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Characteristics and psychopathology of 1,086 patients who self-poisoned using pesticides in Taiwan (2012–2019): A comparison across pesticide groups

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ABSTRACT

Background Previous studies, mainly from low- and middle-income settings, showed that pesticide self-poisonings were mostly impulsive with low levels of psychopathology. We aimed to investigate whether pesticide self-poisoning in a high-income country showed similar profiles, and whether those with certain characteristics and psychopathology were more likely to use specific pesticides.

Methods Data were extracted from hospital records of pesticide self-poisoning patients treated at eight major hospitals in Taiwan between 2012 and 2019. Multinomial logistic regression was used to investigate the association of interpersonal conflicts, triggers of self-poisoning, and psychopathology with the groups of pesticides ingested.

Results A total of 1,086 patients who self-poisoned using pesticides were identified; 67.0% were male and 39.8% aged 65+ years. Approximately three quarters (75.7%) of patients who received psychiatric assessment had at least one psychiatric diagnosis, and the prevalence was 48.3% in all patients. No association was found between the pesticide groups ingested and interpersonal conflicts, most of the triggers, past psychiatric service use, or having psychiatric diagnoses.

Limitations Data were collected from hospital records retrospectively. Only 60.3% of the patients received a psychiatric assessment.

Conclusions The majority of patients who self-poisoned using pesticides and received psychiatric assessment in Taiwan had psychiatric illness. Patients who ingested different groups of pesticides were similar in their characteristics. The choice of pesticides used in self-poisoning more likely relates to availability rather than

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intentional selection. Psychiatric assessment and treatment are important in patients who self-poisoned using pesticides, while restricting access to highly hazardous pesticides is likely to prevent many deaths from pesticide self-poisoning.

1. Introduction

Pesticide self-poisoning is among the leading methods of suicide, accounting for 14–20% of global suicides (Mew et al., 2017). Ninety percent of pesticide suicides worldwide have been found to occur in low- and middle-income countries in the Southeast Asia and Western Pacific regions (Mew et al., 2017), while pesticide self-poisoning may also account for a substantial proportion of suicides in some high-income countries, such as South Korea (Cha et al., 2020) or Taiwan (Chang et al., 2012). In Taiwan, pesticide self-poisoning was once the third most common method of suicide, accounting for 400 to 500 suicide deaths per year, with paraquat being the most common pesticide (53.2%) involved in pesticide suicides (Lin et al., 2010). A better understanding into the characteristics and triggers of pesticide self-poisoning is therefore important to inform local and global prevention strategies.

Pesticide self-poisoning has been more commonly found in low-planned or impulsive (vs high-planned or less impulsive) suicides (Conner et al., 2005; Sun and Zhang, 2016) and is often triggered by recent stressful events (Konradsen et al., 2006). For example, interpersonal conflict was found to be a frequently identified trigger for self-poisoning in Sri Lanka (Rajapakse et al., 2015), where pesticide ingestion is the main method of suicide. In Sri Lanka, approximately 60% of the patients presenting to hospitals with pesticide self-poisoning were males, and more than half of the patients were below age 30 (Mohamed et al., 2009; van der Hoek and Konradsen, 2005). Furthermore, the pesticide ingested was often chosen at short notice, without intentional selection (Eddleston et al., 2006). In China, a smaller proportion of suicide attempters who ingested pesticides had diagnosable mental illness than those using other methods (Xiao et al., 2011). Overall, previous studies often showed that pesticide self-poisoning was an impulsive act associated with acute stressors and limited levels of psychopathology, mostly found in men and young people. A recent systemic review found that the prevalence of psychiatric morbidity in individuals with suicidal behavior in low- and middle-income countries was lower than that in high-income countries (Knipe et al., 2019). Although most pesticide self-poisonings were reported to be impulsive and used pesticides most readily available (Conner et al., 2005; Eddleston et al., 2006), intentional selection of specific pesticides was found in 38.4% of individuals who self-poisoned using paraquat in a study from South Korea (Seok et al., 2009). It is unclear whether the profiles of characteristics, triggers, and psychopathology differed by the pesticide agent involved in pesticide poisoning; this is important as the case fatality of pesticide self-poisoning was found to vary markedly across different pesticides ingested (Buckley et al., 2021; Dawson et al., 2010). If risk factors for using highly hazardous pesticides (HHPs) associated with high case fatality could be identified, intervention could be targeted on specific populations. Alternatively, if pesticide ingestion is not associated with specific characteristics, it would be more important to restrict the availability of these HHPs, rather than targeting specific groups of individuals, e.g., those with existing mental health issues, to prevent deaths from impulsive pesticide self-poisoning.

This study aimed to examine the interpersonal conflicts, triggers, and psychopathology in individuals who self-poisoned using different categories of pesticides in Taiwan. We hypothesized that these characteristics were not associated with using specific pesticides.

2. Material and methods

2.1. Participants and procedure

We retrospectively collected data for patients who self-poisoned using pesticides and were treated at eight major hospitals in Taiwan between 2012 and 2019. These hospitals are regional referral centers for treating pesticide poisoning located in Northern, Southern, Eastern, and Middle Taiwan. The study was approved by the Institutional Review Boards of study hospitals.

The hospital records of patients who received a diagnosis of pesticide poisoning (International Classification of Diseases, Ninth Revision [ICD-9], codes: 989.3 Organophosphate and carbamate and 989.4 Other pesticides, not elsewhere classified; ICD, Tenth Revision [ICD-10], code: T60 Toxic effect of pesticides) were reviewed by research assistants who were registered psychiatric nurses or had medical qualifications. We also screened the hospital records of patients who received the following diagnoses: ICD-9 292.2 Pathological drug intoxication; ICD-9 977.9 Poisoning by unspecified drug or medicinal substance; ICD-9 977.8 Poisoning by other specified drugs and medicinal substances; ICD-10 F19.929 Other psychoactive substance use, unspecified with intoxication, unspecified; ICD-10 T50.9 Poisoning by, adverse effect of and under-dosing of other and unspecified drugs, medicaments and biological substances); these diagnoses were found to be given to some pesticide self-poisoning patients in some study hospitals.

The hospital records reviewed included a comprehensive set of documents such as administrative records, nurses' and physicians' notes, discharge summaries, and assessment reports written by psychiatrists, psychologists, and social workers (if available). Data were extracted systematically from these hospital records using an agreed coding sheet for the following variables: socio-demographics, lifestyle, chronic illness, pesticides involved (identity and amount), precipitating circumstances of self-poisoning, treatments (medications, procedures, intensive care, psychiatric assessments), psychiatric profiles, laboratory data (basic blood tests, cholinesterase, urine toxicology screening), and discharge status. The protocols used by general clinicians to record clinical data may have varied across individual study hospitals. However, important patient variables were recorded in similar formats, as all of these study hospitals were regional referral hospitals or medical centers and they followed government regulations on electronic medical records (EMRs) (Ministry of Health and Welfare, 2021). When treating patients of pesticide self-poisoning, the clinicians routinely collected information about the poisoning circumstances and agents involved. For example, among the 1,086 pesticide self-poisoning episodes included in the analysis, information on the pesticide agents involved was unavailable in only 9.1% of episodes.

