Prevalence, Circumstances, and Management of Acute Pesticide Poisoning in Hospitals in Kampala City, Uganda

Environmental Health Insights
Volume 11: 1–8

DOI: 10.1177/1178630217728924

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ABSTRACT: This study was aimed at assessing prevalence, circumstance, and management of acute pesticide poisoning in hospitals in Kampala. It was a retrospective cross-sectional study that involved reviewing of 739 poisoning patient records from 5 hospitals in Kampala. Of the 739 patients, 212 were due to pesticide poisoning resulting in a prevalence of 28.8%. About 91.4% (191/210) of the cases were due to organophosphate poisoning, 63.3% (133/210) were intentional, and 98.1% (206/210) were exposed through ingestion. Diagnosis was majorly based on poisoning history 91.2% (187/205), and clinical features such as airways, breathing, and circulation examination 48.0% (95/198); nausea and vomiting 42.9% (91/212); muscle weakness 29.7% (63/212); excessive salivation 23.1% (49/212); and confusion 20.3% (43/212). More than half of the patients admitted were treated using atropine 52.3% (113/212). The prevalence of acute pesticide poisoning was high with most managed based on physical and clinical examination.

KEYWORDS: Prevalence, pesticide, management, diagnosis, treatment, public and private

RECEIVED: June 6, 2017. **ACCEPTED:** July 31, 2017.

PEER REVIEW: Four peer reviewers contributed to the peer review report. Reviewers' reports totaled 1883 words, excluding any confidential comments to the academic editor.

TYPE: Original Research

FUNDING: The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was conducted as part of the Danida-funded project on "Pesticides Use, Health and Environment" implemented by UNACOH in Uganda.

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

Pesticides are defined as substances or group of chemicals used predominately in agriculture, forestry, horticulture, and on public lands to increase crop yields. There has been a steady increase in the amount of pesticides marketed for agricultural use worldwide.[1] Pesticide use in Africa makes up 4% of the global pesticide market only, with a rough estimate of 75 000 to 100 000 tons of pesticide active ingredient used in the continent compared with around 350 000 tons in Europe. This implies that because the volume of pesticide used in Africa is lower than elsewhere, the risks and impacts must be correspondingly low.[2] However, the increasing morbidity and mortality due to pesticide exposure and poisoning is a great concern especially with the inadequate notification to health authorities.[3]

Pesticide poisoning is a well-known public health problem in many developing countries. It is estimated by the World Health Organization (WHO) that approximately 18.2 per 100 000 agricultural workers have occupational-related pesticide poisonings worldwide.[4] In addition, more than 168,000 persons die from pesticide self-poisoning every year, with most of them in developing countries.[5] It is also estimated that more than 4.8 million years of healthy lives are lost to unintentional poisoning, a significant proportion of which is due to pesticides.[6]

Uganda's economy is largely dependent on agriculture, and approximately 85% of the population that lives in the cultivatable areas depends on farming and other related activities.[7] Most of the pesticides used for agriculture belong to the WHO class II classification which is moderately hazardous.[8] Pesticides are responsible for a case fatality rate of 1.4 (per 100 000) in Uganda with 64.5% of the poisoning cases as a result of deliberate self-poisoning.[9] Pesticide poisoning also results in skin irritation, headache, extreme tiredness, blurred vision, and dizziness.[7,10] These cases of poisoning are as a result of practicing smoking and drinking during spraying, blowing, and sucking the nozzle of the knapsack sprayer and rarely practicing protective and safety measures.[7,11] The major routes of the pesticide into the human body include respiratory tract, gastrointestinal tract, skin, and eyes.[12]

Most of the pesticide poisoning cases occur in the community, that is, farms, homes, or factories. A study conducted in Tanzania showed that most of the cases go unreported; however, where the victims report to the health facilities, the number of cases registered in hospitals was considerably higher than that in outpatient health care units.[12] In addition, very few health workers could identify the type of pesticide causing the poisoning. Similarly, in Uganda, most of the farmers who experience acute pesticide poisoning do not seek medical attention from the hospitals. Even where records exist, they are usually

hard to negotiate. In addition, medical management is difficult because there is little evidence with which to determine the best strategies for diagnosis and treatment. There are limited resources for treating pesticide-related poisoning in public and private hospitals. Success registered in treatment of pesticide poisoning is usually dependent on the knowledge of health workers on the different types of pesticides and how they are managed. Therefore, this study was conducted to assess the prevalence and management of acute pesticide poisoning cases in 5 public and private hospitals in Kampala.

