

Chronic diseases now a leading cause of death in rural India—mortality data from the Andhra Pradesh Rural Health Initiative

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Introduction India is undergoing rapid epidemiological transition as a consequence of economic and social change. The pattern of mortality is a key indicator of the consequent health effects but up-to-date, precise, and reliable statistics are few, particularly in rural areas.

Methods Deaths occurring in 45 villages (population 180 162) were documented during a 12-month period in 2003–04 by multipurpose primary healthcare workers trained in the use of a verbal autopsy tool. Algorithms were used to define causes of death according to a limited list derived from the international classification of disease version 10. Causes were assigned by two independent physicians with disagreements resolved by a third.

Results A total of 1354 deaths were recorded with verbal autopsies completed for 98%. A specific underlying cause of death was assigned for 82% of all verbal autopsies done. The crude death rate was 7.5/1000 (95% confidence interval, 7.1–7.9). Diseases of the circulatory system were the leading causes of mortality (32%), with similar proportions of deaths attributable to ischaemic heart disease and stroke. Second was injury and external causes of mortality (13%) with one-third of these deaths attributable to deliberate self harm. Third were infectious and parasitic diseases (12%). Tuberculosis and intestinal conditions each caused one-third of deaths within this category. HIV was assigned as the cause for 2% of all deaths. The fourth and fifth leading causes of death were neoplasms (7%) and diseases of the respiratory system (5%).

Conclusion Non-communicable and chronic diseases are the leading causes of death in this part of rural India. The observed pattern of death is unlikely to be unique to these villages and provides new insight into the rapid progression of epidemiological transition in rural India.

Keywords verbal autopsy, mortality surveillance, cause of death, chronic disease, rural India

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Many parts of India are undergoing rapid epidemiological transition as a consequence of economic and social changes.^{1–3} As these changes occur ongoing modification of the health system is required to ensure that the services provided address the main diseases suffered by the population. The Hyderabad-based Byrraju Satyanarayana Raju Foundation⁴ sponsors a rural development initiative in Andhra Pradesh which includes a significant health care component. The foundation is keen to ensure that the scarce resources available for health care are used to maximum effect and mortality data were identified as essential to the decision-making process.

Since precise, reliable, and up-to-date statistics about causes of death were not available for these villages or a close-by area, we established a cause of death surveillance system using a well-established verbal autopsy method.⁵ We report here the results from the first 12 months.

Methods

This work has been conducted as a collaboration (the Andhra Pradesh Rural Health Initiative) between five Indian and Australian institutions (listed in Acknowledgements). The data reported here were collected between 1 October 2003 and 30 September 2004. Approval for the project was received from the Ethics Committees of the CARE Hospital, Hyderabad, India and the University of Sydney, Australia. Informed consent was obtained from each respondent before the collection of any data and we sought to design and conduct the project in line with the Declaration of Helsinki and its subsequent amendments. For participants who could not read or write, the participant information sheet and consent form were explained by the Multipurpose Primary Healthcare Worker (MPHW) and a thumb print was taken.

Population studied

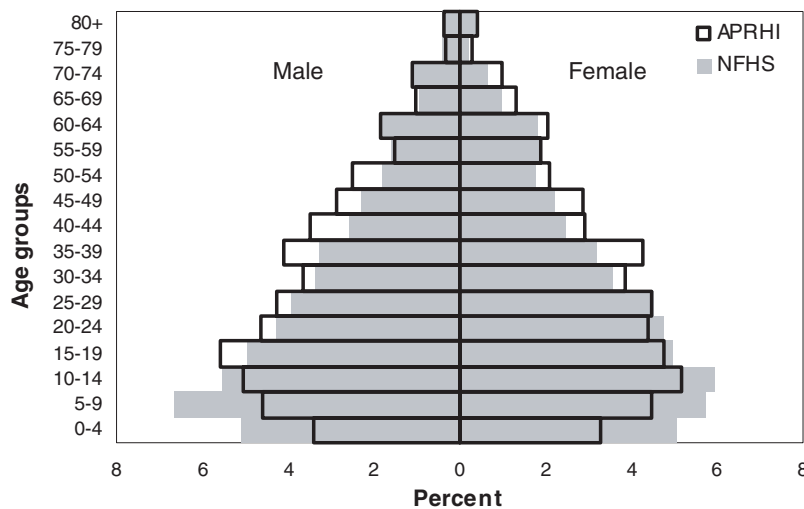
This project was conducted in 45 villages in East and West Godavari in Andhra Pradesh, India. The population ($n = 180\,162$) age and sex structure was defined by a population census conducted by the Foundation in 2002–03 and is shown alongside earlier state-wide estimates for rural Andhra Pradesh⁶ (Figure 1). From a concurrent survey done in the foundation villages it is known that ~54% of the population are literate, the average monthly household income is ~US\$50 dollars, and the majority of the population are labourers working in agriculture or aquaculture.

