The burden of disease in Zimbabwe in 1997 as measured by disability-adjusted life years lost

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The Burden of Disease in Zimbabwe in 1997 as measured by disability-adjusted life years lost

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Abstract

Objective To rank health problems contributing most to the burden of disease in Zimbabwe using Disability-Adjusted Life Years as the population health measure.

Methods The required epidemiological information for this exercise was derived from a variety of sources. Population size and total number of deaths by age and sex for the year 1997 were taken from an inter-censal survey. The cause of death pattern was determined based on the Vital Registration System, which was adjusted for underreporting of HIV and reallocation of ill-defined causes. Non-fatal disease figures were estimated based on local disease registers, surveys and routine health service data supplemented by estimates from epidemiological studies from other settings if no Zimbabwean sources were available. Disease and public health experts were consulted about the identification of the best possible sources of information, the quality of these sources and the data adjustments made.

Findings HIV infection emerged from the information collected as the single most serious public health problem in Zimbabwe responsible for 49% of the total disease burden. A quarter of the total burden of disease was attributed to morbidity rather than premature mortality. The share of the disease burden was marginally higher in females (50.4%) compared to males.

Conclusion Using to a large extent local sources of information, it was possible to develop plausible estimates of the size and the relative significance of the major health problems in Zimbabwe. The disease pattern of Zimbabwe varied substantially from regional estimates for sub-Saharan Africa justifying the need for countries to develop their own burden of disease estimates.

Keywords Disability-Adjusted Life Years; Health status indicators; Epidemiology; Information systems; Population health; Health policy; Health priorities; Zimbabwe (source: MeSH, NLM).

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Introduction

Making a decision on what set of health services to offer among a large number of possible health interventions is particularly difficult when the available government health budget is small in relation to the amount of health problems. The World Bank has developed a methodology to be used for the selection of a set of health interventions in developing countries (*1*, *2*). The two main components informing this priority setting process are the quantification of ill health in a population and the determination of costs and effects of health interventions. Interventions with favourable cost-effectiveness ratios and addressing major health problems are then suggested to make up a minimum package of health actions countries should provide (*2*, *3*).

In order to facilitate the quantification of diseases (first component), a new health status indicator was developed. The Disability Adjusted Life Year (DALY) is a summary measure of population health incorporating time lost due to premature death and healthy time lost as a result of non-fatal illness episodes (*4*, *5*). Four value choices are associated with this particular health measure. First, a premature death is defined as a death occurring before an age-and-sex specific limit based on a model life table corresponding to the highest observed life expectancies in the world in 1990. Second, the standard DALY indicator employs a non-uniform age weighting function of an inverted U shape so that the relative values of life years lost at different points in a life span are not all equal. As a third value choice, future health events are discounted at a rate of 3 percent. Finally, a set of disability weights has been developed to reflect the relative value of time lived in various compromised health states.

In recent years, the Zimbabwean public health care sector has increasingly faced problems meeting the demand for health services. Real per capita allocations from Government have decreased significantly (*6*). At the same time, an increase in demand for health services has arisen from various factors like a growing population (*7*) and the emergence of new, serious health threats (*8*). In order to provide an input to the priority setting process in this seriously resource constrained situation, a research project was conducted measuring the burden of disease in DALYs and the most cost-effective ways of addressing these problems. The present paper describes the first component of this study. It is the first study of its kind in Zimbabwe attempting to determine the overall level of ill health as well as the relative size of individual health problems taking into consideration both premature death and non-fatal illness episodes. We postulate that specific disease patterns in Zimbabwe are likely to be present so that lessons learned from studies conducted in other African countries such as Guinea (*9*) or regional estimates for Sub-Saharan Africa (*10-12*) do not necessarily apply to the Zimbabwean situation.

The main focus of the study was on assembling and critically evaluating the epidemiological information on mortality and morbidity in Zimbabwe. The epidemiological data utilised to calculate DALYs was based on sources already available rather than the collection of new data and various methods were used to assess the quality of available data sources. In addition, the relevance of the specific

value choices embedded in the DALY was briefly assessed for the Zimbabwean context.

