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Source: Environmental Health Insights, 11(1)

Published By: SAGE Publishing

URL: <https://doi.org/10.1177/1178630217713015>

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Characteristics of Pesticide Poisoning in Rural and Urban Settings in Uganda

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Environmental Health Insights
Volume 11: 1–8
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DOI: 10.1177/1178630217713015



ABSTRACT: Pesticide poisoning is a significant burden on health care systems in many low-income countries. This study evaluates cases of registered pesticide poisonings treated in selected rural (N = 101) and urban (N = 212) health facilities in Uganda from January 2010 to August 2016. In the urban setting, pesticides were the most prevalent single poison responsible for intoxications (N = 212 [28.8%]). Self-harm constituted a significantly higher proportion of the total number of poisonings in urban (63.3%) compared with rural areas (25.6%) where unintentional poisonings prevailed. Men were older than women and represented a majority of around 60% of the cases in both the urban and rural settings. Unintentional cases were almost the only ones seen below the age of 10, whereas self-harm dominated among adolescents and young persons from 10 to 29 years of age. Organophosphorus insecticides accounted for 73.0% of the poisonings. Urban hospitals provided a more intensive treatment and had registered fewer complications than rural health care settings. To minimize self-harm with pesticides, a restriction of pesticide availability as shown to be effective in other low-income countries is recommended. Training of health care workers in proper diagnosis and treatment of poisonings and improved equipment in the health care settings should be strengthened.

KEYWORDS: Uganda, pesticides, poisoning, self-harm, suicide

RECEIVED: November 30, 2016. **ACCEPTED:** May 8, 2017.

PEER REVIEW: Four peer reviewers contributed to the peer review report. Reviewers' reports totaled 2604 words, excluding any confidential comments to the academic editor.

TYPE: Review

FUNDING: The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The research was funded by the

Clinic of Occupational Medicine Odense University Hospital and the University of Southern Denmark

DECLARATION OF CONFLICTING INTERESTS: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Introduction

Pesticide poisoning is a well-known public health problem in many developing countries. World Health Organization (WHO) estimates that several million people are getting poisoned each year, of which more than 300 000 people die; a majority of these poisonings happen in developing countries.^{1,2}

Pesticide self-poisoning accounts for about one third of the total number of suicides globally, summing up to 258 000 completed suicides yearly as estimated in a study.³

Individual access to methods of suicide often determines the method chosen, and in developing countries, where pesticides are more easily available, they are the predominant method of suicide.^{4,5}

The intensive medical care required to treat pesticide-poisoned patients may have a significant impact on already stretched health care resources in low-income countries such as Uganda.^{3,6,7}

A retrospective study of poisoning cases in a referral hospital in Western Kenya, a setting that might be similar to Ugandan health service, showed that early treatment yielded positive results in survival of poisoning cases despite inadequate management. About 80% of cases needed mechanical ventilation, and the 10% mortality was solely due to suicide attempts.⁸ A higher mortality in pesticide poisoning correlated with suicidal attempts in a hospital-based surveillance in

Tanzania.⁹ Although there was no differentiation between poisoning cases, it showed that a major proportion of pesticide poisonings was manageable in limited health care settings. However, it also showed the seriousness of suicide attempts with pesticides.

A cross-sectional study showed that self-harm constituted 64.5% of the total number of acute poisonings in Uganda, of which 59.6% were due to pesticides. The study also showed that pesticides were implicated in only 3.1% of accidental poisonings.¹⁰

In a Ugandan study of self-harm, positive correlations were reported for sex (male), low educational level, poor socioeconomic status, alcohol dependency, and interpersonal quarrel with partner.¹¹ Specific risk factors for men were sexual problems. Specific risk factors for women were unwanted pregnancy. Organophosphorus pesticides were the main method among 45% of the cases, significantly higher among male cases (57.1%).¹¹

Studies on Ugandan agricultural use of pesticides shows that most farmers use pesticides (97%–98%), and mainly WHO class II pesticides as WHO class I pesticides are restricted for import.^{12–14}

Uganda has an annual age-standardized suicide rate of 19.5 per 100 000 population, ranking as the country with the 17th highest incidence in the world.^{15–19}



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The purpose of this study was to describe the characteristics of acute pesticide poisonings and the current practices in management of these cases in both an urban and a rural setting. This knowledge might be used to identify opportunities for prevention and improving the current management of pesticide poisonings.