Identification of deaths

The Foundation MPHWS resident in each village was the primary mechanism for identifying deaths. Identification of deaths by the MPHWS was facilitated by her daily contact with the villagers and a network of key informants including the village headman, the 'Panchayat' (village governing body responsible for registration of deaths), priests and cremation staff, other community leaders, and the government MPHWS. The completeness of the identification process was checked between 25th April and 30th May 2005 by the field supervisor or MPHWSs visiting every house in every village and checking that all deaths that occurred in the period 1st October 2003 to 30th September 2004 had been recorded.

Data collection

For each death recorded, the Foundation MPHWS sought to visit the deceased's household within 4 weeks of the date of death. The family member or other carer best able to report on the events antecedent to the death was identified and a systematic inquiry into the events leading up to the death was made using a semi-structured verbal autopsy tool according to an established technique. The questionnaires used in this project were based on the validated verbal autopsy tools used in China,⁷ Tanzania⁸ and the Registrar General of India's Sample Registration System⁹ with modifications made to suit local terminology. Separate questionnaires were used for deaths in each of three age groups (0–28 days, 29 days to 15 years and 15 years onwards) and all included a series of structured questions and an open narrative section. The open narrative section was completed with the aid of systematic prompting by the MPHWS using a defined symptom list with specific inquiry about prescribed treatments, medical procedures, and associated documentation. The MPHWSs were trained in data collection before commencement of the study with refresher training after 6 months.



APRHI: Andhra Pradesh Rural Health Initiative
NFHS: National Family Health Survey 1997–98

Figure 1 Age and sex distribution of the population. The shaded bars indicate the age and sex distribution for rural Andhra Pradesh based on the 1997–98 National Family Health Survey.⁶ The clear outlined bars show the corresponding data for the study population for the year 2002–03

Cause of death assignment

Cause of death assignment was also done using validated materials and processes developed for the Registrar General of India's Sample Registration System.⁹ In brief, each verbal autopsy was assessed independently by two trained physicians who each assigned an underlying cause of death for all cases with immediate and contributory causes also assigned wherever possible. These physicians had several years of experience in coding verbal autopsies and had received training in verbal autopsies and ICD coding. Causes of death were selected from a restricted list derived from the 10th version of the international classification of disease (ICD-10).¹⁰ The causes selected for inclusion in the list comprise the main causes of death which it is considered that trained physician reviewers can reasonably assign on the basis of the information typically collected in a verbal autopsy. Assignment of the causes of death by the physicians was facilitated by a series of algorithms developed for the Sample Registration System.¹¹ In the event of disagreement between the underlying causes of death assigned by the two physicians, a third physician reviewed the evidence and decided upon the underlying cause.

Outcomes

The main outcomes for this study were rates of death by age and sex and the proportion of deaths in men and women attributable to main underlying causes defined by the chapter headings in the International Classification of Diseases version 10. Where >50 deaths fell within one grouping a further breakdown of the main components has been provided.

