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1 **TITLE**

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3 Factors associated with purchasing pesticide from shops for intentional self-poisoning in Sri

4 Lanka

5

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26 **ABSTRACT**

27 **Objective**

28 In South Asia, up to one in five individuals who ingest pesticides for self-poisoning and survive
29 purchased them from a shop immediately prior to the event. Thus far, no research has taken
30 place to determine whether interventions implemented through the pesticide sellers might be
31 acceptable or effective, despite the hundreds of thousands of such risk purchases each year. We
32 aimed to investigate factors associated with purchasing pesticides for self-poisoning in Sri
33 Lanka.

34 **Methods**

35 We used a case-control study. Cases (n=50) were individuals who ingested pesticides after
36 purchasing them for the act and controls (n=200) were customers who bought pesticides but
37 did not use them for self-harm. Logistic regression analysis was used to assess socio-
38 demographic and purchase-specific risk factors.

39 **Results**

40 Alcohol intoxication (adjusted odds ratios [AOR] 36.5, 95% confidence intervals [CI] 1.7-
41 783.4) and being a non-farmer AOR 13.3, 95% CI 1.8-99.6 were the main distinguishing
42 factors when purchasing pesticides for self-poisoning. The positive predictive values were
43 93.3% (95% CI 68.0%-99.8%) and 88.2% (95% CI 72.5%-96.7%) respectively. One and/or
44 other of these factors characterized 72.0% of cases but only 2.5% controls.

45 **Conclusion**

46 While results need to be interpreted cautiously, sales restrictions to prevent alcohol intoxicated
47 persons and non-farmers purchasing pesticides for self-poisoning may be effective.

48

49 **Key words:** Pesticides; Pesticide shops; Self-poisoning; Sri Lanka; Suicide

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71 **INTRODUCTION**

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73 It is estimated that nearly 800,000 people die by suicide every year (1). Self-poisoning with
74 pesticides causes up to one in five of the world's suicides (2) and it has been acknowledged as
75 a serious public health problem in many agricultural communities of low and middle-income
76 countries in Asia (3). Since the 1950s, when the Green Revolution brought highly hazardous
77 pesticides into small-scale farming, an estimated 14 million premature deaths have resulted
78 from pesticide self-poisoning (4). Reducing pesticide self-poisoning is therefore an important
79 focus for reducing global suicides.

80

81 National bans on highly hazardous pesticides, which are commonly ingested in acts of self-
82 poisoning, is considered to be the most effective method for reducing pesticide-specific and
83 overall suicide rates in countries with high pesticide suicide rates (5). However, such strategy
84 has less impact on preventing self-poisoning attempts which are normally several times higher
85 than fatal attempts (6). This emphasizes the need for effective approaches to reducing non-fatal
86 pesticide self-poisoning attempts as well.

87

88 In Sri Lanka, pesticides are readily available to purchase over the counter, which increases their
89 accessibility for self-poisoning (7). Data from Sri Lanka (8)(9) and India (10), indicate that 14-
90 20% of people using pesticides for self-poisoning purchased the pesticide from a shop with the
91 intention of drinking it. Of note, even higher proportions (around 40%) of people who die from
92 pesticide suicide purchase the pesticide for the act (11) and (Weerasinghe et al, unpublished).
93 In our previous work with pesticide vendors, we observed that they would like to act as
94 "gatekeepers" by preventing access to pesticides for self-poisoning from their shops (7).
95 However, the vendors found it difficult to differentiate between customers who might ingest

96 the pesticides from those who purchased pesticides for agricultural purpose. To the best of our
97 knowledge, factors that might help identify individuals who purchase pesticides from shops to
98 use them for self-poisoning have not previously been investigated. In this study, we aimed to
99 investigate factors associated with purchasing pesticides for self-poisoning in Sri Lanka to
100 inform policies and guide the design of appropriate interventions to reduce access to pesticides
101 for self-poisoning.

102

103 **METHODS**

104

105 *Study design*

106 A population-based case-control study was conducted. The protocol of this study has been
107 published (12).

108

109 *Study setting*

110 The study took place in 6 divisional secretariats (divisional secretariat, a government
111 administrative region with a population of about 40,000 people) of Thambuttegama, Thalawa,
112 Nochchiyagama, Rajanganaya, Galnewa and Ipologama of South Western Anuradhapura
113 District, North Central Province of Sri Lanka, with a population of 215,274 (census, 2011). As
114 part of the study, 119 pesticide shops were identified either in this area or within 20 km beyond
115 the boundary, including 10 seasonal pesticide shops (open only during the agricultural
116 seasons). The incidence of self-poisoning in the study area has previously been estimated as
117 447 per 100,000 population (13). The health care services for the residence in the selected area
118 are primarily provided through 11 primary care hospitals, a secondary care hospital and a
119 tertiary care hospital.