Methods

Value choices

The specific value choices that characterised the DALY indicator used as part of the Global Burden of Disease Study (*5*) were applied also to the Zimbabwean study with few exceptions based on the following considerations. Firstly, while the standard life expectancies by age and sex suggested by the global study were considerably higher than the actual life expectancy in Zimbabwe (*7, 13*), the former were nevertheless maintained to facilitate comparison with other studies. Secondly, a study conducted among urban people in Zimbabwe on their views on the relative value of life years at different times in a lifespan showed general agreement with the inverted U-shape of the age-weighting function employed as part of the DALY (*14*). Thirdly, with respect to discounting, no attempt to elicit time preferences in the Zimbabwean population on present and future health consequences was conducted due to the general problems of obtaining stated preferences on this subject (*15, 16*). As an alternative method for determining the size of the discount rate for future health, expected increases in the level of health for future periods, typically measured as expected improvements in life expectancies, has been suggested (*17*). Using the most recent data from Zimbabwe, this would however indicate a negative discount rate for health (*7, 13, 18*). Since this was not considered an acceptable option, a discount rate of 3% as suggested by the global study was employed. Finally, the disability weights given in the Global Burden of Disease Study were utilised in the Zimbabwean study with a few exceptions. A ranking exercise among urban Zimbabweans was designed to broadly confirm or reject the global disability weights (*19*). The ranking of 22 indicator conditions was similar for the two studies particularly in the case of those respondents who were health professionals. Some discrepancies in the rankings were detected for non-professional respondents as compared to the Global Burden of Disease Study. As a result, the disability weights for two health problems, depression and infertility, were lowered and increased, respectively, for the Zimbabwean study.

Epidemiological data

Calculation of the national burden of disease in Zimbabwe using the DALY indicator required extensive epidemiological input. With respect to mortality information, the total number of premature deaths by age, sex and underlying cause was necessary. Furthermore, for the non-fatal component, the needed data incorporated the total number of non-fatal disease episodes, average age at onset and average duration by age, sex and type of disease episode. The following data sources were utilised for this study.

Mortality estimates

Population size and total number of deaths by age and sex for the year 1997 were derived from an inter-censal survey (*7*). These numbers were accepted for the present study with only minor adjustments (such as the smoothing of death numbers by age which formed peaks at certain ages resulting from digit preferences for reporting age of death in the survey). Death numbers by age and sex were used as constraints in the subsequent process of assigning causes of death so that the sum of deaths from individual causes was equal to this mortality "envelope" (*20*).

Information on causes of death was based on the Vital Registration System (VRS). At the commencement of the study in 1997, the most recent complete set of death certificates was the year 1995 and computerised VRS information including ICD-9 codes of causes of death was available up until 1991. A team of five nurses and data entry clerks was employed to convert all data (such as age, sex, residence and causes of death) from the around 76,000 death certificates of the registered deaths in 1995 into a computerised format. The nurses had been trained to attach ICD-9 codes to all diagnoses following the WHO coding rules (*21*) and an experienced clinician visited the nurses on a daily basis to discuss any problems arising during the coding.

For the present study, the computerised 1995 VRS data were subsequently adjusted in three respects in order to provide an estimate of the cause of death pattern in 1997.

{1} While 80% of all registered deaths had been certified by a physician, the remaining deaths had been seen only by the police assigning most deaths to the ICD chapter of symptoms, signs and ill-defined conditions (*21*). In an attempt to improve the information of the data set, specific diagnoses were attached to ill-defined causes by assigning reported symptoms to specific diseases following discussions with public health and clinical experts. The reallocations of deaths from unspecific to specific causes have been listed in Table 1.

