

Suicide mortality in India: a nationally representative survey



Vikram Patel, Chinthanie Ramasundarahettige, Lakshmi Vijayakumar, J S Thakur, Vendhan Gajalakshmi, Gopalkrishna Gururaj, Wilson Suraweera, Prabhat Jha, for the Million Death Study Collaborators

Summary

Background WHO estimates that about 170 000 deaths by suicide occur in India every year, but few epidemiological studies of suicide have been done in the country. We aimed to quantify suicide mortality in India in 2010.

Methods The Registrar General of India implemented a nationally representative mortality survey to determine the cause of deaths occurring between 2001 and 2003 in 1·1 million homes in 6671 small areas chosen randomly from all parts of India. As part of this survey, fieldworkers obtained information about cause of death and risk factors for suicide from close associates or relatives of the deceased individual. Two of 140 trained physicians were randomly allocated (stratified only by their ability to read the local language in which each survey was done) to independently and anonymously assign a cause to each death on the basis of electronic field reports. We then applied the age-specific and sex-specific proportion of suicide deaths in this survey to the 2010 UN estimates of absolute numbers of deaths in India to estimate the number of suicide deaths in India in 2010.

Findings About 3% of the surveyed deaths (2684 of 95 335) in individuals aged 15 years or older were due to suicide, corresponding to about 187 000 suicide deaths in India in 2010 at these ages (115 000 men and 72 000 women; age-standardised rates per 100 000 people aged 15 years or older of 26·3 for men and 17·5 for women). For suicide deaths at ages 15 years or older, 40% of suicide deaths in men (45 100 of 114 800) and 56% of suicide deaths in women (40 500 of 72 100) occurred at ages 15–29 years. A 15-year-old individual in India had a cumulative risk of about 1·3% of dying before the age of 80 years by suicide; men had a higher risk (1·7%) than did women (1·0%), with especially high risks in south India (3·5% in men and 1·8% in women). About half of suicide deaths were due to poisoning (mainly ingestions of pesticides).

Interpretation Suicide death rates in India are among the highest in the world. A large proportion of adult suicide deaths occur between the ages of 15 years and 29 years, especially in women. Public health interventions such as restrictions in access to pesticides might prevent many suicide deaths in India.

Funding US National Institutes of Health.

Introduction

WHO estimates that nearly 900 000 people worldwide die from suicide every year, including about 200 000 in China, 170 000 in India, and 140 000 in high-income countries.¹ The Government of India relies on its National Crime Records Bureau (NCRB) for national estimates, and these report fewer suicide deaths (about 135 000 suicide deaths in 2010)² than is estimated by WHO. The reliability of the NCRB data is questionable because they are based on police reports and suicide is still a crime in India, which might affect the veracity of reporting.

Most public attention in India has focused on suicide in farmers.³ The age-specific and sex-specific death totals, rates, and risks, as well as the mode of suicide in India's diverse sociodemographic populations, are not well understood. Reliable quantification of the suicide deaths is timely because the Government of India's 12th Year Plan for 2012–17 includes strategies to tackle chronic disease and mental health.⁴ Here, we quantify suicide mortality within the ongoing Million Death Study (MDS) in India—one of the few nationally-representative studies of the causes of death in any low-income or middle-income country.^{5–7}

Methods

Study design

Details of the MDS design,^{5–7} assignment of the underlying causes of death, statistical methods, and preliminary results for various diseases and risk factors are available elsewhere.^{5,6,8–10} Briefly, the Registrar General of India divides India into 1 million small areas on the basis of the national census, which is done every 10 years. The Registrar General of India's Sample Registration System (SRS) randomly selected 6671 of these small areas (about 1000 people per area) from the 1991 census and monitored all births and deaths in 1·1 million homes from 1993 to 2003. Every home in which a death had been recorded between 2001 and 2003 was visited by one of 800 non-medical SRS field-surveyors to obtain information about the cause of death as well as marital status, occupation, alcohol use, and education. The underlying cause of each death was sought by an enhanced form of verbal autopsy, known as the routine, reliable, representative, re-sampled household investigation of mortality with medical evaluation (RHIME).^{5–7} The RHIME method is a structured investigation of events before the death, including a written report in the local language of the household. The two-page report was

Lancet 2012; 379: 2343–51

See [Comment](#) page 2318

The London School of Hygiene and Tropical Medicine, UK, and Sangath, India (Prof V Patel PhD); Centre for Global Health Research, St Michael's Hospital, Dalla Lana School of Public Health, and University of Toronto, ON, Canada (Prof P Jha DPhil, C Ramasundarahettige MSc, W Suraweera MSc); The Epidemiological Research Centre, Chennai, India (V Gajalakshmi MD); School of Public Health, Post Graduate Institute of Medical Education and Research, Chandigarh, India (J S Thakur MD); Society for the Natal Effect on Health in Adults, Chennai, India (L Vijayakumar MD); and National Institute of Mental Health and Neurosciences, Bangalore, India (G Gururaj MD)

Correspondence to: Prof Prabhat Jha, Centre for Global Health Research, St Michael's Hospital, Dalla Lana School of Public Health, and University of Toronto, Toronto ON M5B 1W8, Canada prabhat.jha@utoronto.ca

converted into electronic records and assigned randomly (with a computer-generated sequence) to two of 140 specially trained physicians (assignment was stratified only by physicians' ability to read the local language) who independently and anonymously assigned codes to the causes of death using guidelines for the major causes.¹¹ If the two physicians disagreed on the assigned three-digit code from the International Classification of Diseases, 10th Revision (ICD-10),¹² a senior physician adjudicated. About 5% of the deaths were re-sampled by independent teams. Full details of the methods, quality-control checks, and comparisons with hospital deaths have been reported previously, and suggest that the MDS provides classifiable causes of death reliably, especially for individuals younger than 70 years.^{5,13,14}

The deaths by suicide in this study were of all people who had died between 2001 and 2003 and whose causes of death were eventually assigned to ICD-10 codes X60 to X84 (intentional self harm). Interviewers, who were known to the communities from previous rounds of SRS field work, were trained to collect information about the causes of death from any close associate or relative of the deceased individual. The most common respondents for the 1599 men older than 15 years who died by suicide were one of their parents (351; 22%), their wife (328; 21%), or their neighbour (156; 10%); for the 1085 women older than 15 years who died by suicide, the most common respondents were one of their relatives apart from their husband (218; 20%), their husband (174; 16%), or their neighbour (131; 12%).

