

# BMJ Open A nationwide study of patients hospitalised for poisoning in Korea based on Korea National Hospital Discharge In-Depth Injury Survey data from 2005 to 2009

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**To cite:** Kim K, Choi JW, Park M, *et al.* A nationwide study of patients hospitalised for poisoning in Korea based on Korea National Hospital Discharge In-Depth Injury Survey data from 2005 to 2009. *BMJ Open* 2015;**5**: e008823. doi:10.1136/bmjopen-2015-008823

► Prepublication history for this paper is available online. To view these files please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2015-008823>).

Received 19 May 2015  
Revised 7 October 2015  
Accepted 16 October 2015



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## ABSTRACT

**Objectives:** In light of the need to develop an integrated database on poisoning incidents in Korea, this study seeks to determine the characteristics of poisoning incidents in Korea by age, gender, location of incident, causative substance and patient prognosis.

**Data sources:** The Korea National Hospital Discharge In-Depth Injury Survey results (2005–2009) from the Korea Centers for Disease Control and Prevention were used.

**Participants:** 3826 participants in the survey who had been hospitalised for poisoning incidents.

**Results:** The poisoning hospitalisation rate per 100 000 population was higher in women (1.735) than in men (1.372) and increased with age: the rate was 0.458 among individuals aged  $\leq 9$  years, 0.481 among those aged 10–19 years, 1.584 among those aged 20–64 years and 4.053 among those aged  $\geq 65$  years. The intentional poisoning hospitalisation rate differed by gender and age group. Women aged  $\leq 19$  years and 20–64 years showed a higher hospitalisation rate than men, while men aged  $\geq 65$  years showed a higher hospitalisation rate than women in the same age group. The most common poisoning substance was pesticides (33.6%), while antiepileptic, sedative-hypnotic and antiparkinsonism drugs and psychotropic drugs, not elsewhere classified were also very common. Poisoning in those aged  $\leq 9$  years usually involved other drugs, while pesticides were the most common substances in those aged 20–64 years and  $\geq 65$  years.

**Conclusions:** This study analysed poisoning incidents in Korea from 2005 to 2009, by age and gender, causative substance, and characteristics. The results of this study may serve as evidence for new strategies in Korea to prevent poisoning.

## INTRODUCTION

Poisoning incidents are considered a major public health issue worldwide.<sup>1–2</sup> The USA, member countries of the European Union (EU) and some developing countries

## Strengths and limitations of this study

- This study used data from the Korea National Hospital Discharge In-Depth Injury Survey conducted by the Korea Control of Diseases and Prevention to characterise poisoning incidents.
- Unlike previous studies which partially analysed poisoning incidence in Korea, this study offers a comprehensive and nationally representative overview thereof.
- Poisoning patients who attended clinics with under 100 beds and did not go to hospital were not considered in this study.

operate national poison information centres to gather and make public statistical information on poisoning incidents. Recently, incidents caused by chemicals have been emerging as a social issue in South Korea. A national database on accidental chemical intoxication that reflects the current state has yet to be established in Korea, despite the increase in the risk of and number of poisoning incidents.<sup>3</sup>

The American Association of Poison Control Centers (AAPCC) reported 3 624 063 telephone calls regarding poisoning incidents in 2011,<sup>4</sup> while the UK's National Poisons Information Service (NPIS) reported 53 796 calls in 2012 and 2013.<sup>5</sup> In addition, Ireland's National Poisons Information Centre (NPIC) reported that 9563 enquiries concerning poisoning incidents were made in 2012.<sup>6</sup> Estonia's National Poisoning Information Centre reported that children between 1 and 6 years of age accounted for 47% (420 cases) of the 1118 poisoning incidents reported in 2012.<sup>7</sup> The Swedish Poisons Information Centre analysed 86 397 poisoning incidents in 2014 and reported that children aged 10 and under

accounted for 34% of all incidents, while the causative substances, in descending order, were chemical products (41%), pharmaceuticals (28%), plants (11%), cosmetics (8%) and tobacco (4%).<sup>8</sup>

Unlike the countries mentioned above, due to the absence in Korea of a poisoning information management centre, it is hard to accurately perform an epidemiological statistical analysis, and thus difficult to determine the frequency of and substances involved in poisonings in Korea. Studies on poisoning incidents in Korea include one that reported a mortality rate of 8.70 per 100 000 inhabitants,<sup>9</sup> a study on the economic burden of acute pesticide poisoning, a report analysing patients presenting in emergency rooms with pesticide poisoning, and research analysing causative substances and patient prognoses in those with cardiac arrest caused by poisoning before hospital presentation.<sup>10–12</sup>