(Table 1 here)

{2} An analysis of the data revealed that the patterns of age-specific mortality rates in 1995 for all deaths as well as selected diseases were significantly different as compared to similar VRS information from 1984 and 1989 (three examples have been shown in Figures 1-3). In the latter two years, the graphs showed the “normal” J shape with relatively high infant and early childhood mortality (0-4 years), very low mortality in the age groups from 5 years to 19 years and then moderate, gradual increases in mortality in all remaining age groups. Compared to this shape, the 1995 curve had sharply increased mortality rates from the age group 20-24 until the age group 55-59 as well as higher infant mortality rates. This pattern was in particular found for five common infectious diseases including lower respiratory infections, tuberculosis, diarrhoeal diseases, malaria and meningitis. (For other diagnoses, this difference was not found as exemplified by malignant neoplasms in Figure 4.) These specific characteristics suggested to Zimbabwean experts consulted that a large number of deaths in 1995 had been assigned a wrong (underlying) cause and that these diagnostic errors mainly resulted in too few HIV related deaths. Consequently, an underlying cause of HIV was reassigned to a number of deaths by assuming that 95% of the difference observed between the age-specific mortality rates for all causes in 1995 and 1984 (Figure 1) could be explained by HIV deaths. These deaths were retrieved from the five mentioned diseases again assuming that 95% of the difference in the age-specific mortality rates was caused by HIV, which resulted in the reallocation of 29% of all deaths. In addition, a further 11% of all deaths were allocated to HIV by subtracting proportionally from all individual diseases except injuries. Only a total of 14% of deaths registered in the 1995 VRS data was assigned with HIV, but adding the deaths reallocated from other diagnoses, the share of HIV had become 54%.

(Figure 1-4 here)

{3} The coverage of the Vital Registration System was most likely less than complete in 1995. (This claim could be supported by the fact that the number of registered deaths was less than half the estimate of deaths from the most recent census in 1997 (*7*)). The pattern of mortality by age, sex and underlying cause emerging from the VRS data of 1995 after the adjustments described above was therefore as a final step superimposed on the number of deaths by age and sex for 1997 estimated as described above (the mortality envelope). The scaling up was done in a completely proportional fashion except in two respects. First, we hypothesised that that VRS was close to being complete in the three largest urban areas so that nearly all the underreporting of deaths took place in rural areas (and minor urban areas). However, estimates of population changes in the major urban areas suggested that the number of deaths here might have increased by 8% from 1995 to 1997. Second, we believed that the degree of underreporting was relatively low for injury deaths (80% of all deaths assumed reported) due to more frequent police involvement in these cases. As a consequence of these assumptions, the death pattern by diagnosis in the rural areas had to be scaled up much more than the major urban areas to reach the limits defined by the mortality envelope and at the same time taking into account that injury deaths must not be increased with the same factor as the remaining causes.

Morbidity data

One of the sources utilised for the estimation of the morbidity component of the national burden of disease was the National Health Information System (NHIS) containing information on all encounters in Government and mission health facilities. Aspects of the quality of the information available were investigated through visits to the hospitals and health centres where these data originated. A team of medical doctors and other health professionals visited 16 randomly selected Government and mission hospitals as well as 38 health centres and outpatient departments. At each study site, reviews of primary sources of information such as various registries (i.e. inpatient admission/discharge books and outpatient register books) were conducted to find out if the activity statistics reported to the NHIS were correct. Further, a sample of 150 inpatient notes was reviewed at each site in order to assess the quality of the assignment of diagnoses. This exercise was carried out to capture errors arising, for instance, from diagnosing doctors refraining from using certain stigmatised diagnoses (i.e. HIV) even though clinical indicators pointed to this underlying health problem.

In order to complement the information from the routine sources described above, a review of the literature on epidemiological research studies on the prevalence and incidence of specific diseases was conducted through a search of Medline, Cochrane and other databases. In addition, visits to the major health research institutions of Zimbabwe were conducted in an attempt to identify unpublished research.

For some diseases, the above sources did not result in any useful information. Hence, prevalence and incidence rates and other necessary information from the Sub-Saharan Africa estimates of the 1990 Global Burden of Disease Study were used to fill in the gaps (*22*).

Reliance on expert opinion

As a final stage of the study, public health and clinical experts were invited to participate in a workshop during which all the information described above was presented. Experts were then divided into groups according to disease or disease grouping and tasked with scrutinizing the mortality estimates as well as estimating the number and types of disabling sequelae by cause, age and sex based on the available evidence as described above. These epidemiological estimates were assessed using the epidemiological tool, DisMod (*23*). This computer programme represents a mathematical model of the relationship between disease incidence, duration, remission, case-fatality and prevalence and was used for checking internal consistency of epidemiological estimates and to derive missing disease parameters. Inconsistencies identified were presented to and discussed with the experts so that adjusted estimates could subsequently be proposed.