Analysis

We calculated national and state totals of suicide deaths (to inform health planners), age-standardised rates (to understand variation), and risks (to inform individuals). Analyses focused on individuals aged 15 years or older, because childhood deaths by suicide were rare. We applied the age-specific and sex-specific proportion of suicide deaths in the 2001–03 survey to the 2010 UN estimates of absolute numbers of deaths (and age-specific risks) for all causes in India. We used the 2010 UN totals of 9.8 million total deaths to provide contemporary comparisons with other diseases such as cancer¹⁰ and vascular disease. Moreover, the use of the UN totals corrects for the slight undercounts reported in the total death rates in the SRS^{15,16} and for the 12% of SRS deaths missed in the survey.⁶ The proportion of deaths from out-migration of the family from the surveyed unit or from incomplete records that accounted for these missed deaths were similar between states (as presumably were the proportions of these deaths from suicide). We partitioned the 2010 UN total deaths into state-specific total deaths by using the relative SRS death rates for 2007–09 using methods described earlier.^{8–10} We believe that the forward projection to 2010 will not introduce major biases, because the major determinant of state suicide totals (and age-specific risks) is the state-specific

number of all cause deaths, and these are drawn from the more contemporary 2007–09 SRS rates. All suicide rates were standardised to the estimated total Indian population for 2010. Classification of the causes of death and not random variation is the main source of uncertainty in our estimates. Thus, we calculated lower bounds for the total suicide deaths and age-standardised rates on the basis of the numbers of deaths that were immediately coded by both physicians as suicide (table 1), and we calculated the upper bounds on the basis of all deaths with suicide as the initial diagnosis by at least one coder.

We also did a case-control study to compare the risk factors for suicide with risk factors for other deaths. Cases were defined as all suicide deaths at ages 15–69 years (verbal autopsy yields a far greater proportion of classifiable deaths at these ages than deaths at ages 70 years or more, although misclassification of suicide at older ages is less than it is for other causes^{5,17}). Controls were all non-suicide deaths at these ages (exclusion of other injury deaths from the controls did not affect the results). We used logistic regression to compare the following variables for each sex: age at death (15–19 years, 20–29 years, 30–44 years, 45–59 years, 60–69 years), education (below primary, primary or middle, secondary or higher), geographical region (southern states, rest of India), occupation (unemployed, cultivator, agricultural labour, business person or professional), alcohol drinker or non-drinker, residence (rural, urban), and marital status (never married; married or remarried; widow, separated, or divorced); and, as a measure of community wealth, the household fuel type used (gas, electricity, or kerosene *vs* coal, firewood, or other) in each SRS unit.

Role of the funding source

The sponsor 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 had final responsibility for the decision to submit for publication.

Results

Of 95 335 deaths in individuals aged 15 years or older, 2684 were by suicide (table 1). Two physicians agreed on suicide as the cause of death at initial coding in about 86% of possible suicide deaths. The agreement rate was consistent across the age ranges for both sexes, irrespective of the type of informant (ie, household *vs* non-household)—the highest agreement was seen for hanging (88%) and the lowest agreement was seen for poisoning (53–57%; data not shown). Only 502 (19%) of the 2684 suicide deaths occurred in a health facility. 3275 of the deaths that were randomly selected for re-interview by independent teams were eventually matched to the same houses and individuals. Of these re-sampled deaths, 55 were coded as suicide deaths, 45 of which were recorded as suicide deaths in the original survey. Thus,

assuming that the re-sampled deaths are the standard comparison, the sensitivity of the SRS field survey was 82% (45 of 55) and its specificity was 75% (2409 of 3220).

We estimate that there were about 187 000 suicide deaths in India in 2010 in individuals aged 15 years or older (115 000 men, 72 000 women; table 1). Most of the deaths by suicide occurred at ages 15–69 years (110 000 men, 70 000 women). Of the surveyed deaths, only 57 people younger than 15 years died by suicide, and only 20 people older than 80 years died by suicide, so the cumulative risk shown for ages 15–79 years approximates an individual's lifetime risk. Thus, according to the 2010 suicide death rates we estimated, a 15-year-old person in India has a cumulative risk of 1·3% for dying from suicide before

they are 80 years of age, with greater risk in men than in women, and substantially greater risk in southern India than in the rest of India (table 1).

Of the total deaths by suicide in individuals aged 15 years or older, about 40% suicide deaths in men and about 56% of suicide deaths in women occurred in individuals aged 15–29 years (table 1). Suicide deaths occurred at younger ages in women (median age 25 years; IQR 20–36) than in men (median age 34 years; 24–47). The overall age-standardised suicide rate per 100 000 population at ages 15 years or older was higher for men than it was for women (table 1). The age-standardised rate per 100 000 people at all ages was 18·6 (upper bound 15·7, lower bound 19·8) for boys and

