EDITOR'S CHOICE

Epidemiological transition in a rural community of northern India: 18-year mortality surveillance using verbal autopsy

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ABSTRACT

Background Information on causes of death is vital for planning of health services. However, vital events registration systems are weak in developing countries. Therefore, verbal autopsy (VA) tools were incorporated in a community-based surveillance system to track causes of death.

Method and Findings Trained fieldworker identified all deaths and interviewed a living relative of those who had died during 1992–2009, using VA, in eight villages of Haryana (11 864 populations). These field reports detailing events preceding death were reviewed by two trained physicians, who independently assigned an International Classification of Disease-10 code to each death. Discrepancies were resolved through reconciliation and, if necessary, adjudication. Non-communicable conditions were the leading causes of death (47.6%) followed by communicable diseases including maternal, perinatal and nutritional conditions (34.0%), and injuries (11.4%). Cause of death could not be determined in 6.9% cases. Deaths due to cardiovascular diseases showed a significant rise, whereas deaths due to diarrhoeal diseases have declined ($p<0.01$). Majority (90.0%) of the deceased had contacted a healthcare provider during illness but only 11.5% were admitted in hospital before death.

Conclusion Rising trend of cardiovascular diseases observed in a rural community of Haryana in India calls for reorientation of rural healthcare delivery system for prevention and control of chronic diseases.

INTRODUCTION

Cause-of-death information is an important planning tool for health services. However, most low- and middle-income countries lack well-established vital events registration systems.[1] In India, <25% of the deaths are registered.[2] Over two-third of the deaths occur at home, hence, medical certification of cause of death cannot be ascertained for majority of the deaths in the population.[3] Therefore, most developing countries have so far relied on modelling to estimate cause-specific mortality for health planning.[4 5]

Verbal autopsy (VA) is a reliable alternate tool for tracking causes of deaths in settings where coverage and quality of vital registration systems remain poor. Validity of VA has been shown to be satisfactory for generating population-level information on causes of deaths.[6–9] Therefore, VA method has been implemented in several sentinel mortality surveillance systems.[10] A nationally representative study, which used VA to determine causes of death during 2001–2003, has reported non-communicable diseases (NCDs) (42%) to be the leading cause of death in India.[11] However, reliable time trends on causes of death are not yet available to understand the pace of epidemiological transition among demographically diverse communities in India.

As risk factors and disease rates can have substantial heterogeneity especially in a large middle-income country like India, analysis of causes of death in various communities are needed to characterise epidemiological transition for identifying relevant policy priorities. Therefore, this study was aimed at ascertainment of the time trends in distribution of causes of death using VA methods so as to characterise the pace of epidemiological transition in a rural community of northern India.

MATERIALS AND METHODS

In 1992, a community-based surveillance system was set up in eight villages from Raipur Rani Block in Panchkula district of Haryana state in India, which had a population of 11 864. These villages were purposively selected as these were a learning site for Post Graduate Institute of Medical Education and Research. This relationship capacitated study investigators to ensure data quality and good coverage for the entire study period. Agriculture is the primary occupation of this population. Surveillance villages are located at about 3–5 km from the Community Health Centre and about 40 km from the state capital.

A trained 10th grade pass fieldworker visited key informants in each of the surveillance village every week. The key informants included village health volunteers, traditional birth attendants, childcare workers (*anganwadi workers*), health workers, school teachers, members of women's committee (*mahila mandal*) and village headman (*sarpanch*). All deaths reported in surveillance site were investigated using a two-page pretested semi-structured questionnaire. The questionnaire contained basic socio-demographic information such as social status (caste), age, sex, date of death, place of death, time of death, care seeking before death, followed by an open-ended section. A verbatim narrative report of the symptoms/signs and circumstances of death and medical care/treatment sought before death was recorded. Interviews were conducted in local language (*Hindi*) 1 month after the death to allow for the mourning period. Interviewees were close associates of the deceased, for example, spouse, parents, siblings, father/ mother/ bother/sister-in-laws, who were familiar with the events before the death.

The VA interview reports were used by two trained physicians independently to assign the underlying cause of death and a three digit code as per the International Classification of Disease 10th Revision. In case of disagreement on the underlying cause of death between the two physicians, adjudication was done independently by a third physician. Cause of death could not be determined in 6.9% of the deaths; most of these (60%) were in the age group of 60+ years.

