Research paper

Suicide by hanging is a priority for suicide prevention: method specific suicide in India (2001–2014)

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ARTICLE INFO

Keywords:
Suicide
Hanging
Insecticide poisoning
Pesticide poisoning
India

ABSTRACT

Background: India accounts for over a quarter of the global burden of suicide. One of the most effective population level suicide prevention strategies has been restricting access to suicide means.

Method: Trends in method specific suicide rates (2001–14) were calculated using National Crime Records Bureau data stratified by sex, age-group, and geographical region. Multilevel negative binomial regression models stratified by sex and suicide method were specified to investigate associations between state-level indicators of economic development, education, agricultural pesticide use and religious factors.

Results: Suicide by hanging increased by 56% (from 3.9 to 6.1 per 100,000) among males and by 24% (from 2.1 to 2.6 per 100,000) among females over the study period while incidence of insecticide poisoning decreased by 44% (from 2.7 to 1.5 per 100,000) among males and by 52% (from 1.7 to 0.8 per 100,000) among females. In general, states with higher levels of development, higher agricultural employment and higher literacy had higher rates of suicide for each suicide method. States with higher levels of agricultural pesticide use had higher rates of insecticide poisoning suicides.

Limitation: Reported rates might be an underestimation of the true rates as the official data used for the analysis likely underestimates the actual number of suicide deaths in India.

Conclusion: Responsible reporting of suicide by hanging in the media, and limiting fictional portrayals of this method may be useful areas for prevention. Further restrictions on production and sales of highly hazardous pesticides may also help with further reductions in suicide by pesticide poisoning.

1. Introduction

Suicide is a major public health issue in India (Patel et al., 2012; Dandona et al., 2016; Armstrong and Vijayakumar, 2018; Arya et al., 2018) with an estimated 230,314 suicides in 2016 (Dandona et al., 2018). India accounts for over a quarter of the global burden of suicide (Dandona et al., 2018). Rates in India are higher among males (21 per 100,000) than females (15 per 100,000), and while rates have declined among females, male rates have remained stable for the last 30 years (Dandona et al., 2018). Given the enormous size of the problem, a public health approach to suicide is gaining momentum in India, with calls for the development of national and state-level suicide prevention strategies (Armstrong and Vijayakumar 2018; Dandona et al., 2018). To give further impetus to the development of such strategies and targeted suicide prevention activities, information is urgently needed on trends and regional variation in suicide methods.

The changing availability of lethal suicide methods is an important influence on secular trends and international differences in suicide rates (WHO, 2014), and restricting access to means is recognised as one of the most effective population level suicide prevention strategies to date (Mann et al., 2005). Reduction in both method-specific, and in some cases overall, suicide rates have been reported following the restriction of access to carbon monoxide in domestic gas (Kreitman, 1976) and in motor vehicles following the introduction of catalytic converters.
Indian states were categorised in terms of socio-economic development (‘less’ or ‘more’ developed) and also level of agricultural employment (‘more’ or ‘less’ agricultural). A detailed description of the rationale and method for these categorisations has been published elsewhere (Dandona et al., 2016; Arya et al., 2018) (see Web Appendix 2).

2.2. Analysis

Age-standardised rates (using the 2011 census population as the standard) for suicide by hanging, insecticide poisoning, self-immolation and all other methods were calculated for each year (2001–2014), stratified by sex and geographic region (less or more economically developed, and more or less agriculturally employed), to investigate trends and differentials over the study period. Age-specific rates stratified by sex were also investigated to ascertain differences in method-specific suicide rates among different age groups. Age standardised suicide rates for males and females for hanging, insecticide poisoning, self-immolation and all other methods for each state were also calculated (Web Appendix 3–6). Total percentage of hanging, insecticide poisoning, self-immolation and all other methods from 2001–2014 were calculated as well.

