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A PROFILE OF POISONING CASES IN MALAYSIA CAUSED BY HOUSEHOLD CHEMICAL PRODUCTS: 14 YEARS OF REPORTED CASES TO THE NATIONAL POISON CENTRE

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Abstract: The increase in chemical product manufacturing in Malaysia contributed to an expanding array of commercialised household chemical products (HCP). These products, after pesticides and pharmaceuticals, rank among the top three poison reagents listed by the Malaysia National Poison Centre. This study conducts a retrospective review of HCP poisoning admissions to the NPC over a 14-year period, aiming to evaluate the HCP poisoning rates in Malaysia. The database of HCP poisoning exposure calls received by the NPC from 2006 to 2020 was analysed and discussed. State profiles and population-based incidence rates revealed 15,381 HCP poisoning cases. Household cleaning products emerged as the predominant poison reagent (53%) during the study period, followed by solvents and cosmetic/personal care items. The increase in poisoning cases by these products coincided with the spread of the COVID-19 disease. West Coast states (Selangor and Perak) reported higher poisoning exposures compared with East Coast states (Kelantan and Terengganu), with urbanisation appearing to play a role in the disparity of HCP poisoning cases among states. The study recommends intensified prevention efforts and enforcement of HCP poisoning regulations as a fundamental step towards developing national poisoning preventive strategies.

Keywords: Household chemical products, sustainable health, poisoning, poison reagent, Malaysia National Poison Center.
Abbreviations: HCP (Household Chemical Products), NPC (National Poison Centre)

Introduction

Malaysia has the third-largest chemical industry in Southeast Asia and this industry has significantly contributed to the country's economy (Foo, 2015). The Malaysian manufacturing sector can be classified into resource and non-resource-based industries. The resource-based industry notably contributed 51% to the total manufacturing output, relying on the country's natural resources (May, 2000). Additionally, chemical and petrochemical manufacturing, which includes refined petroleum products, basic chemicals (fertilisers and nitrogen compounds), and primary forms of plastics, contributed approximately US$ 51.6 billion, US$ 12 billion, and US$ 5.6 billion, respectively, to Malaysia's total production of manufactured goods in 2014 (MITI, 2015).

The chemical manufacturing production that fulfils the basic needs of consumers to maintain their daily activities is household chemical products (HCP). HCP can be defined as a heterogeneous group of products significantly used for domestic purposes, comprising various chemical compositions like household cleaners, paint thinners, and pest control products, that, if misused or mishandled, can potentially cause poisoning (Klepac *et al*., 2000; Peshin & Gupta, 2018). The term "chemical products" can be classified into household, industrial, and institutional (Gani, 2004; Zhang *et al*., 2020). Among HCP, cleaning products are ubiquitous in most houses due to their wide variety of uses as hygiene maintenance agents (Ab Rahman *et al*., 2021)injection or inhalation of household chemical poisons are the most common cases reported and received by the Malaysia National Poison Centre. In Malaysia, a notable increase of approximately 94% of incidents occurred at home through the ingestion route. Most poisoning incidents can be extrapolated from the demographic factors of a community. The objective of this study is to construct a conceptual framework of knowledge, attitude, and practices (KAP.

It was reported that approximately 26 kg of detergent was used per household in Malaysia (Hee, 2017). Surfactants are among the active ingredients widely used in detergent manufacturing. The annual global production of this ingredient reached 13 million metric tonnes in 2018, marking a 2% from the previous year (Siwayanan *et al*., 2015). During the 20th century, the dominant surfactant was petrochemical-based linear alkyl benzene sulfonate, and Malaysia has emerged as one of the leading importers of this surfactant (Siwayanan, 2015).

According to the Department of Statistics Malaysia (DOSM) (2020), Malaysia's gross domestic product (GDP) grew by 0.7% compared with 3.6% in the fourth quarter of 2019 (Table 1). GDP growth depends on spending from consumers, investors, government, and net exports associated with low unemployment. The country's GDP growth was supported by chemical manufacturing, which grew by 1.5%, encompassing petroleum, rubber, and chemical industries, while other sectors registered negative growth. During this period, the final private consumption (goods and services used by individual households), like food/non-alcoholic beverages, HCP, water, electricity, and other fuels, became essential products in manufacturing. However, in the first quarter of 2020, the manufacturing sector registered slower GDP growth of 1.5% compared with 3.0% from the previous quarter (Table 1). Malaysia's economy was impacted by the global economic performance due to the COVID-19 pandemic.

The abundance of natural resources in Malaysia has proven to be a significant advantage in developing the chemical industry sector during the COVID-19 pandemic (Thakur, 2021). Chemicals play an essential role in the community's daily lives. They can enhance the quality of living conditions, such as ensuring safety measures and actions to prevent the spread of the virus, as well as maintaining and improving people's health and well-being.