Analysis

The rates of death, overall and for each age and sex group, were calculated by dividing the relevant number of deaths by the number of individuals defined by the 2002–03 population census done by the foundation. These results are expressed as rates per 1000 for the 12 months between 1st October 2003 and 30th September 2004. Proportions of deaths were calculated by dividing the number of deaths attributed to a specific cause by the total number of deaths for which a verbal autopsy was done and these results are expressed as percent. Analyses were done using SPSS version 12.

Results

Identification of deaths and cause of death assignment

Between 1st October 2003 and 30th September 2004 there were 1354 deaths identified. Verbal autopsies were completed for 1329 (98%) deaths and a specific underlying cause of death was assigned for 1084 (82% of all verbal autopsies done). Of the 25 deaths for which verbal autopsies were not done, 6 families had migrated from the village before the verbal autopsy could be done, 5 were not willing to participate in the study, and respondents were not available for 14 deaths even after repeated visits to the household. The door-to-door survey uncovered only 29 deaths not identified previously by the MPHWS and most of these were in large villages where there had been turnover of the MPHWS during the surveillance period. For 18% of all verbal autopsies done a symptom code

was assigned because a definite cause of death could not be arrived at. The majority (73%) of those for whom no specific underlying cause of death could be assigned on the basis of the verbal autopsy were >60 years of age. A third physician was required to resolve a discrepancy between the underlying causes of death assigned by the two independent physician reviewers in 173 (13%) cases.

Death rates and proportions attributable to main causes

The population crude death rate was 7.5/1000 (95% confidence interval, 7.1–7.9) with an approximately log-linear increase in death rates with age for men and women from 5 years of age upwards (Figure 2). Rates of death for males exceeded those of females for all age groups except for deaths at 4 years of age or under.

The first leading cause of death in the villages was diseases of the circulatory system (32%) with comparable proportions of ischemic heart disease (14%) and cerebrovascular disease (13%) comprising the majority of deaths in this category (Table 1). The second most common cause of death was injury and other external causes of mortality (13%). One-third of all deaths attributable to injury were due to self-inflicted injuries, and one-fifth were due to falls. Infectious diseases (12%) were the third leading causes of death with tuberculosis and intestinal infections each accounting for one-third of deaths in this category. HIV was assigned as the cause in 2% of all deaths. The other main causes were neoplasms (7%) and diseases of the respiratory system (5%). These five leading causes of death accounted for two-thirds of all deaths.

Diseases of the circulatory system were responsible for a greater proportion of deaths in men although there was some variation in the pattern for the two major vascular causes (Table 2). External causes of mortality were also, overall, more frequent in males with greater numbers of deaths from transport accidents, deliberate self harm and contact with venomous animals and plants in men and only exposure to fire, smoke, and flame, and accidental drowning more common in women. There were comparable proportions of deaths from infectious and parasitic causes in each gender group since greater numbers of deaths from tuberculosis and HIV in men were balanced by greater numbers of deaths from intestinal infectious diseases in women. Neoplasms, in contrast, were almost twice as frequent in women as men. There was no difference between sexes apparent for diseases of the liver.

Overall, 60% of deaths occurred among individuals aged 60 years or over with the majority of the other deaths being among younger adults. Only 6% of deaths occurred at ages of 14 or less and the majority of these were among individuals aged <4 years. About one-quarter of all deaths attributed to diseases of the circulatory system, two-fifths of deaths from cancers, one-half of deaths due to infectious diseases, and two-thirds of all deaths due to external causes occurred at age 60 or less (Table 2).

Discussion

This study shows that chronic diseases and injuries are now the leading causes of death in East and West Godavari surpassing