Associations between socio-demographic factors (literacy, religion, agricultural pesticide use and geographic region) and suicide were investigated by specifying a series of negative binomial regression models of method specific suicide counts (offset by the natural logarithm of the population), and stratified by state, sex, geographic region, and age group. Each of the socio-demographic factors were divided into population tertiles for analyses, resulting in ‘low’, ‘middle’ and ‘high’ categories for each variable. Religion was restricted to proportion Hindu, as high collinearity was observed between proportion Muslim, Christian and Hindu by state. Multivariate models were adjusted for sex, age group, period, and socio-demographic factors (literacy, religion, agricultural pesticide use, geographic region). Model estimates were exponentiated and expressed as rate ratios (RR) with 95% confidence intervals. Analyses were conducted in Stata 15.1 (Mitchell, 2012).

3. Results

Suicide by hanging showed a general increasing trend with sharp increases during the latter years of the study period (2010–2014), occurring contemporaneously with declines in suicide by insecticide poisoning (Table 1, Fig. 1). Among males, suicide by hanging increased by 56% (from 3.9 to 6.1 per 100,000) while suicide by insecticide poisoning decreased by 44% (from 2.7 to 1.5 per 100,000) between 2001 and 2014. Suicide by self-immolation decreased by 14% (0.7–0.6 per 10,000) and all other methods also decreased by 3% (5.9–5.7 per 100,000) (Fig. 1a). Among females, suicide by hanging also increased by 23% (from 2.1 to 2.6 per 100,000) while insecticide poisoning declined by 52% (from 1.7 to 0.8 per 100,000) between 2001 and 2014. Suicide by self-immolation decreased by 40% (from 1.5 to 0.9 per 100,000) while all other methods also decreased by 20% (3.5–2.8 per 100,000) (Fig. 1a).

Among males, middle age groups (30–59 years) had the highest suicide rates for all methods (Fig. 1b). Among females, suicide rates generally declined with age among the three specific suicide methods, especially for hanging (Fig. 1b).

More economically developed states had two to four times higher suicide rates for all the methods compared to less economically developed states among both sexes (Fig. 2a and b), with a general pattern of increasing suicide by hanging, and declines in suicide by insecticide poisoning. Among more or less agricultural states, there was a similar pattern of suicide methods, with slightly higher rates of suicide by hanging among males in less agricultural states, and suicide by self-immolation among females in more agricultural states (Fig. 3a and b).
poisoning among both sexes (Fig. 3a and b).

States with higher (compared to low) literacy had a higher risk of suicide by hanging, insecticide poisoning, and self-immolation (RR range 2.08–6.41) (Table 2). There was also a strong association (RRs > 2.0) between higher (compared to low) per capita agricultural pesticide use, and among more (compared to less) agricultural regions, and suicide by insecticide poisoning, for males and females (Table 2).

Less developed states had lower rates of suicide for all suicide methods (with the exception of female suicide by hanging). States with high (compared to low) proportion Hindu populations had higher rates of suicide by insecticide poisoning and self-immolation, for both males and females (Table 2).

4. Discussion

This study investigated trends and differentials in method-specific suicide in India over the period 2001–14. Suicide by hanging was the most common method in India, followed by suicide by insecticides, and suicide by self-immolation. Suicide by hanging accounted for 35% of all suicides among males and almost 30% of all suicides among females, with rates generally increasing over the study period. In contrast, suicide by insecticide poisoning (accounting for 18% of all suicides in males and 17% of all suicides in females) showed a decreasing trend over the study period. Self-immolation rates were higher among female compared to males (accounting for 5% of all suicides among males, but 16% of all suicides among females) and also showed decreasing trends over the study period.

The current study found higher method-specific suicides among males compared to females (with the exception for suicide by self-immolation), which is consistent with sex differences reported internationally (WHO, 2011). Age specific suicide rates for all methods were generally higher in the middle age groups (30–44 and 45–59 years) among males, while suicide by hanging, insecticide poisoning and self-immolation were highest among the youngest age group (15–29 years) among females. These findings are reflective of age-specific patterns of suicide in previously reported studies of overall suicide rates in India (Patel et al., 2012; Arya et al., 2018; Dandona et al., 2018).