Calculation of DALYs
These epidemiological figures were subsequently converted into DALYs lost by using the appropriate formula (*5*).

Results
An estimated total of 167,808 deaths occurred in 1997 of which 52% were males and 48% female. (This translated into a life expectancy at birth of 51.1 years in males and 47.0 year in females.) These premature deaths represented a total of 3.8 million Years of Life Lost (YLLs) in 1997 as shown in Table 2. HIV was responsible for 57% of the total YLLs. In comparison, all other single causes contributed much lower proportions to total YLLs. After HIV, the most important causes of YLLs included infectious, perinatal and nutritional causes of death prominent in childhood and two causes of largely adult deaths (tuberculosis - not caused by HIV - and road traffic accidents). These top 10 conditions were responsible for 82% of the total YLLs in 1997.

A loss of healthy years of life of 1.2 million Years Lived with a Disability (YLDs) was estimated for all conditions arising in 1997 (Table 2). The pattern of YLDs by underlying cause differed markedly from that of YLLs. Depression and anxiety disorders were the largest cause of YLDs followed closely by HIV. Other major non-fatal illness causes included a variety of maternal conditions, other sexually transmitted diseases and non-communicable diseases in adults. The ten most common causes contributed 68% of the total loss of healthy life measured as YLDs. Only two health problems of the top ten causes of YLDs, namely HIV and birth asphyxia/trauma, were also among the top ten causes of YLLs.

The total burden of disease in Zimbabwe due to health problems arising in 1997 was 4.9 million Disability-Adjusted Life Years (DALYs) lost as displayed in Table 2. In the year 1997, HIV stood out as the single most serious health problem accounting for 49% of the total burden of disease. The second most important health problem, depression and anxiety disorders, contributed 6% to the total amount of DALYs. Subsequent places in the ranking were infectious, perinatal and nutritional causes. A total of 74% of the burden of disease in 1997 was accounted for by the top ten conditions.

(Table 2 here)

Of the total burden of disease of 4.9 million DALYs lost, 24% emanated from non-fatal illness episodes. Males experienced a marginally greater proportion of the fatal burden (51% of YLLs) but less non-fatal burden (44% of YLDs) resulting in a slightly higher overall contribution to the burden of disease by women (50.4%).

The highest DALY rates were experienced in the youngest age group of 0-4 years followed by young adults in the 25 to 44 age range (Figure 5). Lower DALY rates were estimated for the two oldest age groups and the lowest DALY rates were experienced by the young age groups of 5-14 and 15-24 years. The gender differences in DALY rates were small.

(Figure 5 here)

Discussion

Valid information on the levels of suboptimal health and relative importance of diseases is an important input into a priority setting process for the health care sector in a seriously resource constrained setting. The present study attempted to provide this input by estimating the burden of disease caused by a large number of conditions using the DALY as a measure of population health.

While such a major undertaking may provide important insights into the disease picture of a given country, drawbacks of the general methodology for measuring the burden of disease must be recognised. One major problem is that the very extensive information required is not readily available in most developing countries (*24*). Data limitations were also very much present for the Zimbabwean study where population surveys and epidemiological studies were available only for a few health problems. Instead a process comprising the identification of the best possible sources of information, assessment of the quality of these sources followed by crude data adjustments and consultations with experts had to suffice.

Overall death figures for this study were based on a recent inter-censal survey. Population surveys like this are based on household interviews with senior members of the family, but this methodology may miss households that have recently been disbanded due to the deaths of senior members. Due to the severe HIV epidemic, this may not be an unusual occurrence. This might as a consequence have led an underestimate of the number of deaths.

