Plant Exposures Reported to the Poisons Information Centre Erfurt from 2001–2010

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Abstract

At the moment, no recent study about plant exposures in Germany and in the federal states the Poisons Information Centre (PIC) Erfurt is serving is available. To get new information about important characteristics of plant exposures like the development of frequency, plants, age groups involved, circumstances of exposure, and symptom severity, we conducted a retrospective study including all human plant exposures reported to the PIC Erfurt over a 10-year period from the beginning of 2001 to the end of 2010. In total, 13 001 plant exposures were registered. While the absolute number of plant exposures discontinuously increased from 1110 in 2001 to 1467 in 2009, and decreased to 1157 in 2010, their relative frequency to all human exposures fell from 9.2% in 2001 to 5.9% in 2010. Age groups: children 87.5% (toddler 60.0%); adults 11.3% (middle-aged adults 5.2%). Gender: female 39.0% and male 41.2%. Circumstances: accidental 91.6%, unknown 4.6%, abuse 2.9%, suicide 0.9%. Severity of symptoms: none to slight 85.5%, moderate 1.7%, unknown 12.7%, severe 0.1% (in total 9, one 4-year-old girl, involved plant genera: *Aconitum, Arum, Chelidonium, Datura, Brugmansia, Dieffenbachia, Ricinus*, 2 *Taxus*), fatal 0.03% (in total 4, involved plant genera: 2 *Aconitum*, 2 *Taxus*). In comparison to all human exposures, the relative frequency of severe symptoms in accidental and intentional plant exposures by abuse was significantly lower but as high by suicide. The significant higher involvement of children resulted mainly in none or mild symptoms. Severe symptoms could mostly be observed in adults in intentional plant exposures or when poisonous plants were mistaken for eatable. Because some plant exposures resulted in severe symptoms and even death, their dangerousness should not be trivialised.

Abbreviations

A:	adult of unknown age > 17 years
AE:	elderly > 65 years
AM:	middle-aged adult 18–65 years
C:	child of unknown age < 14 years
CA:	adolescent 14–17 years
CB:	baby < 1 year
CT:	toddler 1–5 years
CS:	schoolchild 6–13 years
CI_{95}:	95% confidence interval for differences of the relative frequencies
EP:	endangering potential
L_{lower}:	lower limit of CI_{95}
L_{upper}:	upper limit of CI_{95}
MME:	moderate and major effects
n:	number of total cases
p:	x/n = relative frequency
PIC Erfurt:	Poisons Information Centre Erfurt
PSS:	Poisoning Severity Score
SQRT:	square root
TPE:	total plant exposures
u:	age unknown
x:	number of cases

Introduction

Plant exposures are described to be one of the most frequent reasons for calls to poison information centres in Germany [1,2] and Switzerland [3–5]. In a recent study in the United States [6], a steady decline of the absolute number of plant exposures and the percentage of all exposures registered by U.S. poison centres from 82 559 (4.9%) in 2000 to 54 956 (2.4%) in 2009 was observed. At the moment, no recent study is available about plant exposures in Germany and in the federal states the Poisons Information Centre (PIC) Erfurt is serving. To get new information about impor-

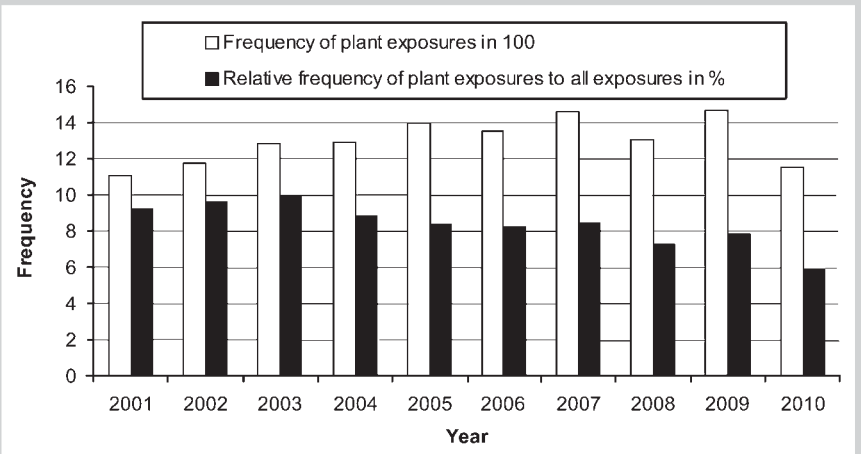

Fig. 1 Frequency of plant exposures (in 100) and relative frequency of plant exposures to all exposures (in %) reported to the PIC Erfurt from the beginning of 2001 to the end of 2010.

tant characteristics of plant exposures like the development of frequency, plants, age groups involved, circumstances of exposure, and symptom severity, we conducted a retrospective study including all human plant exposures reported to the PIC Erfurt over a 10-year period from the beginning of 2001 to the end of 2010.