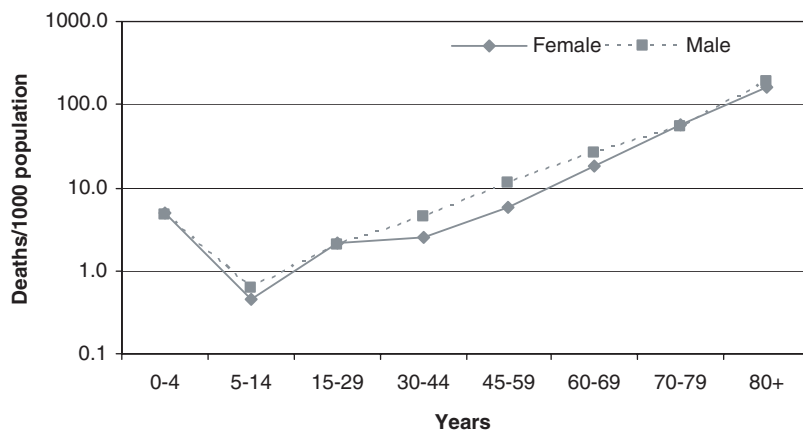


Figure 2 Log plot of death rates by age for men and women

by a considerable margin deaths attributable to communicable diseases and conditions of pregnancy and the puerperium. The data reported here also serve to highlight the premature age at which deaths from non-communicable disease and injury occur in developing regions such as India with a quarter of all deaths attributable to non-communicable diseases and injuries occurring at age 60 or less. Although some other data about causes of death are available for India,¹² the most current information regarding causes of death dates back to 1998¹³ and this is the first study to provide reliable information regarding causes of death across all age groups in a rural area. The crude death rate in this study is also directly comparable with the estimate for rural Andhra Pradesh (7.9, 95% CI: 7.4–8.3) provided by the Sample Registration System.¹⁴

Although correspondingly current information about the pattern of death in most other parts of rural India is not available, the findings of this project are in line with those observed in the earlier Andhra Pradesh Rural Cause of Death study¹⁵ and estimates made for India as a whole by the Global Burden of Disease Study.^{16,17} In both those studies chronic diseases were identified as leading causes of death with cardiovascular conditions predominating and both injuries and cancer among the leading few causes. A further recent study done in the neighbouring state of Tamil Nadu also documented a large proportion of rural deaths from chronic and non-communicable conditions although that study was not able to provide comparative data across age groups since it included only adult deaths.^{18,19}

Although the two districts of Andhra Pradesh included in this study are some of the better developed in the State, agriculture and aquaculture remain the primary employers and the districts are not dissimilar to many other parts of the country. In conjunction with the work of others,^{15,17,20} our data show that while infectious diseases remain the leading causes of death in the earlier years of life, injury and chronic disease predominate in older age groups where the great majority of deaths now occur. The preponderance of chronic and non-communicable causes of death in the study villages fits closely with the population age structure which shows recent lowering of fertility rates and a consequent increase in mean age. This has likely been driven by rapid economic and societal development along with the delivery of basic health services

such as vaccination programs and other maternal and child focused health care.

Among the communicable causes of death that were still widespread in the villages, gastro-intestinal infections and tuberculosis were prominent but so too was HIV/AIDS. HIV/AIDS was identified as the underlying cause of death in 2.2% of cases but this is likely to be an underestimate of the true proportion of deaths for which HIV/AIDS was a contributor. As in other societies, there are significant cultural sensitivities with regard to the reporting of HIV/AIDS and HIV/AIDS may well have been a contributor to other cases of deaths, in particular some of those attributed to tuberculosis.²¹ It would seem that HIV/AIDS could become a very serious problem in this area of India unless effective disease control strategies are rapidly implemented.

Though conditions like diabetes and hypertension do not feature in the overall causes of death in this population, these two conditions would contribute substantially to the high proportion of deaths due to ischaemic heart disease, cerebrovascular disease, and renal failure. Similarly, nutritional anaemia and malnutrition would have contributed towards deaths attributed to infectious diseases and the high proportion of deaths due to intentional self harm (5%) highlights a large unmet burden of depression and other mental disorders in the population.