Most studies analysing poisoning incidents in Korea have focused on identifying causative substances and the characteristics of patients presenting to hospital or emergency care centres. As such, these studies are not comprehensive, making it difficult to examine the causative substances and patient prognosis. In addition, there are few studies on the characteristics of and causative substances used in intentional poisoning, which is reported to represent a high percentage of unnatural deaths.<sup>13</sup> The Korea Centers for Disease Control and Prevention and the Ministry of Health and Welfare have been conducting an in-depth national hospital discharge injury survey since 2004 for time-series analysis of discharged poisoning incident patients.<sup>14</sup>

Using data from the National Hospital Discharge In-Depth Injury Survey conducted by the Korea Centers for Disease Control and Prevention, this study aimed to describe the status of poisoning incidents in Korea. The goals of this study were to analyse: (1) the characteristics of incidents according to age, gender, location and intentionality; (2) the causative substances used by each age group; (3) the prognoses in each age group; and finally, (4) differences in age, gender and causative substances between intentional and unintentional poisonings.

## METHODS

### Data selection for analysis of poisoning incidents in Korea

The Korea Centers for Disease Control and Prevention has performed an in-depth discharge injury survey since 2005, using the NHDS (National Hospital Discharge Survey) methodology of the USA. The discharge injury in-depth survey investigates patients discharged in the previous year from general hospitals with more than 100 beds by selecting 170 sample hospitals by city/province and hospital size. Items investigated include the characteristics of the hospital (location, number of beds), major diagnosis of the patient, surgery, hospitalisation route, information after discharge and causative substances in cases of accidental poisoning.

The age distribution of patients included in the in-depth discharge survey corresponded with that of discharged patients in patient survey data obtained from hospital-level medical institutions in Korea. This indicates that the discharge injury in-depth survey can be used to obtain comprehensive and representative data according to age group to identify the characteristics of patients hospitalised due to poisoning incidents.<sup>15</sup> This study analysed 3826 patients from 2005 to 2009 who met diagnosis codes for poisoning in the in-depth discharge survey data.

### Characteristics of hospitalised poisoning patients and hospitalisation rate

Analysis of patients hospitalised due to poisoning was based on age, gender, hospitalisation route (emergency or outpatient department), location of the incident (eg, home, farm, beach, outdoors) and intentionality of the incident (intentional, unintentional or other poisoning). The hospitalisation rates due to intentional and unintentional poisoning for each age group and gender were estimated by dividing the total number of patients hospitalised from 2005 to 2009 by the total summed population for those years (total population: 246 356 493; total male population: 123 457 323; total female population: 122 899 170).

### Analysis of causative substances in cases of accidental poisoning

Based on the opinions of emergency physicians, patients were classified under codes T36–T65 of the International Classification of Diseases, 10th Revision (ICD-10).<sup>16</sup> Poisoning substances were classified as follow: narcotics and psychodysleptics (hallucinogens) (T40), antiepileptic, sedative-hypnotic and antiparkinsonism drugs, and psychotropic drugs, not elsewhere classified (T42, T43), diuretics and other unspecified drugs, medicaments and biological substances (T50), alcohol (T51), organic solvents, hydrocarbons and metals, etc (T52–T53, T56–T57), corrosive substances (T54), soaps and detergents (T55), carbon monoxide (T58), gases (T59), pesticides (T60), seafood and food (T61–T62, T64), contact with venomous animals (T63), unspecified substances (T65) and other drugs (T36–T39, T41, T44–T49).

### Calculation of hospitalisation rate per 100 000 population and other statistical analyses

Analysis of patients hospitalised due to poisoning was performed using SPSS V.18.0 software. First, a frequency analysis and a descriptive analysis were performed to examine socio-demographic characteristics. Second, a frequency analysis was performed to examine differences in causative substances by age group ( $\leq 19$ , 20–64 and  $\geq 65$  years old), patient prognosis and intentionality. Third, to determine the overall hospitalisation rate per 100 000 population and gender and age-specific hospitalisation rates, the total number of poisoning patients was divided by the total population from 2005 to 2009.

The 95% CIs for each value were calculated as follows:

$$95\% \text{ CI} = p \pm 1.96\sqrt{(pq/n)}$$

where p is case/population, and q is 1-p.