We defined a poisoning event as intentional (i.e., self-poisoning) based on the following criteria: either "suicide", "suicidal", "self-harm", or related terms were mentioned in the hospital records; or the poisoning was apparently self-inflicted; or the poisoning event was reported to Taiwan's National Suicide Surveillance System, which requires all suicide attempts presenting to hospitals to be reported to a centralized registry. The following variables were extracted from the hospital records for data analysis: socio-demographic characteristics (sex, age, marital status, educational level, occupation, area of residence, living alone); lifestyle (cigarette smoking, alcohol drinking, betel nut chewing); chronic illness (i.e., cancer or any medical or psychiatric conditions that require long-term treatments; yes/no); the identity of pesticides ingested; poisoning-related factors (season and time of self-poisoning; co-ingestion of alcohol, medications, or other poisons [yes/no]);

interpersonal conflicts before self-poisoning (yes/no); triggering events of self-poisoning; and discharge outcome (survival/death). The occupation categories included agriculture, non-agriculture, housekeeper/student/retired, and unemployed. Only patients who were actively engaged in agricultural activities at the time of self-poisoning were classified in the 'agriculture' occupation. We used the urbanization index developed by the National Health Research Institutes, Taiwan (Chang et al., 2021a; Liu et al., 2006) to group the area of residence into two categories. Patients' residences located in level 1 (most urban) to 3 districts were categorized as urban and those located in level 4 to 7 (most rural) districts were categorized as rural.

In this study, the most commonly ingested pesticides were herbicides and insecticides (mainly organophosphorus [OP] insecticides). Paraquat, glyphosate, and glufosinate-ammonium were the herbicides most frequently ingested. Paraquat and organophosphorus insecticides were the pesticides that resulted in the most suicide deaths by pesticide poisoning in Taiwan (Lin et al., 2010). Glyphosate, glufosinate-ammonium, and paraquat were non-selective herbicides having the highest market shares in Taiwan (Fong, 2017), while the case fatality was much lower for glyphosate and glufosinate-ammonium than paraquat (Buckley et al., 2021). We thus classified the pesticides ingested into five groups: paraquat, glyphosate, glufosinate-ammonium, OP insecticides, and other pesticides, after excluding unknown pesticides.

The presence of interpersonal conflicts was determined if terms such as "conflict" or "quarrel" or their equivalents were mentioned in the hospital records. Information for psychopathology (previous suicide attempt, past psychiatric service use, and psychiatric diagnoses) was extracted from psychiatric assessment notes written by psychiatrists, or from other hospital records if patients were not assessed by psychiatrists. Psychiatric diagnoses were determined by psychiatrists who assessed the patients according to the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV) or fifth edition (DSM-5), over the study period. All of the board-certified psychiatrists in Taiwan were assessed in the national board examinations regarding their ability to give psychiatric diagnoses based on DSM criteria when interviewing patients. In a reliability study of 10 subjects, the inter-rater reliability (i.e., Cohen's kappa coefficient) between two research assistants for the coded items was moderate to almost perfect, ranging between 0.62 and 1.00 (McHugh, 2012). Specifically, kappa for interpersonal conflict and triggers of self-poisoning ranged between 0.79 and 1.00.

Psychiatric diagnoses were classified into five groups: depressive disorder (including adjustment disorder and bipolar depression); schizophrenia or other psychotic disorders; alcohol use disorder; other substance use disorders; and personality disorder. A patient may have received more than one psychiatric diagnosis. Arranging psychiatric assessment for patients who presented to the hospital with a suicide attempt is a clinical routine in Taiwan. All patients who self-poisoned using pesticides were supposed to be seen by psychiatrists in all eight study hospitals unless they were too ill for assessment, were discharged from the hospital against medical advice before such assessment could occur, or denied any suicidal intent and hence the medical team decided that psychiatric assessment was not necessary.

2.2. Statistical analyses

Chi-square test and Fisher exact test were used to compare the characteristics of patients across different groups. The comparisons of triggers of self-poisoning and psychopathology were restricted to patients who were assessed by psychiatrists, as information would be less complete and the validity of psychiatric diagnoses would be lower in patients who were not assessed by psychiatrists. Sensitivity analyses were conducted by including all patients, with or without a psychiatric assessment. Multinomial logistic regression was used to investigate the association of socio-demographic and lifestyle characteristics, poisoning-related variables, interpersonal conflicts, triggers of self-poisoning, and psychopathology with the group of pesticides ingested, after controlling for sex and age; the dependent variable was the group of pesticides ingested (five categories), with paraquat as the comparison group. The associations were between characteristics examined and each of the four pesticide groups, in comparison with paraquat (the comparison group). Paraquat was selected as the comparison group because it resulted in the most pesticide suicide deaths in Taiwan (Lin et al., 2010).

Chi-square test and Fisher exact test were used to compare the interpersonal conflict and psychopathology between males and females. Multinomial logistic regression analyses stratified by sex for the association between interpersonal conflicts/psychopathology and the group of pesticides used in self-poisoning were conducted. The effect of sex on these associations was examined by including appropriate sex interaction terms in a series of binary logistic regression analyses using data for each of the pesticide groups investigated versus paraquat. All analyses were conducted using SPSS software version 19.

3. Results

A total of 1,173 episodes of pesticide self-poisoning were identified in 2012–2019 (see the Flow chart in Fig. 1). Episodes involving multiple pesticides ($n = 61$) and repeated episodes by the same patients over the study period ($n = 26$) were excluded, leaving a total of 1,086 index episodes involving single pesticides in the analysis. Of the 1,086 pesticide self-poisoning episodes, paraquat (34.7%; $n = 377$), glyphosate (11.1%; $n = 121$), and glufosinate-ammonium (3.5%; $n = 38$) were the herbicides most frequently ingested, while OP insecticides ($n = 148$) and other known pesticides ($n = 303$) accounted for 13.6% and 27.9% of the study sample, respectively.

Among a total of 1,086 patients who self-poisoned using pesticides, two thirds (67.0%) were male and 39.8% were 65 years old or over; only 16.5% were active agricultural workers; 55.9% lived in rural areas; 71.5% had one or more chronic illnesses; 17.3%, 5.7%, and 2.0% ingested alcohol, medications, and other poisons at about the same time of pesticide ingestion, respectively (Table 1). There were some differences in socio-demographic and lifestyle factors across different groups of pesticides, while no statistical evidence for a difference in poisoning-related variables was found. The proportion of patients who were male was highest in patients who ingested glyphosate and lowest in those who ingested glufosinate-ammonium or other pesticides. The proportion of the youngest age group (0–44 years) was highest in patients who ingested paraquat and lowest in those who ingested other pesticides.