Methods

Study design and setting

This article is based on 2 studies, one on urban hospital data from the capital of Uganda Kampala and one on rural health center data from Wakiso and Pallisa.

Retrospective data collection was conducted in 5 hospitals in Kampala, ie, Mulago, Nsambya, Nakasero, Mengo, and International Hospital Kampala. Uganda has a population of 34.85 million, and Kampala where these hospitals are located has a population of 1.51 million.¹⁶

The hospitals in the urban setting were selected as they receive a high number of cases of pesticide poisoning according to the statistics of the Division of Government Analytical Laboratory (DGAL) where they refer cases for testing and confirmation. Mulago hospital is the national referral hospital and receives severe cases from all over the country. The data covered a 5-year period from January 2010 to December 2014 from emergency, pediatric, and medical wards.

In the rural setting, data on pesticide poisonings were collected prospectively from January 2013 to August 2016 from 22 of 61 Health Centers III/IV in the districts of Wakiso and Pallisa. Wakiso has a population of 2 million, whereas Pallisa has a population of 387 000.

Both are rural districts and part of Uganda National Association of Community and Occupational Health's (UNACOH) "Pesticide, Health, and Environment project." The data were collected by clinical staff who had received training in pesticide diagnosis and treatment of poisonings. Health care workers from 42 health centers in Wakiso district and 19 from Pallisa district received this training and agreed to register pesticide poisonings at their health center. The primary purpose of collecting data was to evaluate the impact of the project.

In the urban data, all poisonings were registered by doctors in the hospital journals, but only pesticide poisonings were taken for further analysis. The rural data were based on pre-elaborated forms filled out by health care workers only including cases of pesticide poisonings.

Collection of the urban data was done by the same researcher throughout. Collection of the rural data was done by trained health care workers at each health facility.

Variables

Data included variables on sociodemographics, characteristics of the poisoning, diagnosis, and treatment.

The sociodemographic information consisted of sex and age and in the urban data also religion. Exposure data included the reason for poisoning and responsible type of pesticide. Outcome data contained information on hospitalization, treatment, recovery, and sequelae.

Statistical method

Data were entered in Excel and analyzed in SPSS version 21.00 by one researcher. The dichotomous data were analyzed using frequency analysis, χ^2 test, and Fischer exact test. The nominal data were analyzed using Student *t* test.

Due to the difference in time, purpose, and data collection techniques of the rural and urban data, analyses were done separately in each data set.

Ethical consideration

Ethical clearance was obtained from the Makerere University School of Public Health Higher Degrees Research and Ethics Committee, protocol 322. It was also registered with the Uganda National Council for Science and Technology, registration number SS3947. Permission was sought from the hospital directors to access and review their records.

The data from Wakiso and Pallisa were collected by UNACOH as part of its project evaluations. It had as part of the project permission to collect such data in coordination with the health authorities.

Numbers instead of names were used, and data were anonymized and only reviewed by researchers involved in this study. The study complies with the Helsinki Declaration.

Results

In total, 739 cases of poisonings were identified from patient records in the urban hospital wards in Kampala, of which 212 (28.8%) were due to pesticides (see Table 1).

Of the urban pesticide poisonings, the majority (133 of 210; 63.3%) were due to self-harm, whereas the rest were registered as unintentional and could be due to either accidents or occupational poisonings (see Table 2).

A total of 101 pesticide poisonings were registered in the rural wards in Wakiso and Pallisa. Of these, a minority (26 of 101; 25.7%) were due to self-harm, whereas most poisonings were unintentional in contrast to the urban data (see Table 2).

Organophosphates were the most frequent cause of poisonings, followed by rodenticides. Almost all pesticides were classified in the urban wards, whereas a big proportion was classified as "unknown" in the rural wards (see Table 2).

Male poisonings outnumbered female poisonings in both the urban (132/ of 210; 62.9%) and rural settings (60 of 100; 60%), regardless of whether it was self-harm or unintentional poisoning (see Table 2).

Self-harm cases dominated in the urban setting in both sexes, although most pronouncedly among women (57 of 78;

Table 1. Chemicals responsible for poisoning cases registered in selected urban Kampala Hospital wards from January 2010 to December 2014 (N=739).

