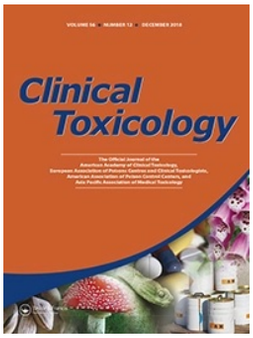

Clinical Toxicology

ISSN: 1556-3650 (Print) 1556-9519 (Online) Journal homepage: https://www.tandfonline.com/loi/ictx20

How many premature deaths from pesticide suicide have occurred since the agricultural Green Revolution?

Ayanthi Karunarathne, David Gunnell, Flemming Konradsen & Michael Eddleston

To cite this article: Ayanthi Karunarathne, David Gunnell, Flemming Konradsen & Michael Eddleston (2019): How many premature deaths from pesticide suicide have occurred since the agricultural Green Revolution?, Clinical Toxicology, DOI: 10.1080/15563650.2019.1662433

To link to this article: https://doi.org/10.1080/15563650.2019.1662433

Published online: 09 Sep 2019.

CLINICAL TOXICOLOGY
https://doi.org/10.1080/15563650.2019.1662433

Taylor & Francis
Taylor & Francis Group

REVIEW

How many premature deaths from pesticide suicide have occurred since the agricultural Green Revolution?

Ayanthi Karunarathne[a], David Gunnell[b], Flemming Konradsen[c] and Michael Eddleston[a]

[a]Centre for Pesticide Suicide Prevention, and Pharmacology, Toxicology & Therapeutics, University/BHF Centre for Cardiovascular Science University of Edinburgh, Edinburgh, UK; [b]Population Health Sciences, Bristol Medical School, University of Bristol, Bristol, UK; [c]Global Health Section, Department of Public Health, University of Copenhagen, Copenhagen, Denmark

ABSTRACT

Introduction: The agricultural Green Revolution in the 1950s and 60s is thought to have averted many deaths from famine. However, it also introduced highly hazardous pesticides such as parathion and endrin into poor rural communities that were totally unequipped to store or use them safely. Pesticide self-poisoning rapidly became one of the two most common global means of suicide. Thus far, no attempt has been made to enumerate the total number of deaths that have occurred subsequent to the Green Revolution.

Objective: To calculate plausible estimates for the total global number of pesticide suicides that have occurred since 1960.

Methods: We performed a literature review on Medline and Embase databases to July 2019 to find papers that reported national or global numbers of pesticide suicides. We restricted our search to papers published in English. We used the search terms: pesticide) OR insecticide) OR paraquat) OR organophosphate) OR organophosphorus) OR agrochemical) AND suicide) OR "") OR deliberate) AND poison in all fields. These searches identified 2,144 papers; a further 8 citations were added through the searching of reference lists and our own paper collections. 2,136 papers were excluded as they contained no data on pesticide suicide, or were case reports, case series, or related to specific socio-demographic groups, or were non-human studies. This left 16 papers giving country specific or global pesticide suicide data.

Long-term national trend in pesticide suicides: We found studies from one low- and middle-income country (Sri Lanka) that recorded long-term trends in suicide throughout the Green Revolution. These data showed a steady increase in suicides from 1960 to the early 1970s, with a more rapid increase from 1979 to 1984. The number of suicides plateaued until 1995, when they started a steady almost linear decrease that has continued at least until 2015. We used the Sri Lankan epidemiology as a model of the incidence of pesticide suicides in other low- and middle-income countries. Data from Bangladesh suggested that the decrease might have started in 2002.

Estimating global numbers since 1960: Starting from a conservative estimate of zero deaths in 1960, the best estimate of the total global burden of pesticide suicides from 1960 to 2018 is 14,272,105 or 14,936,000 (depending on whether a fall in incidence began in 1995 or 2002), with a plausible range of 9,859,667 to 17,303,333 deaths. These are likely underestimates because suicide is illegal in many countries, and most pesticide suicides occur in poor rural areas without effective death registration systems.

Conclusions: Pesticide self-poisoning has been a major clinical and public health problem in rural Asia for decades, while being long ignored. Most pesticide suicides are relatively impulsive with little planning: in the absence of highly hazardous pesticides, many people would have survived their suicidal impulse, gone on to find support amongst family, community, and health services, and lived a full life. Pesticide suicides must therefore be considered a category 4 occupation condition following Schilling's classification - if they had not been brought into rural communities for agricultural use, pesticide suicides would not have occurred. Preventing these deaths should be a global public health priority.