Suicide by hanging is one of most common and lethal methods of suicide in the world (Gunnell et al., 2005; Ajdacic-Gross et al., 2008). Suicide by hanging has historically been a prominent method of suicide in India (Thakur, 1963), with capital punishment in India carried out through hanging, highlighting the prominence of hanging in the Indian culture. The increasing trend in suicide by hanging, occurring contemporaneously with declines in suicide by insecticide poisoning (and with no substantial changes among other methods, and consistent overall suicide rates) (Arya et al., 2018) may suggest a substitution of methods in the Indian population in the latter part of the study period.

Suicide by hanging is known to be difficult to restrict even given that ligature material and ligature points are commonly available (Gunnell et al., 2005). However, the identification of commonly used ligature points, such as ceiling fans (Supraja et al., 2016) (particularly prevalent among lower income households) (Letschert et al., 2009) may be a target for current prevention initiatives; if ceiling fans are commonly used as a ligature point, then strategies might be put in place to make them safer. For example, installing spring fitted ceiling fans that would drop if a weight over 20 kg is suspended on them (Mishra et al., 2019). Other prevention strategies may relate to collaborative efforts with the media to reduce the prominent portrayal of hanging as a method of suicide (Gunnell et al., 2005; Biddle et al., 2010). For example, it has been observed that hanging is over-reported in newspaper reports on suicide events, relative to its occurrence in the general population in India, often with a detailed description of how the hanging was enacted (Armstrong et al.). Evidence suggests that sensational, simplistic and graphic reporting of suicides, a style of reporting that has been observed in India (Armstrong et al., 2018), can lead to the stigmatisation of suicidal behaviour and a reduction in help seeking behaviour while also encouraging imitation acts (Gunnell and Lewis, 2005; Pirkis et al., 2006; Patel et al., 2012; Niederkrotenthaler et al., 2014; Zalsman et al., 2016).

As noted above, though suicide by insecticide poisoning declined over the study period, it was still three times higher in more agricultural states compared to less agricultural states (for males and females), likely related to greater accessibility of pesticides in more agricultural regions (Ajdacic-Gross et al., 2008). India has banned some class I pesticides, such as Aldicarb and Calcium Cyanide, which may explain the general reduction in suicide by pesticide poisoning over the study period (Directorate of Plant Protection, Quarantine and Storage, 2018). However, in 2015–16, India used a total of 2254 tonnes of class I pesticides accounting for 29% of total pesticides use in the country (Taneja, 2017). While a recent ban has been imposed on 7 of the 18 class I pesticides allowed in India, heavily used class I pesticides (for example Monocrotophos and Carbofuran) are yet to be banned along with other known lethal pesticides (for example Paraquat) (Directorate of Plant Protection, Quarantine and Storage, 2018). Pesticide self-poisoning is thought to be often impulsive (Eddleston et al., 2006), and bans on highly toxic products, such as WHO Class I pesticides, may lead to further declines in suicide by pesticide poisoning and possibly overall suicides.

Similar to previous studies investigating overall suicide rates in India (Patel et al., 2012; Arya et al., 2018; Dandona et al., 2018), more...
developed states had higher method specific suicide rates compared to less developed states among both sexes, perhaps associated with rapid modernization and social change in these regions, and an increasing discrepancy between expectations and reality (Mayer, 2011; Patel et al., 2012; Arya et al., 2018; Dandona et al., 2018). Rates for suicide by hanging were higher among less agricultural states compared to more
agricultural states among males, while they were similar for females. Higher hanging rates among less agricultural states may be attributed to the lack of availability of other methods, such as lack of availability of pesticides (Ajdacic-Gross et al., 2008). Rates of suicide by self-immolation were also higher among more agricultural states for both sexes, which may reflect the continued use of more traditional methods of cooking including use of kerosene among agricultural regions (Bansal et al., 2013).

Fig. 2. Direct age-standardised method specific suicide rates by regions of economic development, India 2001–14.
Higher literacy was associated with higher suicide risk across all method categories among both sexes. Suicide rates in general are noted to be higher in populations with a higher level of literacy in India (Arya et al., 2018). For example, southern states, which have the highest literacy rates in India have also recorded the highest suicide rates, while north Indian regions, with the lowest literacy rates in the
### Table 2
Socio-demographic factors associated with hanging, insecticide poisoning, self-immolation and all other suicide methods in India (2001–14).