Globally, poisoning incidents pose a significant threat, especially in developing countries like Malaysia. It is estimated that nearly 604,000 poisoning cases occur annually worldwide, resulting from intentional and unintentional poisoning (Eddleston *et al*., 2008; Leng *et al*., 2020). Although these incidents accounted for less than 0.5% of admissions in public health facilities, the actual number of non-fatal poisoning cases is likely much higher due to underreporting (Litchfield, 2005; Kamaruzaman *et al*., 2020). Furthermore, the prevalence of poisoning due to chemical substances tends to be higher among males than females (Rajasuriar *et al*., 2007). However, literature on the contributing factors for poisoning incidents in South Asia is sparse (Dayasiri *et al*., 2017)there is a wide variation in patterns of poisoning and related risk factors across different geographic regions globally. This hospital based case-control study identifies the risk factors of acute unintentional poisoning among children aged 1−5 years of the rural community in a developing Asian country.

Table 1: GDP percentage changes from 2018 to 2020

Percentage Change from Corresponding Quarter of Preceding Year								
GDP	2017	2018	2019	Q1 2019	Q2 2019	Q3 2019	Q4 2019	Q1 2020
	5.5	4.8	4.3	4.5	4.8	4.4	3.6	0.7
Percentage Change from Preceding Quarter								
Seasonally Adjusted GDP				0.9	1.3	0.8	0.6	-2.0

Methods. This hospital based case-control study included 600 children. Each group comprised three hundred children and all children were recruited at Anuradhapura Teaching Hospital, Sri Lanka, over two years (from February 2012 to January 2014. The epidemiological characteristics of individuals intoxicated by the poison reagent may differ by country depending on lifestyle habits, geographical location, and cultural factors (Akin *et al*., 2011; Ikhile *et al*., 2019)admitted for intoxication in 2005-2007. Of the 2,989 admissions, 330 (11%. Additionally, Bogar *et al*. (2017)although lead exposure remains a threat to youth development in urban environments, no published studies have measured urban youth's knowledge of lead poisoning. A CBPR partnership established a youth advisory council (YAC noted that studies focusing on youth's awareness of environmental health and concerns about poisoning are limited.

Since 1994, the NPC has received more than 55,000 calls regarding poisoning exposures from the public and medical staff in hospitals, and nearly 53% of the cases were caused by HCP (Tangiisuran *et al*., 2018). According to this sole poison centre in Malaysia, the most common poison reagents involved in poisoning incidents are pesticides, pharmaceuticals, HCP, gases, agricultural products, and industrial chemicals. However, most authorities worldwide typically report only poisoning cases caused by pharmaceutical agents and pesticides, which are commonly used in agricultural activities (Ahmed *et al*., 2011; Alwan *et al*., 2020; Boedeker *et al*., 2020)the population attributable risk. It is apparent from the literature findings that there is a lack of studies on specific types of poisoning agents, especially HCP, despite it being listed among the top three common poisoning agents.

The study retrospectively reviewed HCP poisoning admissions to a government health facility, the NPC, from 2006 to 2020 (14 years) to expand current understanding of poisoning in Malaysia and advance nationwide health sustainability efforts. Additionally, the study aims to evaluate the population-based HCP poisoning rates in Malaysia to serve as a fundamental step in developing national preventive strategies against the increasing poisoning incidents. These study findings are essential for developing targeted, cost-effective and sustainable interventions regarding HCP usage with the context of necessary modifications.

Materials and Methods

The study conducted a retrospective database review of HCP poisoning exposure calls received by the NPC from 2006 to 2020. The NPC, one of Malaysia's governmental organisations and sole poison centre, has used near-real-time surveillance systems since 1994 to improve situational awareness of chemical and poison exposures. The NPC fulfils its role by providing assessment and ongoing monitoring of the nation's poisoning cases to promote good health and well-being of the population.

All of the NPC's poisoning exposure calls were recorded based on a standardised poison case report form (PCRF) adapted from the World Health Organisation (WHO) (Tangiisuran *et al*., 2018; Kamaruzaman *et al*., 2020). The calls were handled by an expert team of trained in-house pharmacists seven days a week. They provide medical care consultation regarding poisons or drugs information scheme.

The data presented in this study comprised inquiry calls regarding HCP incident cases. Healthcare professionals across Malaysia answered all inquiry calls regarding HCP poisoning made between January 2006 and December 2020 (14 years). Only PCRF entries with complete information were included in this study, as obtaining full inquiry details (such as poison/product information, patient's age, sex, symptoms of poisoning, and other relevant queries related to the patient) was deemed important at the calls were made. Most of the collected data were obtained without direct interaction with the victims, and medical doctors provided information about their patients to the NPC.

Data analysis was conducted using the Statistical Package for Social Sciences (SPSS) V.27.0 and Microsoft Excel 2016. This study examined the HCP poisoning cases database through descriptive statistics analysis and presented the findings using frequencies and percentages. Subsequently, the database was stratified based on the type of HCP involved and the pattern of the incidents across 13 states of Malaysia and three federal territories, comprising Kuala Lumpur, Putrajaya, and Labuan.

The annual rates of HCP poisoning were calculated based on the number of incident cases per 100,000 population. The outcomes were presented based on the variables of years and states of Malaysia. Population denominators used to calculate incidence rates were estimated from national census data prepared by the DOSM. The 2014 population data were considered to represent the average population for the study duration and thus was used for computing the incidence rate for the 14-year study period.