ARTICLE HISTORY

Received 6 May 2019
Revised 22 July 2019
Accepted 28 August 2019
Published online 7 September 2019

KEYWORDS

Pesticide poisoning; suicide; mortality; Green Revolution

Introduction

The Green Revolution in the 1950s and 60s introduced new farming techniques and high-yield varieties of crop plants, particularly wheat and rice, into low- and middle-income countries [1,2]. Yields increased markedly over the following decades, permitting food production to keep pace with population growth and reduce the risk of famine. However, the Green Revolution had downsides, with the new crop

CONTACT Michael Eddleston m.eddleston@ed.ac.uk Centre for Pesticide Suicide Prevention, and Pharmacology, Toxicology & Therapeutics, University/BHF Centre for Cardiovascular Science University of Edinburgh, QMRI E3.22a, 47 Little France Crescent, Edinburgh EH16 4TJ, UK

varieties being dependent on pesticides and fertilisers, producing harmful effects on human health and environment [1,3,4]. Subsequently, intensified agricultural pesticide use has resulted from a shift from subsistence farming to cash--crop and monocrop farming, a need to increase yield per area of land, a limited focus upon developing alternatives to pesticides use, and an overall increasing focus upon input dependent agriculture [5,6]. Alternative farming approaches without use of pesticides lack the heavy marketing and lobbying support provided by the agrochemical industry [7,8].

The introduction of highly hazardous pesticides [9] such as the organophosphorus (OP) and organochlorine insecticides parathion (E605) and endrin, respectively, [10–14] into poor rural households that were totally unequipped to use or store them safely had immediate repercussions, with deaths soon being reported from unintentional occupational poisoning and intentional (suicidal) self-poisoning [13,15–18]. Self-poisoning with non-pesticide products [19] was relatively safe before the arrival of highly hazardous pesticides. Unfortunately, the easy availability of these pesticides markedly increased the lethality associated with self-poisoning, changing non-fatal to fatal poisoning, and causing a rapid increase in both pesticide and total suicides, as best illustrated by Sri Lanka [20,21].

Pesticide suicides are likely to have killed many millions of people over the last 50–60 years. In 1990, based on Jeyaratnam's work [22], the World Health Organisation (WHO) estimated that 200,000 pesticide suicides occurred each year (while at the same time acknowledging the paucity of data) [23].

Pesticide self-poisoning has been a major clinical and public health problem in low- and middle-income countries for decades while being long ignored [18,24]. Unfortunately, it is difficult to estimate the global number of pesticide suicides largely because most occur in poor rural regions, with weak death certification and reporting systems [25,26]. This problem has been exacerbated by the illegality of suicide in many countries, hindering reporting of suicides and recognition of the scale of the problem [27].

More recently, we have performed systematic reviews to estimate plausible estimates, taking account of underestimation of pesticide suicides in India, of 372,000 deaths/year in the 1990s [28] and 168,000 deaths/year in 2010–2014 [29]. However, no attempt has been made to enumerate the total number of deaths that have occurred subsequent to the Green Revolution.

Objective

To calculate plausible estimates for the total global number of pesticide suicides that have occurred since 1960.

Methods

We performed a literature review on Medline and Embase databases to July 2019 to find papers that reported national or global numbers of pesticide suicides. We restricted our search to papers published in English. We used the search terms: pesticide) OR insecticide) OR paraquat) OR organophosphate) OR organophosphorus) OR agrochemical) AND suicide) OR "") OR deliberate) AND poison in all fields. These searches identified 2144 papers; a further 8 citations were added through the searching of reference lists and our own paper collections. 2136 papers were excluded as they contained no data on pesticide suicide, they were case reports, case series, or related to specific socio-demographic groups, or were non-human studies. This left 16 papers giving country specific or global pesticide suicide data.

Long-term national trend in pesticide suicides

From a review of Medline and Embase databases from inception, we identified three studies that estimated the global burden of pesticide suicides [16,28,29]. Our previous studies from one low- and middle-income country (Sri Lanka) recorded long-term trends in suicide throughout the Green Revolution [20,21,30,31]. These data showed a steady increase in suicides from 1960 to the early 1970s, with a more rapid increase from 1979 to 1984 when pesticide imports were liberalised by a new government [20,32]. The number of suicides plateaued until 1995, when they started a steady almost linear decrease that has continued at least until 2015. The rapid increase in suicides after 1960 was almost completely due to poisoning and most likely pesticides [20]. We used the Sri Lankan epidemiology as a model of the incidence of pesticide suicides in all low- and middle-income countries.

