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Original Article

An epidemiological analysis of occupational poisoning in Malaysia: A retrospective study from the National Poison Centre

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Abstract

The present study aims to describe occupational poisoning in Malaysia by assessing the epidemiological characteristics and identifying the risk factors. Retrospective analysis of telephone enquiries made to the National Poison Centre (NPC) regarding occupational poisoning from 2006-2019 was conducted. The NPC received a total of 1,597 calls of occupational poisoning whereby sociodemographic analysis showed that the most high-risk group included males (80.7%) of Malay race (39.2%) aged between 19 and 29 years (33.6%) who were working at agricultural sites (42.9%) or factories (25.1%). Doctors (87.2%) reported mostly acute (95.5%) exposure through the major routes of inhalation (44.2%) and ingestion (36.6%). Data analysis indicated that state, age and race played a significant role ($p<0.05$) in determining whether occupational poisoning occurred via pesticide (44.8%) or industrial agent (40.5%), which caused the majority of cases. This study emphasized the importance of occupational safety and health (OSH) and the need for designing interventions, strategies and future research for quality improvements in safety at the workplace.

Keywords: occupational safety and health, workplace, agriculture, manufacturing, pesticide

1. Introduction

The World Health Organisation (WHO) and the International Labour Organisation (ILO) estimated that in 2016, 1.88 million deaths and 89.72 million disability-adjusted life years (DALYs) were attributed to occupational illnesses and injuries. Major risk factors included long work hours, exposure to occupational matter, gases and fumes, as well as occupational injuries (World Health Organization and International Labour Organization, 2021). Furthermore, the effects of occupational safety and health (OSH) morbidity and mortality are more prevalent in developing and rapidly industrializing countries (Murray & Lopez, 1996), especially in the WHO African Region, the South-East Asia Region, and the Western Pacific Region (World Health Organization and International Labour Organization, 2021). This causes a tremendous economic burden, costing approximately 4% of the world's Gross Domestic Product (GDP) each year (roughly US$2.8 trillion) (Takala *et al.*, 2014).

Law enforcement ensures efficient conduct at the workplace by covering a myriad of OSH issues, namely the surveillance of work environment and workers' health, advice on prevention and control of occupational health hazards, provision of training and education for employers and employees, conduct of research, and generation of data system (Buranatrevedh, 2015). In Malaysia, the Department of Occupational Safety and Health (DOSH) is the main agency responsible for ensuring that people's safety, health and

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welfare are protected at the workplace by improving OSH standards, and this is achieved through national OSH regulation and enforcement (Laws of Malaysia Act 514: Occupational Safety and Health Act 1994, 2006; Soehod & Laxman, 2007).

An extensive search of the current literature has shown the apparent lack of comprehensive reports on occupational poisoning incidents in Malaysia. In fact, on a global scale, reports on occupational poisoning incidents are still minimal (Schenk, Feychting, Annas, & Öberg, 2018), suggesting that the issue of occupational poisoning is underreported. Therefore, the present work aims to provide an overview type national epidemiological analysis on the magnitude of occupational poisoning in Malaysia, based on enquiry calls to the National Poison Centre (NPC). Moreover, this research aims to identify the high-risk sectors involved in poisoning at the workplace in an effort to provide scientific evidence to serve as a fundamental step in the development of national preventive strategies against this escalating situation.

2. Materials and Methods

This retrospective study details all occupational poisoning cases that were reported to the NPC from 1 January 2006 to 31 December 2019. Sociodemographic factors of occupational poisoning incidents, circumstances of exposure, identification of poisoning agents and other variables are further discussed in this study.

2.1 Data source

Since its establishment in 1994, the NPC remains the sole poison centre in Malaysia, with a significant role in serving an estimated population of 32.66 million (Department of Statistics Malaysia, 2021a). In addition to providing toxicological and poisoning information and consultation to healthcare professionals and the public, the NPC also conducts toxicological testing services. The NPC receives 4,000-6,000 poisoning and drug enquiries annually, and these cases are handled by a team of nine specially trained in-house pharmacists via telephone calls, for 24 hours a day and 7 days a week. In addition, health scientists and toxicology experts are available for consultation in more complex cases. All information regarding poisoning cases were provided to the callers based on references from databases such as Micromedex (Poisondex) and Toxinz or primary literature for unique cases.

