

RESEARCH ARTICLE

Risk Factors for Acute Pesticide Poisoning in Developing Countries: A Systematic Review

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ABSTRACT

Acute pesticide poisoning (APP) is a major public health issue in developing countries. While much country-specific research has been conducted on APP, international epidemiological trends have been difficult to describe. In this systematic review, we summarize individual-level findings from multiple countries. Prominent risk factors identified for both voluntary and involuntary cases include young age, lack of farming experience, low socioeconomic status, lack of education, risky pesticide handling and storage practices, insufficient knowledge of pesticide hazards, and high organophosphate use. In combination with region-specific findings available in the literature, this review contributes to the global understanding of APP as needed for corresponding policy action.

INTRODUCTION

Acute pesticide poisoning (APP), defined by the World Health Organization as “any illness or health effect resulting from suspected or confirmed exposure to a pesticide within 48 hours”, accounts for significant morbidity and mortality worldwide [1]. It can result from either involuntary (e.g., accidental or occupational) pesticide exposure or voluntary pesticide consumption for purposes of suicide and/or self-harm, with the latter becoming more common in recent years, leading to APP increasingly featuring in global health policy dialogue [1].

While vast cross-country variations exist, studies from developing countries have reported APP incidence rates of as high as 180 per 10,000 [2], a trend attributed to a myriad of individual and societal factors. While research on individual-level APP risk factors has been conducted, few researchers have taken the step of compiling multi-

country data to identify cross-cutting trends, an understanding of which is central to the development of a robust international public health response. This systematic review aims to rectify this gap through a geographically broad analysis of the available literature on the risk factors for APP amongst agricultural workers and their families, those most commonly exposed to pesticides, in developing countries, as classified in the United Nations’ most recent 2019 World Economic Situation and Prospects report [3].

METHODOLOGY

To identify studies for inclusion in this review, systematic searches were conducted in three databases: Web of Science (BIOSIS Previews), GeoBase (Engineering Village), and OVID (Embase, Medline, and PsycINFO). Specific search strategies comprising keywords and, where necessary, corresponding subject headings were developed for each database. Articles were successively screened

by title, abstract, and full-text. Eligible articles: a) had a study population consisting of agricultural workers and/or their families, and b) reported either quantitative or qualitative associations between individual-level variables and incidence or prevalence of APP. The search identified 1628 potentially eligible articles. Of these, the full-text of 37 were reviewed, and 15 studies were included in this review (see Figure 1). Studies selected for inclusion were rated for risk of bias (ROB) using the Risk of Bias in Non-Randomized Studies (ROBINS-1) assessment tool. Data was extracted using a pre-constructed data collection chart, and findings pertaining to demographic and work-related risk factors were analyzed by way of comparison and synthesis of results across studies.

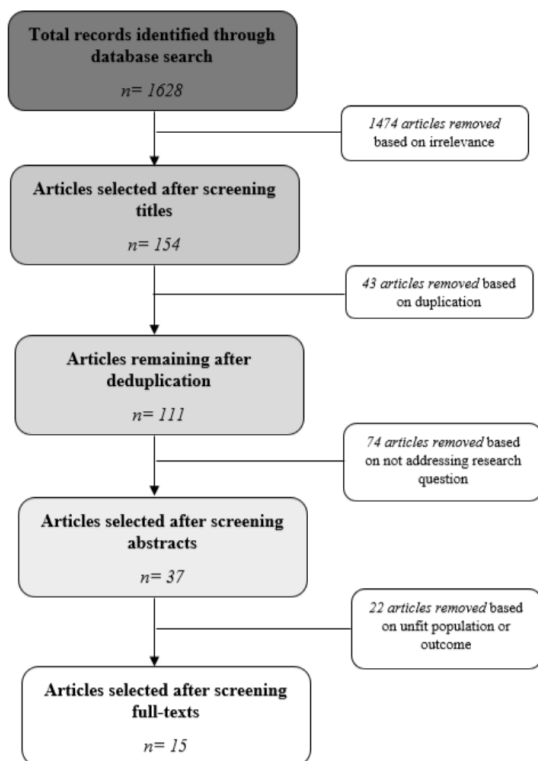


Figure 1. Article Screening Flowchart.

RESULTS

Of the 15 studies, eight [4-18] included only involuntary cases of APP, three [12-14] included only voluntary cases, and four [16-18] included both voluntary and involuntary cases. While most studies (n= 74,6-9,15,17) employed a cross-sectional study

design, two studies [13,16] were retrospective case series', three [10,11,14] were case-controls, one [12] included both a cross-sectional analysis and a retrospective case series, one [5] was a prospective cohort study, and one [18] was a prospective case series. The studies spanned a total of 13 different countries: Iran [4], India [5,12], Jamaica [6], Ethiopia [7], Malaysia [8,17], Uganda [9], Brazil [10], Morocco [4], Sri Lanka [14,16,17], Indonesia [11,17], Thailand [17], Nicaragua [15], and Nepal [18].