120

121 ***Cases***

122 Cases were defined as survivors of intentional pesticide self-poisoning presented to 13
123 government health facilities and who reported purchasing pesticides from pesticide shops for
124 the purpose of self-harm. All patients below 16 years old and patients residing outside the six
125 DS selected divisions were excluded. This was a case-control study nested within a separate
126 cluster randomized controlled trial (14). The self-harm cases were identified between May
127 2014 and January 2015.

128

129 ***Controls***

130 Controls were customers (legitimate pesticide purchasers) who were identified as purchasing
131 pesticides at the same shops where the cases purchased them but used the pesticides for
132 agricultural purposes or for controlling domestic pests (including rats and ants). A pool of
133 potential controls (5 to 20) was identified by direct observation at the shops by field researches,
134 within one week of the cases being identified. The controls were consecutive series of
135 customers buying pesticides at approximately the same time of the day of purchase as each
136 case. Four controls were chosen for each case from the list of potential controls using simple
137 random sampling techniques. These individuals were then invited to participate in the study.
138 Individuals who declined were replaced by other selected controls. The minimum age limit for
139 the participants was 16 years and there was no upper age limit.

140

141 ***Data collection***

142 Interviews were conducted in participants' homes either soon after their discharge from the
143 hospital (cases) or just after their initial identification at the pesticide shop (controls). We used
144 an interviewer-administered semi-structured questionnaire to elicit socio-demographic and
145 purchase-specific information. The socio-demographic information included age, sex,

146 education, marital status, house construction, motor vehicle ownership, farming status, and
147 whether the person was a head of household. The purchase-specific information included
148 whether it was the person's first time purchasing pesticides, whether the person reported being
149 under the influence of alcohol at the time of purchase, whether the person purchased only
150 pesticides, whether the person purchased pesticide for cash but not for credit, cost of the
151 pesticide purchased and whether the person purchased a single pesticide container. For those
152 participants who purchased a single pesticide container more specific information was
153 collected, including whether they purchased an insecticide, a glass pesticide bottle and a liquid
154 pesticide. The amount of pesticide purchased was recorded for customers who purchased liquid
155 pesticides.

156

157 The interviews were conducted by one postgraduate researcher and two trained field
158 researchers with previous experience in community-based health research. All interviewers
159 were extensively trained on data collection procedures and protocols were used to minimize
160 the information bias.

161

162 *Definitions used in the analysis*

163 The participants aged 30 years or below were defined as 'young'. The age cut-off of 30 was
164 pre-specified prior to the analysis following the cut-off used by a previous case-control study
165 (15) in Sri Lanka. The socio-economic status of each household was determined with a
166 composite scoring system and classification. Three points were allocated for either solid house
167 construction or four-wheel motor vehicle, two points for either semi-permanent household
168 construction or two- or three-wheel motor vehicles and one point for either having improvised
169 household construction or a bicycle or no vehicle in the household. Those who scored five or
170 less were classified as having a low socio-economic, otherwise they were scored having a high

171 socio-economic status. A total cost of pesticide purchases equal to or less than 300 LKR (2
172 USD) was considered to be a low-cost purchase. When liquid pesticides were purchased and
173 the quantity was 300 ml or less these were considered as low quantity purchases.

174

175 *Data analysis*

176 The data were entered into Epi Info version 7 and transferred to Stata 14 for further statistical
177 analysis. Descriptive statistics were used to summarize the data.

178

179 We first described the distribution of factors among cases and controls and estimated the
180 unadjusted odds ratios (OR) and 95% confidence intervals (CI) for all factors. We then ran a
181 logistic regression model adjusting for age, sex and socio-economic status because we
182 hypothesized that these factors were confounders. The variables that were associated ($p < 0.05$)
183 with purchasing pesticides from shops for self-poisoning based on the unadjusted odds ratios
184 were included in the final multivariable logistic regression model. We fitted all models with
185 robust standard errors to account for any clustering by pesticide shop. Positive predicted values
186 were calculated for significant independent risk factors identified in the final model.