	Study deaths (2001–03)			All India (2010)			
	Numbers attributed to suicide/all deaths	Proportion of suicide deaths*	Two coders immediately agreed	All deaths/population (millions)	Estimated suicide deaths† (n [lower bound–upper bound for totals])	Suicide death rates per 100 000 population‡ (lower bound–upper bound)	Cumulative risk§
Men and boys							
0–14 years	28/13 645	<0·5%	23 (82%)	1·0/195	2300	1·19 (1·0–1·2)	0·02%
15–29 years	637/4725	13%	556 (87%)	0·4/177	45 100	25·5 (22·3–26·5)	0·40%
30–44 years	486/6817	7%	417 (86%)	0·6/130	35 700	27·4 (24·0–29·7)	0·81%
45–59 years	307/11 731	2%	257 (84%)	1·0/86	22 400	26·2 (21·4–29·3)	1·20%
60–69 years	98/12 120	1%	77 (79%)	0·9/28	6600	23·7 (18·6–27·6)	1·44%
≥70 years	71/18 732	<0·5%	60 (85%)	1·5/17	5000	30·2 (24·2–35·4)	1·71%
Men aged 15 years or older							
Southern states¶	724/13 430	5%	671 (93%)	1·0/94	50 600	52·9 (48·9–54·6)	3·51%
Rest of India	875/40 695	2%	696 (80%)	3·4/344	64 200	18·7 (15·0–20·3)	1·16%
Rural	1392/43 927	3%	1194 (84%)	3·3/303·3	95 100	31·5 (27·0–33·2)	2·05%
Urban	207/10 198	2%	173 (86%)	1·1/134·7	19 700	14·4 (12·1–15·6)	0·81%
All India	1599/54 125	3%	1367 (86%)	4·4/438	114 800 (98 200–12 400)	26·3 (22·5–28·4)	1·69%
Women and girls							
0–14 years	29/13 447	<0·5%	23 (79%)	1·1/179	3000	1·68 (1·3–1·7)	0·03%
15–29 years	667/4394	15%	585 (88%)	0·3/162	40 500	24·9 (21·6–25·7)	0·40%
30–44 years	252/4055	6%	222 (88%)	0·3/121	19 200	15·9 (13·8–16·6)	0·64%
45–59 years	85/6402	1%	73 (86%)	0·6/81	6800	8·4 (7·2–9·2)	0·77%
60–69 years	54/9016	1%	43 (80%)	0·7/29	3800	13·2 (10·4–14·5)	0·85%
≥70 years	27/17 343	<0·5%	27 (100%)	1·5/20	1800	9·1 (9·0–9·7)	0·99%
Women aged 15 years or older							
Southern states¶	457/10 236	5%	425 (93%)	0·8/97	29 500	32·2 (29·6–32·9)	1·76%
Rest of India	628/30 974	2%	525 (84%)	2·6/316	42 600	13·3 (11·1–13·9)	0·70%
Rural	931/33 793	3%	820 (88%)	2·6/293	57 800	20·4 (17·5–20·6)	1·08%
Urban	154/7417	2%	130 (85%)	0·8/120	14 300	12·0 (9·6–12·4)	0·60%
All India	1085/41 210	3%	950 (88%)	3·4/413	72 100 (62 400–75 400)	17·5 (15·2–18·4)	0·96%
Total (men and women aged ≥15 years)	2684/95 335	3%	2317 (86%)	7·8/851	186 900 (160 100–199 500)	22·0 (18·9–23·5)	1·32%

*Compared with all deaths, weighted by state and residence (urban vs rural). †Obtained by multiplying the UN estimated total deaths in 2010 by the weighted proportions from this study. ‡Suicide death rates for individuals aged 15 years or older are age-standardised to the 2010 estimated Indian population. §Cumulative risk for ages ≥15 years was calculated by summing the risk for ages 15–79 years, yielding the probability of death from suicide if there were no other causes of death—cumulative risk = $(1 - \exp(-5 \sum \text{rate}_i))$, where i =age group in 5-year age groups. ¶Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Puducherry, Lakshadweep, and Andaman and Nicobar Islands. ||Rural areas are those with population of less than 5000 or population density of less than 400 per km² or more than 25% of the male working population engaged in agriculture.

Table 1: Suicide-attributed deaths in the study and estimated national totals by age, sex, and region

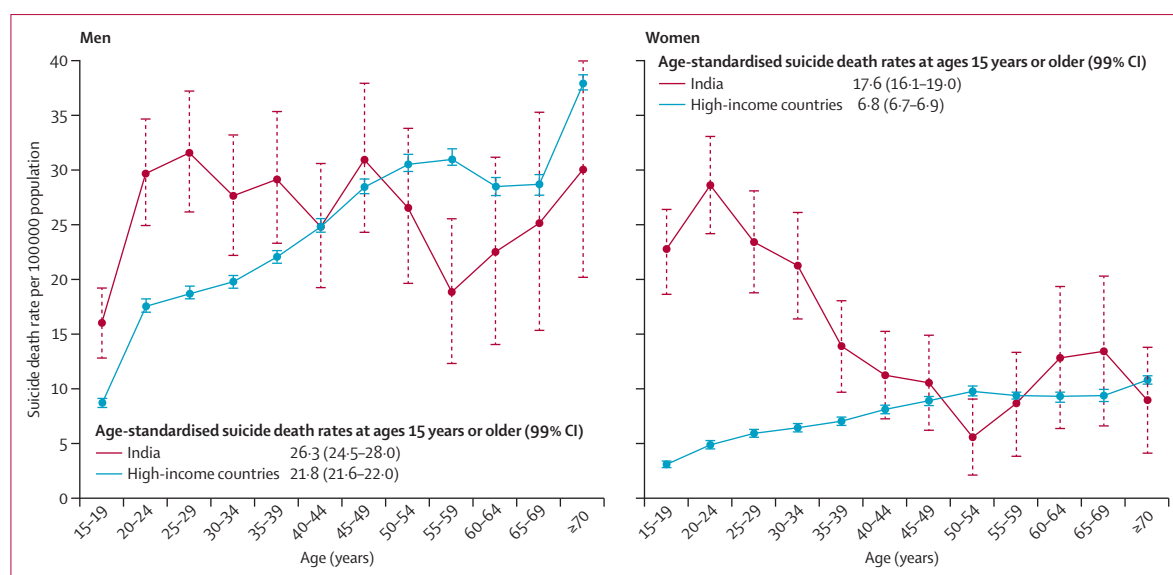


Figure 1: Age-specific suicide death rates in India and high-income countries

Vertical lines are 99% CIs. The rates for high-income countries (8.14 million deaths from all causes and 137 000 suicide deaths from a population of 977 million) are from WHO.¹ The respective age-standardised suicide death rates for male and female individuals of all ages are 18.6 and 12.7, in India and 21.8 and 6.8, in high-income countries.