The Vital Registration System in Zimbabwe was considered a valuable starting point for the estimation of the premature death burden by cause despite the fact that vital registration systems in sub-Saharan Africa were generally not considered optimal for providing epidemiological information on a population basis (*25, 26*). One reason for believing that the cause of death structure of the VRS data had high face validity was that 80% of all causes of deaths had been diagnosed by a qualified physician. In addition, hiring a team of experienced nurses and a clinician for the data entry ensured a high quality of the coding of causes from the (in most cases) verbal description on the death certificates. Having mentioned this, it was however still necessary to adjust the data based on assumptions that were considered probable but unverifiable in the short run. Among the most important assumptions was that 95% of the excess mortality observed between 1984 and 1995 should be attributed to HIV so that, as a consequence, the mortality rates of all other causes had remained stable from the

beginning of the 1980s up to start of this study. It could be argued that this might lead to an underestimation of HIV since a decrease in non-HIV causes of death could be expected following the general improved living standards in the first 10-15 years after independence in 1980. Further, it was assumed that the adjusted cause of death structure from 1995 was applicable also for 1997. Again this could have resulted in a relative underestimation of HIV since the epidemic was not believed to have peaked before 1997. Finally, we assumed that the cause of death structure in registered deaths was the same as the unregistered deaths. Problems with bias could be expected due to for instance differences in the tendency of registering between poorer and richer sections of the population.

Despite the aim of this study of founding epidemiological estimates on Zimbabwean sources, this was not possible in all cases. Gaps in the necessary data were present in particular when it came to the estimation of YLDs. In order to fill in these data shortages, the estimated rates from the 1990 GBD study for Sub-Saharan Africa (*22*) were applied to the Zimbabwean population. This strategy was necessary for cardiovascular diseases, cancers, digestive diseases, chronic respiratory diseases, musculo-skeletal diseases, congenital anomalities, genito-urinary diseases, oral conditions, injuries and for some neuro-psychiatric conditions. GBD estimates were discussed with experts disease by disease and adjusted if there were plausible reasons to assume lower or higher disease occurrence in the Zimbabwean context.

Examples of areas where reasonable local information was available included for instance stroke, malnutrition and depression where population surveys and epidemiological research studies had been conducted (*27-30*).

Having mentioned some of the most important weaknesses of the study, it was nevertheless the conviction of the research team that the results of the methods employed represented improvements over the (unadjusted) information available in 1997 on the relative importance of diseases in Zimbabwe. Several important insights and other benefits were derived from this study.

First of all, more plausible estimates of the extent of the HIV epidemic were arrived at as compared to the routine sources. HIV infection emerged from the information collected as the single most serious public health problem in Zimbabwe in 1997 compared to which all other conditions appeared relatively insignificant. Apart from the YLD component, HIV was clearly the greatest contributor to the burden of suboptimal health. Further, since HIV affected particularly young adults, this led to an unusual pattern of DALYs by age with a peak in young adulthood. This was a rather peculiar age pattern of disease especially compared to regions without a severe HIV problem (*20*).

Secondly, as noted also by similar studies in other countries and regions (*10, 31*), the Zimbabwean National Burden of Disease Study clearly highlighted the importance of including a morbidity component when trying to quantify health problems and determining the relative importance of diseases and injuries. Overall, the total YLDs constituted 24% of the total burden of disease, not a trivial share. In addition, certain conditions would lead mainly to morbidity episodes rather than premature deaths. For instance, depression and anxiety disorders, sexually transmitted infections and sense organ diseases caused very few deaths in 1997 while these conditions ranked as the

most important causes of DALYs lost. In other words, using a composite measure of morbidity and mortality such as the DALY demonstrated that several conditions without a significant burden due to premature death were in fact important health problems.

Thirdly, the results of the Zimbabwean burden of disease study illustrated the importance of conducting this kind of analysis for a specific country rather than assuming that regional estimates would provide a sufficiently similar pattern. For instance, epidemiological figures from a high mortality region of Sub-Saharan Africa (*20*) revealed that the share of the total DALYs lost was 24.8% due to HIV/AIDS, 5.4% for childhood-cluster diseases and 8.1% for lower respiratory infections whereas these same conditions were responsible for percentages 48.6, 0.1 and 3.3 respectively in Zimbabwe in 1997. In addition, the DALY rate pattern by age and sex in the Zimbabwean study was different from the pattern found in regional estimates (*20*). For instance, there was a much lower burden of DALYs in the youngest age groups (for both males and females) in Zimbabwe as compared to the African region reflecting a strong focus on child health services in the public health care sector over many years in Zimbabwe.