POISON	FREQUENCY	%
Pesticides	212	28.8
Chloroform	124	16.8
Food poisoning	106	14.4
Drugs	64	8.7
Snake bite	56	7.6
Alcohol	49	6.6
Solvents	42	5.7
Medicine	31	4.2
Biological toxins	23	3.1
Others	30	5.1
Missing	2	0.2

73.1%) compared with men (76 of 132; 57.6 %). In the rural setting, the opposite situation was seen with more unintentional cases in both sexes—men (42 of 60; 70%) and women (32 of 40; 80%).

Men were older than women in both the urban and rural settings, although only significant in the urban setting (see Table 2).

If we compare the mean age of self-harm cases with unintentional cases, we saw self-harm cases being older in both the urban and rural settings in both sexes. If children less than 10 years of age were omitted from the analysis, the mean age of the self-harm cases became lower than unintentional cases in the urban setting, whereas the difference was ironed out in the rural setting (see Table 2).

Men were older than women in both poisoning groups, except for self-harm in the rural setting (see Table 2). This difference persisted among the self-harm cases but was ironed out for the unintentional cases if we omitted children below the age of 10 years from the analysis.

If we look at the distribution of cases among age groups, we notice 1 case of self-harm in the age group from 0 to 9, whereas self-harm dominates the age groups from 10 to 29 (see Table 2).

In Figure 1, the distribution of self-harm among sex and age groups shows that self-harm was dominated by women from 10 to 19 years of age in both settings. In the age group from 20 to 29, there was no difference among sex in the urban setting, whereas men dominated in the rural setting. Men aged above 29 years dominated in the urban setting, whereas women dominated in the rural setting.

In Figure 2, we see that women dominated the unintentional poisoning in the age group from 0 to 19, and men above 19 years of age dominated in both the urban and rural settings.

In the urban data, religion was registered, and it showed that Christians were more numerous than Muslims, reflecting the population in the 2 religious groups in Uganda (see Table 3).

There was a significant difference in sex with more men among the Christians, whereas there were slightly more women among the Muslims (see Table 3).

Muslims were younger with almost half of the poisoning cases (18 of 39; 46.2%) in the age group below 20 compared with Christians (35 of 163; 21.4%).

Among Christians, a majority of the cases was due to self-harm—67.5% compared with 46.2% among Muslims ($P=.013$).

When analyzing the differences among self-harm cases and sex, we see that 45 of 114 (39.5%) Christians were women compared with 12 of 18 (63.7%) Muslims ($P=.03$). The highest proportion of Muslim self-harm cases was in the age group from 10 to 19 years (7 of 18; 38.9%), whereas most self-harm cases among Christians were in the age group from 20 to 29 years (57 of 110; 51.8%).

The most common symptoms registered in the 2 groups were nausea (30, 41%), weakness (17, 30%), stomach symptoms (19, 26%), salivation (17, 26%), headache (12, 16%), confusion (9, 21%), coughing (8, 17%), drowsiness (11, 14%), and blurred vision (8, 16%).

More poisoning cases were hospitalized in the urban setting where the treatment seemed to be more intensive and diverse compared with the rural setting (see Table 4). From the rural area, 17 of 101 (16.8%) were referred to a central hospital. The majority of patients recovered without sequelae, with the best results in the urban hospitals.

Discussion

The data from Kampala showed that pesticides were responsible for a majority of poisonings in the hospitals, which is consistent with studies from other low- and middle-income countries, where pesticides are easily available in retail shops and sold in the streets.^{3,17,18}

Men were more numerous both among self-harm and unintentional cases of poisoning. This might be due to men more often handling pesticides and therefore being more prone to occupational poisonings and, due to easy accessibility, also self-harm.^{10,19}

This higher proportion of male victims of self-harm has been found in another study of Ugandan self-harm cases linking the daily handling of pesticides with an increased rate of self-harm among men.¹¹

We found that most of the pesticide poisonings in the urban setting were due to self-harm, as shown in other studies where self-harm with pesticides outweighs accidents and/or occupational poisonings at least for those victims reaching the health care system for treatment.^{10,20,21} In contrast to this, most cases in the rural setting were due to accidental or occupational poisonings probably due to more people handling pesticides in the rural setting whereby chances for unintentional poisoning among the working population are bigger.