<table>
<thead>
<tr>
<th></th>
<th>Hanging Male RR(95%CI) (a)</th>
<th>Hanging Female RR(95%CI)</th>
<th>Insecticide poisoning Male RR(95%CI)</th>
<th>Insecticide poisoning Female RR(95%CI)</th>
<th>Self-immolation Male RR(95%CI)</th>
<th>Self-immolation Female RR(95%CI)</th>
<th>All other methods Male RR(95%CI)</th>
<th>All other methods Female RR(95%CI)</th>
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<tbody>
<tr>
<td><strong>Level of economic development (b)</strong></td>
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<tr>
<td>More developed</td>
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<tr>
<td>Less developed</td>
<td>0.87 (0.76–1.00)</td>
<td>1.11 (0.97–1.27)</td>
<td>0.46 (0.40–0.54)</td>
<td>0.63 (0.55–0.73)</td>
<td>0.41 (0.36–0.48)</td>
<td>0.49 (0.42–0.57)</td>
<td>0.71 (0.64–0.79)</td>
<td>0.72 (0.65–0.80)</td>
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<td><strong>Level of agricultural employment (c)</strong></td>
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<tr>
<td>Less agricultural employment</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
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<tr>
<td>More agricultural employment</td>
<td>0.83 (0.72–0.96)</td>
<td>1.04 (0.90–1.19)</td>
<td>3.25 (2.78–3.78)</td>
<td>2.81 (2.46–3.21)</td>
<td>2.08 (1.81–2.38)</td>
<td>2.18 (1.83–2.60)</td>
<td>1.52 (1.36–1.70)</td>
<td>1.80 (1.61–2.01)</td>
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<td><strong>% Literate</strong></td>
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<td>Low (d)</td>
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<tr>
<td>Middle</td>
<td>1.97 (1.67–2.34)</td>
<td>2.64 (2.19–3.18)</td>
<td>2.36 (1.97–2.83)</td>
<td>3.22 (1.12–1.57)</td>
<td>1.92 (1.61–2.38)</td>
<td>1.42 (1.19–1.68)</td>
<td>1.94 (1.70–2.20)</td>
<td>1.66 (1.44–1.91)</td>
</tr>
<tr>
<td>High</td>
<td>4.28 (3.54–5.17)</td>
<td>6.41 (5.17–7.94)</td>
<td>5.24 (4.26–6.46)</td>
<td>2.18 (1.77–2.69)</td>
<td>2.65 (2.15–3.26)</td>
<td>3.30 (2.66–4.10)</td>
<td>1.55 (1.33–1.79)</td>
<td>1.97 (1.66–2.34)</td>
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<td><strong>% Agricultural pesticide use</strong></td>
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<td>Low</td>
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<tr>
<td>Middle</td>
<td>1.52 (1.32–1.76)</td>
<td>1.76 (1.52–2.03)</td>
<td>2.83 (2.44–3.27)</td>
<td>2.73 (2.39–3.12)</td>
<td>1.27 (1.10–1.47)</td>
<td>1.52 (1.33–1.74)</td>
<td>1.44 (1.29–1.61)</td>
<td>1.50 (1.34–1.69)</td>
</tr>
<tr>
<td>High</td>
<td>0.69 (0.57–0.82)</td>
<td>0.79 (0.66–0.95)</td>
<td>2.26 (1.83–2.77)</td>
<td>2.09 (1.74–2.51)</td>
<td>0.99 (0.81–1.19)</td>
<td>1.03 (0.85–1.24)</td>
<td>1.30 (1.13–1.51)</td>
<td>1.33 (1.14–1.55)</td>
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<tr>
<td><strong>% Hindu religion</strong></td>
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<td>Low</td>
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<tr>
<td>Middle</td>
<td>0.74 (0.63–0.87)</td>
<td>0.82 (0.70–0.94)</td>
<td>1.38 (1.18–1.62)</td>
<td>1.15 (1.00–1.33)</td>
<td>1.78 (1.54–2.07)</td>
<td>1.81 (1.58–2.09)</td>
<td>0.82 (0.73–0.92)</td>
<td>0.98 (0.87–1.10)</td>
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<tr>
<td>High</td>
<td>0.92 (0.76–1.10)</td>
<td>1.02 (0.89–1.22)</td>
<td>2.13 (1.75–2.59)</td>
<td>2.23 (1.88–2.65)</td>
<td>1.71 (1.40–2.05)</td>
<td>2.18 (1.83–2.60)</td>
<td>0.68 (0.59–0.78)</td>
<td>0.95 (0.82–1.09)</td>
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</table>