Results and Discussion

It is of crucial to recognise that the increase in manufacturing of chemical products can pose threats to humans and the environment if mitigation steps are not taken. A growing number of HCP are being sold to the public throughout this country, whether legally or otherwise. The proliferation of illegal HCPs that may contain potentially harmful chemicals can lead to various health hazards and become a causative agent of morbidity and mortality stemming from paediatric poisoning.

The analysis of 14 years of HCP poisoning cases has provided insights into the general sociodemographic characteristic distribution, the prevalence of HCPs as poison reagents, and the pattern of HCP poisoning across all states of Malaysia. The annual rates of the identified cases described in the profile of incidence rate determine the magnitude of HCP poisoning in Malaysia.

Sociodemographic Characteristic Statistics

From 2006 to 2020, the NPC handled about 55,000 poisoning exposure calls for consultation. Of the total, HCP ranked as the third-largest classification of poison substances, accounting for 15,214 cases, following pharmaceuticals and pesticide cases. Table 2 presents the general socio-demographic characteristic distribution of victims involved in HCP poisoning cases. Over study period, the data revealed a near equal distribution of HCP poisoning cases between men and women (47.80% vs 42.63%). In terms of age, the adult age group (20-74 years) represented the highest percentage (45.59%, n = 7011), followed by children aged 1-4 years (31.50%, n = 4844).

Among the different ethnicities in Malaysia, HCP poisoning cases were more prevalent among Malays (34.15%), with Indians recording the second highest incidence (26.04%). The majority of exposures were unintentional poisoning (62.04%), with ingestion being the predominant route of exposure at 96.10%, followed by inhalation (2.76%), cutaneous (0.59%) and ocular exposure (0.31%). Various factors, such as socioeconomic disadvantages, limited availability of and access to emergency medical services, easy access, mishandling, and improper storage management, may contribute to the high percentage (67%) of unintentional poisoning incidents (Hirsch, 2006; Achana *et al*., 2016; Zhang *et al*., 2020).

Such explanations may also be applicable in the Malaysian context, compounded by the practice of mixing household chemical reagents, as bleach is often added to detergent. Unintentional HCP poisoning, a category that frequently involves children as victims, has several reasons. Firstly, consumer products often feature attractive and compact designs, which may increase the likelihood of child poisoning incidents (Schwebel *et al*., 2017). Secondly, many manufacturers prioritise product innovations that address commercial value but overlook safety concerns, such as

Table 2: Distribution of victims' socio-demographic characteristics in HCP poisoning cases

Sociodemographic Characteristic (%)	
Gender	**(*n* = 15381)**
Male	7352 (47.80)
Female	6557 (42.63)
Unrecorded	1472 (9.57)
Age	**(*n* = 15380)**
Infant (0-12 months)	565 (3.67)
Toddler (1-4 years)	4844 (31.50)
Children (5-14 years)	1067 (6.94)
Teenager (15-19 years)	1636 (10.64)
Adult (20-74 years)	7011 (45.59)
Senior (≥ 75 years)	156 (1.01)
Unrecorded	101 (0.66)
Race	**(*n* = 15381)**
Malay/Bumiputera	5252 (34.15)
Chinese	1855 (12.06)
Indian	4005 (26.04)
Non-Malaysian	340 (2.21)
Unknown/Unrecorded	3929 (25.54)
Exposure route	**(*n* = 15381)**
Ingestion	14781 (96.10)
Inhalation	425 (2.76)
Cutaneous	91 (0.59)
Ocular	47 (0.31)
Injection	2 (0.01)
Mucosal	16 (0.10)
Placental	1 (0.01)
Otic/aural	1 (0.01)
Unrecorded	17 (0.11)
Type of Incidents	**(*n* = 15274)**
Intentional	5768 (37.76)
Unintentional	9476 (62.04)
Adverse reaction	30 (0.20)

laundry pods and e-cigarette liquids, which have added substantial poisoning risks to young children (Bonney *et al*., 2013; Valdez *et al*., 2014; Schwebel *et al*., 2017).

Profile of Household Chemical Products as Poison Reagents

According to the NPC, commonly used HCP that can become poison reagents can be categorised into several groups. Cleaning HCP (cleaners), like detergents, floor cleaners, and bleach, are widely available in various concentrations. In recent years, some of these products lack safety considerations. For instance, the colourful and attractive packaging of laundry pods poses additional risks as they can be mistaken for sweets by children (Buchmüller *et al*., 2020; Claudet *et al*., 2014)available on the European market for approximately 10 years, are associated with more severe intoxications compared to classic laundry detergents. Aim: To compare symptoms and severity after exposure to classic laundry detergents and new laundry pods in a pediatric population. Material and methods: Retrospective study conducted between 1st January 2002 and 30th June 2013 including all laundry detergent exposure patients admitted to our tertiary level pediatric emergency unit. Collected data were age, sex, date, time and location of exposure, type of product (powder, liquid, tablets, pods.

The groups of HCP included in this study are mixed households (a mixture of two different products), solvents (kerosene oil, thinner, rust remover, and turpentine), cosmetic/personal care (shampoo, body wash, hand sanitiser, and toothpaste), electric/electronic (battery products), automotive (diesel oil, car battery, engine oil, and coolant), stationery/craft and other/unknown household products (thermometer, silica gel, mothball, and air freshener). The increase in the number of COVID-19 cases from 2020 to 2021 boosted the usage of HCP, alongside record rapid productions of gloves and related disinfectants by the manufacturing industry (Klimaszewska *et al*., 2016; Thakur, 2021).