Table 2. Characteristics of acute pesticide poisoning cases registered in selected urban Kampala Hospital wards from January 2010 to December 2014 and rural cases registered in Wakiso and Pallisa district health centers from 2013 to 2016 (χ^2 test, Fischer exact test, and Student *t* test).

VARIABLE	URBAN CASES				RURAL CASES			
	ALL POISONINGS, NO. (%)	SELF-HARM, NO. (%)	UNINTENTIONAL, NO. (%)	P VALUE	ALL POISONINGS, NO. (%)	SELF-HARM, NO. (%)	UNINTENTIONAL, NO. (%)	P VALUE
Sex								
Male	132/210 (62.9)	76/133 (57.1)	56/77 (72.7)	.02	60/100 (60)	18/26 (69.2)	42/74 (56.8)	.26
Female	78/210 (37.1)	57/133 (42.9)	21/77 (37.3)		40/100 (40)	8/26 (30.8)	32/74 (43.2)	
Type of pesticide								
Organophosphorus or carbamate	175/210 (83.3)	106/133 (79.7)	69/77 (89.6)	.06	43/101 (42.6)	15/26 (57.7)	28/75 (37.3)	.20
Other pesticides	8/210 (3.8)	5/133 (3.8)	3/77 (3.9)		14/101 (13.9)	1/26 (3.8)	13/75 (17.3)	
Rodenticide	26/210 (12.4)	22/133 (16.5)	4/77 (5.2)		4/101 (4.0)	1/26 (3.8)	3/75 (4)	
Unknown	1/210 (0.5)	0/133 (0)	1/77 (1.3)		40/101 (39.6)	9/26 (34.6)	31/75 (41.3)	
Age classes, y								
0-9	17/203 (8.4)	1/129 (0.8)	16/74 (21.6)	<.01	17/97 (17.5)	0/25 (0)	17/72 (23.6)	.03
10-19	36/203 (17.7)	27/129 (20.9)	9/74 (12.2)		10/97 (10.3)	5/25 (20)	5/72 (6.9)	
20-29	88/203 (43.4)	63/129 (48.8)	25/74 (33.8)		32/97 (33.0)	9/25 (36)	23/72 (31.9)	
>29	62/203 (30.5)	38/129 (29.5)	24/74 (32.4)		38/97 (39.2)	11/25 (44)	27/72 (37.5)	
Mean age								
Male	26.46 (12.54) <.05	28.49 (11.22) <.01	23.81 (13.87) .43	.04*	27.83 (14.96) .51	31.82 (14.11) .85	26.17 (15.16) .52	.19*
Female	22.97 (11.36)	23.82 (7.89)	20.71 (17.84)	.29**	25.54 (18.83)	33.13 (18.8)	23.58 (18.64)	.21**
Mean age, cases >9y								
Male	28.71 (10.61) .01	28.79 (10.98) <.01	28.84 (10.05) .76	.98*	31.98 (11.53) .85	31.82(14.11) .85	32.06 (10.19) .93	.95*
Female	24.63 (10.19)	23.82 (7.89)	27.73 (16.39)	.19**	32.57 (15.59)	33.13 (18.80)	32.36 (14.76)	.91**

*P value male: self-harm versus unintentional; **P value female: self-harm versus unintentional.