187

188 *Ethical approval*

189 Ethical approval was obtained from the Ethics Review Committee of the Faculty of Medicine
190 and Allied Sciences, Rajarata University of Sri Lanka. Prior to data collection, the purpose of
191 the study was explained, and written consent obtained from all participants.

192

193 **RESULTS**

194

195 *Recruitment*

196 Of the 289 patients who self-poisoned with pesticides during the study period and admitted to
197 surveillance hospitals, 47 were excluded as shown in Figure 1. Of 242 patients available for
198 interview after discharge from hospital, 51 (21.1%, 51/242) patients had purchased pesticides
199 from a shop for self-poisoning. Among them, one patient refused to participate in the study and
200 the remaining 50 patients were recruited as cases. Of 448 customers identified as controls at
201 the pesticide shops, 200 were randomly selected for interview. Ten individuals did not wish to
202 participate and were replaced by additional randomly selected controls.

203

204 *Descriptive analysis*

205 Table 1 presents the socio-demographic and purchase-specific characteristics of the cases and
206 controls. Cases were younger than controls (median age cases 31 [interquartile range (IQR) 40
207 to 26] years vs controls aged 45 [52 to 36] years). Males were predominant among both cases
208 (88.0%) and controls (90.0%). There were no marked differences between cases and controls
209 in the educational level. Sixty percent of the cases were non-farmers compared to only 2.0%
210 of controls. Fourteen (28.0%) cases, all males, reported being intoxicated with alcohol at the
211 time of purchasing pesticides compared to one (0.5%) of the controls. It is important to note
212 that the combination of non-farmers and those who were alcohol intoxicated or either condition
213 accounted for 72.0% of cases vs 2.5% controls. All the cases (100%) paid pesticides in cash
214 (not using credit facilities) compared with 75.0% of the controls and all bought only pesticides
215 (not fertilizers or other items) compared with 95.5% of the controls.

216

217 *Characteristics of individuals purchasing pesticides from shops for self-poisoning*

218 Table 2 presents results of unadjusted analysis, adjusted odds ratios for a model adjusted for
219 age, sex and socio-economic status and a fully adjusted logistic regression model.

220

221 *(1). Unadjusted analysis*

222 In the unadjusted analysis, socio-demographic characteristics associated with an increased risk
223 related to pesticide purchase for self-poisoning were: being a non-farmer, age \leq 30 years, low
224 socio-economic status, being a non-head of the household and being unmarried. Purchase-
225 specific risk factors included being under the influence of alcohol at the point of purchase,
226 purchasing pesticides for the first time, purchasing a single pesticide, low cost purchase,
227 purchasing a smaller quantity, purchasing an insecticide and purchasing pesticides in a glass
228 bottle.

229

230 *(2). Adjusted analysis for age, sex and socio-economic status*

231 Being a non-farmer and being a non-head of the household remained as socio-demographic
232 risk factors when adjusted for age, sex, and socio-economic status. Except for purchasing a
233 glass pesticide bottle, the other purchase-specific risk factors identified from the unadjusted
234 analysis remained as risk factors for purchasing pesticides from shops after adjusting for age,
235 sex and socio-economic status.

236

237 *(3). Independent risk factors in the final model*

238 In the final fully-adjusted logistic regression model, alcohol intoxication at the time of purchase
239 (OR 36.5, 95% CI 1.7 to 783.4), being a non-farmer (OR 13.3, 95% CI 1.8 to 99.6) and age \leq
240 30 years (OR 8.6, 95% CI 1.7 to 43.4) remained significant independent risk factors. The
241 positive predictive value (PPV) for alcohol intoxication at the time of purchase was 93.3%
242 (95% CI 68.0% to 99.8%), for being a non-farmer 88.2% (95% CI 72.5% to 96.7) and for age
243 \leq 30 years 50.0% (95% CI 34.9% to 65.1%).

244

245 **DISCUSSION**

246

247 Our study has shown that a combination of socio-demographic characteristics (being a non-
248 farmer and being below the age of 30 years) in combination with purchase-specific factors
249 (alcohol intoxication at the time of purchase) could best identify a customer at high suicide risk
250 of purchasing pesticides from shops for self-poisoning.

251

252 The controls were selected at approximately the same time of the day of purchase as for the
253 case in order to reduce the alcohol effect in control selection. Four controls were chosen at
254 random from among a pool of eligible controls and this pool was made up of a consecutive
255 series of customers buying pesticides at the same pesticide shop from which the pesticides were
256 purchased for self-harm. Cases and controls were therefore expected to be from the same
257 population, reducing the possibility that selection bias would influence the results.