2.2 Data collection strategy

All poisoning enquiries were entered into a standardized Poison Case Report Form (PCRF), which was adapted from the WHO. Terminologies and classifications used during data collection adhered to the INTOX tools, which were developed by the International Programme on Chemical Safety (IPCS), WHO (World Health Organization, 2020). The retrievable web-based data entry was customized and used cloud management applications for data collection and storage, whereby academics and pharmacists previously established content validation. In addition, the calls were recorded in a Voice Logging and Recording System so that audio could be retrieved for the future purposes of documentation, training and audit.

The enquiry details obtained included five domains of PCRF: caller's information, patient's background, poisoning information, clinical features and patient management before contact with the NPC. In the present study, all reported occupational poisonings were classified as unintentional, which is defined as 'an exposure by any route (or incident) where there was no intention to cause harm' (World Health Organization, 2020).

One poisoning case sometimes might prompt several calls to the NPC (e.g., calls from a member of the public, an emergency care personnel, and/or a doctor), whereby subsequent calls were recorded as 'Communication 2 or more'. As part of the protocol by the NPC to prevent double-counting during data collection, these additional or duplicate calls were cross-checked and consolidated into the primary incident.

2.3 Inclusion and exclusion criteria

Only enquiry calls regarding unintentional poisonings which occurred at the workplace between January 2006 and December 2019 were recorded for this study. All PCRF entries were complete and were recorded in the database.

2.4 Statistical analysis

The information obtained was analysed using statistical software SPSS version 18.0. Distribution of occupational poisoning cases, sociodemographic characteristics as well as types and nature of poisoning were examined using cross-tabulation and descriptive statistics. Chi-square test for independence analysis was performed to determine significant differences between two categorical variables (pesticide and industrial agent, as these chemicals caused the majority by number of occupational poisoning cases) for sociodemographic characteristics (state, gender, race and age group). Multiple logistic regression was performed to determine which sociodemographic characteristics predicted the occurrence of occupational poisoning for pesticide and industrial agent. Adjusted odd ratios and 95% confidence intervals were calculated for each predictor variable. Significance level was determined at $p<0.05$.

2.5 Ethical consideration

Due to the nature of secondary data, full ethical review was exempted from this study. To guarantee that privacy and confidentiality of patients were protected, call enquiries to the NPC contained no personal identifiers of the patients, and any potential for the anonymized data to become identifiable was omitted.

3. Results

During the study period (2006–2019), a total of 1,597 occupational poisoning cases were referred for consultation to the NPC. As illustrated in Figure 1, in the first seven years of the study, occupational poisoning calls received by the NPC were at an average of 4.8% yearly.

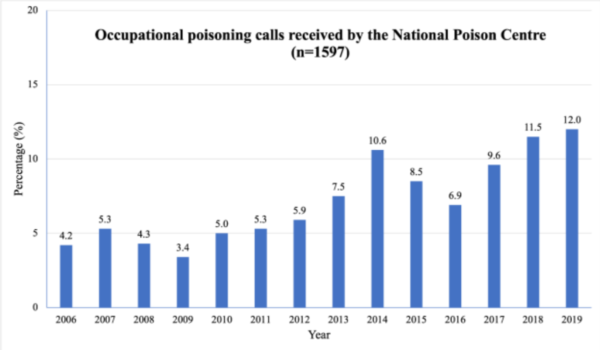

Figure 1. Distribution by year of occupational poisoning cases in Malaysia based on call enquiries made to the NPC from 2006-2019.

Subsequently from 2013 onwards, the number of poisoning cases which occurred at the workplace increased to more than 6% cases each year and the highest number of poisonings was recorded in 2019 with 12% cases.

Based on geographical area as shown in Table 1, Perak appears to be the state which recorded the highest number of occupational poisoning cases (18.9%, n=302). The state of Selangor recorded the second highest number of occupational poisoning cases (14.2%, n=227), followed by Pahang at the third highest (12.1%, n=194). Data in Figure 1 and Table 1 are corroborated in the heat map (Figure 2). Higher intensity is observed in the heat map where more cases were prevalent from 2013 onwards, and the states of Perak, Selangor and Pahang showed higher numbers of cases compared to the other states in Malaysia.