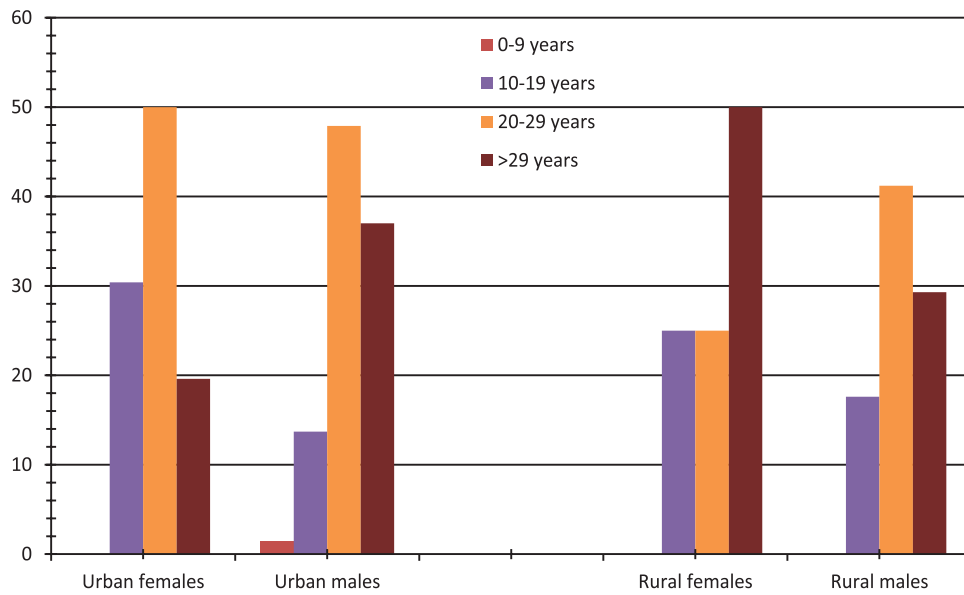


Figure 1. Distribution in age classes of self-harm cases among urban and rural men and women (%).

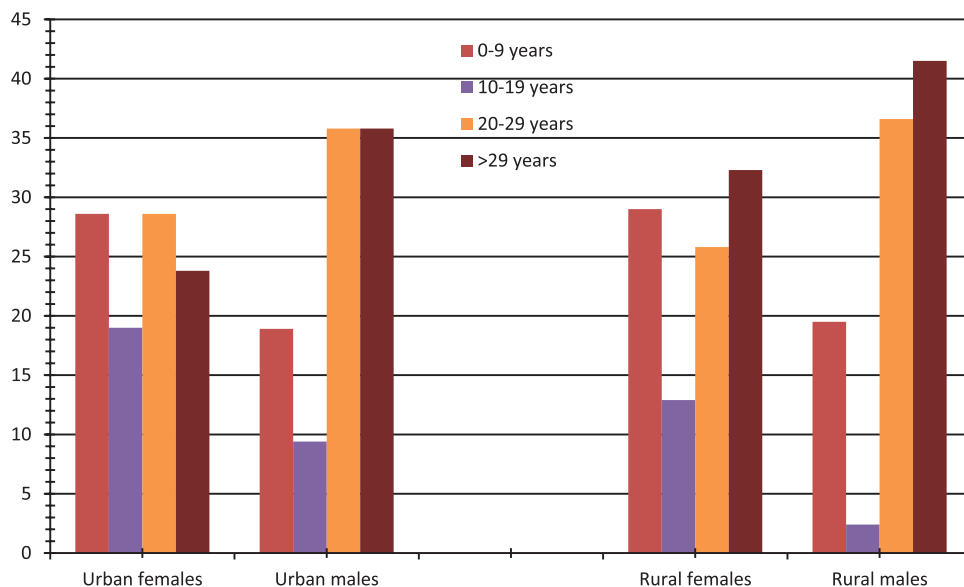


Figure 2. Distribution in age classes of unintentional cases among urban and rural men and women (%).

The higher mean age seen among self-harm cases was due to the youngest age group dragging the mean age of unintentional poisonings down, as the age group up to 10 almost only contains unintentional poisonings. When we exclude the unintentional cases among children, the mean age among cases of self-harm compared with unintentional poisonings is lower as most often found in other studies.^{10,22,23}

Female cases were younger in both the urban and rural data, but the difference was only significant for female urban cases of self-harm, whereas female rural cases of self-harm were slightly older than men. Most other studies found female self-harm cases being younger than men.^{17,24-26}

In our urban material, we had 4 self-harm cases between 6 and 12 years of age, whereas no cases were younger than 16 in the rural data. These differences between urban and rural

settings probably reflect the harsh life in the big urban cities. Suicide is one of the leading causes of death among adolescents and children where poverty, poor family cohesion, divorce, violence, sexual abuse, and loss of emotionally important people through death are all associated with suicidal behavior.²⁷

More Christians than Muslims were poisoned, which coincides with the religious demography of Uganda with 84% Christians and 14% Muslims according to the national census from 2014.