	Estimated deaths in 2010 (n)	Contribution of each cause to the overall mortality*
Men		
Transport accidents	48 000	14%
Suicide	45 000	13%
Other unintentional injuries†	40 000	11%
Tuberculosis	34 000	10%
Cardiovascular diseases	25 000	7%
Total	192 000	54%
Women		
Maternal disorders	46 000	16%
Suicide	40 000	14%
Tuberculosis	30 000	11%
Unintentional injuries	29 000	10%
Cardiovascular diseases	20 000	7%
Total	165 000	56%

*Percentage to overall mortality was calculated after application of sample weights to adjust urban-rural differences for each state in the sample deaths.

†In men, other unintentional injuries include drowning (11%), falls (7%), and snakebite (7%); In women, unintentional injuries include fires (29%), transport accidents (18%), and snakebites (15%).

Table 2: Leading five causes of death in men and women aged 15–29 years from the first phase of the Million Death Study and their contribution to total mortality in 2010

men and 12.7 (10.7, 13.0) for girls and women. The suicide death rate in men aged 15 years or older varied little across age groups in comparison with that of women, which peaked at the ages of 15–29 years and decreased thereafter (table 1 and figure 1). At ages

15–29 years, suicide was the second leading cause of death in both sexes (table 2).

Most suicide deaths occurred in rural areas; the age-standardised death rates at ages 15 years and older were about two times higher in rural than in urban areas (table 1). The age-standardised suicide death rate per 100 000 people at ages 15 years or older varied substantially between states and was generally higher in the south of India (figure 2), ranging between 6.3 in Bihar and 66.3 in Kerala for men and 2.2 in Punjab and 39.7 in Tamil Nadu for women (appendix). In the absence of other causes of death, men aged 15 years or older have a lifetime risk of suicide of 2% or higher in the southern states of Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu, and women aged 15 years or older have a lifetime risk of suicide of 2% in Tamil Nadu (figure 2). More than 42% of suicide deaths in men and 40% of suicide deaths in women occurred in these four southern states, which together constitute 22% of India's population aged 15 years or older. Maharashtra and West Bengal together accounted for an additional 15% of suicide deaths. In absolute numbers, the most suicide deaths in individuals aged 15 years or older were in Andhra Pradesh (28 000), Tamil Nadu (24 000), and Maharashtra (19 000). In the MDS questionnaire, farming was not one of the recorded occupational categories. Therefore, we combined the categories of agricultural labour and cultivator (individuals who own the land on which they work) and defined them as agricultural worker, which included all farmers. However, suicide deaths in unemployed individuals and individuals in professions other than agricultural work were, collectively, about three times greater than they were in agricultural workers (appendix).