We found no publications from low- and middle-income countries other than Sri Lanka that reported the timing of the increase in suicide incidence after the Green Revolution. However, data from China [11,33], India [10,13,34], Sri Lanka [34–36], United Kingdom [37], Israel [38], Denmark [39] and Finland [40] indicate that both unintentional and intentional pesticide poisoning with parathion and endrin were already problems by the end of the 1950s, sufficient to cause Finland to ban parathion in 1960 [40] and Denmark to restrict its availability in 1961 [39]. Unfortunately, despite serious concerns expressed in both India [13] and Sri Lanka [36] about the dangers of making these highly hazardous pesticides freely available over the counter to small-scale farmers in low- and middle-income countries, no such country banned their use at this time. Such a ban would have saved many lives.

One paper reported the timing of reductions in pesticide suicides in Bangladesh as starting in 2002 [41]. Chinese papers were unable to show a start date for the reduction in cases, since they started in 2006 when the incidence was already falling [42,43].

Estimating global numbers since 1960

Conservatively, bearing in mind the evidence that pesticide poisoning was already a problem in the late 1950s, we took 1960 as the approximate beginning of the Green Revolution, when pesticides became widely available for self-poisoning and suicide in small rural communities, consistent with the Sri Lankan data. The number of pesticide suicides in that year was therefore set at zero.

Table 1. Estimated pesticide deaths from 1960 to 2018 (using the Gunnel et al. [28] and Mew et al. [29] estimates, and 1995 vs 2002 for the end of the stable phase).

Period	Pesticide deaths per year		Total deaths for the given period		Cumulative deaths	
Change point	1995	2002	1995	2002	1995	2002
1960–1984	186,000	186,000	4,464,000	4,464,000	4,278,000	4,278,000
1985–1995	372,000		4,092,000		8,556,000	
1985–2002		372,000		6,696,000		11,160,000
1996–2014	270,000		5,130,000		13,686,000	
2003–2014		270,000		3,240,000		14,400,000
2015–2018	146,526		586,105		**14,272,105**	
2015–2018		134,000		536,000		**14,936,000**

The figures in Bold at the bottom right are totals for 1960–2018 using 1995 or 2002 for the end of the stable phase.

In Sri Lanka, deaths increased until 1984 and remained steady until 1995 [20]. In Bangladesh deaths remained steady probably until 2002 [41]. Gunnell and colleagues [28] estimated that the global number of pesticide suicides for the 1990s to be 372,000 (plausible range 347,000 to 439,000), which accounted for likely undercounting of pesticide suicides in India (as subsequently proven in the Million Death [44] and Global Burden of Disease studies [26]). To account for the number of suicides from 1960 to 1984, we presumed that they increased steadily over the period and took half the estimated number of suicides in 1984 (372,000/2 = 186,000) as the annual number of pesticide suicides for these 24 years - a total of 4,464,000 (plausible range 4,164,000 to 5,268,000) global pesticide suicides from December 1960 to December 1984 (Table 1).

Using the Gunnell et al. [28] estimate for the static phase from Jan 1985 to December 1995 (Sri Lankan data) or December 2002 (Bangladeshi data), a total of 4,092,000 (3,817,000 to 4,829,000) or 6,696,000 (6,246,000 to 7,902,000) people, respectively, died from pesticide suicide during this period.

Mew and colleagues [29,44] estimated that 168,000 pesticide suicides occurred in 2014 (including an estimate of missing Indian pesticide suicides). To calculate the number of pesticide suicides between the two estimated time points for the start of the fall in incidence (January 1996 and January 2003) and 2014, we took the midpoint (270,000) of the peak estimate 372,000 and the 2014 estimate 168,000 and calculated the number for these 19 and 12 year periods: 5,130,000 and 3,240,000 respectively.

Estimates for January 2015 to December 2018 were calculated from extending the line linking 1996 or 2003 to 2014, providing estimates for these four years of 586,105 (557,895 to 596,632) and 536,000 (491,333 to 552,667) deaths, respectively.