In the Muslim group, the cases were younger, and women were overrepresented compared with the Christian group. The data show a proportionally higher number of unintentional poisonings than self-harm among Muslims compared with Christians. This might be due to self-harm being a sin in many religions, whereby both the family and the victim might try to

Table 3. Characteristics of Christian and Muslim acute pesticide poisoning cases registered in Kampala Hospital wards from January 2010 to December 2014 (χ^2 test).

	CHRISTIAN (N=171, 81.4%)	MUSLIM (N=39, 18.6%)	P VALUE
Age	25.3 (SD=10.78)	23.3 (SD=15.55)	.33
Sex			
Male	113/171 (66.1%)	18/39 (46.2%)	.02
Female	58/171 (33.9%)	21/39 (53.8%)	
Age classes, y			
0-9	11/165 (6.7%)	6/39 (15.4%)	0.08
10-19	25/165 (15.2%)	12/39 (30.8%)	
20-29	80/165 (48.5%)	9/39 (23.1%)	
30-	49/165 (29.7%)	12/39 (30.8%)	
Poisoning cause			
Intentional	114/169 (67.5%)	18/39 (46.2%)	.013
Unintentional	55/169 (32.5%)	21/39 (53.8%)	

Table 4. Treatment of acute pesticide poisoning cases registered in selected urban Kampala Hospital wards from January 2010 to December 2014 and rural cases registered in Wakiso and Pallisa district health centers from 2013 to 2016.

TREATMENT	URBAN HOSPITALS, NO. (%)	RURAL HEALTH CLINICS, NO. (%)
Hospitalized	187/212 (88.2)	47/101 (47.5)
Atropine	35/212 (16.5)	23/101 (22.8)
Diazepam	58/212 (27.4)	7/101 (6.9)
Buscopan	15/212 (7.1)	0/101 (0)
Gastric lavage and/or charcoal	80/212 (37.7)	15/101 (14.9)
Recovered fully	183/191 (95.8)	67/101 (83.8)
Recovered with sequelae	8/191 (4.2)	10/101 (12.5)
Died	0/191 (0)	3/101 (3.8)
Unknown	0/191 (0)	21/101 (20.8)

obscure the reason for the poisoning to avoid the shame. Such a religious influence on numbers and causes of self-harm has been discussed in other studies as well.^{17,28}

The proportion of adolescent women doing self-harm in the Muslim group was significantly higher than in the Christian group. This might be due to a stricter control with women among Muslims, whereby suicide becomes an attractive solution to avoid the shame or unhappiness by, eg, unwanted pregnancies, sexual abuse, or arranged marriage.²⁸

Organophosphates were found to be the most frequent class of pesticides responsible for poisonings followed by rat poison and other pesticides, reflecting the ease to acquire the poisons. The list of pesticides approved for import by the Ugandan Ministry of Agriculture contains a range of pesticides from WHO classes Ib to U,²⁹ and although the most toxic pesticides should only be accessible for licensed agro-dealers and farmers, we saw street availability of the class Ib pesticide in 100 mL containers at a cost of \$1 to \$2. As effective regulatory mechanisms seem to be lacking, it should be considered to ban the pesticides most often involved in poisonings, as this has proven effective in several countries.^{26,30-32}

There were a number of cases due to unknown pesticides in the rural setting compared with the urban setting where almost all pesticides were classified. We must, however, take this with caution as there seems to be a tendency for urban doctors to register pesticide poisonings as caused by organophosphates per se, probably because they do not know the name of other pesticides (C. Ssemugabo, personal communication, 2016).

The symptoms presented by the victims of pesticide poisoning, ie, nausea, muscle weakness, and salivation, were found to be in accordance with organophosphates being the most frequent pesticide class responsible for most of the poisonings, as also seen from other studies.^{9,12,33,34}

The high proportion of these acute toxic pesticides responsible for the majority of poisonings leaves the victims in a great need of competent initial care.^{34,35} However, according to clinicians, they seldom get to know the product name or toxicity class of the ingested substances, thus making correct management difficult.

The fact that the treatment of cases seemed to be more intensive in the urban hospitals compared with the rural hospitals is likely to be seen in most low-income countries, where resources are scarce in the rural settings. However, relevant life-saving treatment, such as administering atropine, was equal between the 2 settings, although it was only a minority of organophosphate poisonings that actually received a correct treatment with atropine.