Methods

Study design and settings

This was a cross-sectional retrospective study that involved reviewing and extraction of data from files of poisoning patients. The study was conducted in 5 hospitals in Kampala, Uganda. These include International Hospital Kampala, Mulago, Nsambya, Nakasero, and Mengo hospitals. Mulago, with a bed capacity of 1790 patients, is the national referral hospital where patients are admitted from across the country especially who are severely poisoned. Nsambya and Mengo are teaching and those private not-for-profit hospitals with a bed capacity of 361 patients. International Hospital Kampala and Nakasero hospitals with a bed capacity of 200 and 80 patients, respectively, are private for-profit hospitals. These hospitals are the largest within the city and were selected because they receive a large volume of pesticide poisoning patients, have qualified health workers to manage cases and refer cases to Division of Government Analytical Laboratory (DGAL) for testing and confirmation of diagnosis. Kampala is the capital city of Uganda with a population of about 1,516,210 of the country's 34.8 million people.[13]

Data collection

Data were collected in January 2016 for the period of January 1, 2010 to December 31, 2014 from the medicine, pediatrics, and intensive care unit (ICU) wards of the 5 hospitals. A hospital record review tool developed by the researchers based on reviewed literature on prevalence, circumstance and management of pesticide poisoning was used for data collection.[14–16] The tool was pretested using 20 pesticide poisoning patients' files from a public hospital. Research assistants were also trained on how to extract data from patient records. The first section of the data collection tool was used to collect data on socio-demographic characteristics such as age, sex, residence, occupation, reasons for poisoning, the route of intoxication, amount ingested, type of poisoning chemical, type of pesticide poisoning agent, and the outcome of the poisoning. These data were used to determine the prevalence of pesticide poisoning among the total number of persons poisoned. The second section was used to collect data on type of diagnosis performed, type of treatment given to the patients including medicines and other forms of care, and outcome of treatment. These data were used to assess diagnosis and treatment of pesticide poisoning cases. Research assistants were given access to admission records of the internal medicine, pediatrics, and ICU wards where most of the poisoning cases are handled. All patient file numbers with a poisoning-related diagnosis from 2010 to 2014 were recorded. The file numbers were used to identify the patient files for review.

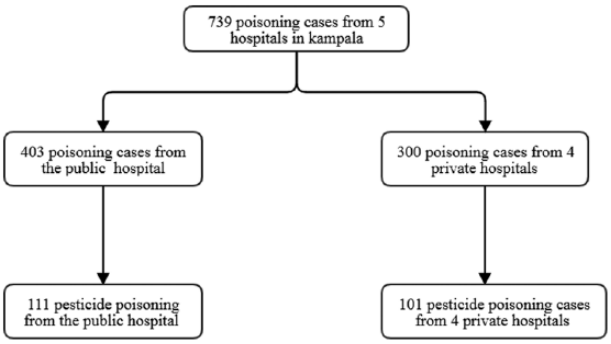

Figure 1. Flow diagram showing number of poisoning cases from different hospitals.

Statistical methods

Data were entered in EpiData 3.02 (EpiData Association, Odense, Denmark), edited, and imported into Stata 12.0 (StataCorp, College Station, TX, USA) for analysis. Analysis was conducted at univariate, bivariate, and multivariate levels. At univariate, descriptive statistics were used to calculate prevalence and magnitude of pesticide poisoning, 5-year trend of poisoning, types of pesticides patients were exposed to, diagnosis conducted including physical and clinical examinations, and treatment given to patients as well as outcomes of poisoning. Crude and adjusted logistic regressions were conducted to obtain odds ratios (ORs) and 95% confidence intervals (CIs) to examine the association between sex and age with intentional poisoning. Sex and age were all included in the multivariable logistic model.

Ethical considerations

Ethical approval to conduct the study was obtained from the Makerere University School of Public Health Higher Degrees, Research and Ethics Committee (HDREC) protocol 322 and registered with the Uganda National Council of Science and Technology registration number 3947. Permission was sought from the hospital directors and approved by their institutional review boards to access and review their records.