A total of 655 (60.3% of 1,086) patients were assessed by psychiatrists after self-poisoning. Among them, just over one third (36.9%) of patients had interpersonal conflicts prior to self-poisoning (Table 2). Overall, the most common recorded triggers of self-poisoning were mental illness (31.1%), physical illness (28.9%), and marital problems (18.5%). Approximately a quarter (25.5%) of patients had a previous suicide attempt, and one third (33.9%) had past psychiatric service use. Three quarters (75.7%) received at least one psychiatric diagnosis, and the most common diagnosis was depressive disorder (67.8%). There was no apparent difference in interpersonal conflicts before self-poisoning and nearly all of the triggers examined across the five pesticide groups, with the only exception being that a smaller proportion of paraquat self-poisonings were precipitated by physical illness than self-poisonings using other pesticides. No difference was found in the frequency of having psychiatric service use in the past or having received a specific psychiatric diagnosis or any psychiatric diagnoses after pesticide ingestion, while patients who ingested paraquat appeared to have a higher percentage of having previous suicide attempts (36.0%) than those who ingested other pesticides.

The results were generally similar in sensitivity analyses including all patients with or without a psychiatric assessment (the prevalence of having any psychiatric diagnosis = 48.3%), except that there were additional differences in the proportions of marital problems and mental

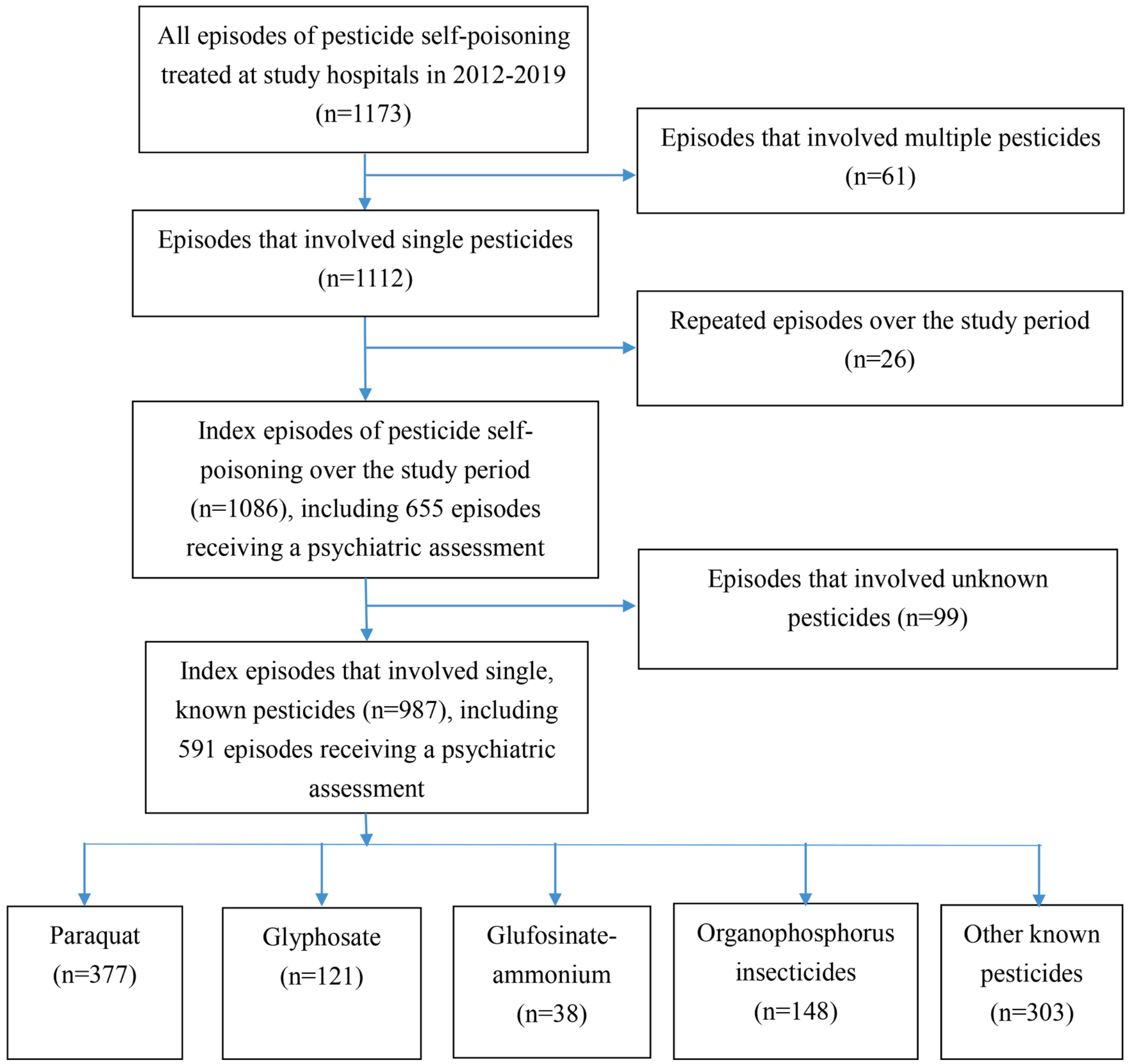

Fig. 1. Flow chart of patients.

illness identified as triggers across pesticide groups (Supplementary Table 1). Furthermore, patients who ingested paraquat were less likely to receive the diagnosis of depressive disorder and any psychiatric diagnoses than patients who ingested other pesticides; this could be due to the markedly lower proportion of receiving psychiatric assessment in patients who ingested paraquat (139/377; 36.9%) than in those who ingested non-paraquat pesticides (452/610; 74.1%). Additional analyses showed that the main reason for not receiving a psychiatric assessment was poor outcome as a result of paraquat ingestion – compared with assessed patients, non-assessed patients were older (65+ year 45.0% vs 36.3%), more likely to ingest paraquat (55.2% vs 21.2%), and more likely to have a fatal outcome at discharge (60.1% vs 11.3%) (Supplementary Table 2). However, among patients who were assessed by psychiatrists, discharge outcome (death vs survival) was not associated with interpersonal conflict before self-poisoning, having a previous suicide attempt, past psychiatric service use, or any or specific psychiatric diagnoses (Supplementary Table 3).

Overall, multinomial logistic regression analysis adjusted for sex and age showed no difference in any of the lifestyle or poisoning-related variables investigated across patients who ingested different groups of pesticides, while some differences in socio-demographic characteristics were found (Table 3). Compared with patients who ingested paraquat, patients who ingested other pesticides (pesticide groups) were less likely to be divorced (other known pesticides [sex-age-adjusted odds ratio (aOR) = 0.49, 95% CI 0.27–0.88]); had a lower educational level (glyphosate [aOR = 0.39, 95% CI 0.21–0.72], OP insecticides [aOR = 0.41, 95% CI 0.23–0.72], other known pesticides [aOR = 0.45, 95% CI 0.27–0.75]); were less likely to be active agricultural workers (glyphosate, OP insecticides, other known pesticides); were less likely to live alone (OP insecticides [aOR = 0.43, 95% CI 0.19–0.95]); and were less likely to have chronic illness (glufosinate-ammonium [aOR = 0.32, 95% CI 0.15–0.68]).