Figure 1 illustrates all types of HCP from the total HCP poisoning cases received by the NPC. Household cleaners predominantly became poison reagents, accounting for 52.45% (*n*=8068) of the total HCP poisoning cases reported, posing similar risks in both developed and developing countries, where most children face common hazards (Rosenberg *et al*., 2011; Malangu, 2014; Gummin *et al*., 2018; Buchmüller *et al*., 2020)55 of the nation's poison centers (PCs. Furthermore, the easy availability of these products through online shopping and improper storage could contribute to increased poisoning incidents (Sawalha, 2007; Arici *et al*., 2012; Marouf *et al*., 2016; Peshin & Gupta, 2018)sex, reason of exposure, clinical signs, rate of endoscopy in oral exposures, treatment attempts, length of hospital stay and outcome were evaluated. A chi-square test was used to analyse statistical differences. Results: Caustic exposures accounted for 8.5% (1160 cases. HCP groups encompass all unspecified toxic agents and products commonly found in households.

The graph clearly shows that in 2011 and 2015, HCP poisoning cases involving cleaning products as poison reagents recorded the highest occurrences at 918 incidents and 853 incidents,

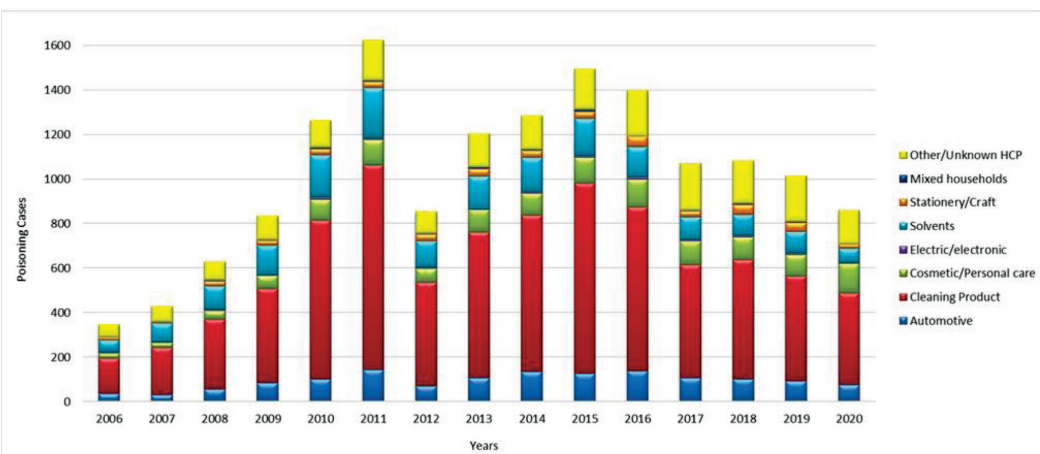

Figure 1: The bar graph of HCP as poison reagents between 2006 to 2020

respectively. The number of HCP poisoning cases involving other/unknown HCPs exceeded those involving solvent products (14.10%, *n* = 2168 vs 12.21%, *n* = 1878), with only a 1.89% difference. Within the other/unknown HCP category, the largest number of poisoning cases was reported in 2017 (*n*=212), followed by 2019 (*n*=207).

Concurrently, cosmetic/personal care is another type of HCP that has shown a significant increasing trend from 2009 until 2020. Most individuals consume these products for personal hygiene and beautification, and they include facial cleansers, body wash, perfume, and hand sanitisers. By 2020, the use of these products has significantly increased, ranking them among the top three highest poisoning reagents with 134 incidents. t seems that the utilization and misuse of cleaning products for personal hygiene in households might elevate the risk of poisoning.

The COVID-19 pandemic, which began in 2019, has had a global impact. The virus is transmitted from infected individuals to healthy individuals through direct contact (Lai *et al*., 2020; Ghafoor *et al*., 2021). Due to the outbreak, communal spaces like schools and institutions were closed, leading to increased time spent by children with parents who still needed to fulfil work duties from home. Consequently, children were more exposed to domestic accidents. Children are particularly vulnerable to exposure poisoning as many cleaner products/disinfectants contain a high percentage of alcohol (Ghafoor *et al*., 2021). Misuse of these products can be toxic to human health and the environment, especially when these chemicals are released through evaporation (Racioppi *et al*., 1994; Millard *et al*., 2014; Slaughter *et al*., 2014, 2019).

Most poison centres, including the NPC, experience varying responses to the duties imposed by the served populace. The NPC observed a growth in exposure inquiries related to HCP poisoning. Alcohol, whether accidentally or deliberately ingested, such as ethanol toxicity, is associated with respiratory depression, which can lead to respiratory arrest, hypothermia, arrhythmia, and in severe cases, cardiac arrest and hypotension. According to the National Poison Data System (NPDS), three groups of substances or products have been classified as COVID-19 products (cleaning/disinfecting agents and bleaches/hand sanitiser) as they exhibited more prominent peaks in information requests during the pandemic (Gummin *et al*., 2021)2020, all 55 of the nation's poison centers (PCs. It is important to critically consider the situation, as most of these products already pose rosls young children even before the pandemic (Meredith, 1993; Helena & Villas, 2008; Gummin *et al*., 2018)55 of the nation's poison centers (PCs.