Results

A total of 739 poisoning cases were identified from the 5 hospitals in Kampala, 111 and 101 pesticide poisoning cases were retrieved from 1 public hospital and 4 private hospitals, respectively, as shown in Figure 1.

Prevalence and characteristics

Of the 739 cases, 212 were due to pesticide poisoning resulting in a prevalence of 28.8%. About 91.4% (194/210) of the pesticide

Table 1. Socio-demographics and characteristics of pesticide poisoning patients.

CHARACTERISTICS	CATEGORIES	FREQUENCY, N=212	PERCENTAGE
Poisoning agent (n=735)	Pesticide	212	28.8
	Drugs	64	8.7
	Medicine	31	4.2
	Alcohol	49	6.7
	Solvents	40	5.4
	Chemicals	147	20.0
	Plants	2	0.3
	Biological toxins	21	2.9
	Food poisoning	104	14.2
	Others (snakes, paraffin)	65	8.8
Sex	Male	133	62.7
	Female	79	37.3
Age	Mean (±SD)	25.1 (±12.2)	
Age groups, y (n=206)	0-12	20	9.7
	13-19	34	16.5
	20-30	100	48.5
	Above 30	52	25.2
Occupation (n=174)	Salaried workers	20	11.5
	Farmer	10	5.7
	Commercial motorcycle rider	5	2.9
	Unemployed	37	21.3
	Casual laborer	102	58.6
Pesticide poisoning agent (n=210)	Organophosphates	192	91.4
	Organochlorines	3	1.4
	Carbamates	15	7.2
Circumstances of poisoning (n=210)	Intentional	133	63.3
	Unintentional	77	36.7
Routes for poisoning (n=210)	Ingestion	206	98.1
	Inhalation	4	1.9

poisonings were caused by organophosphates which were mostly ingested 98.1% (206/210) and attributed to self-harm 63.3% (133/210). Most of the patients were men 62.7% (133/212) and engaged in casual labor 58.6% (102/174). The average age of patients was 25.1 years and SD was 12.2 years (Table 1).

Trends of pesticide poisoning

The distribution of pesticide poisoning cases over the 5-year period is shown in Figure 2.

Association between sex, age, and circumstances of pesticide poisoning

There was no association between sex and circumstances of pesticide poisoning. Compared with children of 12 years and below, persons above 13 years were significantly more likely to have self-implicated pesticide poisoning in the following categories: 13- to 19-year olds (adjusted OR: 9.50; 95% CI: 2.46-36.68), 20- to 30-year olds (adjusted OR: 10.65; 95% CI: 3.23-35.18), and above 30 years (adjusted OR: 6.40; 95% CI: 1.84-22.21) (Table 2).

Diagnosis and treatment

Although almost all the patients had their history of exposure taken 91.2% (187/2015), laboratory examination was conducted in only 8.4% (17/202) of the patients. Most of the patient's blood pressure 94.1% (192/204) was taken. The mean body temperature and heart rate were 36.7°C and 83.2 beats per minute, respectively. Almost all patients' abdomen were soft 96.5% (194/201) and not painful 86.4% (171/198) with a clear chest 87.7% (178/203). More than half of the patients had their central nervous system conscious 52.9% (111/210) with their breathing and circulation 52.0% (103/198) examined. Almost half 48.0% (95/198) of the patients had their airways, breathing, and circulation checked (Table 3).

The signs and symptoms that pesticide poisoning patients presented with are shown in Figure 3. Almost all the patients were admitted 97.9% (187/191) and treated with atropine 52.3% (113/212) and activated charcoal 32.8% (71/212) (Table 4). Averagely, patients received multiple doses of 4.0 mg of atropine at intervals of 1.3 hours, diazepam 41.2 mg, hydrocortisone 84.5 mg at intervals of 12 hours each, and activated charcoal 23.6 mg at intervals of 10.7 hours (Table 5).