## RESULTS

### General characteristics of poisoning patients and poisoning hospitalisation rate per 100 000 population

Overall, 3826 poisoning patients were identified from 2005 to 2009, with more women (2132, 55.7%) than men (1694, 44.3%). Of these, 2566 were 20–64 years old, accounting for 67.1% of all poisoning patients. The hospitalisation rate among all poisoning incidents per 100 000 population was 1.372 (95% CI 1.307 to 1.437) in men and 1.735 (95% CI 1.661 to 1.808) in women. The hospitalisation rate per 100 000 population was 0.458 (95% CI 0.376 to 0.539) in patients  $\leq 9$  years of age, 0.481 (95% CI 0.407 to 0.555) in patients 10–19 years of age, 1.584 (95% CI 1.523 to 1.646) in patients 20–64 years of age and 4.053 (95% CI 3.799 to 4.307) in patients  $\geq 65$  years of age. Regarding hospitalisation route, 3553 people (92.9%) were admitted through emergency rooms. More patients (2171) were hospitalised for intentional poisoning than for unintentional poisoning (table 1).

### Causative poisoning substance for each age group (2005–2009)

Analysis of the causative substances in poisoning cases from 2005 to 2009 showed that incidents were most commonly caused by pesticides (T60) with 1284 cases (33.6%), followed by 847 cases (22.1%) caused by antiepileptic, sedative-hypnotic, antiparkinsonism drugs, and psychotropic drugs, not elsewhere classified (T42, T43), and 512 cases (13.4%) caused by contact with a venomous animal (T63). Further analysis was performed regarding age group. In the  $\leq 9$  year-old age group, other drugs (T36–T39, T41, T44–T49) were the most common causative substances (28 cases, 23.1%), followed by antiepileptic, sedative-hypnotic, antiparkinsonism drugs and psychotropic drugs, not elsewhere classified (T42, T43) (18 cases, 14.9%) and then pesticides (14 cases, 11.6%). In the 10–19-year-old age group, other drugs (T36–T39, T41, T44–T49) were the most common causative substances (74 cases, 45.4%), followed by antiepileptic, sedative-hypnotic, antiparkinsonism drugs, and psychotropic drugs, not elsewhere classified (32 cases, 19.6%), and then pesticides (T60) (17 cases, 10.4%). In the 20–64-year-old age group, pesticides were the most common causative substances (839 cases, 32.7%), followed by antiepileptic, sedative-hypnotic, antiparkinsonism drugs, and psychotropic drugs, not elsewhere classified (621 cases, 24.2%), and

**Table 1** General characteristic of poisoning patients and poisoning hospitalisation rate (per 100 000 population) (N=3826)

	N	Per cent	Hospitalisation rate (per 100 000)
Gender			
Male	1694	44.3	1.372 (95% CI 1.307 to 1.437)
Female	2132	55.7	1.735 (95% CI 1.661 to 1.808)
Age (years)			
$\leq 9$	121	3.2	0.458 (95% CI 0.376 to 0.539)
10 to 19	163	4.3	0.481 (95% CI 0.407 to 0.555)
20 to 64	2566	67.1	1.584 (95% CI 1.523 to 1.646)
$\geq 65$	976	25.5	4.053 (95% CI 3.799 to 4.307)
Admission route			
Emergency	3553	92.9	–
Outpatient	272	7.1	–
Undetermined	1	0.03	–
Outcome			
Home care	3075	80.4	–
Transferred to other hospital	347	9.1	–
Death	313	8.2	–
Undetermined	91	2.4	–
Place of occurrence			
Home	2222	58.1	–
Farm	244	6.4	–
Beach, outdoors	175	4.6	–
Other	235	6.1	–
Unknown	950	24.8	–
Intent			
Unintentional	1361	35.6	–
Intentional	2171	56.7	–
Other	258	6.7	–
Unknown	36	0.94	–