Electric/electronic and mixed household products recorded the lowest number of poisoning cases in the NPC, with 91 incidents and 60 incidents, respectively. There may be several underlying reasons for the fewer cases in this category of HCP. Consumers often dilute or mix the products to achieve effective hygiene results without considering that dangerous chemicals could spread on the surface (Szewczyk & Wisniewski, 2007). These trends were observed from the data collected primarily from health providers and a small number from the public. For example, since the COVID-19 pandemic, many people have been inadvertently mixing bleach solution and vinegar without realising this combination produces toxic chlorine gas (Mundell, 2020). Thus, even small data sets can provide insights into the trend in cases of HCP poisoning in Malaysia, which can be crucial for planning regulatory and enforcement measures..

The Pattern of Household Chemical Product) Poisoning in Malaysia

Data analysis was carried out based on relevant data from the NPC for HCP poisonings and, subsequently, for geographic distribution. These numbers were aggregated to generate nationwide profiles. Malaysia comprises 13 states and 3 federal territories. As depicted in Figure 2, during the 14-year study period, the analysis reveals that each state experienced an upward trend in HCP poisoning incidents.

A noticeable surge in the number of HCP poisoning exposure calls occurred from 2006 to 2011, followed by a sharp decline in 2012, and then a steady increase from 2013 onwards. The rapid expansion of the country's chemical manufacturing sector lead to an increasing generation of toxic and hazardous waste in urban and industrialised areas (Anwar Zainu, 2019). In response to this, the Malaysian government fully implemented federalised chemical waste management and public cleansing with the 10th Malaysia Plan (2011-2015) (Khazanah Research Institute (KRI), 2018).

The states that recorded the highest number of HCP poisoning incidents were Selangor (2967 cases), followed by Perak (2528 cases) and Johor (1456 cases). Selangor represented 19.3% of the total HCP poisoning cases received and experienced a sharp drop after 2011. These three states are on the west coast of Malaysia, where urbanisation appears to influence the high number of occurrences (Rajasuriar *et al*., 2007). Conversely, the states on the east coast of Malaysia, like Kelantan and Terengganu, reported fewer than 1,000 cases during this study period, except for Pahang. The east coast states are considered less urbanised. On the contrary, the fewest number of HCP poisoning calls (below 100 calls) were received from Perlis (42 cases) and Labuan (52 cases). Additionally, 161 cases were reported from unknown/other states, representing uncertain locations where the poisoning incidents occurred.

In 2011, almost all states exhibited an increasing number of HCP poisoning calls, especially Selangor (416 cases), Perak (306 cases), Negeri Sembilan (162 cases), Pulau Pinang (127 cases), and Pahang (111 cases). The high humidity of the country, coupled with urban settings, enhanced the breeding of vectors in households (Abdul Alif *et al*., 2019), thus leading to higher usage of household insecticide products. Several states experienced an increase in the number of poisoning incidents after 2018, such as Perlis, Putrajaya, Kedah, Melaka, and Negeri Sembilan. Most of these states saw increments ranging from 3% to 20% in the number of HCP poisoning calls. On the other hand, the line graph for Perlis and Labuan consistently remained at zero incidents between 2006 and 2012, which showed that the NPC had received no HCP poisoning exposure calls from both of these regions.

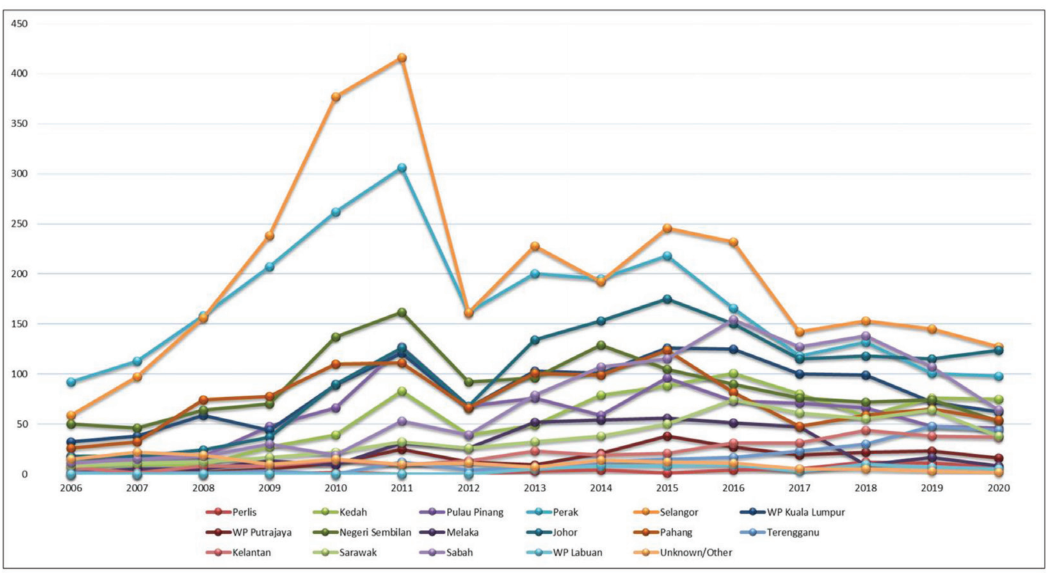

Figure 2: Horizontal profile of HCP poisoning incidents reported in the 16 states and federal territories in Malaysia