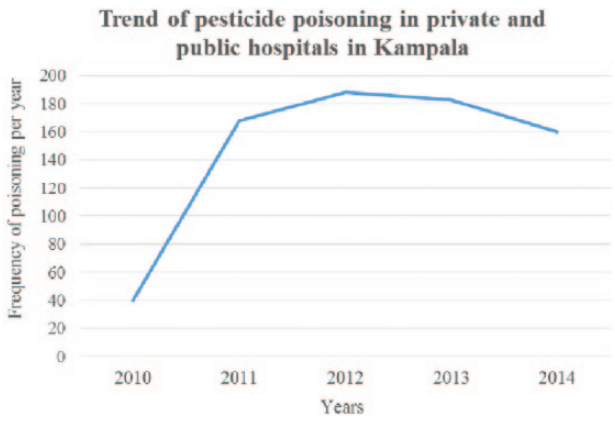

Figure 2. Number of poisoning cases per year.

Other treatments given were intravenous fluids 71.2% (151/212), gastric lavage 36.8% (78/212), and normal saline 25.9% (55/212) among others. Most of the patients were monitored for vital signs 82.7% (172/208), recommended to have a bed rest 66.0% (134/203), and had a psychiatric review 62.1% (126/203). However, almost all the patients 88.8% (183/206) did not receive patient education and their home or workplaces were not surveyed for continued exposure 99.0% (206/208). Most of the admitted patients recovered 95.8% (183/191) (Table 4).

Discussion

This study assessed the prevalence, circumstance, and management of acute pesticide poisoning in public and private hospitals. Our study revealed that the prevalence of pesticide poisoning is high among poisoning patients registered at public and private hospitals in Kampala with most of the cases attributed to self-harm. Given the small number of farmers in the study sample, this result might be attributed to easy access to lethal pesticides by individuals due to economic and social challenges, misuse of alcohol, misunderstanding in marriages, and domestic, physical, sexual, or psychosocial abuse. This finding corroborates with findings from studies conducted in India and Sri Lanka and from a systematic review.[16–19] Our study findings also show a dramatic increase in the number of pesticide poisoning from 2010 to 2011 compared with that happened from 2011 to 2014. This could be attributed to the general increase in the use of pesticide in agriculture, hence making them more available in the market. Most of the pesticide poisonings were due to organophosphates. This is understandable as organophosphate compounds are the most acute toxic pesticides that are readily available at a cheap rate on the market. Other researchers who have studied organophosphates

Table 2. Crude and adjusted odds ratios comparing circumstances of pesticide poisoning with age and sex.

CHARACTERISTICS	INTENTIONAL NO. (%)	UNINTENTIONAL NO. (%)	CRUDE OR (95% CI)	*P* VALUE	ADJUSTED OR (95% CI)	*P* VALUE
Sex						
Female	57 (42.9)	21 (27.3)	1		1	
Male	76 (57.1)	56 (72.7)	**2 (1.90-3.67)**	**.025**	1.93 (0.99-3.74)	.052
Age groups, y						
0-12	4 (3.1)	16 (21.6)	1		1	
13-19	24 (18.5)	9 (12.2)	**10.7 (2.80-40.61)**	**.001**	**9.50 (2.46-36.68)**	**.001**
20-30	71 (54.6)	28 (37.8)	**10.1 (3.12-32.99)**	**≤.001**	**10.65 (3.23-35.18)**	**≤.001**
Above 30	31 (23.9)	21 (28.4)	**5.9 (1.73-20.15)**	**.005**	**6.40 (1.84-22.21)**	**.003**

Abbreviations: CI, confidence interval; OR, odds ratio.
Results in bold represent sex and age groups that are statistically significant with circumstances of pesticide poisoning.

Table 3. Clinical features assessed among patients.

VARIABLE	CATEGORIES	FREQUENCY	PERCENTAGE
Oral examination (n=209)	Yes	19	9.1
	No	190	91.9
Blood pressure taken (n=204)	Yes	192	94.1
	No	12	5.9
Body temperature, °C (n=73)	Mean (±SD)	36.7 (±1.1)	
Heart rate, bpm (n=188)	Mean (±SD)	83.2 (±19.4)	
Abdomen (n=201)	Soft	194	96.5
	Hard	7	3.5
Abdomen painful (n=198)	Yes	27	13.6
	No	171	86.4
Respiratory system (n=203)	Chest clear	178	87.7
	Chest undrowning	16	7.9
	Respiratory distress	9	4.4
CNS examined (n=210)	Conscious	116	55.2
	Unconscious	94	44.8
History of exposure taken (n=205)	Yes	187	91.2
	No	18	8.8
Airways, breathing, and circulation checked (n=198)	Yes	95	48.0
	No	103	52.0
Laboratory examination conducted (n=202)	Yes	17	8.4
	No	185	91.6

Abbreviations: bpm, beats per minute; CNS, central nervous system.