**Table 2** Causative substance (agent) of poisoning for each age group (2005–2009) (N=3826)

Causative substance (agent)	Age (years)				Total
	≤9 N (%)	10–19 N (%)	20–64 N (%)	≥65 N (%)	
Drugs, medicaments and biological substances					
Other drugs (T36–T39, T41, T44–T49)	28 (23.1)	74 (45.4)	353 (13.8)	58 (5.9)	513 (13.4)
Drugs and psychodysleptics (T39)	0 (0.0)	1 (0.6)	5 (0.2)	1 (0.1)	7 (0.2)
Antiepileptic, sedative-hypnotic and antiparkinsonism drugs, psychotropic drugs, not elsewhere classified (T42, T43)	18 (14.9)	32 (19.6)	621 (24.2)	176 (18.0)	847 (22.1)
Diuretics and other and unspecified drugs, medicaments and biological substances (T50)	13 (10.7)	11 (6.7)	63 (2.5)	24 (2.5)	111 (2.9)
Alcohol (T51)	1 (0.8)	1 (0.6)	12 (0.5)	3 (0.3)	17 (0.4)
Non-medical substances					
Organic solvents, hydrocarbons and metals, etc (T52–T53, T56–T57)	7 (5.8)	3 (1.8)	35 (1.4)	11 (1.1)	56 (1.5)
Corrosive substances (T54)	13 (10.7)	3 (1.8)	80 (3.1)	35 (3.6)	131 (3.4)
Soaps and detergents (T55)	8 (6.6)	0 (0.0)	32 (1.2)	4 (0.4)	44 (1.2)
Carbon monoxide (T58)	1 (0.8)	2 (1.2)	60 (2.3)	24 (2.5)	87 (2.3)
Gases (T59)	2 (1.7)	0 (0.0)	42 (1.6)	8 (0.8)	52 (1.4)
Pesticides (T60)	14 (11.6)	17 (10.4)	839 (32.7)	414 (42.4)	1284 (33.6)
Seafood and food (T61–T62, T64)	4 (3.3)	6 (3.7)	80 (3.1)	21 (2.2)	111 (2.9)
Contact with venomous animals (T63)	9 (7.4)	11 (6.7)	305 (11.8)	187 (19.2)	512 (13.4)
Unspecified substances (T65)	3 (2.5)	2 (1.2)	39 (1.5)	10 (1.0)	54 (1.4)

then other drugs (353 cases, 13.8%). In the ≥65-year-old age group, pesticides were the most common poisoning substance (414 cases, 42.4%), followed by contact with a venomous animal (187 cases, 19.2%) and then antiepileptic, sedative-hypnotic, antiparkinsonism drugs, and psychotropic drugs, not elsewhere classified (176 cases, 18.0%) (table 2).

### Age differences in treatment outcomes

A total of 3133 (81.9%) of the 3826 patients survived the incident. By age group, 4 (2.5%) of the 10–19-year-old patients died, 194 (7.5%) of the 20–64-year-old patients, and 115 (11.8%) of the ≥65-year-old patients. The ≤9-year-old age group showed the highest survival of all age groups, with 96.7% (117 patients) considered cured (table 3).

### Gender differences in hospitalisation rate for intentional poisonings (per 100 000 population)

A total of 2171 patients were hospitalised for intentional poisonings from 2005 to 2009, giving a hospitalisation

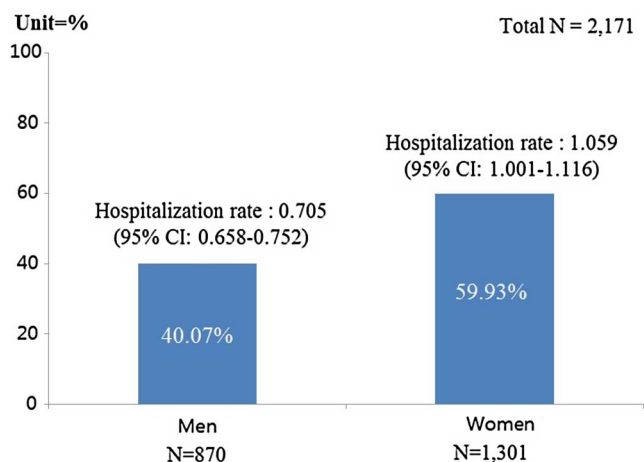
rate of 0.705 (95% CI 0.658 to 0.752) per 100 000 population in men and 1.059 (95% CI 1.001 to 1.116) per 100 000 population in women (figure 1).

### Gender differences in hospitalisation rates in different age groups for intentional poisonings (per 100 000 population)

Regarding intentional poisonings, 100 occurred in people ≥19 years of age, 1620 in people 20–64 years of age and 451 in people ≥65 years of age. The hospitalisation rate per 100 000 population was 0.166 (95% CI 0.133 to 1.198) in the ≤19-year-old age group, 1.000 (95% CI 0.952 to 1.049) in the 20–64-year-old age group and 1.873 (95% CI 1.700 to 2.046) in the ≥65-year-old age group. In the ≤19-year-old age group, males had a lower hospitalisation rate per 100 000 population (0.092, 95% CI 0.058 to 0.125) than females (0.248, 95% CI 0.190 to 0.305). In 20–64-year-old age group, the hospitalisation rate for men (0.749, 95% CI 0.689 to 0.808) was lower than that for women (1.260, 95% CI 1.182 to 1.337). In the ≥65-year-old age group, men showed a higher hospitalisation rate (2.350, 95% CI 2.043 to