Household Chemical Product Poisoning Incidence Rate

In this section, 14 years of the incidence rate of HCP poisoning cases recorded by the NPC are presented in Figure 3. In contrast, Figure 4 illustrates the distribution of HCP poisoning incidence rates in all states in Malaysia.

Based on Figure 3, the depicts an increasing trend in HCP poisoning starting from 2011, with an estimated average incidence rate of 3.41 per 100,000 population. The average incidence rate in the study on pesticide poisoning is only 0.5%, differing from a previous decade's study (Kamaruzaman *et al*., 2020). The average HCP poisoning incidence rate in this country is relatively high compared to another study that reported an incidence rate between 2.0 and 4.3 per 100,000 (Clark *et al*., 2011; Leng *et al*., 2020)3.8%.

HCP poisoning was more prevalent in 2011, with the highest value of 5.59 per 100,000 population, followed by 2015, at 4.80 per 100,000 population. The high incidence rate may be influenced by sociopsychological problems, such as marital disharmony, family conflicts, settlement in life, and inability to cope with the stress, which can lead to intentional HCP poisoning (Fernando *et al*., 2010; Senarathna *et al*., 2012; Alwan *et al*., 2020; Prabhakar Abhilash *et al*., 2022)especially when administered in large doses or overextended periods, can initiate a toxic condition. Therefore, the objective of this study was to examine nationwide, the patterns attributed to poisoning, and to describe the sociodemographic, and geographic distribution of poisoning, by identifying the category of substances implicated in these cases. DATA SOURCES AND METHODS: A retrospective study based on telephone calls reported on poisoning caused by pharmaceutical products undertaken by the National Poisoning Centre (NPC. Additionally, lack of knowledge and maturity, the rapid evolution of various HCPs, and the inability to recognise the risks contribute to the prevalence of HCP poisoning (Lekei *et al*., 2017; Valdez *et al*., 2014; Yin *et al*., 2018)this study describes the distribution, circumstances, and patterns of APP involving children under 18 years in Tanzania. Methodology . A 12-month prospective study was conducted in 10 Tanzanian healthcare facilities in 2006 using a data collection tool for surveillance. Results . Of 53 childhood poisoning cases identified, 56.6% were female. The most common poisoning circumstances were accidents (49.1%.

HCP poisoning was found to be less prevalent in the early years of this study period (2006-2008), with an estimated average of 1.74 per 100,000 population. However, those

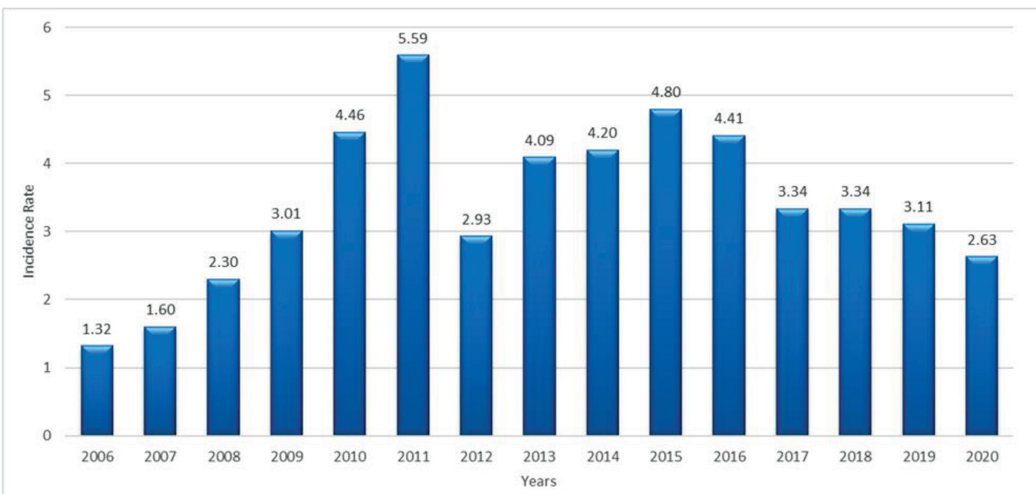

Figure 3: Incidence rate from 2006 until 2020 for HCP poisoning incidents (per 100,000 population)

rates gradually increased from 2.30 to 3.01 per 100,000 population. Then, the rates remained generally stable over four years (2013-2016) after a sharp drop in 2012. A significant decline in the incidence rate was observed in 2012 due to budgetary constraints and changes in operating hours at the NPC (Tangiisuran *et al*., 2018). Subsequently, the Drug Poison Information Service under the NPC was forced to temporarily withdraw its 24/7 service, but it reverted to its previous operational arrangement after a half-year break.