General demographic characteristics of patients involved in occupational poisoning are presented in Table 2, which shows that occupational poisoning was more prevalent among males (80.7%, n=1288) than in females (15.3%, n=245). Among different races in Malaysia, most occupational poisonings involved the Malay race (39.2%, n=626). 'Others', which categorizes a combination of other minority races in Malaysia, recorded the second highest number of occupational poisoning incidents (15.7%, n=251), while non-Malaysians, who are foreigners working in Malaysia, came in third with 201 cases (12.6%). Regarding distribution by age group, the most cases were observed among those at early working age of 19–29 years old (33.6%, n=537), followed by those of 30–39 years old (25.3%, n=404) and of 40-49 years old (14.9%, n=238). Looking at locations, the majority of poisoning cases occurred in agricultural areas (42.9%, n=685) followed in rank order by factories (25.1%, n=401). In addition, most cases were reported by medical doctors (87.2%, n=1393) while the public reported only three incidents (0.2%).

Table 3 summarizes various types and nature of occupational poisoning calls made to the NPC. The majority of poisoning exposure was acute (95.5%, n=1525), with inhalation being the predominant route of exposure (44.2%, n=706), followed by ingestion (36.6%, n=584), cutaneous (11.4%, n=182), ocular (4.6%, n=73) and bite/sting (1.9%, n=31). By looking at types of poisoning, pesticide (44.8%, n=715) and industrial agent (40.5%, n=646) were the most common agents implicated in occupational poisoning in Malaysia. In details, among different types of pesticides involved, almost half were due to herbicide (46.9%, n=335), with insecticide (35.5%, n=254) ranking second.

Data analysis was conducted to determine if state, gender, age or race might have affected poisoning by pesticide or industrial agent (Table 4). These two types of poisoning agents were selected as they recorded the majority percentages of occupational poisoning cases. Test of independence (Chi-square test) when conducted on types of poisoning agents

Table 1. Numbers of workplace poisoning exposure calls, by state in Malaysia

State	Population ('000)	Number of occupational poisoning cases (n =1597)
Perlis	255.0	3 (0.2)
Kedah	2,193.9	96 (6.0)
Penang	1,783.6	70 (4.4)
Perak	2,518.6	302 (18.9)
Selangor	6,569.5	227 (14.2)
Kuala Lumpur*	1,773.9	68 (4.3)
Putrajaya*	108.9	15 (0.9)
Negeri Sembilan	1135.9	132 (8.3)
Melaka	936.9	32 (2.0)
Johor	3,776.6	151 (9.5)
Pahang	1,682.9	194 (12.1)
Terengganu	1,259.0	34 (2.1)
Kelantan	1,904.9	36 (2.3)
Sarawak	2,828.7	91 (5.7)
Sabah	3,907.5	129 (8.1)
Labuan*	99.6	4 (0.3)
Unknown	-	13 (0.8)

* Federal territory

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Perlis	0	0	0	0	0	0	0	0	0	0	0	2	0	1
Kedah	2	0	2	0	5	4	3	6	9	15	11	14	14	11
Pulau Pinang	1	2	2	1	4	2	4	7	7	6	1	9	12	12
Perak	21	24	15	21	19	19	21	13	38	20	30	18	24	19
Selangor	10	19	14	6	16	18	11	23	18	19	14	11	24	24
Kuala Lumpur*	3	6	5	3	3	3	4	3	7	4	3	10	5	9
Putrajaya*	0	2	1	0	2	0	1	0	1	2	1	2	1	2
Negeri Sembilan	7	6	5	3	10	16	14	13	13	11	5	13	10	6
Melaka	1	0	1	0	1	2	2	4	8	5	2	3	2	1
Johor	4	2	3	4	9	5	4	14	11	11	12	23	23	26
Pahang	11	11	14	9	7	9	12	14	23	21	12	14	19	18
Terengganu	0	0	0	1	0	0	0	1	3	2	4	7	12	4
Kelantan	1	0	3	1	2	0	1	3	4	3	2	4	4	8
Sarawak	0	2	0	2	0	2	10	5	15	8	6	10	9	22
Sabah	5	8	2	4	1	4	6	12	9	8	7	13	24	26
Labuan*	0	0	0	0	0	0	0	0	2	0	0	0	0	2
Unknown	1	2	2	0	1	0	2	2	1	0	0	1	1	0

* Federal territory

Figure 2. A heat map of occupational poisoning in Malaysia depicting cases in all states for the years 2006-2019

(pesticide and industrial agent) vs the three states with the highest number of poisoning cases (Perak, Selangor and Pahang) shows a highly significant result with $p<0.001$, which indicates that the type of poisoning depended on the state.