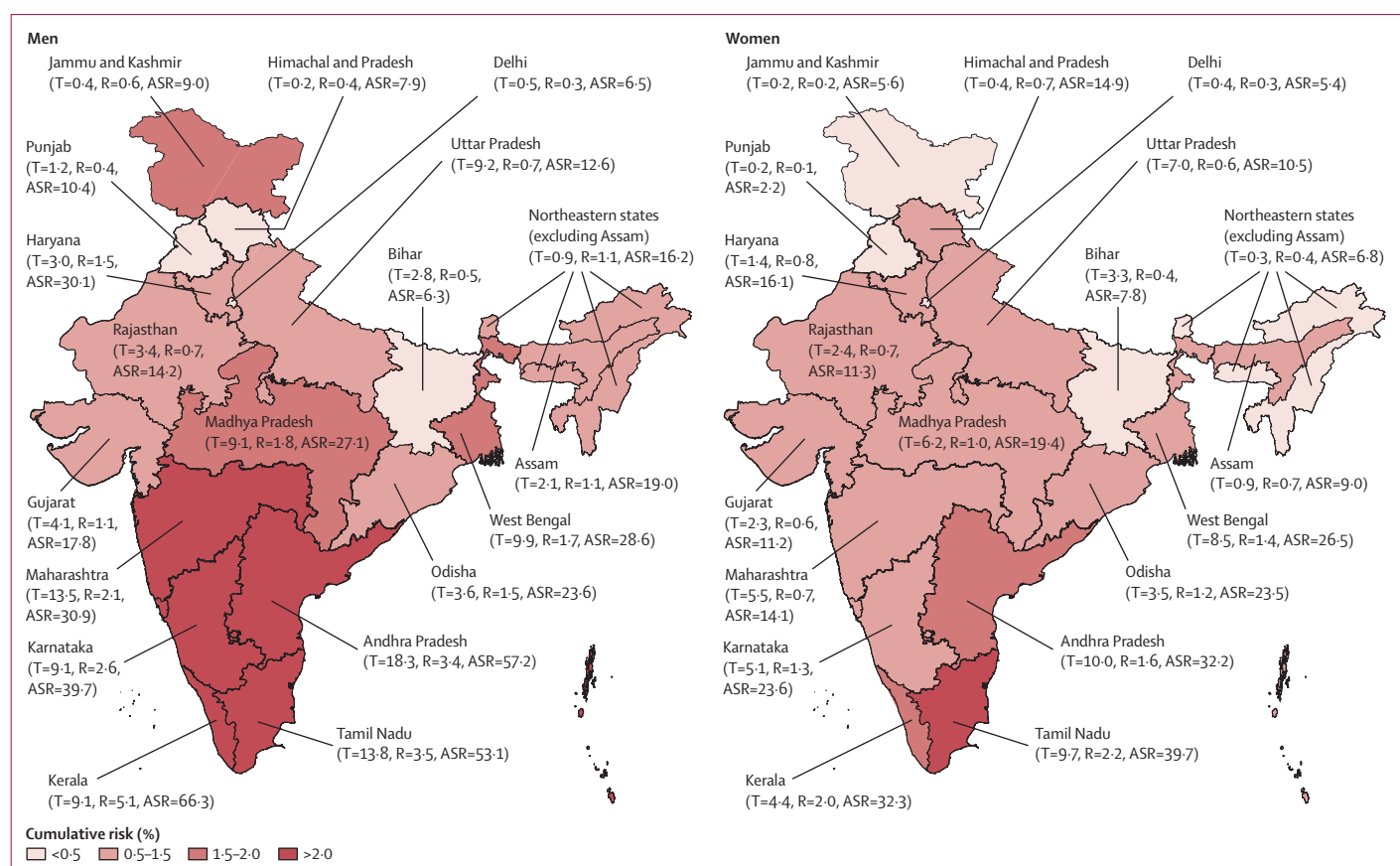


Figure 2: Risk of suicide, age-standardised suicide death rates, and total estimated suicide deaths in individuals aged 15 years or older in India (2010)
 ASR=age-standardised suicide death rate per 100 000 population. R=cumulative risk (%). T=estimated number of suicide deaths in 2010 (thousands).

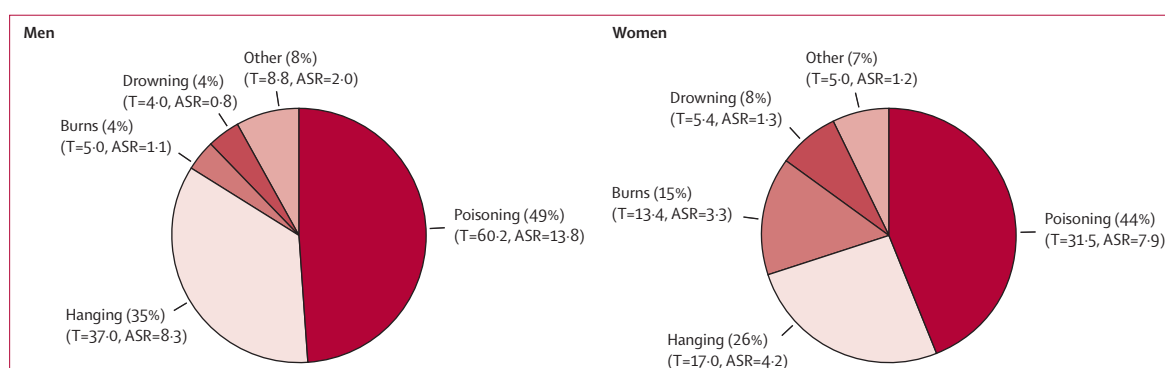


Figure 3: Methods of suicide in India

The proportions are based on the deaths of 1599 men (≥ 15 years of age) and 1085 women (≥ 15 years of age), with rates based on UN national totals of deaths for 2010. ASR=age-standardised suicide death rate per 100 000 population. T=estimated number of suicide deaths in 2010 (thousands).

Poisoning, mostly from pesticides (mainly organophosphates) used in agriculture, was the leading method of suicide in both men and women, corresponding to about 92 000 deaths nationally in individuals 15 years or older (figure 3). More than half (679) of the 1276 poisonings in the 2001–03 survey were classifiable (ICD-10 codes X60–X68) and 579 were unclassifiable (X69). Of classifiable poisonings, the vast majority (535)

were from pesticide poisoning (X68). A keyword search of the narratives among the unspecified poisonings suggested that an additional 75 were also due to pesticide poisoning. Hanging was the second most common method in both men and women; burns were a common method in women, accounting for about a sixth of suicide deaths in women (figure 3). Nearly three-fifths of suicide deaths (1498) occurred at home.

	Men			Women		
	Numbers attributed to suicide (N=1393)/ other deaths (N=31 351)	Proportion suicide/other deaths	Odds ratio of suicide versus other deaths (99% CI)*	Numbers attributed to suicide (N=964)/ other deaths (N=21 217)	Proportion suicide/other deaths (%)	Odds ratio of suicide versus other deaths (99% CI)*
Education						
Secondary or higher	231/4069	16%/13%	1.43 (1.1–1.8)	135/962	14%/4%	1.90 (1.4–2.6)
Primary or middle	594/8522	43%/27%	1.60 (1.4–1.9)	298/2929	31%/14%	1.43 (1.1–1.8)
Below primary	568/18 760	41%/60%	1.00 (–)	531/17 326	55%/82%	1.00 (–)
Region						
Southern states	624/7719	45%/25%	2.68 (2.3–3.1)	387/4688	40%/22%	2.96 (2.4–3.6)
Rest of India	769/23 632	55%/75%	1.00 (–)	577/16 529	60%/78%	1.00 (–)
Marital status						
Widower, divorced, or separated	51/3622	4%/12%	0.75 (0.5–1.1)	67/7181	7%/34%	0.64 (0.4–0.9)
Never married	464/4064	33%/13%	1.10 (0.9–1.4)	264/1694	27%/8%	0.92 (0.7–1.2)
Married or remarried	878/23 665	63%/75%	1.00 (–)	633/12 342	66%/58%	1.00 (–)
Occupation						
Unemployed	449/9644	32%/31%	1.16 (1.0–1.4)	648/14 799	67%/70%	0.86 (0.6–1.2)
Agricultural labour	151/2720	11%/9%	1.23 (0.9–1.6)	77/1464	8%/7%	0.84 (0.6–1.2)
Cultivator	282/7003	20%/22%	1.30 (1.1–1.6)	61/1822	6%/8%	1.17 (0.9–1.5)
Professional or business person	511/11 984	37%/38%	1.00 (–)	178/3132	19%/15%	1.00 (–)
Alcohol use						
Yes	627/10 585	45%/34%	1.84 (1.6–2.2)	35/1102	4%/5%	0.95 (0.6–1.5)
No	766/20 766	55%/66%	1.00 (–)	929/20 115	96%/95%	1.00 (–)
Residence						
Rural	1216/25 301	87%/81%	1.45 (1.1–1.9)	826/17 642	86%/83%	1.07 (0.8–1.5)
Urban	177/6050	13%/19%	1.00 (–)	138/3575	14%/17%	1.00 (–)
Household asset (fuel type)						
Coal, firewood, or other	1225/25 989	88%/83%	1.20 (0.9–1.6)	850/18 011	88%/85%	1.31 (0.9–1.8)
Gas, electricity, or kerosene	168/5362	12%/17%	1.00 (–)	114/3206	12%/15%	1.00 (–)

*Odds ratios adjusted for age (five age categories) and for the other variables in the model. The analysis excluded 229 (8%) suicide cases and 4106 (7%) other deaths with missing or unknown values.