Participants and Methods

The PIC Erfurt serves a population of 10.4 million inhabitants in four federal states (Mecklenburg-Western Pomerania, Saxony, Saxony-Anhalt, and Thuringia) in Germany. All calls regarding acute human plant exposure registered by the PIC Erfurt from 2001 to 2010 were analysed retrospectively. Data were evaluated regarding circumstances of exposure, patient age groups, plants involved, and symptom severity. Age groups were: baby (CB: < 1 year), toddler (CT: 1 to 5 years), schoolchild (CS: 6 to 13 years), child of unknown age (C: younger than 14 years), adolescent (CA: 14 to 17 years), middle-aged adult (AM: 18 to 65 years), elderly (AE: older than 65 years), adult of unknown age (A: older than 17 years), age unknown (u). The severity of symptoms was classified as none to mild (0 + 1), moderate (2), severe (3), and fatal, according to the Poisoning Severity Score (PSS) [7]. For all plant genera that caused at least twice moderate or severe symptoms the PSS classification as previously described [2] was used to assess the endangering potential (EP) of the single plant genus from symptoms described in the literature [8–10].

The relative frequencies of symptom severity, age groups, and circumstances of exposure were compared and analysed according to the chi-square test for significant differences ($p < 0.05$) between a plant and all exposures. The 95% confidence interval (CI_{95}) for the difference of relative frequencies was calculated by approximation to Gaussian distribution for big control samples according to the equation described by Sachs and Hedderich [11]: L_{upper}: upper limit of CI_{95}; L_{lower}: lower limit of CI_{95}; SQRT: square root; x = number of cases; n = number of total cases; p = x/n = relative frequency; z = 1.96 for CI_{95}; for $n \times p > 5$ and $n \times (1 - p) > 5$:

$$L_{upper} \approx (p + 1/2\,n + z \times SQRT\,(p \times (1 - p)/n);$$
$$L_{lower} \approx (p - 1/2\,n - z \times SQRT\,(p \times (1 - p)/n).$$

Results

In total, the PIC Erfurt registered 13001 plant exposures corresponding to 8.2% of all exposures from the beginning of 2001 to the end of 2010. While the absolute number of plant exposures discontinuously increased from 1110 in 2001 to 1467 in 2009, and decreased afterwards to 1157 exposures in 2010, the relative frequency to all human exposures fell from 9.2% in 2001 to 5.9% in 2010 (**Fig. 1**), because the number of all exposures rose from 12012 in 2001 to 19649 in 2010. Plant exposures showed typical seasonal changes with the highest total rates in July (1422), August (2143), September (2179), and October (1639). The lowest total rates of plant exposures were seen in December (570), January (463), February (424), and March (602). The plant genera involved most frequently in plant exposures are summarised in **Table 1**. While some plant genera like *Taxus, Ligustrum,* and *Ficus* were continuously among the most often involved plant genera during the whole study period, exposures to other plant genera like *Brugmansia* (decrease from 81 in 2001 to 7 in 2010) showed time-dependent changes.

The distribution of age groups is summarised in **Table 2**. In comparison to all exposures, plant exposures were significantly more often seen in children of unknown age ($p < 0.05$) [plant exposures 164 (1.26%), all exposures 757 (0.48%)]; babies [plant exposures 2007 (15.44%), all exposures 6324 (3.99%)]; toddlers [plant exposures 7803 (60.02%), all exposures 41964 (26.46%)]; and schoolchildren [plant exposures 1137 (8.75%), all exposures 5952 (3.75%)] and significantly less frequently observed in adolescents ($p < 0.05$) [plant exposures 270 (2.08%), all exposures 8439 (5.32%)]; adults of unknown age [plant exposures 662 (5.09%), all exposures 29953 (18.89%)]; middle-aged adults [plant exposures 682 (5.25%), all exposures 55797 (35.18%)]; and the elderly [plant exposures 128 (0.98%), all exposures 8115 (5.12%)]. The proportion of each age group in plant and all exposures remained almost unchanged from 2001 to 2010 except for the proportion of adolescents, which decreased from 100 (4.37%) in 2001 to 20 (0.76%) in 2010 in plant exposures and for the same period from 2005 (8.23%) to 1516 (3.95%) in all exposures. The gender of persons involved in plant exposures was equally distributed amongst females (5062, 39.0%) and males (5350, 41.2%) (**Table 3**). The circumstance of exposure (**Table 4**) was significantly more often accidental in plant (11894, 91.56%) than in all exposures (70972, 44.93%) ($p < 0.05$). Other circumstances of exposure, however, were significantly less frequent in