**Table 3** Age differences in treatment outcomes (N=3826)

Treatment result	Age (years)				Total
	≤9 N (%)	10–19 N (%)	20–64 N (%)	≥65 N (%)	
Improved (cured)	117 (96.7)	151 (92.6)	2111 (82.3)	754 (77.2)	3133 (81.9)
Not improved	2 (1.7)	5 (3.1)	155 (6.0)	63 (6.5)	225 (5.9)
Not treated	2 (1.7)	3 (1.8)	73 (2.8)	27 (2.8)	105 (2.7)
Considered incurable	0 (0.0)	0 (0.0)	20 (0.8)	12 (1.2)	32 (0.8)
Death	0 (0.0)	4 (2.5)	194 (7.5)	115 (11.8)	313 (8.2)
Other	0 (0.0)	0 (0.0)	13 (0.6)	5 (0.5)	18 (0.5)



**Figure 1** Gender differences in hospitalisation rates for intentional poisonings (per 100 000 population).

2.656) than women (1.556, 95% CI 1.353 to 1.759) (table 4).

#### Differences in causative substance between unintentional and intentional poisonings for each age group

In the  $\leq 9$ -year-old age group, the most common substances for unintentional poisonings was other drugs (T36–T39, T41, T44–T49), while antiepileptic, sedative-hypnotic, antiparkinsonism drugs, and psychotropic drugs, not elsewhere classified were the most common for intentional poisonings. In the 10–19-year-old age group, other drugs (T36–T39, T41, T44–T49) were the most common agents for both intentional and unintentional poisonings. In both the 20–64-year-old and  $\geq 65$ -year-old age groups, contact with a venomous animal (T63) was the most common cause of unintentional poisoning, while pesticide-related poisonings (T60), antiepileptic, sedative-hypnotic, antiparkinsonism

drugs and psychotropic drugs, not elsewhere classified (T42, T43) were the most common substances in intentional poisonings (table 5).

#### Age differences in causative substances for inpatient mortality

Pesticides (T60) caused the most deaths in all age groups ( $\leq 19$ , 20–64,  $\geq 65$ ). For the 20–64-year-old age group, corrosive substances (T54) and other and unspecified substances (T65) were the next most common causes of inpatient mortality. Corrosive substances (T54) and other drugs (T36–T39, T41, T44–T49), diuretics and other and unspecified drugs, medicaments and biological substances (T50) were other notable causes of inpatient mortality in the 65-year-old age group (table 6).

#### DISCUSSION

This study analysed nationally representative data from the Korea National Hospital Discharge In-Depth Injury Survey from 2005 to 2009, to investigate hospitalisation rates due to, and the characteristics of, poisoning incidents in Korea. The hospitalisation rate per 100 000 population was higher for women (1.735) than for men (1.372). The  $\geq 65$ -year-old age group had the highest risk of poisoning incidents, with a hospitalisation rate of 4.053, which was higher than that of the  $\leq 9$ -year-old (0.458), 10–19-year-old (0.481) and 20–64-year-old (1.584) age groups. The AAPCC reported in 2012 that of the 2 275 141 cases of poisoning in the USA, 1 167 584 (51.32%) involved women and 1 096 954 (48.21%) involved men.<sup>4</sup> These results agree with a previous 2012 study by the Estonian National Poisoning Information Centre, which showed that there were more poisoning incidents in women (584 cases) than in men (495 cases).<sup>7</sup> In Taiwan, 11 523 patients were hospitalized for poisoning incidents between 2005 and 2007, giving a hospitalization rate of 16.83 per 100 000 population; the hospitalisation rate was higher in women than in men, and the 45–69-year-old age group had the highest rate (52.85).<sup>17</sup> However, we found two studies analysing poisoning patients where men outnumbered women. In the South Karnataka region of India, the ratio of men to women who visited a hospital following poisoning was 2.29:1,<sup>18</sup> while men accounted for 71% of all poisoning incidents in the Kampala region of Uganda.<sup>19</sup>

The main causative substances were, in descending order, pesticides (T60) (33.6%, 1284 cases), antiepileptic, sedative-hypnotic and antiparkinsonism drugs and psychotropic drugs, not elsewhere classified (T42, T43) (22.1%, 847 cases) and contact with venomous animals (T63) (13.4%, 512 cases). In Morocco, according to CAPM (the Anti-Poison and Pharmacovigilance Centre of Morocco), the top three causative substances (responsible for 24.62% of poisoning incidents) were other drugs, gaseous substances and noxious substances eaten as food.<sup>20</sup>