Noticeably, sex- and age-adjusted multinomial logistic regression analysis showed no difference in the pattern of having interpersonal conflicts, triggers, and psychopathology across patients who ingested different groups of pesticides (Table 4), with only a few exceptions: increased odds of having mental illness (aOR = 1.95, 95% CI 1.11–3.42) or physical illness (aOR = 2.60, 95% CI 1.29–5.23) as self-poisoning triggers in patients who ingested OP insecticides and glyphosate, respectively, and decreased odds of having a previous suicide attempt in patients who ingested glufosinate-ammonium (aOR = 0.21, 95% CI 0.06–0.75) and other known pesticides (aOR = 0.51, 95% CI 0.31–0.85), compared with those who ingested paraquat.

Compared with male pesticide self-poisoning patients, female patients had an increased likelihood of having interpersonal conflicts before self-poisoning, having a previous suicide attempt, having past psychiatric service use, and having a depressive disorder, but had a decreased likelihood of having alcohol use disorder; there was no sex difference in receiving any psychiatric disorders (Supplementary Table 4). Age-adjusted multinomial logistic regression analysis stratified by

Table 1
Characteristics and poisoning-related variables of patients who self-poisoned using pesticides ($N = 1{,}086$), overall and by pesticide group. Comparisons were made across five groups of pesticides ($N = 987$).

	All ($N = 1{,}086$)		Paraquat ($N = 377$)		Glyphosate ($N = 121$)		Glufosinate-ammonium ($N = 38$)		Organophosphorus insecticides ($N = 148$)		Other known pesticides ($N = 303$)		χ^2 / Fisher's exact test		
	n	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)		df	*p* value
Characteristics															
Sex													14.8	4	**0.005**
Male	728	(67.0)	267	(70.8)	90	(74.4)	23	(60.5)	106	(71.6)	181	(59.7)			
Female	358	(33.0)	110	(29.2)	31	(25.6)	15	(39.5)	42	(28.4)	122	(40.3)			
Age group													50.3	8	**<0.001**
0–44 y/o	303	(27.9)	127	(33.7)	37	(30.6)	11	(28.9)	38	(25.7)	57	(18.8)			
45–64 y/o	351	(32.3)	137	(36.3)	41	(33.9)	9	(23.7)	49	(33.1)	77	(25.4)			
≥65 y/o	432	(39.8)	113	(30.0)	43	(35.5)	18	(47.4)	61	(41.2)	169	(55.8)			
Marital status													41.6	12	**<0.001**
Married	578	(61.3)	175	(55.4)	61	(58.1)	22	(64.7)	93	(66.4)	180	(66.4)			
Single	137	(14.5)	63	(19.9)	13	(12.4)	4	(11.8)	17	(12.1)	25	(9.2)			
Divorced	116	(12.3)	53	(16.8)	18	(17.1)	3	(8.8)	16	(11.4)	19	(7.0)			
Widowed	112	(11.9)	25	(7.9)	13	(12.4)	5	(14.7)	14	(10.0)	47	(17.3)			
Education level													56.2	4	**<0.001**
Elementary school or below	418	(50.2)	101	(35.1)	49	(51)	15	(46.9)	69	(56.6)	156	(67.5)			
Junior high school or above	414	(49.8)	187	(64.9)	47	(49)	17	(53.1)	53	(43.4)	75	(32.5)			
Occupation													58.6	12	**<0.001**
Agriculture	145	(16.5)	67	(22.3)	7	(7.1)	10	(30.3)	21	(17.5)	32	(12.2)			
Non-agriculture	219	(24.9)	87	(28.9)	31	(31.6)	10	(30.3)	29	(24.2)	44	(16.7)			
Housekeeper, student, or retired	187	(21.2)	39	(13.0)	22	(22.4)	2	(6.1)	32	(26.7)	84	(31.9)			
Unemployed	330	(37.5)	108	(35.9)	38	(38.8)	11	(33.3)	38	(31.7)	103	(39.2)			
Area of residence													8.6	4	0.072
Urban	475	(44.1)	149	(39.6)	53	(44.9)	11	(28.9)	68	(46.3)	144	(48.0)			
Rural	601	(55.9)	227	(60.4)	65	(55.1)	27	(71.1)	79	(53.7)	156	(52.0)			
Living alone	96	(10.9)	39	(13.0)	17	(17.9)	7	(21.9)	8	(6.1)	22	(8.5)	14	4	**0.007**
Cigarette smoking	372	(43.2)	152	(52.2)	45	(45.5)	13	(40.6)	53	(40.2)	79	(32.6)	21.5	4	**<0.001**
Alcohol drinking	378	(41.3)	143	(47.0)	48	(44.4)	11	(34.4)	50	(37.3)	85	(32.2)	14.7	4	**0.005**
Betel nut chewing	140	(16.8)	62	(21.6)	18	(18.8)	3	(9.7)	18	(14.4)	29	(12.5)	9.7	4	**0.046**
Having chronic illness	777	(71.5)	253	(67.1)	91	(75.2)	19	(50)	115	(77.7)	234	(77.2)	20.8	4	**<0.001**
Poisoning-related variables															
Season of self-poisoning													7.4	12	0.83
Spring	288	(26.5)	108	(28.6)	24	(19.8)	10	(26.3)	44	(29.7)	79	(26.1)			
Summer	286	(26.3)	97	(25.7)	36	(29.8)	7	(18.4)	36	(24.3)	87	(28.7)			
Autumn	285	(26.2)	96	(25.5)	37	(30.6)	13	(34.2)	40	(27.0)	80	(26.4)			
Winter	227	(20.9)	76	(20.2)	24	(19.8)	8	(21.1)	28	(18.9)	57	(18.8)			
Time of self-poisoning													9.4	12	0.67
Night (0–6am)	96	(10.5)	30	(9.4)	11	(10.9)	3	(9.7)	17	(13.5)	23	(8.9)			
Morning (6am-12pm)	292	(32.1)	95	(29.7)	37	(36.6)	11	(35.5)	42	(33.3)	85	(32.9)			
Afternoon (12–6pm)	296	(32.5)	118	(36.9)	32	(31.7)	8	(25.8)	32	(25.4)	82	(31.8)			
Evening (6pm-0am)	227	(24.9)	77	(24.1)	21	(20.8)	9	(29)	35	(27.8)	68	(26.4)			
Co-ingestion of alcohol	188	(17.3)	58	(15.4)	20	(16.5)	5	(13.2)	30	(20.3)	47	(15.5)	2.4	4	0.67
Co-ingestion of medication	62	(5.7)	13	(3.4)	8	(6.6)	2	(5.3)	14	(9.5)	16	(5.3)	8	4	0.092
Co-ingestion of other poisons	22	(2.0)	4	(1.1)	0	0.0	0	0.0	1	(0.7)	10	(3.3)	–	–	0.083

[a]p values less than 0.05 are highlighted in bold.

sex showed generally similar patterns of the associations between interpersonal conflicts/psychopathology and the group of pesticides ingested in males and females (Supplementary Table 5). There was no statistical evidence for sex difference for these associations (p values ranging 0.13 to 0.99), with the only exception of a weak association between past psychiatric service use and decreased odds of ingesting glufosinate-ammonium (vs paraquat) in females but not in males (interaction $p = 0.026$) (Supplementary Table 6).