Table 1 Top ten plant genera involved in plant exposures reported to the PIC Erfurt from 2001 to 2010.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2001–2010
1	*Brugmansia* 81	*Taxus* 72	*Taxus* 67	*Taxus* 78	*Ligustrum* 72	*Taxus* 89	*Ligustrum* 96	*Ligustrum* 82	*Taxus* 129	*Taxus* 65	*Taxus* 742
2	*Ligustrum* 70	*Ligustrum* 65	*Lonicera* 62	*Ligustrum* 63	*Ficus* 64	*Sorbus* 55	*Physalis* 87	*Ficus* 59	*Physalis* 78	*Ficus* 60	*Ligustrum* 633
3	*Ficus* 52	*Brugmansia* 49	*Physalis* 50	*Ficus* 61	*Taxus* 63	*Ligustrum* 55	*Taxus* 80	*Taxus* 58	*Prunus* 67	*Physalis* 40	*Ficus* 569
4	*Lonicera* 43	*Lonicera* 41	*Ficus* 50	*Physalis* 57	*Physalis* 59	*Ficus* 54	*Ficus* 74	*Physalis* 47	*Ficus* 54	*Ligustrum* 37	*Physalis* 519
5	*Sorbus* 41	*Ficus* 41	*Ligustrum* 47	*Brugmansia* 48	*Euphorbia* 50	*Prunus* 47	*Prunus* 63	*Prunus* 45	*Lonicera* 50	*Spathiphyllum* 35	*Prunus* 416
6	*Taxus* 41	*Physalis* 39	*Brugmansia* 46	*Prunus* 44	*Lonicera* 48	*Physalis* 38	*Euphorbia* 50	*Crassula* 43	*Ligustrum* 46	*Euphorbia* 35	*Lonicera* 405
7	*Lathyrus* 29	*Sorbus* 37	*Sorbus* 43	*Lonicera* 41	*Prunus* 46	*Euphorbia* 34	*Mahonia* 42	*Lonicera* 38	*Sorbus* 44	*Crassula* 27	*Euphorbia* 385
8	*Datura* 28	*Euphorbia* 33	*Euphorbia* 42	*Euphorbia* 36	*Sorbus* 42	*Lonicera* 30	*Brugmansia* 36	*Euphorbia* 37	*Euphorbia* 42	*Convallaria* 26	*Brugmansia* 377
9	*Euphorbia* 26	*Cotoneaster* 29	*Prunus* 41	*Cotoneaster* 28	*Brugmansia* 39	*Brugmansia* 30	*Symphoricarpos* 35	*Sambucus* 35	*Lathyrus* 41	*Mahonia* 26	*Sorbus* 365
10	*Mahonia* 25	*Solanum* 29	*Sambucus* 40	*Lathyrus* 27	*Sambucus* 31	*Convallaria* 29	*Lonicera* 32	*Sorbus* 34	*Crassula* 34	*Zamioculcas* 24	*Mahonia* 279

plant than in all exposures ($p < 0.05$) [abuse: plant exposures 371 (2.86%), all exposures 6040 (3.81%); suicide: plant exposures 119 (0.94%), all exposures 210 (36.08%); unknown: plant exposures 617 (4.6%), all exposures 24 378 (15.17%)]. The symptom severity (**Table 4**) was significantly more often none to mild in plant exposures (11 114, 85.5%) than in all exposures (103 334, 65.20%) ($p < 0.05$). The other symptom severity grades occurred significantly less frequently in plant than in all exposures ($p < 0.05$) [moderate: plant exposures 220 (1.69%), all exposures 11 635 (7.33%); severe: plant exposures 9 (0.07%), all exposures 5504 (3.47%); unknown: plant exposures 1654 (12.70%), all exposures 37 828 (23.90%); death: plant exposures 4 (0.03%), all exposures 299 (0.18%)]. Information on symptom severity in relation to the circumstances of plant and all exposures is given in **Table 4**. Accidental plant exposures resulted significantly more often in none to mild symptoms (10 578, 88.94%) than in all accidental exposures (58 672, 82.67%) ($p < 0.05$). Moderate and severe symptoms as well as fatalities and unknown symptoms occurred significantly more frequently in all accidental exposures [moderate symptoms: 1730 (2.44%); severe symptoms: 351 (0.49%)] than in accidental plant exposures [moderate symptoms: 97 (0.82%); severe symptoms: 4 (0.03%)] ($p < 0.05$) (**Table 4**). Intentional plant exposures by abuse caused significantly less none to mild (84, 22.64%) and severe symptoms (1, 0.27%) than all intentional exposures by abuse ($p < 0.05$) [none to mild symptoms: 2141 (35.45%); severe symptoms: 429 (7.10%)] (**Table 4**). Plant exposures with suicidal intention, however, showed nearly the same frequency of the symptom severity as all exposures in suicidal intention (**Table 4**). Fatalities, however, were even significantly more frequent with suicidal plant exposures (4, 3.36%) than in all exposures (88, 0.36%) with suicidal intention ($p < 0.05$) (**Table 4**). No significant differences between female and male persons in plant and all exposures concerning the symptom severity could be observed (**Table 3**).

More detailed information on plant exposures with severe symptoms or even a fatal outcome is given in **Table 5**. In total, only 9 severe plant exposures (plant genera: *Aconitum, Arum, Chelidonium, Datura, Brugmansia, Dieffenbachia, Ricinus*, 2 *Taxus*) were observed. A child (4-year-old girl) was involved only once. In four cases (plant genera: 2 *Aconitum*, 2 *Taxus*), the outcome of the plant exposure was fatal.

Table 6 shows all plant genera that caused at least twice moderate or severe symptoms after exposure. The most frequent moderate or severe symptoms were seen in exposures to *Brugmansia* (54), *Datura* (23), and *Euphorbia* (17).

Discussion

As described above, the U.S. poison centres registered a steady decline of 33% of the relative percentage as well as of the absolute number of plant exposures during the decade of 2000–2009 [6]. This decline was even more dramatic (a decrease of 400%) if a time period over 3 decades (1983–2009) was investigated. The authors explained this phenomenon with the increasing use of the Internet for identifying plants and getting information about them. In Germany, the use of the Internet in persons older than 14 years also rose from 38.8% in 2001 to 69.4% in 2010 [13]. In the present study, plant exposures reported to the PIC Erfurt discontinuously increased from 1110 in 2001 to 1467 in 2009 and decreased afterwards to 1157 in 2010 (**Fig. 1**). Therefore, from our point of view, the hypothesis that augmented Internet use resulted in a decreased number of calls concerning plant exposure seems to be questionable, at least for the federal states that the PIC Erfurt is serving.