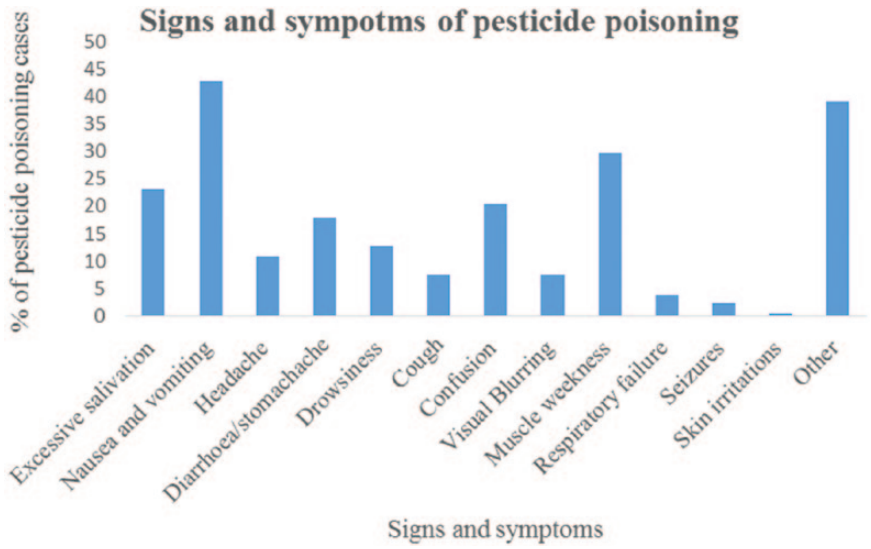

Figure 3. Signs and symptoms.

Table 4. Treatment.

VARIABLE	CATEGORIES	FREQUENCY	PERCENTAGE
Patients admitted (n = 191)	Yes	187	97.9
	No	4	2.1
Types of antidotes given (n = 212)	Atropine	113	52.3
	Diazepam	16	7.4
	Hydrocortisone	11	5.1
	Activated charcoal	71	32.8
	Sucrose polyester	4	1.9
	Alkaline diuresis	1	0.5
Other treatment (n = 212)	Intravenous fluids	151	71.2
	Normal saline	55	25.9
	Gastric lavage	78	36.8
	Respiratory resuscitation	14	6.6
	Panadol	1	0.5
	Paracetamol	6	2.8
	Others	35	16.5
Outcome of treatment (n = 191)	Recovery	183	95.8
	Recovery with a complication	8	4.2
Patients monitored for vital signs (n = 208)	Yes	172	82.7
	No	36	17.3
Bed rest recommended (n = 203)	Yes	134	66.0
	No	69	34.0
Psychiatric review performed (n = 203)	Yes	126	62.1
	No	77	37.9
Patient education (n = 206)	Yes	23	11.2
	No	183	88.8
Home or work surveillance for exposure (n = 208)	Yes	2	1.0
	No	206	99.0

Table 5. Amounts and time intervals of giving antidotes.

ANTIDOTES GIVEN	QUANTITY, MG MEAN (±SD)	INTERVAL OF ADMINISTRATION, H MEAN (±SD)
Atropine	4.0 (±18.8)	1.3 (±2.8)
Diazepam	41.2 (±122.4)	0
Hydrocortisone	84.5 (±51.4)	12
Activated charcoal	23.6 (±44.3)	10.7 (±6)
Sucrose polyester	75 (±50)	0
Alkaline diuresis	200	0

have also showed that it is a great cause of poisoning among other pesticides.[17,20–23]

In this study, the most affected age group was between 21 and 30 years, which is similar to other studies conducted in India.[17,23] This shows that this age group has more chances of having poisoning casualty because of their very aggressive and social nature and the mental and economical stress in their life. Our study discovered that hospitals follow the ABC protocol where they assess whether the airway is not blocked, breathing is normal, and circulation is good. Other parameters used in the diagnosis of pesticide poisoning include patient history, symptoms, oral examination, blood pressure, body temperature, and hardness or softness of abdomen. The ABC protocol and other measurements have been shown in other studies as procedures followed in immediate management of pesticide poisoning.[22,24] The use of such parameters in management of pesticide poisoning is understandable as they are also used in diagnosis of other cases of poisoning. However, the clinical features were not examined in all patients, yet they are part of the routine examination of poisoning victims. This implies that routine examination was partially performed in some patients. Therefore, there is need for appropriate training of staff in diagnosis and treatment of pesticide poisoning to improve patient outcomes.