**Table 4** Gender differences in hospitalisation rates in different age groups for intentional poisonings (per 100 000) (N=2171)

	N	Per cent	Hospitalisation rate (per 100 000)
<b><math>\leq 19</math> years of age* (N=100)</b>			
Total	100	100.0	0.166 (95% CI 0.133 to 1.198)
Male	29	29.0	0.092 (95% CI 0.058 to 0.125)
Female	71	71.0	0.248 (95% CI 0.190 to 0.305)
<b>20–64 years of age (N=1620)</b>			
Total	1620	100.0	1.000 (95% CI 0.952 to 1.049)
Men	615	38.0	0.749 (95% CI 0.689 to 0.808)
Women	1005	62.0	1.260 (95% CI 1.182 to 1.337)
<b><math>\geq 65</math> years of age (N=451)</b>			
Total	451	100.0	1.873 (95% CI 1.700 to 2.046)
Men	226	50.1	2.350 (95% CI 2.043 to 2.656)
Women	225	49.9	1.556 (95% CI 1.353 to 1.759)

\*Three patients (one boy and two girls) who were below 9 years of age were included in the 10–19-year-old age group.

**Table 5** Differences in causative substances (agents) between unintentional and intentional poisonings for each age group (N=3532)

Causative substance (agent)	Age (years)															
	≤9 (N=107)				10–19 (N=148)				20–64 (N=2400)				≥65 (N=877)			
	Unintentional		Intentional		Unintentional		Intentional		Unintentional		Intentional		Unintentional		Intentional	
	N	Per cent	N	Per cent	N	Per cent	N	Per cent	N	Per cent	N	Per cent	N	Per cent	N	Per cent
Drugs, medicaments and biological substances																
Other drugs (T36–T39, T41, T44–T49)	24	23.1	–	–	18	35.3	49	50.5	47	6.0	278	17.2	26	6.1	15	3.3
Narcotics and psychodysleptics (T40)	–	–	–	–	–	–	–	–	–	–	5	0.3	–	–	1	0.2
Antiepileptic, sedative-hypnotic and antiparkinsonism drugs, and psychotropic drugs, not elsewhere classified (T42, T43)	14	13.5	2	66.7	5	9.8	24	24.7	64	8.2	510	31.5	41	9.6	108	23.9
Diuretics and other and unspecified drugs, medicaments and biological substances (T50)	8	7.7	–	–	4	7.8	–	–	14	1.8	38	2.3	9	2.1	11	2.4
Alcohol (T51)	1	1.0	–	–	1	2.0	–	–	9	1.2	2	0.1	3	0.7	0	–
Non-medical substances																
Organic solvents, hydrocarbons and metals, etc (T52–T53, T56–T57)	7	6.7	–	–	1	2.0	–	–	21	2.7	13	0.8	8	1.9	2	0.4
Corrosive substances (T54)	11	10.6	–	–	–	–	3	3.1	22	2.8	53	3.3	16	3.8	16	3.5
Soaps and detergents (T55)	8	7.7	–	–	–	–	–	–	12	1.5	20	1.2	2	0.5	2	0.4
Carbon monoxide (T58)	1	1.0	–	–	1	2.0	1	1.0	40	5.1	16	1.0	18	4.2	4	0.9
Other gases, fumes and vapours (T59)	2	1.9	–	–	–	–	–	–	40	5.1	2	0.1	6	1.4	0	–
Pesticides (T60)	12	11.5	1	33.3	5	9.8	9	9.3	112	14.4	664	41.0	89	20.8	287	63.6
Seafood and food (T61–T62, T64)	4	3.8	–	–	5	9.8	–	–	80	10.3	–	–	19	4.5	1	0.2
Contact with venomous animals (T63)	9	8.7	–	–	11	21.6	–	–	304	39.0	1	0.1	186	43.7	1	0.5
Other and unspecified substances (T65)	3	2.9	–	–	–	–	2	2.1	15	1.9	18	1.1	3	0.7	3	0.7
<b>Total</b>	<b>104</b>	<b>100</b>	<b>3</b>	<b>100</b>	<b>51</b>	<b>100</b>	<b>97</b>	<b>100</b>	<b>780</b>	<b>100</b>	<b>1620</b>	<b>100</b>	<b>426</b>	<b>100</b>	<b>451</b>	<b>100</b>