Finally, several areas for future work emerged from the study. One such area could be additional research on causes of unregistered deaths and disease incidence at population level for selected diseases in order to confirm some of the results described above. One possibility could be the utilisation of some of the rapid epidemiological tools like verbal autopsies (*32, 33*) and morbidity interviews (*34, 35*). Another desirable research topic would be a further assessment of the specific value choices contained in the DALY measure. For instance, the values of individual disability weights and the discount rate specified for the global study could be investigated through exercises conducted among Zimbabweans.

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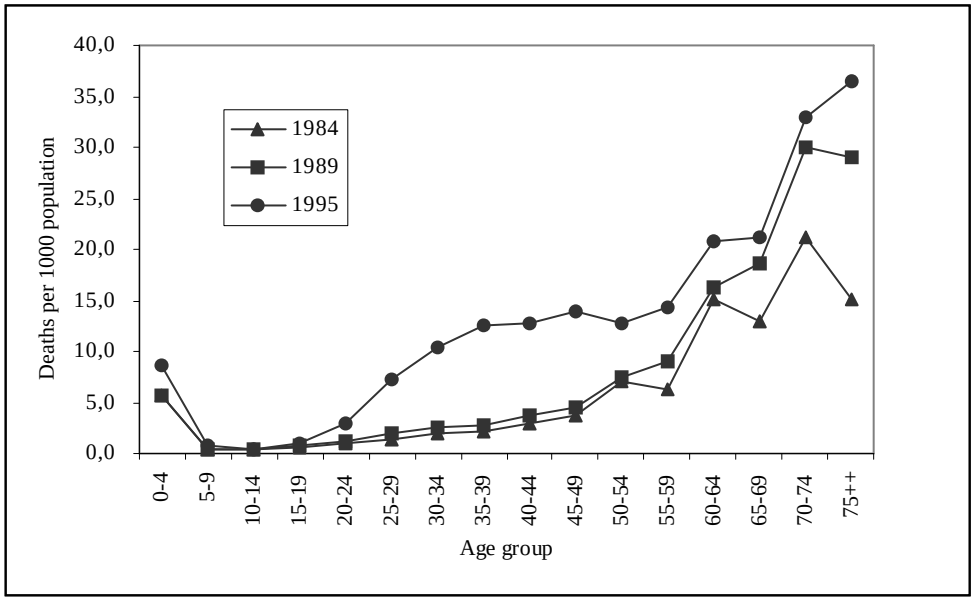
Table 1: Reallocation of deaths assigned a code from the "Symptoms, signs and ill-defined conditions" category (ICD-9 codes 780-799).

Condition (ICD-9 code)	Reallocated to:	Method of allocation:	Number of deaths
Ill-defined respiratory problems (786)	Tuberculosis Pneumonia	Proportionally across mentioned diseases	3,100
Ill-defined abdominal problems (789)	Diarrhoea Pelvic inflammatory disease Digestive disorders	Proportionally across mentioned diseases	2,576
Ill-defined head and neck problems (784)	Meningitis Malaria Stroke	Proportionally across mentioned diseases	1,103
Rest of ill-defined conditions (780-783, 785, 787, 788, 790-799)	All diseases excluding injuries and poisoning as well as external causes	Proportionally across mentioned diseases	6,905

Table 2: Total YLLs, YLDs and DALYs and distribution by top 20 underlying causes, Zimbabwe, 1997.