Table 3: Risk factors for suicide versus other deaths in men and women aged 15–69 years in India

Poisonings were the most common method for suicide deaths in health facilities, and hangings and poisonings were the two leading methods for suicide deaths at home (appendix).

A higher education level (compared with below primary education) and residency in south India (compared with residency in the rest of India) were associated with an increased risk of suicide at ages 15–69 years versus other causes of death in both men and women (table 3). Drinking alcohol and an occupation of agricultural work were associated with the risk of suicide in men, whereas being widowed, divorced, or separated were associated with a slightly decreased risk of suicide in women (table 3).

Discussion

Findings from our nationally representative survey of causes of deaths in India show that suicide is an important cause of death, especially in young people aged 15–29 years (panel). Studies from high-income countries typically show male-to-female suicide death ratios of about three to one.¹⁸ In our study, the male-to-female

suicide death ratio was about one and a half to one at all ages, and about the same in young adults aged 15–29 years. The age-standardised suicide rate in Indian women aged 15 years or older is more than two and a half times greater than it is in women of the same age in high-income countries¹ and nearly as high as it is in China.^{1,19} The suicide rate in men aged 15 years or older is about 1.2 times greater than it is in men of the same age in high-income countries.²⁰ In view of the steady decreases in maternal mortality from 1997–2009,²¹ suicide will probably become the leading cause of death in young women in India in the next few years.

Our estimated national total of suicide deaths in individuals aged 15 years or older of 187 000 is close to the upper uncertainty range of WHO's indirect estimates based on disease models (about 170 000 [uncertainty range 155 000–185 000] in 2004).¹ The regional suicide death rates are also broadly consistent with, or lower than, the death rates recorded in smaller regional studies, most of which are from south India.^{22–25} The suicide totals and death rates are, as expected, much higher than those

reported from official police crime statistics. Comparison with our data suggests that NCRB underestimates suicide deaths in men by at least 25% and women by at least 36%, with many of the under-reported suicide deaths occurring in women and men aged 15–29 years and in women aged 60 years or older (appendix). The main method of suicide was poisoning, mostly from use of organophosphate pesticides used in agriculture, as has been noted in other Asian countries.²⁶ Suicide death rates were higher in rural India than they were in urban India, perhaps because of the higher availability of pesticides combined with poorer access to emergency medical care in the rural areas.²⁷ Although most suicide deaths occur in rural areas, our findings do not suggest that suicide is any more prevalent in agricultural workers (including farmers) than it is in any other profession (appendix).

The southern states have nearly a ten times greater age-standardised suicide death rate than some of the northern states. A difference between the north and the south remained after adjustment for education and mode of suicide (poisoning vs all others methods). The substantial regional variations seen in our study are, however, much less than those reported by the NCRB.²⁸ The incorrect reporting of suicide deaths as homicides is unlikely to explain these sharp regional differences in view of the fact that the absolute number of homicide deaths is about 20% of the total number of suicide deaths (appendix). Furthermore, most suicide deaths in each of the southern states were reported in the local language and not in Hindi or English or other regional languages from adjacent states (data not shown). This fact suggests that migration to the southern states does not explain the higher rates of suicide in each of these southern states. Studies from south India have shown that the most common contributors to suicide are a combination of social problems, such as interpersonal and family problems and financial difficulties, and pre-existing mental illness.^{29–31} Suicidal ideation in Puducherry (near Tamil Nadu) is reported to be as common as it is in high-income countries.³² The high suicide rates in south India might therefore be partly attributable to a combination of prevalent suicidal thinking or planning and social acceptance of suicide as a method to deal with difficulties,³³ combined with ready access to highly lethal pesticides.

More suicide deaths occurred in richer states (many of which are in the south) and in individuals with higher levels of education compared with those who had below primary education. By contrast with these findings, in high-income countries, suicide death rates are greater in individuals with lower education.^{29,34,35} We recorded a reduced risk of suicide versus other causes of death in women who were widowed, divorced, or separated compared with married women and men, a finding consistent with China, but in contrast with the higher risks of suicide reported in formerly married women and men in the USA.³⁶

Panel: Research in context

Systematic review

We did a systematic review of PubMed with research terms “India” [abstract] AND “suicide” [abstract] AND “rates” OR “estimates” [all fields]. We identified 58 studies from 1976 to 2010, of which 51 were published after 1990. Only three studies used national data.^{41,44,45} We identified 11 small scale. The remaining studies were comments, correspondence, editorials, or studies comparing trends or rates with other countries. No studies were available that provide nationally representative data for rates and estimates for India.

Interpretation

To our knowledge, this study is the first to provide nationally-representative estimates and rates of suicide deaths in men and women in India. We estimated the age-specific and sex-specific suicide deaths and suicide death rates for India, for major states, and for rural and urban India. Our findings show that suicide is an important cause of avoidable deaths in India, especially in young adults. Suicide rates for both sexes are higher in rural areas than they are in urban areas, and suicide rates vary substantially between states. Poisoning was the leading method used in cases of death by suicide. Higher education and residency in southern India was associated with an increased risk of suicide.