Verbal autopsy methods have been used extensively in previous studies and remain a cornerstone of mortality surveillance systems in developing countries.^{20,22} Although the method was initially developed for child^{23,24} and maternal deaths,^{25,26} extension of the technique for use in deaths occurring across all age groups is now well established.^{27–30} In this study we used previously validated methods^{20,31} and careful training of the MPHWs in data collection with close supervision by a dedicated field coordinator. In conjunction with cause of death assignment done by experienced physician coders trained in the use of standardized procedures this should have ensured consistency and high quality across the project. Nonetheless, it was not possible to assign a specific cause for some 18% of deaths, a figure comparable with that observed in previous studies.^{20,32} Although it is difficult to be sure how better knowledge of these deaths might have influenced the findings it seems unlikely that it would substantively influence

Table 1 Causes of death overall and by sex

Causes of death	Number	Percent ^a		
		Female	Male	Total (95% CI) ^b
Circulatory system (I00-I99)	431	30	34	32 (30–35)
Ischaemic heart disease	183	11	16	14
Cerebrovascular disease	170	14	12	13
Others (Chronic rheumatic heart disease, Heart failure, Other unspecified disorders of the circulatory system)	78	5	7	6
External causes of mortality (S00-Y98)	177	12	15	13 (11–15)
Intentional self harm	64	4	5	5
Fall	35	3	3	3
Transport injuries	23	1	3	2
Accidental drowning	15	2	1	1
Exposure to smoke, fire, and flame	7	1	0.1	1
Contact with venomous animals and plants	11	0.2	1	1
Others	22	1	2	2
Infectious and parasitic diseases (A00-B99)	157	12	12	12 (10–13)
Tuberculosis	50	3	5	4
Intestinal infectious diseases	48	5	2	4
HIV	29	2	3	2
Others	30	2	2	2
Neoplasm (C00-D48)	97	10	5	7 (6–9)
Digestive organs	21	2	2	2
Lip, oral cavity, and oropharynx	14	2	1	1
Female genital organs	10	2	0	1
Respiratory and intrathoracic organs	7	0.3	1	1
Ill-defined and unspecified sites	18	1	1	1
Others	27	3	1	2
Respiratory system (J00-J99)	71	5	6	5 (4–7)
Chronic lower respiratory disease	42	3	4	3
Others	29	2	2	2
Digestive system (K00-K93)	63	5	5	5 (4–6)
Diseases of liver	46	3	4	4
Others	17	2	1	1
Genitourinary system (N00-N99)	38	3	3	3
Nervous system (G00-G99)	15	2	1	1
Conditions in the perinatal period (P00-P96)	14	1	1	1
Congenital malformations (Q00-Q99)	12	1	1	1
Pregnancy, childbirth, and the puerperium (O00-O99)	3	1	0	0.2
Blood/blood forming organs (D50-D89)	2	0.2	0.1	0.2
Endocrine, nutritional, and metabolic diseases (E00-E90)	2	0.3	0	0
Skin and subcutaneous tissue (L00-L99)	1	0.2	0	0
Mental and behavioral disorder (F00-F99)	1	0.2	0	0
Not elsewhere classifiable (R00-R99)	245	19	18	18 (16–21)
Sudden death	56	4	4	4
Ill-defined cause of death	101	8	7	8
Incomplete questionnaires	76	5	6	6
Others	12	1	1	1
Total	1329	100	100	100

^a Values above one rounded to nearest whole number and values less than one reported to one decimal place. Totals may not add precisely due to rounding.

^b 95% confidence intervals have been provided where 50 or more deaths were reported.