4. Discussion

Two thirds of patients who self-poisoned using pesticides in Taiwan were male, and two fifths were older people aged 65+ years, while only one sixth were actively involved in agriculture at the time of self-poisoning. Approximately three quarters (75.7%) of patients who were assessed by psychiatrists received at least one psychiatric diagnosis, with depressive disorder being the most common diagnosis. Mental illness (31.1%), physical illness (28.9%), and marital problems (18.5%) were the most common triggers of pesticide self-poisoning identified. After adjusting for sex and age, the group of pesticides used in self-poisoning was not associated with interpersonal conflicts, most of the triggers examined, past psychiatric service use, or having psychiatric diagnoses; such findings were similarly found in male and female patients.

4.1. Strengths and limitations

This study was among the largest to investigate the triggers and compare the characteristics and psychopathology of patients who self-poisoned using different pesticides. Some limitations need to be mentioned. First, the study included patients who presented to study hospitals with pesticide self-poisoning; hence, patients who did not seek medical attention because their conditions were very mild and patients who were dead at discovery and not sent to hospitals would not be included in this study. Patients who were not coded correctly could have

Table 2
Interpersonal conflicts, triggers of self-poisoning, and psychopathology in patients who self-poisoned using pesticides (only patients who received psychiatric assessment were included; N = 655), overall and by pesticide group. Comparisons were made across five groups of pesticides (N = 591).

	All		Paraquat		Glyphosate		Glufosinate-ammonium		Organophosphorus insecticides		Other known pesticides		χ2 / Fisher's exact test	df	p value
	(N = 655)		(N = 139)		(N = 93)		(N = 29)		(N = 99)		(N = 231)				
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)			
Interpersonal conflicts	242	(36.9)	60	(43.2)	28	(30.1)	12	(41.4)	35	(35.4)	87	(37.7)	4.5	4	0.35
Triggers of self-poisoning															
Partner relational problems	52	(7.9)	18	(12.9)	7	(7.5)	1	(3.4)	8	(8.1)	12	(5.2)	8.1	4	0.09
Marital problems	121	(18.5)	24	(17.3)	9	(9.7)	6	(20.7)	21	(21.2)	45	(19.5)	5.6	4	0.23
Mental illness	204	(31.1)	35	(25.2)	29	(31.2)	10	(34.5)	40	(40.4)	72	(31.2)	6.4	4	0.18
Physical illness	189	(28.9)	19	(13.7)	34	(36.6)	9	(31)	24	(24.2)	84	(36.4)	25.8	4	**<0.001**
Bereavement	31	(4.7)	6	(4.3)	6	(6.5)	0	(0.0)	5	(5.1)	13	(5.6)	–	–	0.78
Parent-child relational problems	74	(11.3)	20	(14.4)	6	(6.5)	2	(6.9)	10	(10.1)	31	(13.4)	5	5	0.29
Economic problems	82	(12.5)	25	(18)	10	(10.8)	4	(13.8)	10	(10.1)	22	(9.5)	6.6	4	0.16
Employment problems	17	(2.6)	3	(2.2)	2	(2.2)	0	(0.0)	3	(3.0)	6	(2.6)	–	–	0.99
Relational problems with other relatives	67	(10.2)	23	(16.5)	9	(9.7)	3	(10.3)	9	(9.1)	19	(8.2)	6.9	4	0.14
School or work-related problems	29	(4.4)	8	(5.8)	3	(3.2)	2	(6.9)	6	(6.1)	5	(2.2)	–	–	0.20
Loneliness	10	(1.5)	1	(0.7)	1	(1.1)	0	(0.0)	1	(1.0)	5	(2.2)	–	–	0.86
Legal problems	24	(3.7)	4	(2.9)	6	(6.5)	1	(3.4)	2	(2.0)	9	(3.9)	–	–	0.54
Psychopathology															
Previous suicide attempt	167	(25.5)	50	(36)	25	(26.9)	3	(10.3)	26	(26.3)	47	(20.3)	14.9	4	**0.005**
Past psychiatric service use	222	(33.9)	52	(37.4)	37	(39.8)	7	(24.1)	40	(40.4)	69	(29.9)	6.7	4	0.15
Psychiatric diagnosis															
Depressive disorder	444	(67.8)	88	(63.3)	66	(71.0)	20	(69.0)	72	(72.7)	154	(66.7)	3	4	0.57
Schizophrenia or psychotic disorder	34	(5.2)	7	(5)	4	(4.3)	1	(3.4)	5	(5.1)	12	(5.2)	–	–	1.00
Alcohol use disorder	100	(15.3)	31	(22.3)	14	(15.1)	3	(10.3)	18	(18.2)	26	(11.3)	9.2	4	0.06
Other substance use disorder	30	(4.6)	10	(7.2)	6	(6.5)	1	(3.4)	3	(3.0)	8	(3.5)	–	–	0.40
Personality disorder	12	(1.8)	5	(3.6)	1	(1.1)	0	(0.0)	2	(2.0)	2	(0.9)	–	–	0.38
Any of the above diagnoses	496	(75.7)	104	(74.8)	70	(75.3)	22	(75.9)	81	(81.8)	171	(74.0)	2.4	4	0.66

[a]p values less than 0.05 are highlighted in bold.

also been missed; however, we included additional codes to identify these misclassified patients. Second, data for some variables such as co-ingested substances, interpersonal conflicts, and triggers may underestimate their true prevalence as data were collected from the hospital records retrospectively. The original information in hospital records was recorded for the purpose of clinical assessment rather than research. Psychiatric diagnoses might not be systematically assessed in interviews; although psychiatric diagnoses based on DSM-IV or DSM-5 criteria were provided in hospital records, variations in the practice of interviews and utilizing the diagnostic criteria may still exist across psychiatrists. Third, only 60% of the patients received a psychiatric assessment. In this study, 23.8% (259 out of 1,086) of patients having a fatal outcome may have been too ill to receive a psychiatric interview, and many of these patients ingested paraquat. However, we found that a fatal outcome was not associated with psychopathology in assessed patients. Last, the reason for choosing the specific pesticides was not documented in the hospital records in most patients. A prospective study that interviews patients would provide more comprehensive information on the triggers of self-poisoning and reasons for selecting particular pesticides; such studies previously conducted in Sri Lanka showed no specific selection of individual pesticides or pesticide classes (Eddleston et al., 2006).