(a) Relative Risk (RR) adjusted for age group, period, level of economic development, level of agricultural employment, % literate, % pesticide consumption, % Hindu religion.
(b) Less developed areas: Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh, Uttarakhand, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura.
(c) Areas of higher agricultural employment: Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Jharkhand, Karnatka, Madhya Pradesh, Maharashtra, Odisha, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal.
(d) ‘Low’ is lowest 20% of the population, ‘Middle’ is middle 60% of the population, ‘High’ is the highest 20% of the population.
country, have recorded some of the lowest suicide rates among both sexes (Patel et al., 2012; Arya et al., 2018; Dandona et al., 2018). A higher proportion Hindu population was also associated with higher suicide risk for suicide by insecticide poisoning and self-immolation. Self-immolation among Hindus, especially among women, holds cultural significance in India (Vijayakumar, 2009). Suicide by hanging, however, showed no association between suicide risk and the proportion Hindu.

There are some methodological limitations when considering the findings of the current study. Firstly, it is acknowledged that suicide enumerated via the NCRB likely under-estimates total suicide cases in India (Patel et al., 2012; Dandona et al., 2018), given the social stigma, as well as legal ramifications associated with reporting suicidal behaviour (attempted suicide was illegal in India until 2017) (Section 309 in The Indian Penal Code; Vijaykumar, 2007; Behera et al., 2015). Specific suicide methods, such as suicide by poisoning, also may be more likely to be under-enumerated as suicidal intent is more difficult to ascertain in comparison to, for example, suicide by hanging (Gunnell et al., 2013). Furthermore, pesticide poisoning suicides might also be underestimated due to their misclassification as ‘other poisoning’ suicides in the NCRB data. The NCRB suicide data suggests such misclassification for the year 2015 where ‘insecticide poisoning’ suicides note a sharp upward trend coinciding with a sharp downward trend in ‘other poisoning’ suicides (Web Appendix 8). Further investigation of this potentially artefactual misclassification is required when more recent data for years post-2015 become available. However, in general, both, ‘insecticide poisoning’ and ‘other poisoning’ note a downward trend from 2001–2014. Secondly, the study derives population and covariate estimates from two census years with inter-censal years interpolated, potentially under-estimating any non-linear trends in the covariates included in analyses. Additionally, the identified socio-demographic factors were specified as ecological variables for each region (that is as a proportion of the corresponding population), which limits the attribution of associations of these characteristics to individuals residing within these regions.

Suicide by hanging is the leading method of suicide in India for both males and females, and has increased substantially in the most recent period. This has occurred in the context of declines in suicide by insecticide poisoning, and stable overall suicide rates in males and females. The prominence of media reports and fictional portrayals of suicide by hanging in India may be areas of priority for suicide prevention initiatives. Suicide by insecticide poisoning also remains an important priority for prevention, especially in more agricultural regions where accessibility to pesticides is more common, and a continuation of restricting access (through sales and import mechanisms) to hazardous pesticides is likely to be an effective prevention strategy. Suicide has emerged as an important public health issue in India, and current study findings indicate that the geographic and socio-demographic heterogeneity of suicide methods will need to be considered in future strategic responses and the prioritisation of suicide prevention activity.

Funding

This work was supported by Australian Government Research Training Program Scholarship which has been awarded to Vikas Arya as part of his doctoral research.

Conflict of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2019.07.005.

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Author/s:
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Title:
Suicide by hanging is a priority for suicide prevention: method specific suicide in India (2001-2014)

Date:
2019-10-01

Citation:

Persistent Link:
http://hdl.handle.net/11343/268056

File Description:
Published version