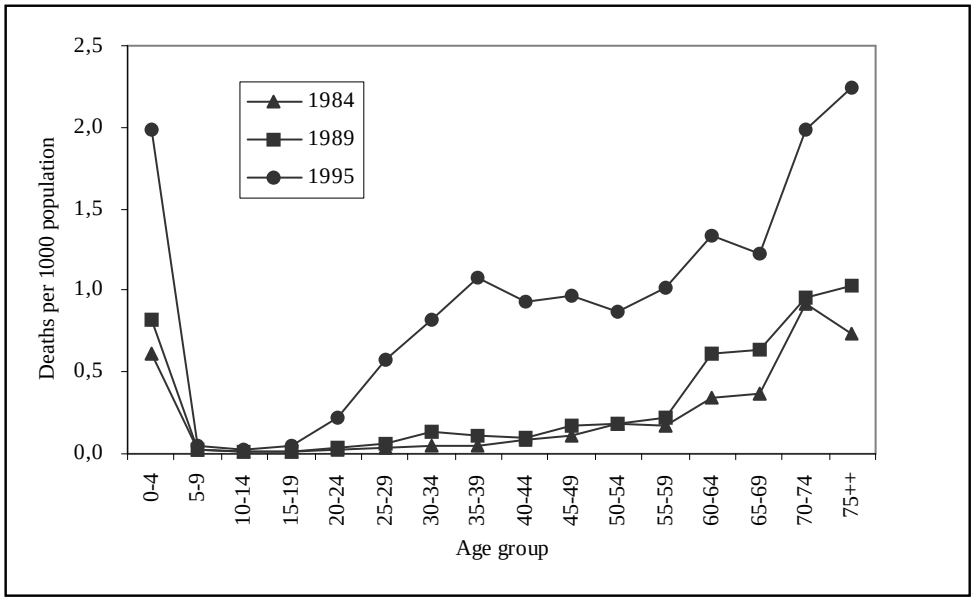
	YLLs		YLDs		DALYs
Total	3,753,474	Total	1,194,698	Total	4,948,172
Cause	%	Cause	%	Cause	%
HIV	56.9	Depression and anxiety disorders	23.1	HIV	48.6
Diarrhoeal diseases	4.4	HIV	22.4	Depression and anxiety disorders	5.6
Lower respiratory infections	4.4	Iron-deficiency anaemia	4.1	Diarrhoeal diseases	3.5
Low birth weight	4.2	Sense organ diseases	3.6	Low birth weight	3.4
Birth asphyxia and birth trauma	2.9	Maternal sepsis	3.5	Lower respiratory infections	3.3
Protein-energy malnutrition	2.6	STIs excluding HIV	3.4	Birth asphyxia and birth trauma	2.7
Malaria	2.2	Alcohol dependence	2.4	Protein-energy malnutrition	2.3
Tuberculosis	2.0	Obstructed labour	2.1	Malaria	1.8
Road traffic accidents	1.2	Birth asphyxia and birth trauma	1.9	Tuberculosis	1.6
Bacterial meningitis	1.1	Oral conditions	1.6	Road traffic accidents	1.1
Self-inflicted injuries	0.9	Osteoarthritis	1.6	STIs excluding HIV	1.0
Cerebrovascular disease	0.8	Chronic obstructive pulmonary disease	1.6	Iron-deficiency anaemia	1.0
Rheumatic heart disease	0.7	Epilepsy	1.3	Bacterial meningitis	0.9
Endocrine disorders	0.6	Protein-energy malnutrition	1.2	Maternal sepsis	0.9
Hypertensive heart disease	0.6	Asthma	1.2	Sense organ diseases	0.9
Cirrhosis of liver	0.5	Abortion	1.0	Self-inflicted injuries	0.8
Nephritis and nephrosis	0.5	Low birth weight	0.9	Cerebrovascular disease	0.7
Violence	0.4	Dementia	0.9	Endocrine disorders	0.6
Diabetes mellitus	0.4	Down syndrome	0.9	Alcohol dependence	0.6
Drownings	0.4	Falls	0.8	Rheumatic heart disease	0.6
All other conditions	12.4	All other conditions	20.6	All other conditions	18.2

Figure 1: Age specific mortality rates, all causes, Zimbabwe, 1984, 1989 and 1995.