258

259 The high level of alcohol intoxication during the purchases for self-harm emphasizes the
260 importance of the links between alcohol and self-harm. This mirrors findings from another
261 study in the same area (16) and from other previous studies elsewhere in Sri Lanka (17)(18),
262 where alcohol has been identified as an important risk factor for pesticide poisoning.

263

264 The results showed that 60% of the individuals who accessed pesticides from shops for self-
265 poisoning were non-farmers. The equivalent figure in a previous study in the same area in Sri
266 Lanka was 45% (9). Individuals who self-poison with pesticides who are living in non-farming
267 households may not have access to pesticides in their domestic environment and therefore have
268 to obtain them from shops. But 20 out of 50 (40%) individuals who purchased pesticides for
269 self-poisoning from a shop were farmers. It is unclear what motivated farmers to choose a
270 pesticide shop to access pesticides for self-poisoning. These farmers might either have simply

271 used up their supplies for agricultural purpose or pesticides may not have been easily accessible
272 in these farming households (e.g. locked away or hidden, stored in a field located some
273 kilometers from the house). It is unlikely that respondents were mis-identified as farmers or
274 non-farmers at the data collection as same data collection techniques (setting, interviewers and
275 time) were used for both cases and controls and standard definitions were used across all
276 participants.

277

278 Overall, on the basis of the very high odds ratios and positive predictive values we have
279 identified two key factors that might be used at the point of pesticide sale to prevent purchases
280 for self-poisoning: being intoxicated and being a non-farmer. Use of these factors could
281 identify up to 72% of cases where pesticides were bought from shops for self-poisoning. This
282 group therefore appears to be an important target for future interventions (e.g. training vendors
283 to screen for high risk customers, introducing a farmer identity card etc.) aimed at reducing
284 access to pesticides from shops for this purpose. However, before such interventions are
285 implemented, their feasibility and acceptability has to be assessed with stakeholders and field
286 tested before implementation of a large-scale intervention trial to assess effectiveness.

287

288 The major limitations of this study were possible information (data) bias (e.g. alcohol
289 intoxication at the time of purchase) due to self-report and possible interviewer bias because
290 interviewers were not blind to case/control status. Some of the associations are imprecise due
291 to small numbers and therefore it was not possible to assess interactions between the variables.
292 This sample size was calculated to provide 80% power (at the 5% level of statistical
293 significance) to detect risk ratios of 2.5 or more in relation to risk factors with a 50% prevalence
294 in the control group. The power calculation was not done in order to look at the interactions in
295 sub-groups. Another limitation was that the study also focused on patients who survived self-

296 poisoning and it is uncertain if the findings would equally apply to those who die as the latter
297 may differ from survivors in terms of risk factors (and may have much higher rates of
298 purchasing pesticides for the attempt than survivors) (11). However, obtaining information
299 from the next of kin after a person's death is likely to be inaccurate for some variables (e.g.
300 intoxication with alcohol). Finally, recall bias could have been introduced with respect to
301 purchasing behaviors, possibly resulting in an underestimation of the importance of risk
302 factors.

303

304 The current study showed that 21% of individuals hospitalized in this area of rural Sri Lanka
305 following pesticide self-poisoning had obtained the pesticides from a shop for self-poisoning.
306 This is in keeping with the findings of two previous studies conducted in the same setting 5 to
307 8 years before our investigation (8)(9).

308

309 In conclusion, this study identified alcohol intoxication during the purchase and being a non-
310 farmer were strong risk factors for purchasing pesticides from shops for self-poisoning.
311 Interventions aimed at avoiding selling pesticides to this target group might prevent hundreds
312 of thousands of pesticide self-poisonings each year.

313

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317 up the study. DG and KH are both National Institute for Health Research (England) Senior
318 Investigators. ME was a Lister Research Prize Fellow.

319

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- 378

Table 1: Socio-demographics and purchase-specific factors associated with purchasing pesticides from shops for self-poisoning in rural Sri Lanka, 2014-15.