Our study has some limitations. First, we might have underestimated suicide deaths, especially in women. Suicide is a crime in India, and suicide deaths of married young women are especially sensitive issues because her husband or his family are potentially held responsible if the suicide occurs within 7 years of marriage. However, the SRS field surveyors are well known in these communities because they have visited these communities every 6 months from 1993 to 2003. Moreover, field surveyors were trained not to ask obviously embarrassing questions. Therefore, the slightly lower specificity than sensitivity of the re-sampled suicide deaths might be expected; the resurvey teams were less well known to the community than were the SRS field team. This implies that stigma in the reporting of suicide might have affected our findings, possibly leading to an underestimation of the total number of suicide deaths in India. Second, some suicide deaths might have been misclassified in the verbal autopsy as unintentional deaths, especially for poisoning deaths and burns in women.³⁷ However, the variation in suicide rates between states had no association with the proportion of deaths from accidents or homicide (appendix). Moreover, the absolute numbers of homicides and burn deaths were small, suggesting that any misclassification in either direction would only marginally alter the national estimates of suicide deaths. Third, unlike in the NCRB, we did not classify the few suicide deaths in individuals with HIV as suicide, instead classifying them as HIV

deaths (because widespread access to HIV/AIDS treatment was not available during the survey period).⁸ Fourth, the NCRB police reports a 2.5% annual increase in reported suicide deaths from 2006 to 2010.²⁸ If this increase is a true increase in the incidence of suicide, then the national totals for 2010 might be underestimates. However, this increase might be attributable to under-reporting in earlier years rather than a true increase in the number of suicide deaths. Indeed, the age-specific patterns in the NCRB have changed little between 2000 and 2010, suggesting little change in suicide incidence during this period (appendix). Also, the proportions of suicide to total deaths in selected urban hospitals³⁸ seem to have been stable between 1999 and 2004. There have been a few public health initiatives for the prevention of suicide,⁴ which might be expected to increase reporting. Finally, we believe that the projection to 2010 does not introduce major biases because use of 2004 and 2010 UN totals yielded similar results (data not shown).

In India, suicide is the cause of about twice as many deaths as is HIV/AIDS,⁸ and about the same number as maternal causes of death in young women.²¹ However, unlike these two other causes of death, suicide attracts little public health attention. Most Indians do not have community or support services for the prevention of suicide and have restricted access to care for mental illnesses associated with suicide, especially access to treatment for depression, which has been shown to reduce suicidal behaviours.³⁹ Reductions in binge alcohol drinking through regulations, higher alcohol taxation, or brief interventions in primary care might also reduce suicide deaths in men and violence against women, a determinant of suicide in women.^{31,40,41} In the medium term, the most feasible strategy would be to reduce access to organophosphate pesticides along with public education to improve acceptance of restrictions to access.⁴² Urgent research is needed to explore the reasons for suicide in young people and the large regional variations seen in this study. These efforts should be paired with the implementation of comprehensive and evidence-based suicide prevention strategies.⁴³

Contributors

PJ and the academic partners in India (Registrar General of India-CGHR Collaborators) planned the Million Death Study in close collaboration with the Office of the Registrar General of India. VP, CR, and PJ did the statistical analyses. All authors contributed to data interpretation and critical revisions of the paper, and approved the final version. PJ is the study guarantor.

Conflicts of interest

We declare that we have no conflicts of interest.

Acknowledgments

A list of all Million Death Study Collaborators is given in the appendix. The study was supported by grants from the John E Fogarty International Center of the National Institutes of Health (R01-TW05991-01 and TW07939-01); the Canada Research chair programme and University of Toronto (to PJ); and the Wellcome Trust (Grant 091834/Z/10/Z to VP). The opinions expressed in this Article are those of the authors and do not necessarily represent those of the Government of India or the Office of

the Registrar General. We thank the Office of the Registrar General for the productive collaboration on the Million Death Study; David Gunnell and Arthur S Slutsky for their helpful comments and Colin Mathers for providing WHO mortality estimates.

References

- WHO. The global burden of disease: 2004 update. Geneva: World Health Organization, 2008.
- National Crime Records Bureau. Accidental deaths and suicides in India. New Delhi: Ministry of Home Affairs, Government of India, 2008.
- Mishra S. Farmers suicide in Maharashtra. *Economic and Political Weekly* 2006; **41**: 1538–45.
- Patel V, Chatterji S, Chisholm D, et al. Chronic diseases and injuries in India. *Lancet* 2011; **377**: 413–28.
- Jha P, Gajalakshmi V, Gupta PC, et al. Prospective study of one million deaths in India: rationale, design, and validation results. *PLoS Med* 2006; **3**: e18.
- Jha P, Jacob B, Gajalakshmi V, et al. A nationally representative case-control study of smoking and death in India. *N Engl J Med* 2008; **358**: 1137–47.
- Registrar General of India and Centre for Global Health. Causes of death in India, 2001–2003 sample registration system. New Delhi: Government of India, 2009.
- Jha P, Kumar R, Khera A, et al. HIV mortality and infection in India: estimates from nationally representative mortality survey of 1.1 million homes. *BMJ* 2010; **340**: c621.
- Dhingra N, Jha P, Sharma VP, et al. Adult and child malaria mortality in India: a nationally representative mortality survey. *Lancet* 2010; **376**: 1768–74.
- Dikshit R, Gupta PC, Ramasundarahettige C, et al. Cancer mortality in India: a nationally representative mortality survey. *Lancet* 2012; **379**: 1807–16.
- Sinha D, Dikshit R, Kumar V, Gajalakshmi V, Dhingra N, Seth J. Technical document VII: Health care professional's manual for assigning causes of death based on RHIME household reports. Toronto: Centre for Global Health Research, University of Toronto, 2006.
- WHO. The ICD-10 classification of mental and behavioural disorders. Geneva: World Health Organization, 1992.
- Kumar R, Thakur JS, Rao BT, Singh MM, Bhatia SP. Validity of verbal autopsy in determining causes of adult deaths. *Indian J Public Health* 2006; **50**: 90–4.
- Joshi R, Cardona M, Iyengar S, et al. Chronic diseases now a leading cause of death in rural India—mortality data from the Andhra Pradesh Rural Health Initiative. *Int J Epidemiol* 2006; **35**: 1522–29.
- Mari Bhat PN. Completeness of India's sample registration system: an assessment using the general growth balance method. *Popul Stud* 2002; **56**: 119–34.
- Sivanandan V. An assessment of the completeness of death registration in India over the periods 1975–1978 and 1996–1999 under the generalized population model: an analysis based on SRS data Mumbai, India. Mumbai: International Institute for Population Sciences, 2004.
- Gajalakshmi V, Peto R, Kanaka S, Balasubramanian S. Verbal autopsy of 48 000 adult deaths attributable to medical causes in Chennai (formerly Madras), India. *BMC Public Health* 2002; **2**: 7.
- Cantor CH. Suicide in the western world. In: Hawton K, van Heeringen K, eds. International handbook of suicide and attempted suicide. Chichester: John Wiley and Sons, 2000: 9–28.
- Phillips MR, Li X, Zhang Y. Suicide rates in China, 1995–99. *Lancet* 2002; **359**: 835–40.
- WHO. Suicide rates per 100 000 by country, year and sex. http://www.who.int/mental_health/prevention/suicide_rates/en/ (accessed Aug 8, 2011).
- Registrar General of India. Special bulletin on maternal mortality in India 2007–09. http://www.censusindia.gov.in/vital_statistics/SRS_Bulletins/Final-MMR%20Bulletin-2007-09_070711.pdf (accessed Aug 8, 2011).
- Gajalakshmi V, Peto R. Suicide rates in rural Tamil Nadu, South India: verbal autopsy of 39 000 deaths in 1997–98. *Int J Epidemiol* 2007; **36**: 203–07.
- Aaron R, Joseph A, Abraham S, et al. Suicides in young people in rural southern India. *Lancet* 2004; **363**: 111–18.