4.2. Comparison with previous studies

The male-to-female ratio of pesticide self-poisoning was 2.03 in this study. By contrast, suicide attempts (all methods) were generally found to be more common in women than men; for example, the male-to-female ratio of suicide attempts presenting to hospitals was 1:2.28 in a previous study from Taiwan (Kuo et al., 2012). However, the sex ratios of suicide attempters varied across suicide methods and were found to be greater than one for pesticide self-poisoning (i.e., male dominance) in previous studies from Taiwan - the male-to-female ratio was 3.49 for paraquat self-poisoning (Lin et al., 2014) and 2.05 for non-paraquat pesticide self-poisoning (Lee et al., 2017). Similarly, the male-to-female ratio of pesticide self-poisoning was 1.95 in a recent large study from Sri Lanka (Buckley et al., 2021) and 1.80 in another large study from South Korea (Lee et al., 2015). The male dominance in pesticide self-poisonings could be explained by men more frequently choosing suicide methods of high lethality comparison with women (Spicer and Miller, 2000). Furthermore, men were more likely to be active agriculture workers or previously engaged in farm work (Council of Agriculture, 2019), and thus had greater access to and were more familiar with pesticides than women. Hence, men might be more likely to use pesticides for suicide than women due to both means availability and familiarity.

In contrast to studies from Sri Lanka, which reported that more than half of the pesticide self-poisoning patients presenting to hospitals were below 30 years old (Buckley et al., 2021; van der Hoek and Konradsen, 2005), our study showed that 39.8% of patients were older people aged 65 years or over. Meanwhile, the patient's age profile in this study was more similar to that (mean age: 57.5 years) reported in a recent study from South Korea (Lee et al., 2015). Population aging, especially in rural areas, may account for the different findings from studies in Sri Lanka versus South Korea and Taiwan (Chang et al., 2012). Furthermore, older people in Taiwan were more likely to have experiences of farm work than younger people, and pesticide poisoning as a method of suicide would have been better known and accessed by older people than their younger counterparts. Hence, pesticide self-poisoning in older populations in Taiwan could be a cohort phenomenon.

Patients who self-poisoned using pesticides in Taiwan appeared to have a lower prevalence of recent interpersonal conflicts and greater psychiatric morbidity than that reported previously among patients who self-poisoned (using pesticides or other poisons) in low- and middle-income countries. For example, in Sri Lanka, only 29% (12 of 42) of

Table 3
Results of multinomial logistic regression analyses: adjusted odds ratios (aORs; sex-age-adjusted) and 95% confidence intervals (CIs) of characteristics and poisoning-related variables in patients who self-poisoned using glyphosate, glufosinate-ammonium, organophosphorus (OP) insecticides, or other known pesticides versus paraquat (the comparison group). The associations were between characteristics examined and each of the four pesticides groups, in comparison with paraquat (the comparison group). The analyses were based on 987 patients who self-poisoned using known pesticides.

	Glyphosate			Glufosinate-ammonium			OP insecticides			Other known pesticides		
	aOR	95%CI		aOR	95%CI		aOR	95%CI		aOR	95%CI	
Characteristics												
Marital status												
Married	1 [reference]			1 [reference]			1 [reference]			1 [reference]		
Single	0.59	(0.28	, 1.26)	0.59	(0.17	, 2.13)	0.58	(0.29	, 1.14)	0.62	(0.34	, 1.12)
Divorced	0.96	(0.51	, 1.81)	0.58	(0.16	, 2.14)	0.62	(0.33	, 1.17)	**0.49**	**(0.27**	**, 0.88)**
Widowed	1.49	(0.69	, 3.21)	1.19	(0.40	, 3.58)	0.94	(0.46	, 1.95)	1.31	(0.76	, 2.29)
Education level												
Elementary school or below	1 [reference]			1 [reference]			1 [reference]			1 [reference]		
Junior high school or above	**0.39**	**(0.21**	**, 0.72)**	1.64	(0.60	, 4.46)	**0.41**	**(0.23**	**, 0.72)**	**0.45**	**(0.27**	**, 0.75)**
Occupation												
Agriculture	1 [reference]			1 [reference]			1 [reference]			1 [reference]		
Non-agriculture	**4.11**	**(1.65**	**, 10.19)**	1.28	(0.45	, 3.66)	1.30	(0.66	, 2.57)	1.63	(0.90	, 2.97)
Housekeeper, student, or retired	**5.31**	**(2.03**	**, 13.88)**	0.24	(0.05	, 1.16)	**2.42**	**(1.20**	**, 4.89)**	**3.33**	**(1.85**	**, 5.98)**
Unemployed	**3.43**	**(1.44**	**, 8.16)**	0.59	(0.24	, 1.50)	1.13	(0.61	, 2.09)	**1.80**	**(1.07**	**, 3.00)**
Area of residence												
Urban	1 [reference]			1 [reference]			1 [reference]			1 [reference]		
Rural	0.81	(0.53	, 1.23)	1.62	(0.78	, 3.37)	0.77	(0.53	, 1.14)	0.73	(0.53	, 1.00)
Living alone	1.49	(0.79	, 2.79)	1.91	(0.77	, 4.77)	**0.43**	**(0.19**	**, 0.95)**	0.67	(0.38	, 1.18)
Cigarette smoking	0.89	(0.56	, 1.42)	1.07	(0.48	, 2.39)	0.96	(0.62	, 1.49)	0.83	(0.57	, 1.21)
Alcohol drinking	1.16	(0.73	, 1.84)	0.92	(0.41	, 2.07)	0.99	(0.64	, 1.53)	1.09	(0.75	, 1.58)
Betel nut chewing	0.92	(0.51	, 1.67)	0.56	(0.16	, 1.96)	0.81	(0.45	, 1.46)	0.86	(0.53	, 1.42)
Having chronic illness	1.45	(0.88	, 2.39)	**0.32**	**(0.15**	**, 0.68)**	1.50	(0.93	, 2.41)	1.10	(0.75	, 1.61)
Poisoning-related variables												
Season of self-poisoning												
Spring	1 [reference]			1 [reference]			1 [reference]			1 [reference]		
Summer	1.67	(0.93	, 2.99)	0.78	(0.28	, 2.13)	0.91	(0.54	, 1.53)	1.22	(0.80	, 1.87)
Autumn	1.75	(0.97	, 3.13)	1.49	(0.62	, 3.58)	1.03	(0.62	, 1.72)	1.16	(0.76	, 1.78)
Winter	1.43	(0.75	, 2.71)	1.14	(0.43	, 3.02)	0.92	(0.53	, 1.62)	1.06	(0.67	, 1.68)
Time of self-poisoning												
Night (0–6am)	1 [reference]			1 [reference]			1 [reference]			1 [reference]		
Morning (6am-12pm)	1.03	(0.47	, 2.29)	0.97	(0.25	, 3.77)	0.75	(0.37	, 1.51)	0.93	(0.49	, 1.76)
Afternoon (12–6pm)	0.73	(0.33	, 1.62)	0.6	(0.15	, 2.42)	0.47	(0.23	, 0.96)	0.78	(0.42	, 1.46)
Evening (6pm-0am)	0.77	(0.33	, 1.79)	1.15	(0.29	, 4.59)	0.84	(0.41	, 1.72)	1.18	(0.62	, 2.26)
Co-ingestion of alcohol	1.15	(0.65	, 2.04)	1.08	(0.39	, 2.98)	1.64	(0.99	, 2.71)	1.51	(0.97	, 2.34)
Co-ingestion of medication	2.11	(0.85	, 5.26)	1.57	(0.34	, 7.31)	3.16	(1.44	, 6.95)	1.65	(0.77	, 3.56)
Co-ingestion of other poison	-[b]			-[b]			0.62	(0.07	, 5.61)	3.07	(0.91	, 10.31)