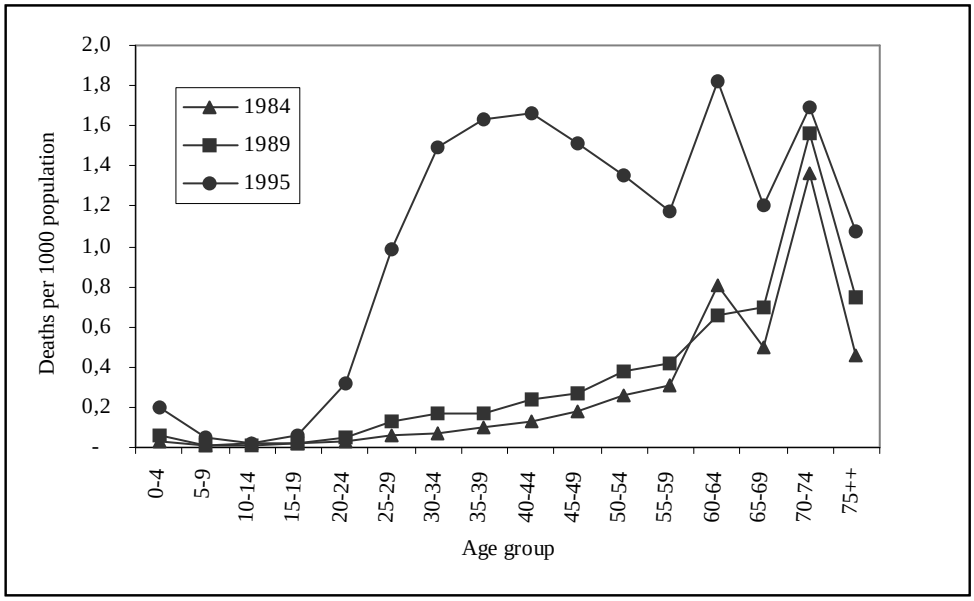
Source: Vital Registration System, Zimbabwe.

Figure 2: Age specific mortality rates, lower respiratory infections, Zimbabwe, 1984, 1989 and 1995.



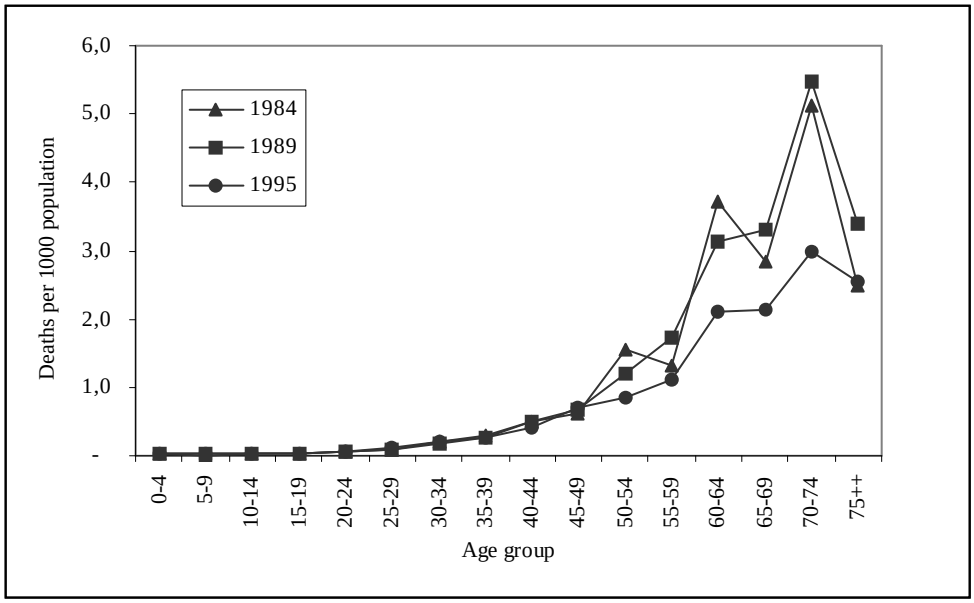
Source: Vital Registration System, Zimbabwe.

Figure 3: Age specific mortality rates, tuberculosis, Zimbabwe, 1984, 1989 and 1995.



Source: Vital Registration System, Zimbabwe.

Figure 4: Age specific mortality rates, malignant neoplasms, Zimbabwe, 1984, 1989 and 1995.



Source: Vital Registration System, Zimbabwe.

Figure 5. Number of DALYs lost per 1000 population by age group and sex, Zimbabwe, 1997.