Table 2. Sociodemographic characteristics of patients from occupational poisoning

Sociodemographic characteristics		n (%)
Gender (n=1597)	Male	1,288 (80.7)
	Female	245 (15.3)
	Unknown	64 (4.0)
Race (n=1597)	Malay	626 (39.2)
	Chinese	73 (4.6)
	Indian	169 (10.6)
	Others	251 (15.7)
	Non-Malaysian	201 (12.6)
	Unknown	277 (17.3)
Age group (n=1597)	19-29	537 (33.6)
	30-39	404 (25.3)
	40-49	238 (14.9)
	50-59	126 (7.9)
	Above 60	95 (1.2)
	Unknown	197 (12.3)
Incident location (n=1597)	Agricultural site	685 (42.9)
	Factory	401 (25.1)
	Laboratory	35 (2.2)
	Office	14 (0.9)
	Oil rig/well	7 (0.4)
	Workshop	43 (2.7)
	Others	171 (10.7)
	Unknown	21 (1.3)
Source of calls (n=1597)	Doctor	1,393 (87.2)
	Pharmacist	6 (0.4)
	Hospital assistant	4 (0.3)
	Public	3 (0.2)
	Unknown	919 (12.0)

Table 3. Types and nature of occupational poisonings

Types and nature of poisoning		n (%)
Exposure type (n=1597)	Acute	1,525 (95.5)
	Chronic	41 (2.6)
	Acute on chronic	19 (1.2)
	Unknown	12 (0.8)
Exposure route (n=1597)	Inhalation	706 (44.2)
	Ingestion	584 (36.6)
	Cutaneous	182 (11.4)
	Ocular	73 (4.6)
	Bite/sting	31 (1.9)
	Injection	11 (0.7)
	Mucosal	6 (0.4)
	Otic/aural	1 (0.1)
	Unknown	3 (0.2)
Poisoning type (n=1597)	Pesticide	715 (44.8)
	Industrial agent	646 (40.5)
	Household	111 (7.0)
	Agricultural/garden	44 (2.8)
	Environmental	5 (0.3)
	contaminant	2 (0.1)
	Food and beverages	2 (0.1)
	Mixture of agents	34 (2.1)
	Natural toxins	14 (0.9)
	Pharmaceutical	2 (0.1)
	Substance of abuse	19 (1.2)
	Others	3 (0.2)
	Unknown	
Pesticide type (n=715)	Herbicide	335 (46.9)
	Insecticide	254 (35.5)
	Fungicide	8 (1.1)
	Household insecticide	3 (0.4)
	Rodenticide	5 (0.7)
	Mixed pesticides	7 (1.0)
	Other pesticides	4 (0.6)
	Unknown	99 (13.8)

Table 4. Association between demographic characteristics and occupational poisoning by pesticide and industrial agent