Like in the U.S. [6], in our present study plant exposures were mostly seen during the more temperate months of the northern hemisphere. Differences, however, were observed in the rank order of the most common plant exposures. While in the U.S. study *Spathiphyllum, Ilex, Philodendron, Euphorbia, Phytolacca, Fragaria, Hemerocallis*, *Schefflera, Calendula*, and *Ficus* were among the 10 most frequent plant exposures, the rank order in our study was *Taxus, Ligustrum, Ficus, Physalis, Prunus, Lonicera, Euphorbia, Brugmansia, Sorbus*, and *Mahonia*, which is comparable, with

Table 2 Absolute number, relative frequencies and CI_{95} of age groups from time intervals of 2 years and a decade in plant and all exposures reported to the PIC Erfurt from 2001 to 2010. Significant differences ($p < 0.05$) between plant and all exposures are noted by *.

	Plant exposures	All exposures	Plant exposures	All exposures	Plant exposures	All exposures	Plant exposures	All exposures	Plant exposures	All exposures	Plant exposures	All exposures
Age groups	**2001–2002**	**2001–2002**	**2003–2004**	**2003–2004**	**2005–2006**	**2005–2006**	**2007–2008**	**2007–2008**	**2009–2010**	**2009–2010**	**2001–2010**	**2001–2010**
C	**33** (1.44%* CI_{95}: 0.93–1.95%)	**132** (0.54% CI_{95}: 0.45- 0.64%)	**37** (1.44%* CI_{95}: 0.96–1.91%)	**132** (0.48% CI_{95}: 0.42–0.53%)	**29** (1.05%* CI_{95}: 0.65–1.46%)	**153** (0.46% CI_{95}: 0.39–0.54%)	**28** (1.01%* CI_{95}: 0.62–1.41%)	**135** (0.39% CI_{95}: 0.32–0.45%)	**37** (1.41%* CI_{95}: 094–1.88%)	**205** (0.53% CI_{95}: 0.46–0.61%)	**164** (1.26%* CI_{95}: 1.07–1.46%)	**757** (0.48% CI_{95}: 0.44–0.51%)
CB	**331** (14.46%* CI_{95}: 13.00–15.92%)	**900** (3.69% CI_{95}: 3.45–3.93%)	**336** (13.04%* CI_{95}: 11.72–14.36%)	**1012** (3.66% CI_{95}: 3.43–3.88%)	**388** (14.11%* CI_{95}: 12.79–15.43%)	**1153** (3.48% CI_{95}: 3.28–3.67%)	**488** (17.67%* CI_{95}: 16.23–19.11%)	**1544** (4.41%* CI_{95}: 4.19–4.63%)	**464** (17.68%* CI_{95}: 16.20–19.16%)	**1715** (4.47%* CI_{95}: 4.26–4.68%)	**2007** (15.44%* CI_{95}: 14.81–16.06%)	**6324** (3.99% CI_{95}: 3.89–4.08%)
CT	**1397** (61.03%* CI_{95}: 59.01–63.05%)	**6367** (26.13% CI_{95}: 25.58–26.69%)	**1598** (62.01%* CI_{95}: 60.12–63.90%)	**7561** (27.32% CI_{95}: 26.79–27.85%)	**1689** (61.44%* CI_{95}: 59.60–63.28%)	**8995** (27.11% CI_{95}: 26.63–27.59%)	**1631** (59.05%* CI_{95}: 57.20–60.90%)	**9268** (26.48%* CI_{95}: 26.01–26.94%)	**1488** (56.71%* CI_{95}: 54.79–58.62%)	**9773** (25.47% CI_{95}: 25.03–25.90%)	**7803** (60.02%* CI_{95}: 59.17–60.86%)	**41 964** (26.46% CI_{95}: 26.24–26.68%)
CS	**171** (7.47%* CI_{95}: 6.37–8.57%)	**966** (3.96% CI_{95}: 3.71–4.21%)	**221** (8.58%* CI_{95}: 7.48–9.68%)	**998** (3.61% CI_{95}: 3.38–3.83%)	**240** (8.73.% * CI_{95}: 7.66–9.80%)	**1098** (3.31% CI_{95}: 3.12–3.50%)	**263** (9.52%* CI_{95}: 8.41–10.63%)	**1439** (4.11% CI_{95}: 3.90–4.32%)	**242** (9.22%* CI_{95}: 8.10–10.35%)	**1451** (3.78% CI_{95}: 3.59–3.97%)	**1137** (8.75%* CI_{95}: 8.26–9.23%)	**5952** (3.75% CI_{95}: 3.66–3.85%)
CA	**100** (4.37%* CI_{95}: 3.51–5.23%)	**2005** (8.23% CI_{95}: 7.88–8.58%)	**66** (2.56%* CI_{95}: 1.93–3.19%)	**1801** (6.51% CI_{95}: 6.22–6.80%)	**45** (1.64%* CI_{95}: 1.14–2.13%)	**1639** (4.94% CI_{95}: 4.71–5.17%)	**39** (1.41%* CI_{95}: 0.95–1.87%)	**1478** (4.22% CI_{95}: 4.01–4.43%)	**20** (0.76%* CI_{95}: 0.41–1.11%)	**1516** (3.95% CI_{95}: 3.75–4.15%)	**270** (2.08%* CI_{95}: 1.83–2.32%)	**8439** (5.32% CI_{95}: 5.21–5.43%)
A	**103** (4.50%* CI_{95}: 3.63–5.37%)	**3271** (13.42% CI_{95}: 12.99–13.86%)	**121** (4.70%* CI_{95}: 3.86–5.53%)	**4789** (17.30% CI_{95}: 16.85–17.75%)	**138** (5.02%* CI_{95}: 4.19–5.85%)	**6411** (19.32% CI_{95}: 18.90–19.75%)	**146** (5.29%* CI_{95}: 4.43–6.14%)	**6635** (18.95% CI_{95}: 18.54–19.37%)	**154** (5.87%* CI_{95}: 4.95–6.79%)	**8847** (23.05% CI_{95}: 22.63–23.48%)	**662** (5.09%* CI_{95}: 4.71–5.47%)	**29 953** (18.89% CI_{95}: 18.69–19.08%)
AM	**114** (4.98%* CI_{95}: 9.67–10.76%)	**9306** (38.19% CI_{95}: 37.58–38.81%)	**120** (4.66%* CI_{95}: 3.82–5.49%)	**9826** (35.50% CI_{95}: 14.10–14.62%)	**163** (5.93%* CI_{95}: 5.03–6.83%)	**11 785** (35.52% CI_{95}: 35.00–36.04%)	**122** (4.42%* CI_{95}: 3.63–5.20%)	**12 466** (35.61% CI_{95}: 35.11–36.12%)	**163** (6.21%* CI_{95}: 5.27–7.15%)	**12 414** (32.35% CI_{95}: 31.88–32.82%)	**682** (5.25%* CI_{95}: 4.86–5.63%)	**55 797** (35.18% CI_{95}: 34.95–35.42%)
AE	**17** (0.74%* CI_{95}: 4.07–5.89%)	**1173** (4.81% CI_{95}: 4.54–5.09%)	**27** (1.05%* CI_{95}: 0.64–1.46%)	**1222** (4.41% CI_{95}: 4.17–4.66%)	**18** (0.65%* CI_{95}: 0.34–0.97%)	**1625** (4.90% CI_{95}: 4.66–5.13%)	**26** (0.94%* CI_{95}: 0.56–1.32%)	**1846** (5.27% CI_{95}: 5.04–5.51%)	**40** (1.52%* CI_{95}: 1.04–2.01%)	**2249** (5.86% CI_{95}: 5.62–6.10%)	**128** (0.98%* CI_{95}: 0.81–1.16%)	**8115** (5.12% CI_{95}: 5.01–5.23%)
Unknown	**23** (1.00% CI_{95}: 0.57–1.44%)	**245** (1.01% CI_{95}: 0.88–1.13%)	**51** (1.98%* CI_{95}: 1.42–2.54%)	**335** (9.06% CI_{95}: 8.70–9.42%)	**39** (1.42%* CI_{95}: 0.96–1.88%)	**319** (0.96% CI_{95}: 0.85–1.07%)	**19** (0.69% CI_{95}: 0.36–1.01%)	**193** (0.55% CI_{95}: 0.47–0.63%)	**16** (0.61% CI_{95}: 0.29–0.93%)	**207** (0.54% CI_{95}: 0.46–0.61%)	**148** (1.14%* CI_{95}: 0.95–1.32%)	**1299** (0.82% CI_{95}: 0.77–0.86%)
Number of cases	2289	24 365	2577	27 676	2749	33 178	2762	35 004	2624	38 377	13 001	158 600