The HCP poisoning incidence rate distribution among the states of Malaysia is shown in Figure 4. The annual distribution rate of HCP poisoning for each state contrasts with the study conducted by Rajasuriar *et al*. (2007). In that study, the Borneo states recorded a high incidence rate for all poisoning cases. However, west coast states dominated the HCP poisoning in this study. The majority of the west coast states in Malaysia reported higher incidence rates of HCP poisoning exposure calls to NPC than other states, with an estimated average of approximately 30.0 per 100,000 population affected by this type of poisoning. Perak and Negeri Sembilan stood out as states with particularly high population incidence rates, ranging from around 103.0 to 121.0 per 100,000. On the Borneo side, only Labuan, located in the western region, reported a similarly high incidence rate of 58.60 per 100,000 population.

The urban-rural distinction seems to a the hidden factor, as it is frequently associated with the prevalence of adolescent (children over 12) self-harm poisonings. States like Selangor, Perak, and Johor reported more HCP poisoning cases than east coast states, which are not considered urbanised (Hutchinson, 2016). This disparity could be attributed to the concentration of resources and infrastructure, particularly in the chemical manufacturing sector, along the west coast of Peninsular Malaysia (Anwar Zainu, 2019).

The white-highlighted states, comprising Perlis, Kelantan, Terengganu, Sabah, and Sarawak, represent states with a low prevalence of HCP poisoning incidents at around 29.9 per 100,000 population. In these two states, Perlis and Terengganu reported less than 10 cases during the first half of the study period's decade, gradually increasing through 2020. However, the growth remained below 50 cases by the end of 2020. The low number of cases and incidence rate of HCP poisoning in these states, such as Kelantan, Terengganu, Sabah, and Sarawak, suggest a lack of awareness among people in the East Coast region, where the NPC is located in the northwest state of Pulau Pinang. Additionally, there are possibilities that the existence and roles of the NPC are unclear. Therefore, attention must be shifted away from a sole focus on urban development and towards promoting even urbanization, economic growth,

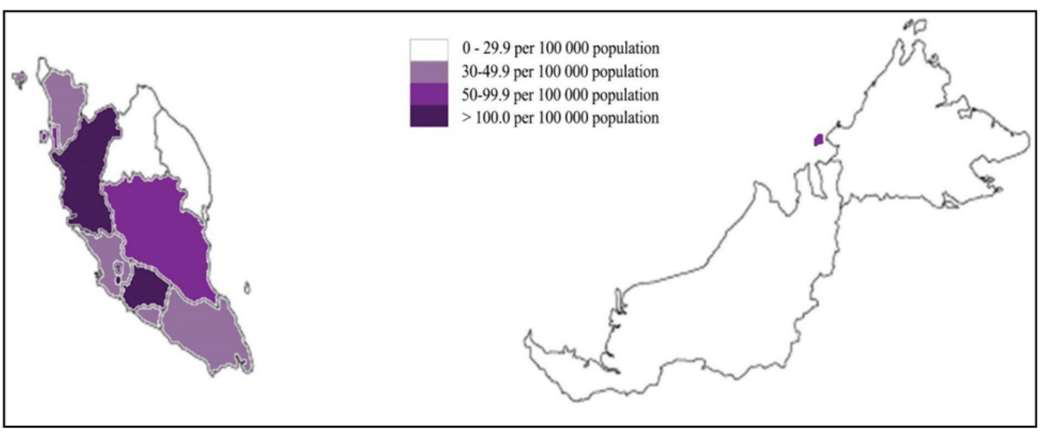

Figure 4: Geographical distribution of HCP poisoning incidence rates in Malaysia, 2006-2020

and a deeper understanding of HCP poisoning awareness.

Aside from urbanisation, the term "race groups" may be linked toh Malaysia's religious demographics, where a lower number of poisoning cases were reported in states such as Perlis, Kelantan, and Terengganu. These states are predominantly Malay, with approximately 90% of the population being Malay (DOSM, 2020). Most Malays were registered as Muslims. This finding is consistent with Pedersen *et al*. (2017), who reported that Christians had more poisoning incidences than Muslims, especially in intentional poisoning cases. This difference might be because many religions forbid self-harm, considering it a major sin. Similarly, other studies have discussed the religious influence on the number of poisoning cases (Aliverdinia & Pridemore, 2009; Jørs *et al*., 2014; Pedersen *et al*., 2017).

Nearly 38% of HCP poisoning cases accumulated from 2006 to 2020 fell into the intentional poisoning incident category (Table 2). Most self-harm poisoning incidents related to HCP occur in urban areas (Bundotich & Gichuhi, 2015; Gunnell & Eddleston, 2007; Pedersen *et al*., 2017). A higher rate of self-harm in adolescents can be explained by a higher tendency to internalise emotional and behavioural problems (Madge *et al*., 2008; Azab *et al*., 2016). They are likelier to intentionally ingest the chemicals for abuse and suicide (Lowry, 2015). Previous studies have highlighted a relationship between the extent of urbanisation and poisoning exposures (Boland *et al*., 2005; Kerry *et al*., 2016). Self-poisoning incidents caused by chemical products have been documented over centuries in many countries such as Sri Lanka (Senarathna *et al*., 2012), Taiwan (Chang *et al*., 2012), Korea (Cha *et al*., 2014), Australia (Cairns *et al*., 2019), and India (Abhilash *et al*., 2022). Understanding the patterns of the incidence rate distribution in the states of Malaysia will provide a foundation to recognise the areas needing emphasis on training and education.

