(21 v 1.6), the lower limit of the 95% confidence interval (equivalent to the loss of 1 life per 1000) means that the compatibility of the results cannot be excluded. However, in their meta-analysis of all randomised clinical trials of prehospital treatment versus hospital treatment, the European Myocardial Infarction Project Group's point estimate of the benefit of treatment given one hour earlier is similar to that reported by Dr Rawles (17% (95% confidence interval 2 to 29), $P=0.03$).² Furthermore, Dr Rawles' report is the first to show that time to treatment favourably influences the benefit of fibrinolytic treatment on long term mortality, and it would be worth confirming in other studies or in a meta-analysis.

The clinical implication from Dr Rawles' paper remains that patients with suspected acute myocardial

infarction should be given fibrinolytic treatment as early as possible, but the precise magnitude of the benefit is still debatable.

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Outlook for survivors of childhood in sub-Saharan Africa: adult mortality in Tanzania

Henry M Kitange, Harun Machibya, Jim Black, Deo M Mtasiwa, Gabriel Masuki, David Whiting, Nigel Unwin, Candida Moshiri, Peter M Klima, Mary Lewanga, KGMM Alberti, Donald G McLarty on behalf of the Adult Morbidity and Mortality Project

Abstract

Objective—To measure age and sex specific mortality in adults (15-59 years) in one urban and two rural areas of Tanzania.

Design—Reporting of all deaths occurring between 1 June 1992 and 31 May 1995.

Setting—Eight branches in Dar es Salaam (Tanzania's largest city), 59 villages in Morogoro rural district (a poor rural area), and 47 villages in Hai district (a more prosperous rural area).

Subjects—40 304 adults in Dar es Salaam, 69 964 in Hai, 50 465 in Morogoro rural.

Main outcome measures—Mortality and probability of death between 15 and 59 years of age ($_{45}Q_{15}$).

Results—During the three year observation period a total of 4929 deaths were recorded in adults aged 15-59 years in all areas. Crude mortalities ranged from 6.1/1000/year for women in Hai to 15.9/1000/year for men in Morogoro rural. Age specific mortalities were up to 43 times higher than rates in England and Wales. Rates were higher in men at all ages in the two rural areas except in the age group 25 to 29 years in Hai and 20 to 34 years in Morogoro rural. In Dar es Salaam rates in men were higher only in the 40 to 59 year age group. The probability of death before age 60 of a 15 year old man ($_{45}Q_{15}$) was 47% in Dar es Salaam, 37% in Hai, and 58% in Morogoro; for women these figures were 45%, 26%, and 48%, respectively. (The average $_{45}Q_{15}$ s for men and women in established market economies are 15% and 7%, respectively.)

Conclusion—Survivors of childhood in Tanzania continue to show high rates of mortality throughout adult life. As the health of adults is essential for the wellbeing of young and old there is an urgent need to develop policies that deal with the causes of adult mortality.

Introduction

Since the late 1960s most public health programmes in the countries of sub-Saharan Africa have been directed towards reducing maternal, infant, and childhood mortality. Adult mortality has received much less attention, due partly to a widespread impression that

mortality in adults is low.¹ Indeed, at a recent World Bank workshop on health care priorities in East Africa it was stated that once a child reaches the age of 2 he or she will "likely live almost as long in an African country as in an industrialised country."² Increasing evidence, however, suggests that this may not be true; even after surviving the early years of life people in low income countries continue to face high risks of death throughout their lives.³

No country in mainland sub-Saharan Africa, including Tanzania, has a vital registration system that captures a sufficient number of deaths to provide meaningful death rates.⁴ Murray and Lopez have recently described probabilities of death specific for age and cause for adults aged 15 to 59 years in sub-Saharan Africa, but these were based solely on model estimates.⁵ The adult morbidity and mortality project was established in 1992 to measure rates, causes, and consequences of morbidity and mortality in adults in Tanzania. We describe the mortality and probabilities of death between 1 June 1992 and 31 May 1995 for 160 733 adults living in one urban and two rural areas of Tanzania.

Subjects and methods

SELECTION OF THE STUDY AREAS

In planning the project we chose three contrasting areas for surveillance: eight branches (described below) in Dar es Salaam, 59 villages in Morogoro Rural District, and 47 villages in Hai District (figure 1). To have sufficient power to analyse age, sex, and cause specific mortality we aimed to include about 20 000 households in each area. Dar es Salaam is Tanzania's largest city with a population of 1.5 million. Administratively the city is divided into districts, branches, and 10 cell units. The 10 cell unit is the smallest administrative unit, containing 10 or more households. A branch is roughly equivalent to a large village, containing about 2000 subjects. We chose eight branches in two of the three districts of the city, containing 16 123 households (65 826 people on 30 November 1993). The median household size was three people. The branches were chosen to cover a wide range of socioeconomic conditions.