The ROBINS-1 ROB assessment tool identified one study [10] at low risk, three [4,5,18] at moderate risk, eight [6-9,11,14,15,17] at serious risk, and three [12,13,16] at critical risk of bias.

The distribution of studies reporting demographic and work-related risk factors is summarized in Table 1. Individuals below the age of 30 had an increased risk of APP in six of the eight studies that assessed its effect, suggesting that age is a potential risk factor. Additionally, low socioeconomic status (SES) was associated with APP in all four of the studies that assessed its impact. Other demographic variables such as sex, educational status, and farm size appear only weakly correlated with APP incidence.

With regards to work-related factors, the following characteristics increase risk of APP: lacking knowledge of pesticide hazards (e.g., due to lack of training or inability to read pesticide hazard labels), engaging in risky pesticide handling practices (e.g., not using personal protective equipment (PPE), using a leaking sprayer), storing pesticides at home or in a domestic facility, and using organophosphates extensively.

DISCUSSION

The findings of this review, summarized in Table 1, reveal a myriad of factors that have the potential to influence the vulnerability of agricultural workers to both voluntary and involuntary APP. Yet, most interesting are the ways in which the identified risk factors can be causally linked to APP through multiple plausible pathways. For example, young age may correspond to a lack of farming experience,

which could render one less adept to safe pesticide handling and storage practices and less aware of pesticide hazards. This notion is further supported by the protective effect of a high level of farming experience, as indicated in Table 1. Due to the relationship between age and impulsivity [19], young age could also increase the likelihood of acting upon thoughts of suicide in times of adversity. Most notably, low SES (defined by caste, income level, or unemployment in the reporting studies listed in Table 1) may hold relationships with other risk factors. Due to its association with lower levels of education and literacy, low SES may reduce one's capacity to read or understand pesticide hazard labels, particularly when highly technical terminology is used. Furthermore, the financial barriers associated with low SES would presumably reduce one's ability to access PPE and high-quality (i.e., leak-proof) spraying equipment. Financial pressures may also increase the daily hardships experienced by rural farmers, thus increasing their likelihood of ingesting pesticides for purposes of mental distress alleviation.

Table 1. Summary of Findings on Demographic and Work-Related Risk Factors for Acute Pesticide Poisoning from Reviewed Studies (n= 15).

	Risk Factors	# Studies Reporting that Factor Increases Risk	# Studies Reporting that Factor Decreases Risk	# Studies Reporting that Factor Has Negligible Effect	# Studies Not Assessing Effect of Factor
Demographic Characteristics	Being Below 30 Years of Age	6	1	1	7
	Being Male	5	4	0	6
	Having Low Education	5	0	3	7
	Having Low Socioeconomic Status	4	0	0	11
	Owning or Working on a Small as Opposed to Large Farm	2	1	0	12
Work-Related Factors	Lacking Knowledge of Pesticide Hazards	5	0	1	9
	Engaging in Risky Pesticide Handling Practices	7	0	2	6
	Storing Pesticides at Home or in a Domestic Facility	5	0	0	10
	Using Organophosphates	7	0	3	5
	Having a High Level of Farming Experience	0	3	0	12

Given the multifaceted role that poverty appears to play in shaping one's APP risk profile, new programs should primarily support poor and marginalized agricultural workers to overcome the constraints impeding them from upholding safe occupational practice standards, as well as those rendering them vulnerable to such things as suicidal ideation. Potential initiatives could include community agriculture programs involving the distribution of subsidized PPE, the provision of comprehensive pesticide application training and other social supports to financially vulnerable farmers, policies that promote greater clarity of hazard information on pesticide labels (e.g., policies that mandate its depiction in both textual and pictorial—universally comprehensible—formats), and efforts to standardize global regulations on pesticide use such that highly toxic compounds subject to bans in industrialized nations are similarly discontinued in developing countries [20-22].

Before drawing broader conclusions from these results, it is important to acknowledge their limitations given the methodological weaknesses (e.g., ill-defined APP diagnostic criteria, use of retrospective/cross-sectional data, subjectively measured exposure variables) and resulting high risk of bias of many of the included studies. Still, this review makes an important contribution to the existing literature on APP, and when combined with future, more robust research on the topic, this will help establish a powerful knowledge base for informing policy-level action.

CONCLUSION

Overall, the findings presented in this study provide a global view of APP and its interconnected social determinants, generating the conclusion that APP risk is deeply interconnected with one's unique social profile and economic standing. By compiling cross-country data from [13] different countries, the results exhibit extensive geographic scope, an important departure from country-specific studies. The identified risk factors, namely age, gender, education level, and work-related factors, can be used to inform the direction of future studies that strengthen the corresponding evidence base. Such

knowledge can, in turn, inform both national and international decision-making processes, with the aim of addressing the APP epidemic and its widespread global health implications.

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