Table 3 Absolute number, relative frequencies, and CI_{95} of symptom severity in the single gender groups in plant and all exposures reported to the PIC Erfurt from 2001 to 2010.

	Plant exposures – Gender			All exposures – Gender		
Symptom severity	**Male**	**Female**	**Unknown**	**Male**	**Female**	**Unknown**
0 + 1	**4519** (84.47% CI_{95}: 83.49–85.45%)	**4386** (86.63% CI_{95}: 85.68–87.58%)	**2209** (85.32% CI_{95}: 83.70–86.44%)	**42882** (64.46% CI_{95}: 64.10–64.82%)	**48715** (64.17% CI_{95}: 63.83–64.51%)	**11737** (72.65% CI_{95}: 71.96–73.34%)
2	**119** (2.22% CI_{95}: 1.82–2.62%)	**86** (1.70% CI_{95}: 1.33–2.07%)	**15** (0.58% CI_{95}: 0.27–0.89%)	**5170** (7.77% CI_{95}: 7.57–7.97%)	**5899** (7.77% CI_{95}: 7.58–7.96%)	**566** (3.50% CI_{95}: 3.22–3.79%)
3	**3** (0.06% CI_{95}: n. c.)	**6** (0.12% CI_{95}: 0.01–0.23%)	**0** (0% CI_{95}: n. c.)	**2501** (3.76% CI_{95}: 3.61–3.91%)	**2835** (3.73% CI_{95}: 3.59–3.87%)	**168** (1.04% CI_{95}: 0.88–1.20%)
Fatal	**1** (0.02% CI_{95}: n. c.)	**3** (0.06% CI_{95}: n. c.)	**0** (0% CI_{95}: n. c.)	**152** (0.23% CI_{95}: 0.19–0.27%)	**127** (0.17% CI_{95}: 0.14–0.20%)	**20** (0.12% CI_{95}: 0.07–0.18%)
Unknown	**708** (13.23% CI_{95}: 12.32–14.16%)	**581** (11.48% CI_{95}: 10.59–12.37%)	**365** (14.10% CI_{95}: 12.74–15.46%)	**15822** (23.78% CI_{95}: 23.46–24.10%)	**18341** (24.16% CI_{95}: 23.85–24.47%)	**3665** (25.93% CI_{95}: 25.25–26.60%)
Number of cases	5350	5062	2589	66527	75917	16156