**Table 6** Age differences in causative substances (agents) for inpatient mortality (N=313)

Causative substance (agent)	Age (years)			Total
	≤19* N (%)	20–64 N (%)	≥65 N (%)	
Drugs, medicaments and biological substances				
Other drugs (T36–T39, T41, T44–T49)	0 (0.0)	1 (0.5)	2 (1.7)	3 (1.0)
Antiepileptic, sedative-hypnotic and antiparkinsonism drugs, and psychotropic drugs, not elsewhere classified (T42, T43)	0 (0.0)	2 (1.0)	1 (0.9)	3 (1.0)
Diuretics and other and unspecified drugs, medicaments and biological substances (T50)	0 (0.0)	0 (0.0)	2 (1.7)	2 (0.6)
Alcohol (T51)	0 (0.0)	2 (1.0)	0 (0.0)	2 (0.6)
Non-medical substances				
Organic solvents, hydrocarbons and metals, etc (T52–T53, T56–T57)	0 (0.0)	0 (0.0)	1 (0.9)	1 (0.3)
Corrosive substances (T54)	0 (0.0)	6 (3.1)	3 (2.6)	9 (2.9)
Carbon monoxide (T58)	0 (0.0)	2 (1.0)	0 (0.0)	2 (0.6)
Pesticides (T60)	4 (100.0)	175 (90.2)	105 (91.3)	284 (90.7)
Seafood and food (T61–T62, T64)	0 (0.0)	1 (0.5)	0 (0.0)	1 (0.3)
Contact with venomous animals (T63)	0 (0.0)	2 (1.0)	1 (0.9)	3 (1.0)
Other and unspecified substances (T65)	0 (0.0)	3 (1.5)	0 (0.0)	3 (1.0)
Total	4 (100.0)	194 (100.0)	115 (100.0)	313 (100.0)

\*Three patients (one boy and two girls) below 9 years of age were included in the 10–19-year-old group.

Regarding causative substances by age group, other drugs (T36–T39, T41, T44–T49) ranked first in the ≤9-year-old and ≤19-year-old age groups with 28 (23.1%) and 74 cases (45.4%), respectively. Pesticides ranked first in both the 20–64-year-old and ≥65-year-old age groups with 839 (32.7%) and 414 cases (42.4%), respectively.

The Swedish poisoning centre reported that the major causative substances in poisoning incidents in 2013 were, in descending order, chemical products (42%), pharmaceuticals (28%), plants (11%), cosmetics (8%) and tobacco (4%).<sup>8</sup> Causative substances in poisoning patients hospitalised in a tertiary hospital in Mumbai, India, were, in descending order, household products, pesticides and pharmaceuticals.<sup>21</sup>

As this study analysed causative substances using ICD codes, the results differ from those of poison information centres in other countries.

In this analysis of 2171 cases of intentional poisoning, men (0.705) had a lower hospitalisation rate than women (1.059) per 100 000 population. This result is similar to the hospitalisation rate for total poisoning incidents, which was higher in women (1.735) than in men (1.372).

In a study of intentional poisoning deaths in southern India, the ratio of men to women was 2.7:1.<sup>13</sup> The Taiwan National Poison Control Centre (PCC) reported a male:female ratio in unnatural poisoning deaths of 1.6:1 (67 men vs 42 women), which differs from the results of this study.<sup>22</sup> However, numbers reported from China are similar, as women (2865 cases, 60.6%) experienced unnatural poisoning deaths more frequently than men (1863 cases, 39.4%).<sup>23</sup>

This analysis of hospitalisation rates following intentional poisoning per 100 000 population by age group,

found an incidence rate of 0.166 among the ≤19-year-old age group, 1.000 among the 20–64-year-old age group, and 1.873 among the ≥65-year-old age group. An analysis of 250 cases of poisoning among those aged ≥65 years identified 109 (43.6%) intentional poisonings,<sup>22</sup> while other studies found more than half of poisonings among those aged ≥65 years were intentional.<sup>24 25</sup> These results show that a high proportion of elderly citizens carry out intentional poisonings.

Additionally, analysis of intentional poisonings by gender for each age group in this study showed that intentional poisonings occurred more frequently among women in the ≤19-year-old and 20–64-year-old age groups than in men of the same age. In the ≥65-year-old group, however, more men than women had intentional poisoning. The finding that women aged 20–64 years experience more intentional poisonings than men of the same age contradicts the results of previous studies.