Clinically, a number of signs or symptoms, such as nausea and vomiting, excessive salivation, diarrhea, muscle weakness, reduced consciousness, and drowsiness, among others, were used to diagnose pesticide poisoning. These findings corroborate with those in a review conducted in studies on management of acute organophosphorus pesticide poisoning.[20,25] Diagnosis of pesticide poisoning is confirmed with the signs and symptoms the victim presents with or by a laboratory examination.[26] In our study, diagnosis was majorly based on signs and symptoms and patient history. In addition, very few patients were subjected to laboratory examination. This shows that diagnosis based on clinical features and patient history are the most suitable for health workers to diagnose and treat cases of pesticide poisoning especially in low-income settings.[12] In addition, as highlighted in an article from *The Lancet* by Eddleston et al,[20] laboratory assessment results are rarely available on time to effect clinical decision making and a luxury in developing countries.

Almost all the cases of pesticide poisoning in our study were admitted. Among those admitted, most were treated using atropine and activated charcoal. This may be due to the fact that they are the most readily available antidotes in all hospitals. In addition, atropine has also been shown in other studies as one of the most important antidote for treating/managing organophosphate poisoning[20,21] which is the major cause of poisoning in our study. In addition, our study showed that patients received a relatively bigger dose at a larger interval compared with that highlighted a systematic review on management of pesticide poisoning.[27] This suggests that there was misuse of atropine. Our study also showed the use of hydrocortisones in management of pesticide poisoning, that is, organophosphates and carbamates that are responsible for poisoning in this study. As revealed by Eddleston et al,[22] there was no need of using hydrocortisone and activated charcoal after treatment with atropine. Most of the patients were also reviewed for psychiatric disorders especially those due to intentional poisoning. This is very important as a study conducted on psychiatric comorbidity and attempted suicide using paraquat poisoning showed that psychiatric disorders were associated with high risk of mortality.[28]

There is need to conduct a prospective study to accurately identify the total number of cases and deaths due to pesticide poisoning in Kampala. In addition, a detailed regional hospital-based epidemiologic study on prevalence and management of pesticide poisoning will be very helpful in understanding the problem and designing appropriate intervention measures.

Study limitations

This study should be interpreted in light of the following limitations. Very few patients in our study were subjected to a laboratory test to confirm occurrence and pesticide responsible for the poisoning. This raises concerns on the prevalence and treatment of pesticide poisoning presented in this study. Also, the study relied on secondary data which could have introduced measurement and selection biases which may lead to under or overestimation of pesticide poisoning. In addition, there was a lot of missing data in hospital records.

Conclusions

The prevalence of pesticide poisoning among all poisoned patients admitted to public and private hospitals in Kampala from 2010 to 2014 was high with most of the cases due to self-harm. Most of the hospitals did not have diagnosis and treatment protocols and thus based on physical examination and identified signs and symptoms to diagnose and treat cases. Atropine was the major antidote used in treatment of patients with most of them recovering without any disabilities. There is a need for different stakeholders to develop guidelines for management of pesticide poisoning and ensure provision of the necessary antidotes at health facilities.

Acknowledgements

The authors thank the executive directors of the hospitals that participated in this study for granting us permission to access the patient files and the records officers of the different hospitals for their guidance and cooperation in identifying the records. They also want to thank the research assistants for reviewing all patient files diligently. Finally, they specially thank the Pesticide Use, Health and Environment project team at Uganda National Association of Community and Occupational Health (UNACOH) for their support and coordinator of grant activities.

Author Contributions

CS, AAH, RMN, MMK, DS, and EJ conceived and designed the study. CS analyzed the data and wrote the first draft of the manuscript. CS, AAH, RMN, VN, MMK, DS, and EJ agreed with manuscript results and conclusions. CS 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 contributorship, 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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