n. c. = not calculated

small differences, to the rank order seen in other studies conducted in Germany [2] and Switzerland [3–5].

While the rate of accidental exposures to plant genera like *Taxus, Ligustrum,* and *Ficus* was continuously high during the whole study period, the exposure by abuse to plant genera like *Brugmansia* and *Datura* showed time-dependent changes with the highest rate being in 2001 and a decreasing frequency in the following years. Concurrently, with the decrease of *Datura* and *Brugmansia* exposure, the proportion of adolescents compared to the other age groups in plant exposures was also reduced, while the proportion of the other age groups involved in plant exposures remained quite stable (**Table 2**). *Datura* and *Brugmansia* genera were mainly abused by adolescents and young adults, and were mostly responsible for moderate or severe symptoms in plant exposures in our study and in other studies as well [1–6, 12, 14] (**Table 6**). Unfortunately, in these studies no information was given if the exposure to these plant genera by abuse was also decreasing.

In the above-mentioned U.S. study [6], nearly 55% of the plant-related fatalities involved males and slightly more than 60% of the exposures that had a moderate or major outcome occurred in males. In our present study, no such gender specific influence on the symptom severity was observed (**Table 3**).

In our study as well as in other studies [1–6, 12], plant exposures more frequently resulted in none to mild symptoms and less often resulted in moderate and severe symptoms, and even death, than all exposures. These results can at least partially be explained by the fact that the proportion of babies and toddlers and accidental exposure was significantly higher, and the proportion of adults and intentional exposure by abuse and suicide was significantly lower in plant exposures than in all exposures (**Table 4**). To exclude the influence of the circumstances of exposure on symptom severity, we directly compared the frequencies of symptom severity in the single circumstance groups in plant and all exposures (**Table 4**). After this procedure, accidental plant exposures also resulted more often in none to mild symptoms and resulted less often in moderate and severe symptoms, and even death, than all accidental exposures; but these differences were less pronounced than in the analysis regardless of the circumstances of exposure. In plant exposures by abuse, significant differences to all exposures by abuse were only seen for the frequencies of none to mild and severe symptoms. When exposure occurred due to suicidal intention, no significant difference between plant and all exposures concerning symptoms with none to high severity was observed. Fatalities, however, were even more significantly ($p < 0.05$) frequent in suicidal plant exposures than in all exposures due to suicidal intention (**Table 4**).

As can be seen in **Table 5**, we observed only 9 severe plant exposures (plant genera: *Aconitum, Arum, Chelidonium, Datura, Brugmansia, Dieffenbachia, Ricinus*, 2 *Taxus*) and four fatal cases (plant genera: 2 *Aconitum*, 2 *Taxus*) (**Table 4**). While in the U.S. study mainly *Datura* and *Cicuta* species were responsible for fatal outcomes and only one *Taxus chinensis* exposure resulted in death, no fatality after *Aconitum napellus* exposure was observed [6]. In Switzerland, 3 of 4 fatal plant exposures were caused by *Colchicum autumnale* and one by *Taxus baccata*.

While *Aconitum* contains the sodium channel activators aconitine and related alkaloids in all parts of the plant, especially in the leaves and roots, in *Taxus baccata,* most of the plant, including the seeds but not the red aril, contains the toxic taxine alkaloids that block sodium and calcium currents [8]. Most paediatric cases of *Taxus baccata* exposure involve ingestion of the seeds and aril with usually none to minimal symptoms. Therefore, the toxic potential of *Taxus baccata* could be underestimated [15]. Substantial ingestion of the leaves, however, that ocurrs mainly with the intention of suicide can result in severe cardiovascular effects including bradycardia, premature ventricular contractions, atrioventricular conduction defects, or ventricular tachydysrhythmias [16].

Betweeen 2001 and 2010, 20% of all exposures in children registered by the PIC Erfurt concerned plant exposures. The main groups of callers due to plant exposure besides private persons (8212, 63.0%) were physicians from hospitals (2217, 17.1%) and general practitioners or practice-based paediatricians (1624, 12.5%). These data show that the clinical significance of plant exposure is high because the knowledge about plants and their toxicity in the general public as well as in health care professionals seems to be low.

Table 4 Absolute number, relative frequencies, and CI_{95} of symptom severity in the single circumstance groups in plant and all exposures reported to the PIC Erfurt from 2001 to 2010. Significant differences ($p < 0.05$) between plant and all exposures are noted by *.