When this study was conducted, the world was in the midst of the COVID-19 pandemic, with 2.2 million confirmed cases and 39,000 related deaths in October 2020 (WHO, 2020). Poison control centres unexpectedly found themselves heavily involved during the global health crisis. Sadly, many people resorted to ingesting harmful disinfectants in an attempt to combat the novel virus (Mehrpour & Sadeghi, 2020). It can be inferred that incidence of HCP poisoning escalated during the COVID-19 containment period.

Due to the absence of effective drugs or vaccines against COVID-19 during the study period, disinfectants or cleaning agents gained widespread use. The public, particularly in healthcare settings, was encouraged to use them for personal hygiene to curb the virus spread (Kanakaraju *et al*., 2021). Many individuals were unaware of the active ingredients in these disinfectants, potentially contributing to changes in poisoning cases, including a notable rise in the misuse of such products for personal hygiene (Chang *et al*., 2020; Tan *et al*., 2020; Motawei *et al*., 2022). However, it was observed that the peak frequency of poisoning exposure to cleaning products did not occur in this country, possibly because cases were not reported to healthcare facilities or because they were manageable without further intervention (Tangiisuran *et al*., 2018; Kamaruzaman *et al*., 2020). As per the Centers for Disease Control and Prevention (CDC) guidelines aimed at mitigating virus transmission, thorough cleaning and disinfection of high-touch surfaces became imperative (CDC, 2020; Chang *et al*., 2020).

The COVID-19 pandemic has led to increased use of various types of HCP, including personal care items, cleaning household products, and solvents. Among these, cleaning agents, particularly hand sanitisers, have seen widespread consumption due to recommendations from health organisations to prevent virus transmission. In response to the pandemic, public health authorities established guidelines to promote the safe use of hand sanitisers for hand hygiene (Holzman *et al*., 2021). Hand sanitisers typically contain 40%-95% alcohol, which can be harmful to the human digestion system. According to Mehrpour and Sadeghi (2020), following the widespread outbreak of coronavirus, unfounded rumors circulated on social media suggesting that drinking or gargling alcohol could prevent or cure COVID-19. Consequently, global poison centers experienced a surge in referral calls related to alcohol poisoning (American Association of Poison Control Centers (AAPCC), 2020; Mahmood *et al*., 2020; Holzman *et al*., 2021), including the NPC, which reported a 27.6% increase in such cases in 2020 compared to the previous year, 2019. Additionally, many hand sanitizer products are designed for easy accessibility, with most poisoning exposures occurring at home (The Children's Hospital of Philadelphia, 2020).

Limitations of the Study

The number of cases reported from unknown/ other states surpasses those from Perlis and Labuan. The trends depicted in Figure 2 may not fully reflect the situation in several states in Malaysia, as the actual number of poisoning exposures during the study period may have been higher and under-reported. Reporting of poisoning exposure to the NPC is not mandatory, leading to potential underreporting (Tangiisuran *et al*., 2018; Kamaruzaman *et al*., 2020). exposures are reported to the NPC, particularly when cases are treatable and do not require additional management or treatment information. Some medical providers and physicians in certain states possess expertise in managing poisoning cases and may not rely on NPC for information (Klepac *et al*., 2000).

Moreover, the low number of reported HCP poisoning cases may indicate a lack of awareness among the general public about the existence and role of the NPC and Poison Control System in managing poisonings(Guyer *et al*., 2004; Tangiisuran *et al*., 2018). Therefore, the study underscores the importance of implementing effective enforcement protocols to esnure the reporting of all the poisoning cases to the NPC. This would enable the centre to provide comprehensive details and insights, thus highlighting national trends in poisoning incidents.

Conclusion

This study presents a comprehensive analysis of HCP poisoning incidents based on databases compiled by the NPC, providing insights into the current situation in Malaysia. The profiles of HCP poisoning incidents were determined through enquiry calls handled by the NPC, which primarily serves Malaysia's population of 32.8 million people. Throughout the study, it was evident that increased attention is needed, particularly for poisoning incidents involving the top three poison reagents, HCP.

The NPC experienced a surge in calls during the COVID-19 pandemic, notably concerning exposures to cleaners, disinfectants, and hand sanitizers. Key factors contributing to the rise in HCP poisoning rates in Malaysia include easy access and a lack of awareness and education, especially in rural areas.

While fatal cases of HCP poisoning in Malaysia are rare, the incidence of both intentional and unintentional poisoning acts continues to rise, necessitating more proactive regulations. It is imperative for Malaysian authorities to prioritize initiatives aimed at providing information on proper storage and handling of HCP. This should be considered a primary national concern. Therefore, intensive prevention efforts and enforcement, particularly targeting vulnerable groups such as children, must be implemented to reduce the burden of HCP poisoning and ensure health sustainability in Malaysia.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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