Table 2 Causes of deaths by age group

Causes of death	Number	Percent ^a				
		0–4 years	5–14 years	15–59 years	60+ years	15+ years
Circulatory system (I00-I99)	431	0	0	27	39	34
Ischaemic heart disease	183	0	0	15	14	15
Cerebrovascular disease	170	0	0	6	18	14
Others (Chronic rheumatic heart disease, Heart failure, and Other unspecified disorders of the circulatory system)	78	0	0	5	7	6
External causes of mortality (S00-Y98)	177	10	32	22	8	13
Intentional self harm	64	0	0	12	1	5
Fall	35	0	0	1	4	3
Transport injuries	23	3	0	4	1	2
Accidental drowning	15	3	16	1	1	1
Exposure to smoke, fire, and flame	7	0	0	1	0.4	1
Contact with venomous animals, and plants	11	2	5	1	0.4	1
Others	22	2	11	2	1	2
Infectious and parasitic diseases (A00-B99)	156	7	32	16	9	12
Tuberculosis	50	0	11	5	3	4
Intestinal infectious diseases	48	5	11	2	4	3
HIV	29	0	0	6	0	2
Others	30	2	11	2	2	2
Neoplasm (C00-D48)	97	2	5	9	7	8
Digestive organs	21	0	0	2	2	2
Lip, oral cavity, and oropharynx	14	0	0	1	1	1
Female genital organs	10	0	0	1	1	1
Respiratory and intrathoracic organs	7	0	0	1	1	1
Ill-defined and unspecified sites	18	0	5	1	2	1
Others	27	2	0	4	1	2
Respiratory system (J00-J99)	71	22	0	2	6	5
Chronic lower respiratory disease	42	0	0	2	4	3
Others	29	22	0	0.4	2	1
Digestive system (K00-K93)	63	5	5	6	4	5
Diseases of liver	46	3	5	4	3	3
Others	17	2	0	2	1	1
Genitourinary system (N00-N99)	38	0	0	2	4	3
Nervous system (G00-G99)	15	2	5	2	1	1
Conditions in the perinatal period (P00-P96)	14	24	0	0	0	0
Congenital malformations (Q00-Q99)	12	12	16	0.4	0	0.2
Pregnancy, childbirth, and the puerperium (O00-O99)	3	0	0	1	0	0.2
Blood/blood forming organs (D50-D89)	2	0	0	0.4	0	0.2
Endocrine, nutritional, and metabolic diseases (E00-E90)	2	0	0	0.2	0.1	0.2
Skin & subcutaneous tissue (L00-L99)	1	0	0	0.0	0.1	0.1
Mental and behavioral disorder (F00-F99)	1	0	0	0.2	0	0.1
Not elsewhere classifiable (R00-R99)	245	17	5	12	23	19
Sudden death	56	0	0	2	6	4
Ill-defined cause of death	101	10	0	3	10	8
Incomplete questionnaires	76	7	0	6	6	6
Others	12	0	5	1	1	1
Total	1329	100 (59)	100 (19)	100 (456)	100 (795)	100 (125)

^a Values above one rounded to nearest whole number and values less than one reported to one decimal place. Totals may not add precisely due to rounding.

our primary conclusions about the importance of chronic and non-communicable conditions in these villages. For example, one-quarter of the unclassified deaths fell into the category 'sudden death' and would likely have been due to cardiovascular causes³³ and more than three-quarters of the unclassified deaths were in the elderly among whom chronic and non-communicable conditions predominate. The pattern of death across the sexes was also broadly consistent with that observed for comparable projects for causes such as vascular disease, injuries,^{34–36} HIV,³⁷ and cancer³⁸ providing further reassurance about the likely validity of the findings reported here.

The implications of these study results are substantial. Hundreds of millions of individuals living in rural India are probably now at much greater risk of death from chronic or non-communicable conditions than from communicable diseases. The socio-economic impact of premature death due to chronic disease is enormous. The death of the main income earner in a rural household, at a relatively young age, has direct consequences on the welfare of the family drawing them into a downward spiral of poverty.³⁹ Although the primary healthcare system in rural India appears to have been very effective in dealing with the problems of infectious diseases and maternal and child health, it is less well equipped to deliver care and prevention for chronic diseases.⁴⁰ An urgent reorientation of the health delivery system is required to enable the implementation of evidence-based strategies that can address this new challenge of non-communicable conditions.

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KEY MESSAGES

- India is undergoing rapid epidemiological transition.
- Mortality pattern is an indicator of the consequent health effects but up-to-date, precise and, reliable statistics are few, particularly in rural areas.
- Chronic diseases and injuries are the leading causes of death in this part of rural India.
- Most deaths now occur amongst adults but a large proportion amongst adults under the age of 60.

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