[a]The 95% confidence intervals of odds ratios that do not include one are highlighted in bold.
[b] None of the patients who ingested glyphosate or glufosinate-ammonium had co-ingestion of other poison hence the odds ratios were not calculated.

patients with pesticide self-poisoning were suspected to have major depression when assessed by Composite International Diagnostic Interview Short Form (van der Hoek and Konradsen, 2005). By contrast, approximately 50–70% of self-poisonings were preceded by an immediate interpersonal conflict in Sri Lanka (Hettiarachchi and Kodituwakku, 1989; Rajapakse et al., 2015). Hence, pesticide self-poisoning has been commonly described as an impulsive act associated with limited psychiatric morbidity, particularly in low- and middle-income settings (Knipe et al., 2019). A recent systemic review and meta-analysis found that psychiatric disorders were less common in individuals who engaged in fatal and nonfatal suicidal behavior in low- and middle-income countries (any psychiatric disorders: 45–58%; mood disorders: 21–25%) (Knipe et al., 2019) than in high-income countries (any psychiatric disorders: 80–92%; mood disorders: 43–59%) (Arsenault-Lapierre et al., 2004; Cavanagh et al., 2003; Cho et al., 2016; Hawton et al., 2013). One of the explanations for such a difference provided by the authors is that the commonly used suicide methods (e.g., pesticide ingestion) in low- and middle-income countries are associated with impulsivity and low suicidal intent and individuals who used these suicide methods may be less likely to have a psychiatric illness (Knipe et al., 2019).

The present study showed that the prevalence of diagnosable psychiatric disorders was high (75.7%) in patients who attempted suicide by ingesting pesticides and were assessed by psychiatrists. By contrast, among the studies included in the systemic review by Knipe et al. (2019), those using clinician diagnoses showed that the prevalence of psychiatric diagnoses ranged 47–57% in samples in which pesticide poisoning was the leading suicide method used. There are several possible explanations for the relatively high prevalence of psychiatric diagnoses in our data. First, our sample was older than previous studies, and the prevalence of some psychiatric disorders, e.g., depression, tended to increase with age. The age profile of our sample is due to the rapid aging of rural populations as a result of urbanization and industrialization in Taiwan over the past decades. Similar change may occur in low- and middle-income countries in the future, and the prevalence of psychiatric disorders may increase as their rural populations age. Second, the systemic review by Knipe et al. (2019) found higher prevalence of psychiatric disorders among people with non-fatal suicidal behaviors in studies including more than 50% of males than those including less than 50% of males. The male-to-female ratio of our sample was about two. However, no difference in the prevalence of all psychiatric diagnoses between males and females was found in our data. In addition, we did not find evidence for a sex interaction effect on the association between psychopathology and the pesticides used in self-poisoning. Third, some of the medical teams providing care for these patients might have decided to not consult psychiatrists when patients denied suicidal intent. These patients were likely to self-poison under an impulse and might have short-lived suicidal intent and a lower level of psychopathology than those who were referred to psychiatric assessment. However, in our study hospitals it is routine to refer patients who

Table 4
Results of multinomial logistic regression analyses: adjusted odds ratios (aORs; sex-age-adjusted) and 95% confidence intervals (CIs) of interpersonal conflicts, triggers of self-poisoning, and psychopathology in patients who self-poisoned using glyphosate, glufosinate-ammonium, organophosphorus (OP) insecticides, or other known pesticides versus paraquat (the comparison group). The associations were between characteristics examined and each of the four pesticides groups, in comparison with paraquat (the comparison group). The analyses were based on 591 patients who self-poisoned using known pesticides and were assessed by psychiatrists.

	Glyphosate			Glufosinate-ammonium			OP insecticides			Other known pesticides		
	aOR	95%CI		aOR	95%CI		aOR	95%CI		aOR	95%CI	
Interpersonal conflicts	0.64	(0.36	, 1.13)	1.06	(0.46	, 2.43)	0.82	(0.47	, 1.41)	0.97	(0.61	, 1.54)
Triggers												
Partner relational problems	0.68	(0.27	, 1.72)	0.33	(0.04	, 2.60)	0.73	(0.30	, 1.77)	0.58	(0.26	, 1.30)
Marital problems	0.56	(0.24	, 1.30)	1.29	(0.46	, 3.59)	1.45	(0.74	, 2.85)	1.27	(0.70	, 2.30)
Mental illness	1.29	(0.72	, 2.34)	1.45	(0.61	, 3.46)	**1.95**	**(1.11**	**, 3.42)**	1.24	(0.75	, 2.04)
Physical illness	**2.60**	**(1.29**	**, 5.23)**	1.58	(0.57	, 4.37)	1.31	(0.63	, 2.70)	1.67	(0.91	, 3.10)
Bereavement	1.39	(0.43	, 4.53)	–[b]			1.08	(0.31	, 3.70)	1.05	(0.37	, 3.02)
Parent-child relational problems	0.40	(0.15	, 1.05)	0.41	(0.09	, 1.90)	0.65	(0.29	, 1.47)	0.85	(0.44	, 1.64)
Economic problems	0.66	(0.29	, 1.47)	1.11	(0.34	, 3.64)	0.6	(0.27	, 1.34)	0.80	(0.42	, 1.55)
Employment problems	1.20	(0.19	, 7.48)	–[b]			1.69	(0.33	, 8.70)	2.14	(0.50	, 9.18)
Relational problems with other relatives	0.67	(0.29	, 1.56)	0.75	(0.20	, 2.76)	0.62	(0.27	, 1.43)	0.65	(0.33	, 1.31)
School or work-related problems	0.77	(0.20	, 3.08)	2.22	(0.42	, 11.85)	1.50	(0.49	, 4.62)	0.77	(0.23	, 2.51)
Loneliness	1.51	(0.09	, 25.27)	–			1.43	(0.09	, 23.91)	2.57	(0.27	, 24.89)
Legal problems	3.00	(0.80	, 11.21)	1.90	(0.20	, 18.27)	0.86	(0.15	, 4.85)	2.42	(0.69	, 8.46)
Psychopathology												
Previous suicide attempt	0.73	(0.41	, 1.32)	**0.21**	**(0.06**	**, 0.75)**	0.71	(0.40	, 1.26)	**0.51**	**(0.31**	**, 0.85)**
Past psychiatric service use	1.26	(0.72	, 2.20)	0.57	(0.22	, 1.45)	1.30	(0.75	, 2.24)	0.84	(0.52	, 1.35)
Psychiatric diagnoses												
Depressive disorder	1.36	(0.76	, 2.41)	1.12	(0.47	, 2.69)	1.49	(0.84	, 2.64)	1.00	(0.62	, 1.60)
Schizophrenia or psychotic disorder	0.90	(0.25	, 3.20)	0.72	(0.08	, 6.17)	1.06	(0.32	, 3.50)	1.16	(0.42	, 3.20)
Alcohol use disorder	0.74	(0.36	, 1.53)	0.62	(0.17	, 2.27)	0.93	(0.47	, 1.82)	0.77	(0.42	, 1.43)
Other substance use disorder	1.31	(0.44	, 3.88)	0.76	(0.09	, 6.46)	0.56	(0.15	, 2.14)	0.94	(0.34	, 2.60)
Personality disorder	0.37	(0.04	, 3.30)	-[b]			0.69	(0.13	, 3.75)	0.35	(0.06	, 2.06)
Any of the above diagnoses	1.02	(0.55	, 1.89)	1.00	(0.39	, 2.56)	1.52	(0.79	, 2.89)	0.91	(0.54	, 1.52)