The major difference between the urban and rural settings was in the treatment of possible complications due to pesticide poisoning, such as seizures and gastric cramps. This might be a question of availability of these relatively specific drugs. Gastric lavage and/or use of activated charcoal were used twice as often in the urban setting compared with the rural, which might be due to these procedures requiring a higher capacity of staff and availability of equipment. However, the procedures have no proven effect and might even harm victims of intentional poisoning.^{36,37}

No victims died in the urban setting, whereas 3 victims died in the rural setting that also included more patients with sequelae. These differences could be a result of more intensive care in the urban setting and higher capacity through better educated staff and higher quality of equipment. It could also be due to

longer transport to a treatment facility in the rural settings making a quick treatment of the poisoning less likely and thus sequelae more likely.

As for reasons of self-harm, quarrels with partners, domestic violence, unwanted pregnancies, and doomed love were given when asking health care workers in Pallisa district. This coincides with other studies from low- to middle-income countries, including one from Uganda, where also alcohol seemed to be involved.^{11,17,38}

In Uganda, a point has to be made regarding the role of human immunodeficiency virus (HIV) infection and the victim's ideation of self-harm, as Ugandan studies showed an increase in risk of self-harm among patients with HIV.^{39,40} Uganda has approximately a 7% prevalence of HIV, and it has been shown to disproportionately affect young women.⁴¹

Pesticide poisonings due to abortion attempts could explain part of the relatively high prevalence among the adolescent women, as has been seen in other studies.⁴² However, our study did not register whether the victim was pregnant.

Strengths and limitations

This study adds to the scarce knowledge on pesticide poisonings from Uganda.

The different methods and time frames for collection of data in the urban versus the rural settings are a weakness as the data could not be compiled and analyzed together. A cohort study is needed to get better data and thereby knowledge on poisonings, including incidence rates.

The nature of hospital reporting being biased toward the affluent patients and less severe cases is another weakness. This is due to patients in Uganda having to reach health facilities by own means and to pay for treatment and drugs. The less severe cases are not likely to reach health care settings for treatment, eg, farmers suffering from an occupational poisoning know that it will pass within some hours and they will not waste time or money to go for treatment. This makes occupational poisonings underrepresented in health care statistics.

The same goes for the severe, suicidal cases dying before reaching a health care setting for treatment and registering, and suicides with poisons are subject to misclassification more often than other suicidal methods.^{43–45}

Future research should include police and morgue data or making ecological analyses of intentional self-poisoning as seen in studies from Sri Lanka.^{7,46}

Conclusions

Pesticides are most frequently involved in poisonings in the Ugandan health care settings included in this survey. Men are more often poisoned than women. Self-harm was more frequent in the urban than in the rural setting where unintentional poisonings were more common. Self-harm was more frequent among young women and Muslims in the urban setting, compared with the rural setting where women were older

than men. Treatment of cases was more intensive in the urban data where fewer complications were registered.

To prevent poisonings, access to the most toxic pesticides should be restricted. Easier access to well-supplied health facilities with educated staff would decrease sequelae after poisonings.

Acknowledgements

Thanks go to the participants in interviews and the workers and volunteers at Ugandan National Association of Community and Occupational Health (UNACOH) for making data collection possible. And thanks to Dialogos for facilitating contacts and supervision.

Author Contributions

CS, BP, and EJ conceived and designed the study. EJ and BP analyzed the data. BP wrote the first draft of the manuscript. BP and EJ contributed to the writing of the manuscript. BP, CS, VN, and EJ agree with manuscript results and conclusions. BP and EJ jointly developed the structure and arguments for the paper. All authors reviewed and approved the final manuscript.

Disclosures and Ethics

As a requirement of publication author(s) have provided to the publisher signed confirmation of compliance with legal and ethical obligations including, but not limited to, the following: authorship and contribution, conflicts of interest, privacy and confidentiality, and (where applicable) protection of human and animal research subjects. The authors have read and confirmed their agreement with the ICMJE authorship and conflict of interest criteria. The authors have also confirmed that this article is unique and not under consideration or published in any other publication, and that they have permission from rights holders to reproduce any copyrighted material. Any disclosures are made in this section. The external blind peer reviewers report no conflicts of interest.

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