	Accidental		Abuse		Suicide		Unknown		All circumstances	
Symptom severity	Plant exposures	All exposures	Plant exposures	All exposures	Plant exposures	All exposures	Plant exposures	All exposures	Plant exposures	All exposures
0 + 1	**10578** (88.94%* CI_{95}: 88.37–89.50%)	**58672** (82.67% CI_{95}: 82.39–82.95%)	**84** (22.64%* CI_{95}: 18.25–27.03%)	**2141** (35.45% CI_{95}: 34.24–36.67%)	**62** (52.10% CI_{95}: 42.70–61.50%)	**30098** (52.61% CI_{95}: 52.20–53.02%)	**383** (62.07* CI_{95}: 58.16–65.98%)	**12125** (49.74% CI_{95}: 49.11–50.37%)	**11114** (85.50%* CI_{95}: 84.89–86.11%)	**103334** (65.20% CI_{95}: 64.97–65.43%)
2	**97** (0.82%* CI_{95}: 0.65–0.98%)	**1730** (2.44% CI_{95}: 2.32–2.55%)	**74** (19.95% CI_{95}: 15.75–24.15%)	**1316** (21.79% CI_{95}: 20.74–22.845)	**16** (13.45% CI_{95}: 6.90–20.00%)	**6354** (11.10% CI_{95}: 10.84–11.36%)	**33** (5.35%* CI_{95}: 3.49–7.21%)	**2209** (9.06% CI_{95}: 8.70–9.42%)	**220** (1.69%* CI_{95}: 1.46–1.92%)	**11635** (7.33% CI_{95}: 7.20–7.46%)
3	**4** (0.03%* CI_{95}: n. c.)	**351** (0.49% CI_{95}: 0.44–0.55%)	**1** (0.27%* CI_{95}: n. c.)	**429** (7.10% CI_{95}: 6.44–7.76%)	**3** (2.52% CI_{95}: n. c.)	**3649** (6.38% CI_{95}: 6.18–6.58%)	**1** (0.16%* CI_{95}: n. c.)	**1069** (4.38% CI_{95}: 4.12–4.64%)	**9** (0.07%* CI_{95}: 0.02–0.12%)	**5504** (3.47% CI_{95}: 3.38–3.56%)
Fatal	**0** (0%* CI_{95}: n. c.)	**25** (0.04% CI_{95}: 0.02–0.05%)	**0** (0% CI_{95}: n. c.)	**26** (0.43% CI_{95}: 0.26–0.60%)	**4** (3.36%* CI_{95}: n. c.)	**160** (0.28% CI_{95}: 0.24–0.32%)	**0** (0% CI_{95}: n. c.)	**88** (0.36% CI_{95}: 0.28–0.44)	**4** (0.03%* CI_{95}: n. c.)	**299** (0.18% CI_{95}: 0.16–0.20%)
Unknown	**1215** (10.22%* CI_{95}: 9.67–10.76%)	**10194** (14.36% CI_{95}: 14.10–14.62%)	**212** (57.14%* CI_{95}: 51.97–62.31%)	**2128** (35.23% CI_{95}: 34.02–36.44)	**34** (28.57% CI_{95}: 20.03–37.20%)	**16949** (29.63% CI_{95}: 29.25–30.01%)	**200** (32,41% CI_{95}: 28.64–36.18%)	**8887** (36.46% CI_{95}: 35.85–37.07%)	**1654*** (12.70% CI_{95}: 12.12–13.28%)	**37828** (23.90% CI_{95}: 23.69–24.37%)
Number of cases (relative frequency and CI_{95} in % of total plant and all exposures)	**11894** (91.56%* CI_{95}: 91.12–92.08%)	**70972** (44.93% CI_{95}: 44.65–45.14%)	**371** (2.86%* CI_{95}: 2.57–3.15%)	**6040** (3.81% CI_{95}: 3.72–3.90%)	**119** (0.94%* CI_{95}: 0.77–1.11%)	**57210** (36.08% CI_{95}: 35.86–36.34%)	**617** (4.64%* CI_{95}: 4.27–5.01%)	**24378** (15.17% CI_{95}: 15.02–15.38%)	**13001**	**158600**

n. c. = not calculated

Table 5 Cases of plant exposures that resulted in severe symptoms or even death reported to the PIC Erfurt from 2001–2010.