Age and sex distribution of the population was obtained from the health workers who conduct a complete family census of the villages every 5 years. Cause-specific mortality was calculated for three time periods, that is, 1992–1997, 1998–2003 and 2004–2009. Causes of deaths were categorised into three groups. group II: NCD and group III: injuries - group II: NCD; and group III: injuries. Direct standardisation methods were used to take into account changes in age and sex composition of the population. 95% CIs were estimated for the directly standardised cause-specific mortality rates. Data were analysed using STATA software.[12]

RESULTS

Over a period of 18 years (1992–2009), 1440 deaths were recorded; 59.2% were men and 47.0% belonged to low-social status families. Most (90.0%) of the deceased had availed healthcare during the illness; 54.0% had consulted allopathic and 31.0% had contacted indigenous (*ayurvedic*) medical practitioners. Twelve per cent deceased were admitted in hospital before death, predominantly in government hospitals.

Age and sex composition of population has changed in the study community during the 18-year period (1992–2009). Crude birth and death rate have declined from 21.2 to 14.2 and 7.6 to 6 per 1000 population, respectively. Age-specific mortality has declined significantly in the age group of 0–4 years and 60+ years, but it did not change in the age group of 15–59 years (table 1). Infant mortality rate has declined from 75 to 53 and maternal mortality ratio has dropped from 2.3 to 1.4 per 1000 live births.

Overall, about 47.6% deaths were due to NCDs, 34.0% had died due to communicable diseases including maternal, perinatal and nutritional conditions, and 11.4% of the deaths were due to injuries. Of the 26 stillbirths, adequate VA reports were available for 19 births, and half of them had causes related to intra-natal period. Majority (53%) of stillbirths were related to factors associated to mother-like premature rupture of membranes, pregnancy-induced hypertension and obstructed labour.

As shown in table 2, perinatal conditions, respiratory infections and diarrhoeal diseases ranked highest among children younger than 5 years. Injuries were the most common cause of death in the age group of 15 to 39 years. Cardiovascular diseases (CVDs), cancers and chronic respiratory diseases were the leading causes of death among mature adults (40+ years). Deaths due to CVDs and injuries were higher among men, whereas diarrhoeal diseases and respiratory infections were more common among women. Out of the eight maternal deaths, five were due to postpartum haemorrhage.

Cause-specific mortality has changed significantly (figure 1). CVDs mortality rate has doubled in last 18 years ($p<0.05$). Mortality due to chronic respiratory diseases and cancers has not changed, but deaths due to genitor-urinary diseases have declined. Injury mortality also did not register significant change. Overall, deaths due to communicable diseases have registered an impressive decline. Diarrhoeal disease mortality has dropped by about 75% ($p<0.05$). Deaths due to respiratory infections have also declined by about 35%. The decline in diarrhoea and respiratory infections mortality occurred predominantly in children younger than 5 years, but mortality due to perinatal conditions did not change.

DISCUSSION

The global burden of disease and injury estimates had stated that India is undergoing health transition. This study confirms that rural communities in Haryana state are passing through demographic and epidemiological transition. Crude birth rate as well as death rate declined in the study community as is also the case in rest of Haryana state.[13] The proportion of people aged <5 years has declined in the population over the last 18 years. Deaths due to infectious diseases especially diarrhoeal disease mortality have registered a decline, whereas cardiovascular diseases were found to be rising in the study population, indicating epidemiological transition. Other rural areas of India may also be passing through epidemiological transition. A study from a rural community of southern India had also reported chronic non-communicable as leading cause of mortality.[14] The causes of death study in the sample registration system during 2001–2003 has reported about 40% of the deaths due to NCDs in rural areas of India. However, these studies did not provide time trends for causes of deaths.

