, and storage of pesticides are under the control of public health institutions. No unregistered pesticides are sold on the black market, unlike the "street pesticides" in Africa or Brazil (Balme et al., 2010). Czech toxicologists nowadays mostly have solved situations, when the pesticide users did not follow the instructions on the label of the product or did not store the product safely to prevent children's and animals' accidental exposures.

5. Conclusion

It shows that acute human pesticide exposures in the Central Europe are mainly accidental and have favorable prognosis in general, due to a lower toxicity of commercial products used. The number of calls to the Czech TIC due to pesticides in the past two decades is

relatively stable, most important are the positive changes of the spectrum of pesticides, available on the market. During the past years, the number of calls concerning toxic pesticides, such as organophosphates and carbamates insecticides slowly decreased. It can be seen, that the number of calls due to rodenticides mildly increased, however no serious sequel has been recorded. The course of ingestion of pesticides is favorable and no harmful effects in children or successful suicides using pesticides have been registered at the Toxicological Information Centre.

Lower number of deaths is the most important difference from the situation in the late 80ies, both after suicidal and non-intentional ingestions.

6. Acknowledgment

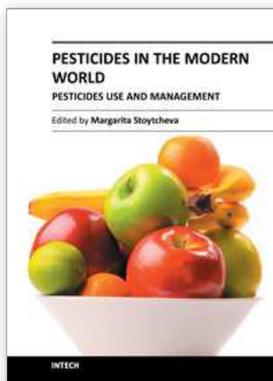
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Pesticides in the Modern World - Pesticides Use and Management

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This book brings together issues on pesticides and biopesticides use with the related subjects of pesticides management and sustainable development. It contains 24 chapters organized in three sections. The first book section supplies an overview on the current use of pesticides, on the regulatory status, on the levels of contamination, on the pesticides management options, and on some techniques of pesticides application, reporting data collected from all over the world. Second section is devoted to the advances in the evolving field of biopesticides, providing actual information on the regulation of the plant protection products from natural origin in the European Union. It reports data associated with the application of neem pesticides, wood pyrolysis liquids and bacillus-based products. The third book section covers various aspects of pesticides management practices in concert with pesticides degradation and contaminated sites remediation technologies, supporting the environmental sustainability.

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