Case number	Plant	Circumstances of exposure	Patient	Symptoms	Measures
1	*Aconitum napellus* unknown amount	suicidal ingestion	woman, age unknown	initially no symptoms, afterwards death	no treatment
2	*Aconitum napellus* unknown amount of a soup from the plant	suicidal ingestion	63-year-old man	20 min after ingestion first symptoms with malaise, vomiting, abdominal pain, coma, respiratory insufficiency, hyporeflexia, hypothermia, bradycardia (54 beats/min), initial hypertension then hypotension (systolic RR 40 mmHg), in X-ray atelectasis of the left lung	intubation and ventilation, gastric lavage, activated charcoal plus sodium sulfate, cardiopulmonary monitoring, catecholamines, infusion, sedation with propofol, acetylcysteine and antibiotics to treat bronchopneumonia (38 °C) in the further course, recovered completely
3	*Aconitum napellus* unknown amount of a liquid extraction from the plant	suicidal ingestion	74-year-old man	coma, respiratory failure, hypotension	died in the further course of treatment at an intensive care unit
4	*Arum cornutum* unknown amount of the root tuber	accidental ingestion, mix-up with celery	man, age unknown	swelling of the left side of the tongue and pharynx, respiratory insufficiency	cardiopulmonary monitoring, antihistaminics, improvement of the symptoms in the further course
5	*Chelidonium majus* unknown amount	accidental ingestion as herbage	man, age unknown	jaundice, convulsion, shortly high elevation of transaminases	viral hepatitis was excluded, symptomatic treatment, transaminases decreased in the further course
6	*Datura stramonium* unknown amount of tea prepared from seeds	ingestion for unknown reason	42-year-old woman	initially coma, in the further course apathia, pronounced agitation, tachycardia, mydriasis	cardiopulmonary monitoring, infusion, clonidine, nitroglycerin, diazepam, haloperidol, single dose of physostigmine and furosemide, recovered completely
7	*Brugmansia* unknown amount	abusal ingestion	17-year-old girl	pronounced psychotic reaction, tachycardia (180 beats/min), mydriasis	ipecac-induced emesis, activated charcoal, cardiopulmonary monitoring, unknown outcome
8	*Dieffenbachia* unknown amount of plant juice	accidental dermal contamination of an open wound of the thumb 1 month ago	42-year-old woman	dermal necrosis	surgical debridement and plastic coverage of the wound, delayed wound healing, no underlying disease (diabetes) was known
9	*Ricinus communis* unknown amount of leaves	accidental ingestion, mix-up with leaves from *Rheum rhabarbarum*	4-year-old girl	permanent vomiting, bloody aqueous diarrhoea, hypotension, hypothermia	intravenous administration of fluid and electrolytes, diagnostically no other cause was found, unknown outcome
10	*Taxus baccata* unknown amount of leaves	suicidal ingestion	16-year-old girl	initially malaise, unconsciousness, in autopsy pronounced mydriasis, brain and lung oedema, congestion in liver, spleen, and kidneys	resuscitation, death, in autopsy big amounts of *Taxus baccata* leaves in larynx, oesophagus, stomach and duodenum
11	*Taxus baccata* unknown amount of leaves	suicidal ingestion	woman, age unknown	no information, the woman was found dead	in postmortem analysis the serum concentration of 3,5-dimethoxyphenol was 60 µg/L
12	*Taxus baccata* unknown amount of leaves	suicidal ingestion	48-year-old woman	coma, respiratory and renal failure, hypotonia	intubation and ventilation, gastric lavage, activated charcoal, cardiopulmonary monitoring, recovered completely
13	*Taxus baccata* unknown amount of leaves	suicidal ingestion	52-year-old woman	coma, asystole, after resuscitation and defibrillation bradycardia with escape rhythm, pronounced QRS complex widening	intubation and ventilation, gastric lavage, multiple-dose activated charcoal, cardiopulmonary monitoring, pacemaker installation, lidocaine (50 mg as i. v. bolus and 1 g/24 h) reduced remarkably the QRS complex widening, recovered completely after 7 days of treatment at an intensive care unit

Plant genera	EP	TPE	MME	MME/TPE in %
Brugmansia	+++	377	54	14.3
Datura	+++	127	23	18.1
Euphorbia	+	385	17	4.4
Taxus	+++	742	9	1.2
Atropa	+++	53	6	11.3
Heracleum	++	59	6	10.2
Laburnum	++	143	5	3.5
Sambucus	+	268	5	1.9
Narcissus	+	115	4	3.5
Aconitum	+++	43	3	7.0
Dictamnus	++	7	3	42.9
Dieffenbachia	++	210	3	1.4
Digitalis	++	67	3	4.5
Ricinus	+++	40	3	7.5
Solanum	++	246	3	1.2
Colchicum	+++	59	2	3.4
Hedera	++	119	2	1.7

Table 6 List of plant genera that caused at least twice moderate or severe symptoms with the number of total plant exposures (TPE), the endangering potential (EP) from the literature, and the absolute number and relative frequency of moderate and major effects (MME).

Limitations

Our study had several limitations. The study was only retrospective. Case records of the PIC Erfurt were from self-reported calls, and reflect only information provided by a layperson or health care professional. Exact information about the ingested amount of the plant was often missing. Therefore, it was not possible to investigate the relationship of plant amount and its toxicity. The plant involved in exposure was often not identified by a plant expert and the plant exposure was mostly not confirmed by laboratory analysis.

Conclusions

In contrast to the development seen by the U.S. PICs, the PIC Erfurt observed a decrease in the frequency of plant exposures in relation to all exposures but not in their absolute numbers in the decade 2001–2010.

While some plants genera like *Taxus, Ligustrum*, and *Ficus* were continuously among the most often involved plant genera during the whole study period, exposures to other plant genera like *Brugmansia* and *Datura* showed time-dependent changes.

In comparison to all human exposures, the relative frequency of severe symptoms in accidental and intentional plant exposures by abuse is significantly lower, but as high by suicide.

The significantly higher involvement of children resulted mainly in none or mild symptoms. Severe symptoms can mostly be observed in adults with intentional ingestion when poisonous plants are mistaken for eatable.

Because the ingestion of some plants resulted in severe symptoms (*Aconitum, Arum, Chelidonium, Datura, Brugmansia, Dieffenbachia, Ricinus*, 2 *Taxus*) and even death (2 *Aconitum*, 2 *Taxus*), their dangerousness should not be trivialized.

Conflict of Interest

All contributing authors state that no conflict of interest is involved with this work.

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