Putting together these three periods of increase, stability, and reduction (1960–1984, 1985–1995 or 2002, and 1996 or 2003 to 2018), we estimate a total number of pesticide suicides since 1960 of 14,272,105 (13,470,132 to 16,421,395) or 14,936,000 (14,052,667 to 17,303,333) depending on whether a global fall in incidence began in 1996 or 2003.

In 1990, WHO estimated the number of global pesticide suicide deaths in the 1980s to be 200,000, although without providing supporting data [23]. Using this value for 1984, rather than the value of 372,000, we calculated lower estimates of 12,208,105 and 12,872,000 depending on whether the fall began in 1995 or 2002. Outer estimates for pesticide deaths over the 59-year period using this WHO estimate were 9,859,667 to 14,435,333.

Discussion

The number of pesticide suicide deaths has fallen over the last 10–20 years, largely driven by a reduction in China [42] which was previously responsible for around half of the world's pesticide suicides [45,46]. This reduction has likely occurred due to movement of people from rural areas (where highly hazardous pesticides are widely available) to cities (where such pesticides are used infrequently), to mechanisation of agriculture, and to pesticide regulations which have banned highly hazardous pesticides [42].

Importantly, pesticide bans have not been associated with reduced agricultural yield [31,41,47,48]. Continued global regulation of pesticides to remove highly hazardous pesticides from poor smallholder farms in low- and middle-income countries, that are totally unable to use them safely, will further and rapidly reduce pesticide and total suicide rates [49].

In summary, we have here attempted to calculate the number of pesticide suicide deaths that have occurred since highly hazardous pesticides were introduced into rural agriculture of low- and middle-income countries in the 1950s/60s. We believe that a plausible estimate is at least 14 million deaths (with outer estimates of 9.9 and 17 million using WHO and Gunnell et al. [28] values for 1984, respectively) which is close to the total number of lives lost during WWI. It is also close to half the number of deaths that have occurred from human immunodeficiency virus infection (35 million) yet has comparatively received almost no public health attention. Many pesticide suicide attempts are impulsive with little planning [50,51]. Many deaths have been of young people with little desire to die but who died because the poisons at hand in their rural communities were highly hazardous pesticides for which no effective treatment is available [14,23,52]. Similar patients poisoning themselves in high-income countries would have survived due to the relatively low toxicity of available poisons [53].

This large number is likely to be an underestimate because of the registration and legal issues faced recording suicide deaths [25]. Studies in India in particular have reported very high rates of pesticide suicides in rural community verbal autopsy studies, rates far higher than the official statistics [25,54,55]. The global estimates proposed by Gunnell et al. [28] and Mew et al. [29] attempted to account for these high unofficial rates by increasing the estimate for India, following

in Mew's case the work of the Indian million death study [44]. More recent estimates for suicides in India, published after that systematic review, suggest that as many as 230,314 Indian people died from suicide during 2016 [26], of whom at least 70,000 (30%) would have died from pesticide suicide [44]. The importance of pesticide suicides in many parts of the world is also under-recognised and under-researched, particularly in Africa [56] and parts of West Asia [29].

Limitations

Our review has several clear limitations, most importantly the lack of accurate annual global data for deaths from pesticide poisoning. Instead, we have relied on two systematic reviews of the literature for the number of cases at the peak of the problem in 1990–2007 and 2010–2014. These provide us with plausible estimates for these two time points, allowing an estimate to be calculated for the total number of deaths since 1960.

Reasonably accurate national data from low- and middle-income countries on the epidemiology of pesticide suicides from before 1980 was only available from Sri Lanka. However, the Sri Lanka data provided a basic structure for the estimate - an increase from zero when pesticides were introduced into agriculture, a peak point followed by a period of stability, then a reduction due to pesticide regulation and perhaps migration from countryside to cities. Pesticide suicides were first reported before 1960 but the numbers were likely to have been very small compared to our overall estimate. It is possible that pesticide suicides increased more slowly in other countries, but we have no data to support this idea. Data from China and India - the two countries where most pesticide suicides occur - clearly show that poisoning was a significant problem by the end of the 1950s. The duration of the stable phrase is unclear, and so we have used two estimates - one from Sri Lanka and one from Bangladesh. To estimate the numbers of cases from 2015–2018, we have proposed that the number of cases has continued to fall steadily after 2014. This is likely conservative since there has been only a very modest fall if any in India, where the majority of global pesticide suicides now occur [26,29].