Demographic characteristic	Occupational poisoning		Chi-square test	Multivariate logistic regression
	Pesticide n (%)	Industrial agent n (%)		AOR[a] (95% CI)
State (n=610)			*p*=0.000	*p*=0.000
Perak	141 (54.0)	120 (46.0)		1.00
Selangor	76 (40.6)	111 (59.4)		0.57 (0.39-0.85)**
Pahang	103 (63.6)	59 (36.4)		1.57 (1.04-2.38)*
Gender (n=1361)			*p*=0.991	*p*=0.678
Male	584 (52.5)	528 (47.5)		1.00
Female	106 (52.5)	96 (47.5)		1.13 (0.67-1.90)[NS]
Unknown	25 (53.2)	22 (46.8)		1.41 (0.59-3.37)[NS]
Race (n=1361)			*p*=0.000	*p*=0.007
Malay	260 (46.9)	294 (53.1)		1.00
Chinese	24 (40.0)	36 (60.0)		0.69 (0.29-1.65)[NS]
Indian	76 (55.9)	60 (44.1)		2.10 (1.20-3.67)**
Others	140 (67.3)	68 (32.7)		2.51 (1.42-4.44)**
Non-Malaysian	98 (55.7)	78 (44.3)		1.46 (0.87-2.45)[NS]
Unknown	117 (51.5)	110 (48.5)		1.47 (0.87-2.49)[NS]
Age group (n=1361)			*p*=0.000	*p*=0.000
19-29	201 (44.3)	253 (55.7)		1.00
30-39	180 (51.4)	170 (48.6)		1.17 (0.77-1.78)[NS]
40-49	116 (56.9)	88 (43.1)		2.02 (1.16-3.53)*
Above 50	146 (77.7)	42 (22.3)		3.29 (1.79-6.061)***
Unknown	72 (43.6)	93 (56.4)		0.91 (0.57-1.64)[NS]

[NS] Not significant, *$p<0.05$, **$p<0.01$, ***$p<0.001$.
[a] Adjusted odds ratio; state, gender, race and age group are adjusted for the odds ratio estimation.

Perak and Pahang recorded higher numbers of pesticide poisonings, while Selangor recorded higher number of industrial agent poisonings. Meanwhile, when tested by gender, the test of independence produced a large *p*-value of 0.991, suggesting that the types of poisoning are not affected by gender. In contrast, test on race against type of poisoning shows a highly significant result ($p<0.001$), thus indicating that type of poisoning can be influenced by race. It can be deduced that the Malay race was more prone to industrial poisoning, while other minorities in 'Others' and foreigners working in Malaysia, were more prone to pesticide poisoning. In regards to the age groups, the test of independence produced another highly significant result with $p<0.001$. Analysis of the age of people exposed to poisoning shows that the youngest employee generation of 19-29 years old was the most affected by industrial poisoning compared to pesticide poisoning. Meanwhile, older generations from 30 years and older have a higher tendency to be involved in pesticide poisoning. In summary, data analysis has shown that factors such as state, age, and race affect the type of occupational poisoning, whether industrial agent or pesticide ($p<0.001$). Meanwhile, gender was not a determining factor ($p>0.05$) for these two types of agents.

The analysis continued with the multivariate association between sociodemographic characteristics and occupational poisoning, also summarized in Table 4. Incidence of occupational poisoning from pesticide is significantly predicted by sociodemographic characteristics such as state, race, and age group. People in Pahang state were 1.57 times more likely to be subject to pesticide poisoning when compared to people from Perak state. Indians and other races were 2.10 and 2.51 times more likely to be poisoned by pesticide than the Malays. Age groups of 40-49 and over 50 had higher odds of being poisoned by pesticide, by 2.02 and 3.29 fold respectively, than the age group of 19-29 years olds.

4. Discussion

The present study details occupational poisoning trends in Malaysia identified over a period of 14 years based on calls received by the NPC. Data in Figure 1 shows that the number of occupational poisoning cases had an upward trend. Malaysia as a developing country is rapidly entering into Industrial Revolution 4.0 (IR 4.0) and the modernization of agricultural activity happens simultaneously with increased development, reliance and employment in many sectors, especially in manufacturing and agriculture (Bujang & Abu Bakar, 2019; Hee, 2014). In addition, high employment rates in these sectors indicate expansion of agriculture and manufacturing industries, exposing workers to more risks of occupational hazards, including poisonings at the workplace (Department of Statistics Malaysia, 2020, 2021b)

Malaysia is a federation consisting of 13 states and three federal territories (Mekhilef, Saidur, Safari, & Mustaffa, 2011). The occurrences of occupational poisoning were reported to be highest in the states of Perak, Selangor and Pahang, as these states are economically developed with a certain degree of urbanization (Tangiisuran *et al.*, 2018) and carry extensive agriculture and manufacturing. This is corroborated as pesticide and industrial agent were the majority causes of occupational poisoning, at 44.8% and 40.5% respectively (Table 3). This finding is also consistent with the locations of incidents, whereby agricultural sites and factories made up the majority of cases of occupational poisoning (Table 2). In the context of this study, different types of pesticides included herbicide, insecticide, fungicide and rodenticide, while industrial agents consisted of detergent (cleaning agent), hydrocarbon (thinner, diesel, petrol, etc.), gases, acids, and alkalines.