In the present study, CVDs were found to be the leading cause of deaths. Previous studies conducted in the study area showed increasing prevalence of hypertension[15–17] with rising prevalence of overweight.[16] A study from urban slums of Kolkata has also reported cardiovascular mortality as a top cause of death followed by malignancies and respiratory ailments.[18] The social gradient in NCDs' risk factors seems to be changing in northern India.[17] It was interesting to find a significant decline in deaths due to genito-urinary diseases. Most of these conditions are related to benign enlargement of prostate in men. This could be due to a combination of decline in incidence of these conditions or

Table 1 Age and sex wise death rate per 1000 population per year in a rural community of Haryana, India

		1992–1997		1998–2003		2003–2009	
Age group (years)	Sex	Population	Death rate	Population	Death rate	Population	Death rate
0–4	Male	936	15.0	1029	11.7	809	11.5
	Female	896	15.8	785	13.2	655	8.4
5–14	Male	1195	1.1	1313	0.9	1442	0
	Female	1030	1.0	1132	0.9	1243	0.7
15–59	Male	3152	3.7	3462	3.4	3802	4.0
	Female	3113	1.9	3419	1.9	3755	2.0
60+	Male	331	67.0	364	60.4	400	54.2
	Female	440	32.6	483	29.7	530	29.6
All		11 093	7.6	11 987	6.6	12 636	6.0

Table 2 Top 10 cause-specific mortality rates per 1000 population per year by age and sex in a rural community of Haryana, India, 1992–2009

Causes (ICD codes)	Age (years)					Sex		
	0–4	5–14	15–39	40–59	60+	Male	Female	Total
Cardiovascular diseases (I00–I52, I60–I69, I70–I99, G81–83)	–	–	0.2 (21)	2.4 (57)	12.4 (190)	1.3 (145)	1.2 (123)	1.3 (268)
Diarrhoeal diseases (A00, A01, A03, A04, A06–A09)	2.4 (73)	0.1 (4)	0.04 (4)	0.1 (2)	3.3 (51)	0.6 (62)	0.7 (72)	0.6 (134)
Chronic respiratory diseases (J30–J99)	–	–	0.01 (1)	0.7 (17)	6.6 (101)	0.7 (77)	0.4 (42)	0.6 (119)
Malignant neoplasm (C00–C97, D00–D48)	–	–	0.12 (15)	1.5 (34)	4.4 (67)	0.6 (67)	0.5 (49)	0.6 (116)
Perinatal conditions (P00–P08, P10–P15, P20–P29, P35–P94, P96)	3.6 (113)	–	–	–	–	0.6 (67)	0.4 (46)	0.5 (113)
Respiratory infections (J00–J06, J10–J18, J20–J22, H65–H67)	2.1 (65)	0.02 (1)	0.1 (6)	0.04 (1)	1.1 (16)	0.4 (40)	0.5 (49)	0.5 (89)
Genito-urinary conditions (N00–N99)	–	–	–	0.5 (12)	3.3 (50)	0.5 (50)	0.1 (12)	0.4 (62)
Motor vehicular injuries (V01–V89)	0.1 (4)	0.05 (2)	0.2 (24)	0.6 (14)	0.6 (9)	0.4 (47)	0.1 (6)	0.3 (53)
Tuberculosis (A15–A19, B90)	–	–	0.04 (4)	0.5 (12)	2.4 (36)	3.0 (33)	0.2 (19)	0.3 (52)
Digestive system diseases (K20–K23, K25–K31, K35–K38, K40–K67, K70–K93)	0.2 (5)	0.1 (4)	0.1 (7)	0.4 (9)	1.6 (24)	0.3 (37)	0.1 (12)	0.2 (49)
Others*	0.7 (21)	0.1 (5)	0.8 (77)	3.5 (81)	13.2 (201)	2.1 (231)	1.5 (154)	1.8 (385)
All	9.2 (281)	0.4 (16)	1.6 (159)	10.2 (239)	48.7 (745)	7.8 (856)	5.6 (584)	6.7 (1440)

Dash (–) in cell means no death. Figure in parenthesis are number of deaths from 1992 to 2009.
*O00–O08, O10–O16, O20–O43, O47–O63, O67–O99, D50–D53, R50, E10–E14, F01–F99, G06–G73, G90–G99, M00–M02, M05–M09, M11–M14, M20–M36, M60–M99, Q01–Q99, D60–D64,W00–W99, X00–X59, Y40–Y89, Y00, Y09, Y35, Y36, Y10–Y34, R04–R17, R50–R64, R55–R99.
ICD, International Classification of Disease.

improved survival due to availability of safer transurethral resection procedure compared with the traditional prostate surgery.