Both Sri Lanka and Bangladesh, like many others, first used pesticides in the 1950s, with increasing use and novel pesticide classes over subsequent decades [57]. Review of data from the Food and Agricultural Organisation of the United Nations (FAO; www.fao.org/faostat/) indicate that Sri Lanka's pattern of pesticide use (stable from 1990, then declining from 2010) resembles India, Sub-Saharan Africa, Central America & Caribbean, and Central Asia while Bangladesh's pattern (slow increase from 1990, more marked increase from 1998) is similar to low- and middle-income countries in South America, Northern Africa and East Asia. This suggests that the two countries are reasonably representative of global pesticide use in low- and middle-income countries. However, we acknowledge that the population with easy access to highly hazardous pesticides for self-harm will be mostly determined by the number engaged in small-scale agriculture, who keep pesticides in their homes, rather than overall national pesticide use.

We did not attempt to enumerate deaths from accidental or occupational poisoning, although these were estimated to number at least 20,000 deaths per year in the 1980s [23]. There will likely have been many tens of thousands of non-suicide deaths from pesticide poisoning worldwide since 1960. Similarly, this paper does not capture the health impacts of environmental exposure to pesticides.

Conclusions

In conclusion, pesticide suicide rates increased dramatically once the Green Revolution brought highly hazardous pesticides into poor rural households resulting in an estimated fourteen million premature deaths. The number is now falling worldwide but still accounts for around 150,000 deaths each year. Pesticide suicides must be considered as a category 4 occupation condition following Schilling's classification [58,59] - if pesticides had not been brought into rural communities and houses for agricultural use, pesticide suicides would not have occurred. Effective prevention will require better data and should rely on pesticide regulation to remove all highly hazardous pesticides from small scale farming [60], since improved pesticide storage is unlikely to be effective [61].

Acknowledgements

We thank Dr Odin Chang and Dr Tse Man-Li for their help with reviewing the early Chinese language literature on pesticide poisoning. The Centre for Pesticide Suicide Prevention is funded by an Incubator Grant from the Open Philanthropy Project Fund, an advised fund of Silicon Valley Community Foundation, on the recommendation of GiveWell, USA. DG is supported by the NIHR Biomedical Research Centre at University Hospitals Bristol NHS Foundation Trust and the University of Bristol, England. The views expressed in this publication are those of the author(s) and not necessarily those of the NHS, the National Institute for Health Research or the Department of Health and Social Care.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and final responsibility for the decision to submit for publication.

ORCID

Flemming Konradsen http://orcid.org/0000-0003-1036-6949
Michael Eddleston http://orcid.org/0000-0002-6857-3441

References

[1] Pingali PL. Green revolution: impacts, limits, and the path ahead. Proc Natl Acad Sci USA. 2012;109(31):12302–12308.

[2] Davies WP. An historical perspective from the Green Revolution to the gene revolution. Nutr Rev. 2003;61(6 Pt 2):S124–S134.

[3] World Health Organization. The impact of pesticides on health. www who int/mental_health/prevention/suicide/en/Pesticideshealth2 pdf, World Health Organization. 2004.

[4] Pimentel D. Green revolution agriculture and chemical hazards. Sci Total Environ. 1996;188(Suppl 1):S86–S98.

[5] Popp J, Pető K, Nagy J. Pesticide productivity and food security. A review. Agron Sustain Dev. 2013;33(1):243–255.

[6] Zinyemba C, Archer E, Rother HA. Climate variability, perceptions and political ecology: factors influencing changes in pesticide use over 30 years by Zimbabwean smallholder cotton producers. PLoS One. 2018;13(5):e0196901.

[7] Elver H. Report of the Special Rapporteur on the right to food. A/HRC/34/48. United Nations General Assembly, Human Rights Council. 2017.

[8] The Lancet. Phasing out harmful use of pesticides. Lancet. 2017;389:1076.

[9] Food and Agriculture Organization of the United Nations. International code of conduct on pesticide management. Guidelines on highly hazardous pesticides. Rome: FAO; 2016.

[10] Karunakaran CO. The Kerala food poisoning. J Indian Med Assoc. 1958;31(5):204–205.