Looking closely at the data analysis presented in Table 4, there is a higher distribution of pesticide poisonings at workplaces in Perak and Pahang, while in Selangor, there is a higher distribution of industrial agent poisonings. According to the Department of Agriculture Malaysia, Perak and Pahang states are among the most active states in agriculture (Department of Agriculture Malaysia, 2019; Ministry of Plantation Industries and Commodities, 2016). Malaysia depends its economy highly on agricultural activities, as it is also known as the second major exporter of palm oil in the world. Therefore, with extensive palm oil plantations, pesticides become essential to productive growth of the palm oil trees (Abdullah & Sulaim, 2013). In addition, the state of Selangor recorded the highest GDP at 6.8%, while the manufacturing sector contributed the second highest GDP in the state at 7.3% (Department of Statistics Malaysia, 2019e).

Data in Table 2 show a high preponderance of males (80.7%) in occupational poisoning cases in Malaysia, and this is corroborated by local data (Leong *et al.*, 2018) as well as by data from other countries including Sweden (Schenk *et al.*, 2018), Brazil (Magalhães & Caldas, 2019), China (Zhang *et al.*, 2010) (Zhang, Wang, & Li, 2010) and South Korea (Cha, Khang, & Lee, 2014). This can be further explained by the dominance of males working in agriculture and manufacturing industries, thereby increasing their exposure to chemicals as well as to risks of poisoning (Department of Statistics Malaysia, 2019b; Sirajuddin *et al.*, 2001).

Malaysia is a multi-racial South-East Asian country. Data in Table 2 show that the Malay race constituted the largest group (39.2%) of people exposed to occupational poisoning. This is further supported by reports from the Department of Statistics Malaysia (DOSM), whereby data from 1982-2019 showed that the Malays dominated employability and labour force in Malaysia (Department of Statistics Malaysia, 2011, 2019c). Interestingly, quite a large number of non-Malaysians (12.6%) were affected by occupational poisoning. Due to the steady economic growth, demographic changes and demand for labour, Malaysia has become a magnet for foreign labour. In fact, foreign workforce contributes to around 15% of the total labour force in Malaysia, where the number of non-Malaysians in the labour has steadily increased from 138,500 in 1982 to a drastic 2,276,100 in 2019 (Department of Statistics Malaysia, 2019d). These workers mostly originated from neighbouring countries, predominantly Indonesia, Nepal, Bangladesh, India, Myanmar, Pakistan, the Philippines and Vietnam, who comprised of 80% males and were mostly engaged in manufacturing, construction and plantation sectors (World Bank, 2019). Their exposures to poisoning at the workplaces might be due to the lower-than-average levels of education and communication difficulties between these foreigners who speak different languages, which consequently might have hampered their understanding of job risks. To corroborate this, a study in the United States (US) found that the injury and fatality rates of immigrants working in the country increased as their ability to speak English declined (Orrenius & Zavodny, 2009). The Centers for Disease Control and Prevention also reported that language and literacy problems exacerbated OSH knowledge, training and supervision inadequacies which caused a comparatively high number of occupational deaths among foreign-born Hispanics in the US (Centers for Disease Control and Prevention, 2008).

Data analysis in Table 4 shows that people of Malay and Chinese races were more prone to industrial poisoning in comparison to pesticide, while the Indians and the foreigners were more exposed to pesticide poisoning. The Malays and Chinese combined constitute the majority of the Malaysian population, and these groups of people catered for the demanding industrialization in Malaysia. In addition, a recent study conducted by the NPC showed the prevalence of Indians in pesticide poisoning in Malaysia (Kamaruzaman *et al.*, 2020), and the agricultural sector also employs a large number of non-Malaysians as workers (Hamzah, Sarifin, Shamsinor, & Aziz, 2020).