Diarrhoeal diseases have shown a remarkable decline, but perinatal conditions still continue to be the leading cause of mortality among children younger than 5 years. Hence, specific health initiatives such as skilled care at the time of childbirth are needed. Respiratory infections still figure as a prominent cause of death. Overall, among all ages, more than one-third of deaths continue to be due to communicable conditions diseases, perinatal/maternal and nutritional conditions. It indicates that rural communities now face dual burden of communicable as well as NCDs.

The care-seeking pattern shows that although most of the deceased had consulted medical practitioners, but only a small proportion of them were admitted in hospitals (11.5%). Primary healthcare utilisation from public facilities improved from 17% to 27% in the last 10 years in rural area of the state.[19] However, in view of the rising burden of CVDs, healthcare availability will pose more challenges in future. Hence, now is the right time for investing resources in reorientation of the healthcare delivery system for prevention and control of CVDs. So far rural health services were geared to tackle communicable diseases, nutritional, perinatal and maternal conditions. A field trial has demonstrated the feasibility of implementing CVDs prevention

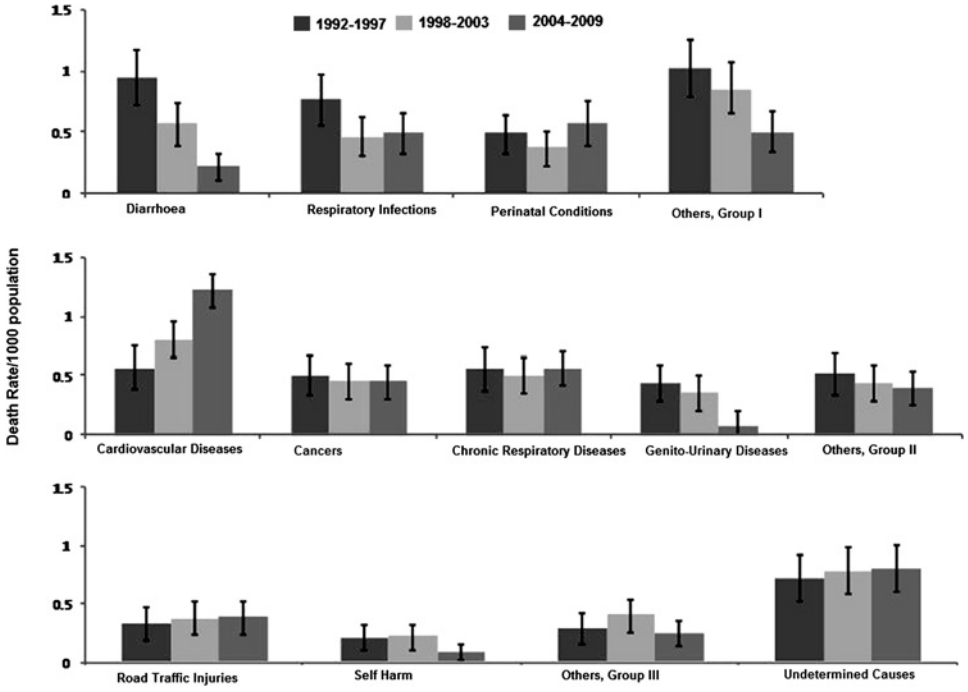

Figure 1 Time trends in cause-specific mortality standardised for age and sex in a rural community of Haryana, India, 1992–2009.

What is already known on this subject

- Indirect estimates suggest that mortality patterns are changing in low- and middle-income countries.
- Trends on causes of death have not been reliably measured in these countries as vital events registration systems are weak. Verbal autopsy is a reliable alternate method to ascertain cause of death.

What this study adds

- Eighteen-year surveillance using verbal autopsy revealed significant change in mortality pattern in a rural community of north India.
- Deaths due to infectious diseases like diarrhoea have declined, while cardiovascular disease mortality has risen.
- Epidemiological transition is underway in rural communities of north India.

and treatment model through non-physician health workers in rural primary healthcare setting.[20]

To conclude, a mortality surveillance system that incorporated VA methods revealed a rising trend of deaths due to cardiovascular diseases and a decline in deaths due to diarrhoeal diseases in a rural community of northern India. These results imply that these rural communities are undergoing epidemiological transition that calls for reorientation of healthcare priorities.

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Competing interests None.

Patient consent Obtained.

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