[11] Liang BX. [Clinical analysis report of 75 cases of E605 insecticide poisoning] [Chinese]. Med Pharm Yunnan. 1959;3:37–39.

[12] Reddy DB, Edward VD, Abraham GJ, et al. Fatal endrin poisoning. A detailed autopsy, histopathological and experimental study. J Indian Med Assoc. 1966;46(3):121–124.

[13] Indian Council of Agricultural Research. Report of the Special Committeeon Harmful Effects of Pesticides. New Delhi: ICAR; 1967.

[14] Eddleston M. Patterns and problems of deliberate self-poisoning in the developing world. QJM. 2000;93(11):715–731.

[15] Jeyaratnam J, Lun KC, Phoon WO. Survey of acute pesticide poisoning among agricultural workers in four Asian countries. Bull World Health Organ. 1987;65(4):521–527.

[16] Jeyaratnam J. Acute pesticide poisoning: a major global health problem. Wld Hlth Statist Quart. 1990;43:139–144.

[17] Wesseling C, McConnell R, Partanen T, et al. Agricultural pesticide use in developing countries: health effects and research needs. Int J Health Serv. 1997;27(2):273–308.

[18] Eddleston M, Sheriff MHR, Hawton K. Deliberate self harm in Sri Lanka: an overlooked tragedy in the developing world. BMJ. 1998;317(7151):133–135.

[19] Hossain K. Suicidal poisoning in Calcutta. Ind Med Gaz. 1946;81(10):418–422.

[20] Gunnell D, Fernando R, Hewagama M, et al. The impact of pesticide regulations on suicide in Sri Lanka. Int J Epidemiol. 2007;36(6):1235–1242.

[21] Knipe DM, Gunnell D, Eddleston M. Preventing deaths from pesticide self-poisoning - learning from Sri Lanka's success. Lancet Global Health. 2017;5(7):e651–e652.

[22] Jeyaratnam J, de Alwis Seneviratne RS, Copplestone JF. Survey of pesticide poisoning in Sri Lanka. Bull World Health Organ. 1982;60(4):615–619.

[23] World Health Organization. Public health impact of pesticides used in agriculture. ed. Geneva: WHO; 1990.

[24] Konradsen F, van der Hoek W, Gunnell D, et al. Missing deaths from pesticide self-poisoning at the IFCS forum IV. Bull World Health Organ. 2005;83(2):157–158.

[25] Prasad J, Abraham VJ, Minz S, et al. Rates and factors associated with suicide in Kaniyambadi Block, Tamil Nadu, South India, 2000-2002. Int J Soc Psychiatry. 2006;52(1):65–71.

[26] India State-Level Disease Burden Initiative Suicide Collaborators. Gender differentials and state variations in suicide deaths in India: the Global Burden of Disease Study 1990-2016. Lancet Public Health. 2018;3:e478–e489.

[27] World Health Organization. Preventing suicide. A global imperative. Geneva: WHO; 2014.

[28] Gunnell D, Eddleston M, Phillips MR, et al. The global distribution of fatal pesticide self-poisoning: systematic review. BMC Public Health. 2007;7(1):357.

[29] Mew EJ, Padmanathan P, Konradsen F, et al. The global burden of fatal self-poisoning with pesticides 2006-15: systematic review. J Affect Disord. 2017;219:93–104.

[30] Knipe DW, Metcalfe C, Fernando R, et al. Suicide in Sri Lanka 1975-2012: age, period and cohort analysis of police and hospital data. BMC Public Health. 2014;14:839.

[31] Knipe DW, Chang SS, Dawson A, et al. Suicide prevention through means restriction: impact of the 2008-2011 pesticide restrictions on suicide in Sri Lanka. PLoS ONE. 2017;12(3):e0172893.

[32] Jupp J. Democratic socialism in Sri Lanka. Pacific Affairs. 1977;50(4):625–643.

[33] Liu JZ. [Preliminary understanding of the use of E605 and first aid and prevention of poisoning] [Chinese]. Inter Med J. 1957;5:37–39.

[34] Jayewardene CH, Saravanabavananthan N. Insecticide poisoning. Ceylon Med J. 1966;11(4):143–152.

[35] Vethanayagam AV. Folidol poisoning. Ceylon Med J. 1962;7:209–211.

[36] Vethanayagam AV. Folidol' (parathion) poisoning. BMJ. 1962;2(5310):986–987.