Socio-demographic characteristics	Cases		Controls		Purchase-specific factors	Cases		Controls	
	No.	%	No.	%		No.	%	No.	%
Age (years)					Purchasing only pesticides				
≤ 30	23	46.0	23	11.5	Yes	50	100.0	150	75.0
≥ 31	27	54.0	177	88.5	No	0	0.0	50	25.0
Sex					Cash purchases				
Male	44	88.0	180	90.0	Yes	50	100.0	191	95.5
Female	6	12.0	20	10.0	No	0	0.0	9	04.5
Education ≤ 5 years					Low cost purchase (≤ 300 LKR)				
Yes	9	18.0	45	22.5	Yes	23	46.0	19	9.5
No	41	82.0	155	77.5	No	27	54.0	181	90.5
Marital status					Purchasing single pesticide				
Unmarried	19	38.0	27	13.5	Yes	49	98.0	139	69.5
Married	31	62.0	173	86.5	No	1	2.0	61	30.5
Socio-economic status					Purchasing an insecticide				
Low	42	84.0	109	54.5	Yes	39	79.5	69	49.6
High	8	16.0	91	45.5	No	10	20.5	70	50.4
Non-farmer					Purchasing a glass pesticide “bottle”				
Yes	30	60.0	4	2.0	Yes	42	85.7	88	63.3
No	20	40.0	196	98.0	No	7	14.3	51	36.7
Non-head of the household					Purchasing liquid pesticide				
Yes	28	56.0	47	23.5	Yes	43	87.7	117	84.2
No	22	44.0	153	76.5	No	6	12.3	22	15.8
First time pesticide purchasing					Purchasing less quantity (≤ 300 ml)				
Yes	16	32	4	2.0	Yes	35	81.4	53	45.3
No	34	68	196	98.0	No	8	18.6	64	54.7
Alcohol intoxicated during purchase									
Yes	14	28.0	1	0.5					
No	36	72.0	199	99.5					

Table 2: Unadjusted odds ratios, adjusted odds ratios and positive predicted values for factors associated with purchasing pesticides for self-poisoning in rural Sri Lanka, 2014-15.

Category	Unadjusted		Adjusted for age, sex and socio-economic status			Adjusted for all variables			Positive predictive value		
	Odds ratio	95% conf. interval	Odds ratio	95% conf. interval	conf.	Odds ratio	95% conf. interval	conf.	%	95% conf. interval	conf.
Age ≤30 years	6.5	3.3-13.0	-	-	-	8.6	1.7-43.4	-	50	34.9-65.1	-
Male sex*	0.8	0.2-2.8	-	-	-	-	-	-	19.6	14.6-25.4	-
Education ≤5*	0.7	0.3-1.8	-	-	-	-	-	-	16.7	7.9-29.3	-
Unmarried	3.9	1.8-8.6	2.1	0.8-5.5	-	2.4	0.6-9.5	-	41.3	27.0-56.8	-
Low socio-economic status	4.4	1.7-11.1	-	-	-	2.7	0.5-13.7	-	27.8	20.8-35.7	-
Non-farmer	73.5	19.8-272.3	71.6	14.2-360.5	-	13.3	1.8-99.6	-	88.2	72.5-96.7	-
Non-head of the household	4.1	2.0-8.6	2.8	1.1-7.1	-	0.3	0.1-1.5	-	37.3	26.4-49.3	-
First time purchase of pesticides	23.0	8.9-59.7	14.5	4.9-42.9	-	1.9	0.5-8.3	-	80.0	56.3-94.3	-
Alcohol intoxication at the time of purchase	77.4	9.1-657.1	95.1	9.1-993.6	-	36.5	1.7-783.4	-	93.3	68.0-99.8	-
Low cost purchase (≤ 300 LKR)	8.1	3.8-17.3	6.8	2.8-16.2	-	1.4	0.4-4.6	-	54.8	38.7-70.1	-
Purchasing single pesticide	21.5	2.8-163.7	17.7	2.0-154.3	-	N/A	N/A	-	26.1	19.9-32.9	-
Purchasing an insecticide	3.9	2.1-7.5	5.9	2.4-14.7	-	3.0	0.7-12.5	-	36.1	27.1-45.9	-
Purchasing a glass pesticide bottle	3.5	1.1-10.5	2.2	0.6-7.6	-	1.7	0.3-10.9	-	32.3	24.4-41.1	-
Purchasing liquid pesticide*	1.3	0.5-3.7	-	-	-	-	-	-	26.9	20.2-34.4	-
Purchasing low quantity (≤ 300 ml)	5.3	2.5-11.1	8.6	3.1-23.4	-	2.8	0.9-9.1	-	39.8	29.5-50.8	-

* These variables were excluded from the adjusted models because they did not reach the pre-specified cut-off $p = 0.05$ in the unadjusted analysis.

N/A - Excluded from the model due to collinearity.

Figure 1: Flow chart of cases and controls recruited in the study