The highest percentage of workers exposed to poisoning was from the group of people aged 19-29, followed by people aged 30-39 and 40-49. This is corroborated by studies which have shown that higher number of the younger generations were employed in the industries, thereby increasing their risks of workplace poisoning (Abdullah & Sulaim, 2013; Trueblood & Shipp, 2018). In addition, the DOSM reported that younger generations aged 19-39 dominated the number of employed people, and this trend could be observed from 1982-2019 (Department of Statistics Malaysia, 2019a), with the youngest generation aged 19-29 majorly contributing specifically in the labour force (Department of Statistics Malaysia, 2019c). Moreover, it was reported that youth workers were most likely to experience occupational hazards as they were probably new, inexperienced and unfamiliar with the tasks given to them and they also might lack job-specific training, physical and/or emotional maturity. Furthermore, they were less likely to ask questions and make demands to employers, thus rendering them unprepared to conduct their required tasks safely (Laberge *et al.*, 2011). To support this argument, a study in Italy found that workers aged 30 years old and below showed higher risk of occupational injuries and that job tenure is inversely associated with injury risks (Giraudo, Bena, & Costa, 2017). Table 4 also suggested that younger workers were more susceptible to industrial poisoning, while people of 30 years old and above were more susceptible to pesticide poisoning. As the age increases for these workers, the gap between pesticide and industrial poisoning increases, thus clearly indicating the association between age and type of occupational poisoning.

As shown in Table 2, the enquiry calls were predominantly made by medical doctors, and the public made only a mere 0.2% of calls. This surprising finding suggests that affected public members, whether employers or employees did not make enquiry calls to the NPC. It seems likely that considerable underreporting of occupational poisoning cases still occurred in Malaysia, almost 20 years after a similar study by Sirajuddin *et al.* (2001) suggested the same. This may occur due to a few reasons: employers lacking the awareness of reporting requirements, employers perceiving reporting to be incriminating or time-consuming, and other organisational factors such as safety incentive programs that penalize accidents and injuries which may disincentivize employees from reporting occupational incidents to employers (Schenk *et al.*, 2018). This pattern is similarly reported in other countries such as Singapore, Sweden, the US, Italy, and the United Kingdom (Probst, Barbaranelli, & Petitta, 2013; Schenk *et al.*, 2018; Tan, Teo, & Tseng, 2014; Walters *et al.*, 2013).

Based on Table 3, the majority of poisoning calls at the workplace reported acute exposure (95.5%), with inhalation (44.2%) as the major route of exposure, a finding which is further supported by other studies (Schenk *et al.*, 2018; Sirajuddin *et al.*, 2001). A few examples of inhalation cases reported to the NPC included inhaling chemicals during the mixing process while not wearing appropriate personal protective equipment (PPE), inhaling poisonous gases such as ammonia and chlorine gasses due to leakage in factories or sites, inhaling chemicals while disposing them without following proper protocol (pouring chemicals into the drain or to the ground), trying to identify chemicals by inhaling directly from the containers and inhaling chemicals as a result of leakage from damaged or improperly sealed containers of chemicals.

While data received by the NPC underwent assessment, analysis and recording according to the established protocols, some limitations were identified in this study. Recall bias due to the retrospective nature of this study might occur as most data were collected from information provided by patients to their doctors based on their ability to recall their poisoning exposure. Data presented might possibly be underreported since reporting a poisoning case at the workplace to the NPC is not mandatory according to Malaysian law. In addition, the NPC did not routinely record information of medical outcome of patients, so further insight into the depth of the problem could not be explored.

4. Conclusions

The upward trend of occupational poisoning from 2006-2019 in Malaysia suggests that the younger generation of Malay males are at the highest risk. In addition, pesticides and industrial chemicals caused the highest numbers of occupational poisonings at agricultural sites and factories, respectively, whereby inhalation and ingestion were the main routes of exposure. While gender was not a factor, other factors such as state, race, and age played roles in the distribution of pesticide or industrial chemical poisonings. Information presented in this study can be utilized to inform various industries in Malaysia, namely agriculture and manufacturing, to identify potential areas of concern in order strategize effective interventions to improve OSH among employees and employers, as well as the development of future research to explore further patterns identified in the present study. This is an important step to reduce human mortality and health risks related to exposure to toxic chemicals at the workplaces.

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