[37] Davies GM, Lewis I. Outbreak of food-poisoning from bread made of chemically contaminated flour. Br Med J. 1956;2(4989):393–398.

[38] Eshchar Y. Insecticide poisoning, based on material from the Kaplan Hospital. Isr Med J. 1961;20:85–94.

[39] Frost J, Poulsen E. Poisoning due to parathion and other organophosphorus insecticides in Denmark. Dan Med Bull. 1964;11:169–177.

[40] Ohberg A, Lonnqvist J, Sarna S, et al. Trends and availability of suicide methods in Finland. Proposals for restrictive measures. Br J Psychiatry. 1995;166(1):35–43.

[41] Chowdhury FR, Dewan G, Verma VR, et al. Bans of WHO Class I pesticides in Bangladesh - suicide prevention without hampering agricultural output. IntJEpidemiol. 2017;47:175–184.

[42] Page A, Liu S, Gunnell D, et al. Suicide by pesticide poisoning remains a priority for suicide prevention in China: analysis of national mortality trends 2006-2013. J Affect Disord. 2017;208:418–423.

[43] Wang L, Wu Y, Yin P, et al. Poisoning deaths in China, 2006-2016. Bull World Health Organ. 2018;96(5):314–326a.

[44] Patel V, Ramasundarahettige C, Vijayakumar L, et al. Suicide mortality in India: a nationally representative survey. Lancet. 2012;379(9834):2343–2351.

[45] Phillips MR, Li X, Zhang Y. Suicide rates in China, 1995–99. Lancet. 2002;359(9309):835–840.

[46] Phillips MR, Yang G, Zhang Y, et al. Risk factors for suicide in China: a national case-control psychological autopsy study. Lancet. 2002;360(9347):1728–1736.

[47] Manuweera G, Eddleston M, Egodage S, et al. Do targeted bans of insecticides to prevent deaths from self-poisoning result in reduced agricultural output? Environ Health Perspect. 2008;116(4):492–495.

[48] Cha ES, Chang SS, Gunnell D, et al. Impact of paraquat regulation on suicide in South Korea. Int J Epidemiol. 2016;45(2):470–479.

[49] Eddleston M, Karalliedde L, Buckley N, et al. Pesticide poisoning in the developing world-a minimum pesticides list. Lancet. 2002;360(9340):1163–1167.

[50] Conner KR, Phillips MR, Meldrum S, et al. Low-planned suicides in China. Psychol Med. 2005;35(8):1197–1204.

[51] Eddleston M, Karunaratne A, Weerakoon M, et al. Choice of poison for intentional self-poisoning in rural Sri Lanka. Clin Toxicol (Phila). 2006;44(3):283–286.

[52] Eddleston M, Phillips MR. Self poisoning with pesticides. BMJ. 2004;328(7430):42–44.

[53] Gunnell D, Eddleston M. Suicide by intentional ingestion of pesticides: a continuing tragedy in developing countries. Int J Epidemiol. 2003;32(6):902–909.

[54] Joseph A, Abraham S, Muliyil JP, et al. Evaluation of suicide rates in rural India using verbal autopsies, 1994-9 . BMJ. 2003;326(7399):1121–1122.

[55] Aaron R, Joseph A, Abraham S, et al. Suicides in young people in rural southern India. Lancet. 2004;363(9415):1117–1118.
[56] Mars B, Burrows S, Hjelmeland H, et al. Suicidal behaviour across the African continent: a review of the literature. BMC Public Health. 2014;14(1):606.
[57] Zhang WJ. Global pesticide use: profile, trend, cost/benefit and more. Proc Int Acad Ecol Environm Sci. 2018;8:1–27.
[58] Schilling RS. Health protection and promotion at work. Br J Ind Med. 1989;46(10):683–688.
[59] London L, Jors E, Neupane D. Pesticide poisoning: a response to Eddleston. Environ Health Insights. 2019;13:1178630218825243.
[60] Roberts DM, Karunarathna A, Buckley NA, et al. Influence of pesticide regulation on acute poisoning deaths in Sri Lanka. Bull World Health Organ. 2003;81(11):789–798.
[61] Pearson M, Metcalfe C, Jayamanne S, et al. Effectiveness of household lockable pesticide storage to reduce pesticide self-poisoning in rural Asia: a community-based, cluster-randomised controlled trial . Lancet. 2017;390(10105):1863–1872.