- 24 Joseph A, Abraham S, Muliyl JP, et al. Evaluation of suicide rates in rural India using verbal autopsies, 1994–99. *BMJ* 2003; **326**: 1121–22.
- 25 Abraham VJ, Abraham S, Jacob KS. Suicide in the elderly in Kaniyambadi block, Tamil Nadu, South India. *Int J Geriatr Psychiatry* 2005; **20**: 953–55.
- 26 Gunnell D, Eddleston M. Suicide by intentional ingestion of pesticides: a continuing tragedy in developing countries. *Int J Epidemiol* 2003; **32**: 902–09.
- 27 Jha P, Laxminarayan R. Choosing health: an entitlement for all Indians. Toronto: Centre for Global Health Research, 2009.
- 28 National Crime Records Bureau. Accidental deaths and suicides in India 2010. New Delhi: National Crime Records Bureau, Ministry of Home Affairs; 2011.
- 29 Manoranjitham SD, Rajkumar AP, Thangadurai P, Prasad J, Jayakaran R, Jacob KS. Risk factors for suicide in rural south India. *Br J Psychiatry* 2010; **196**: 26–30.
- 30 Vijayakumar L, Rajkumar S. Are risk factors for suicide universal? A case-control study from India. *Acta Psychiatrica Scandinavica* 1999; **99**: 407–11.
- 31 Maselko J, Patel V. Why women attempt suicide: the role of mental illness and social disadvantage in a community cohort study in India. *J Epidemiol Community Health* 2008; **62**: 817–22.
- 32 Borges G, Nock MK, Haro Abad JM, et al. Twelve-month prevalence of and risk factors for suicide attempts in the world health organization world mental health surveys. *J Clin Psychiatry* 2010; **71**: 1617–28.
- 33 Manoranjitham S, Charles H, Saravanan B, Jayakaran R, Abraham S, Jacob KS. Perceptions about suicide: a qualitative study from southern India. *Natl Med J India* 2007; **20**: 176–79.
- 34 Rehkopf DH, Buka SL. The association between suicide and the socio-economic characteristics of geographical areas: a systematic review. *Psychol Med* 2006; **36**: 145–57.
- 35 Phillips MR, Yang G, Zhang Y, Wang L, Ji H, Zhou M. Risk factors for suicide in China: a national case-control psychological autopsy study. *Lancet* 2002; **360**: 1728–36.
- 36 Kessler RC, Berglund P, Borges G, Nock M, Wang PS. Trends in suicide ideation, plans, gestures, and attempts in the United States, 1990–1992 to 2001–2003. *JAMA* 2005; **293**: 2487–95.
- 37 Jagnoor J, Ivers R, Kumar R, Jha P. Fire-related deaths in India: how accurate are the estimates? *Lancet* 2009; **374**: 117.
- 38 Registrar General of India. Medically-certified causes of death, statistical report: 2004. New Delhi: Government of India, 2007.
- 39 Patel V, Weiss H, Chowdhary N, et al. The effectiveness of a lay health worker led collaborative stepped care intervention for depressive and anxiety disorders on clinical, suicide and disability outcomes over 12 months: the Manas cluster randomized controlled trial from Goa, India. *Br J Psychiatry* 2012; **199**: 459–66.
- 40 Jacob KS. The prevention of suicide in India and the developing world: the need for population-based strategies. *Crisis* 2008; **29**: 102–06.
- 41 Mayer P, Ziaian T. Suicide, gender, and age variations in India: are women in indian society protected from suicide? *Crisis* 2002; **23**: 98–103.
- 42 Gunnell D, Fernando R, Hewagama M, Priyangika WD, Konradsen F, Eddleston M. The impact of pesticide regulations on suicide in Sri Lanka. *Int J Epidemiol* 2007; **36**: 1235–42.
- 43 Patel V. Commentary: preventing suicide: need for a life course approach. *Int J Epidemiol* 2007; **36**: 1242–43.
- 44 Lester D, Natarajan M, Agarwal K. Suicide in India. *Arch Suicide Res* 1999; **5**: 91–96.
- 45 Mayer P. Female equality and suicide in the Indian states. *Psychol Rep* 2003; **92**: 1022–28.