[a]The 95% confidence intervals of odds ratios that do not include one are highlighted in bold.
[b] None of the patients who ingested glufosinate-ammonium reported bereavement, employment problems, or loneliness as the trigger of self-poisoning or was given a diagnosis of personality disorder hence the odds ratios were not calculated.

ingested pesticides to psychiatric assessment unless strong evidence for accidental poisoning is presented. Fourth, the psychiatric diagnoses in this study were made by psychiatrists. It is possible that psychiatrists were more sensitive in identifying mental illness than other health professionals, who made the psychiatric diagnoses in some of previous studies (Knipe et al., 2019).

No difference in interpersonal conflicts before self-poisoning, most of the triggers, and psychiatric diagnoses was found among patients who ingested different groups of pesticides. This lack of association of pesticides used in self-poisoning with these psychological precipitants suggested that, at time of pesticide ingestion, the choice of pesticides involved was not from intentional selection and may depend on pesticides immediately available. In keeping with this, previous studies from Sri Lanka showed that 76% of the pesticides ingested in self-poisoning were stored around the house (Mohamed et al., 2009) and about half of the patients who self-poisoned using pesticides reported easy availability as their reason of choosing the poison (Eddleston et al., 2006; Mohamed et al., 2009). Furthermore, among individuals who attempted suicide by ingesting paraquat in South Korea, 62% did not intentionally select the pesticide (Seok et al., 2009).

Overall, we did not find consistent associations between ingesting a particular pesticide with psychopathology. The prevalence of psychiatric diagnoses did not differ between different pesticide groups. In sex- and age-adjusted regression analyses, paraquat ingestion was associated with increased odds of having a previous suicide attempt when compared with glufosinate-ammonium and other known pesticides ingestion but not glyphosate or OP insecticides. The association of paraquat ingestion with a history of a suicide attempt warrants further investigation. Some individuals with high suicidal intent and past suicide attempts may become aware of the high toxicity of paraquat and chose this pesticide for self-poisoning; this would increase the risk of mortality in repeated suicide attempts, although this would be prevented by restricting or banning paraquat. In Taiwan, paraquat was banned in two stages (2018–2020), and a recent study showed an early effect of the first-stage ban on the import and production of paraquat on reducing pesticide suicide rates in 2019 (Chang et al., 2021b).

Our data showed that patients who ingested different pesticides varied in some of their socio-demographic variables investigated. Patients who ingested paraquat were younger and had higher education level than those using other pesticides. A possible explanation for this finding is that paraquat is the most frequently ingested pesticide in self-poisonings in Taiwan (Lin et al., 2010) and therefore paraquat self-poisonings were more likely to be reported in the media. Younger people and those with higher education levels may be more likely to have access to such information and hence suicidal individuals in this group may have specifically chosen paraquat for self-poisoning due to the cognitive availability of paraquat. This needs support from studies that prospectively interview patients to know their reasons for choosing paraquat for self-poisoning. However, a South Korean study of individuals who attempted suicide using paraquat found no difference in age or education level between those who intentionally selected paraquat and those who did not (Seok et al., 2009), indicating that factors influencing cognitive availability may vary across settings. Patients who ingested glufosinate-ammonium tended to be active agriculture workers. This could be attributable to the recent marked increase in the sale and use of glufosinate-ammonium in Taiwan – the sale amount of glufosinate-ammonium increased 3.7-fold in 2007–2016 (Fong, 2017). It is important to closely monitor trends in self-poisoning using this pesticide and associated morbidity and mortality.

4.3. Policy implications

Our findings indicated that although pesticide self-poisoning is often impulsive and precipitated by acute stressors, a substantial proportion of individual who self-poison using pesticides may have pre-existing psychiatric illness that could trigger the self-poisoning and require clinical attention. Early identification and effective treatment of psychiatric illness in individuals living in rural / farming areas may prevent pesticide self-poisonings. Psychiatric assessment, treatment, and follow-up after pesticide self-poisoning could be important for preventing repeated episodes.

Meanwhile, the varied demographic profiles among patients who ingested different pesticides showed potential heterogeneity in individuals who self-poisoned using pesticides. Our study showed that paraquat self-poisoning was more common in younger people; however, as a whole, patients who ingested paraquat were not more likely to have psychiatric illness compared with suicide attempters who used other pesticides. Hence, minimizing the accessibility and cognitive availability of HHPs is crucial to decreasing deaths from pesticide self-poisoning and increasing the chances of treating psychiatric illness among individuals who survived pesticide self-poisoning episodes (Eddleston and Bateman, 2011; Florentine and Crane, 2010).

5. Conclusions

Our data showed that the majority of patients who self-poisoned using pesticides in Taiwan had psychiatric diagnoses and the prevalence of recent interpersonal conflicts was lower than previously reported in low- and middle-income countries. A substantial proportion of pesticide self-poisonings could be associated with psychopathology, not just a result from impulsive behavior, in some settings, where psychiatric assessment and treatment are important in managing patients who self-poisoned using pesticides. However, no association was found between psychopathology and the pesticides involved in pesticide self-poisonings, indicating the important role of physical availability in the selection of pesticides. Restricting or banning HHPs would be effective in reducing many deaths from pesticide self-poisoning.

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Availability of data and materials

The data were from the hospital records at the eight study hospitals where we conducted the study. We were not permitted to share the data.

CRediT authorship contribution statement

Chao-Ying Tu: Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Tzung-Hai Yen:** Data curation, Writing – review & editing. **Chia-Ming Chang:** Data curation, Writing – review & editing. **Hsien-Yi Chen:** Data curation, Writing – review & editing. **Yung-Chieh Yen:** Data curation, Writing – review & editing. **Ming-Chao Guo:** Data curation, Writing – review & editing. **Tsung-Hua Lu:** Data curation, Writing – review & editing. **Chi-Shin Wu:** Data curation, Writing – review & editing. **I-Ming Chen:** Data curation, Writing – review & editing. **Hai-Ching Cheng:** Data curation, Writing – review & editing. **Wei-Lieh Huang:** Data curation, Writing – review & editing. **Cheng-Che Chen:** Data curation, Writing – review & editing. **Michael Eddleston:** Writing – review & editing. **Shu-Sen Chang:** Conceptualization, Data curation, Writing – original draft, Writing – review & editing, Funding acquisition.

Declaration of Competing Interest

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2021.12.058.

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