Analysis of data from KOSTAT (Statistics Korea) in 2002 showed suicide mortality rates per 100 000 people in men aged between 35–64 years (37.8) were higher than in women of the same age (12.5). Among those aged 65 and older, the suicide rate was also higher among men (71.1) than among women (31.2).<sup>26</sup> Studies suggest that the increased participation of women in economic activities can weaken social support and increase the suicide rate.<sup>27</sup> Furthermore, the increase in male suicide rates may be due to changes in economic and social status caused by retirement. In this study, agricultural pesticides were most frequently used in intentional poisonings among individuals aged 20–64 and ≥65 years. This finding coincides with the results of another study which identified agricultural pesticides as the main causative substances in intentional poisonings in China.<sup>23</sup>

The Taipei Poisoning Information Centre reported that benzodiazepines, insecticides, herbicides, warfarin and alcohol were the key causative substances ingested by patients aged 65 and older who visited an emergency room due to poisoning incidents.<sup>22</sup>

The majority of studies that have analysed poisoning incidents have reported that children aged 5 and younger have a high incidence of unintentional poisoning.<sup>4 5 7</sup>

The results of our study also demonstrate that incidents involving individuals  $\leq 19$  years old were more likely to be registered as unintentional than intentional poisonings. Since relatively few children aged  $\leq 5$  years were included in this study, all individuals aged  $\leq 19$  years were classified into one group. We therefore believe that this finding is the result of the relatively low hospitalisation rate among children  $\leq 5$  years old due to the low toxicity of the main causative substances reported in young children.<sup>28</sup>

Analysis of substances causing death in Taiwan by age showed that pesticides posed the highest risk for all age groups. Poisoning incidents involving methanol, herbicides and organophosphorus pesticides resulted in high inpatient mortality. A high Charlson Comorbidity Index (CCI) score, acute respiratory failure, alcohol and pesticide-related poisoning, procedures or surgery for poisoning incidents and short hospital stay were related to high inpatient mortality.<sup>17</sup> Pesticides, animal and plant venom and gaseous products had the highest fatality rates in Morocco from 2013 to 2014.<sup>20</sup>

Analysis of national mortality (1999–2008) and hospital discharge (2000–2009) data from New Zealand showed that two-thirds of causative substances in intentional poisonings (92.7% of which involved carbon monoxide) were other gases and vapours, and one-third were pharmaceuticals (ICD-10 codes X60–X64). Antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified were responsible for 17.9% of poisonings. Causative substances for unintentional poisonings were mostly pharmaceuticals (codes X40–X44), of which 50.0% were related to narcotics and psychotropic drugs, not elsewhere classified (codeine or morphine), 44.1% were related to methadone. 18.1% of unintentional poisonings were related to alcohol.<sup>29</sup>

The WHO recommends that all countries provide 24/7 poisoning advice and related information, and also operate poisoning management, information and research centres.<sup>30</sup> The US manages 55 national poisoning management and information centres through the AAPCC, providing 24-hour poison information to medical staff and the general public by phone free of charge.<sup>31</sup> Japan has provided 24-hour information to the general public and professionals since 1986 through the Japan Poison Information Center in Osaka.<sup>32</sup> In the western Pacific region, Australia, Hong Kong, Japan, Malaysia, Mongolia, the Philippines and Vietnam

operate poisoning management and information centres.<sup>33</sup> However, Korea lacks such centres which could administer a national poisoning surveillance system.<sup>34 35</sup>

A large number of studies have reported that fatal poisoning incidents can be reduced in children through preventive education.<sup>36</sup> The AAPCC reported that the operation of a poisons centre reduced the number of poisoning patients requiring hospitalisation by 12.0%, and reduced medical expenses by 24.0%. The number of unnecessary emergency room visits also declined by 24.0–37.0%.<sup>37</sup> These results indicate the need for a cost effectiveness analysis of the treatment of poisoning patients and a trend analysis of poisoning incidents nationwide, in order to provide data for a Korean poisoning information and management centre.

A limitation of this study is the exclusion of poisoning patients who visited medical institutions with fewer than 100 beds. Nevertheless, the in-depth discharge survey data allowed causative substances in poisoning incidents to be analysed by age group and intentionality, and is representative at a national level.

## CONCLUSION

This study analysed poisoning incidents by gender and age group, causative substances by age group, and intentionality. Findings confirmed that poisoning incidence rates vary by age group and gender. Men had a higher incidence of intentional poisoning than women, particularly among those aged 65 and older, which differs from the results of previous studies. The findings of this study are significant in that they could be used as a basis for establishing a national poisons centre in Korea, as well as providing policy data for the formulation of preventive policies related to poisoning.

**Contributors** J-WC and KK conducted overall research. ESL analysed the Korea National Hospital Discharge In-Depth Injury Survey data from 2005 to 2009. MP and MSK analysed the survey data. KK and JWC were responsible for writing the paper. All authors were involved in study conception and design, and reviewed the final draft of the manuscript.

**Competing interests** None declared.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data sharing statement** No additional data are available.

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