Hai District lies on the southwestern slopes of

Ministry of Health, PO Box 9083, Dar es Salaam, Tanzania

Henry M Kitange, *specialist physician*
Deo M Mtasiwa, *district medical officer*
Gabriel Masuki, *district medical officer*
Harun Machibya, *district medical officer*
Mary Lewanga, *field supervisor*

c/o Redd Bama, PO Box 4581, Harare, Zimbabwe
Jim Black, *public health specialist*

Department of Medicine, Medical School, University of Newcastle upon Tyne, Newcastle upon Tyne NE2 4HH
David Whiting, *data manager*
KGMM Alberti, *professor of medicine*
Donald G McLarty, *professor of medicine*

Departments of Medicine and Epidemiology and Public Health, Medical School, University of Newcastle upon Tyne, Newcastle upon Tyne, NE2 4HH
Nigel Unwin, *Barclay lecturer in epidemiology*

Muhimbili Medical Centre, PO Box 65001, Dar es Salaam, Tanzania
Candida Moshiri, *statistician*

Dar es Salaam Urban Health Project PO Box 63320 Dar es Salaam Tanzania
Peter M Kilima, *director of preventive services*

Correspondence to: Professor D G McLarty, Muhimbili Medical Centre, PO Box 63320, Dar es Salaam, Tanzania.

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Figure 1—Location of three study areas

Mount Kilimanjaro and covers 13 000 square kilometres. The main economic activity is farming, but in contrast with Morogoro Rural District the district is comparatively wealthy, with much activity devoted to the production of cash crops. According to the 1988 national census the infant mortality in Hai was 60 per 1000 live births, the under 5 mortality 92 per 1000 live births, and the average regional maternal mortality 70 per 100 000 total births.⁶ The adult morbidity and mortality project study area includes 47 out of 61 villages in the district, comprising 142 414 people in 30 643 households (median household size four) on 30 November 1993.

Morogoro Rural District is 180 kilometres inland from Dar es Salaam and covers 19 250 square kilometres. Most of the people live by subsistence farming or by working on sisal plantations. The study area covers a continuous geographic area that includes 59 of 215 villages in the district, comprising 99 672 people in 25 149 households (median household size four) on 30 November 1993. The 1988 national census reported an infant mortality of 145 per 1000 live births, an under 5 mortality of 245 per 1000 live births, and an average regional maternal mortality of 199 per 100 000 total births.⁶

METHODS OF DATA COLLECTION

Enumeration of the study populations—The size, age, and sex structures of the denominator populations in the three areas were defined by regular censuses: twice a year in Dar es Salaam, and once a year in the other areas. In Dar es Salaam community development workers were seconded as enumerators. In the other areas health and education staff were recruited. All enumerators attended workshops in which they were taught how to conduct the census. Pilot censuses were conducted after training sessions. Entry errors and other problems were discussed with the enumerators before the main censuses. The first censuses (carried out in the first half of 1992) collected data from the head of household or other adult on the age, sex, smoking and drinking habits, education, and occupation of each resident in the household. Each person's relationship to the head of the household and the date and mode of his or her entry to the study area were also recorded. A household was defined as one or more people taking meals together. In the study areas this almost always meant residing together as well. Many houses, especially in Dar es Salaam, contained several different households. A resident was defined as some-

one who regarded the surveillance areas as their normal area of residence. Incoming migrants were regarded as residents if their intention was to stay in that area. People visiting during holidays, for example, were therefore regarded as non-residents. Subsequent censuses completely re-enumerated the areas and determined who had left the area (by migration or death) and who had entered the area (by migration or birth). During each census all completed forms were reviewed by a field supervisor, and those with obvious errors or inconsistencies were returned to the enumerators for correction. Forms were then sent to a central data centre at Muhimbili medical centre in Dar es Salaam. The forms were scrutinised a second time before entry by data clerks onto a database on microcomputer. The data entry process included numerous validity checks (for example, to query entries with household heads under 15 years) as well as checks of consistency within households (for example, entry of data for a child whose age differed from his or her mother's by less than 15 years provoked an error message). Forms with inconsistencies were referred back to the field for checking and correction. A further check on the accuracy of the data for individual households was made during subsequent censuses by cross checking with data collection in earlier censuses.

Ascertainment of deaths—A network of people was established in each of the study areas whose responsibility it was to inform a field supervisor of all deaths occurring in their areas. Locally known and respected people were selected for this task and included health workers, religious leaders, and undertakers. When a death was reported the field supervisor in that area visited the home of the deceased and carried out a "verbal autopsy." This entailed interviewing the family by using a standard proforma with the aim of determining the cause of death. (The use of verbal autopsy, its validation, and the results of analysis will be reported elsewhere.) Most were interviewed between two and four weeks after the bereavement to minimise problems of recall. In keeping with local tradition a small gratuity was paid to each family interviewed. Lists of all deaths identified during censuses were given to the area supervisor to check that these deaths had been previously reported in the active monitoring systems. Any additional deaths identified during the censuses were recorded by the supervisors. The number of deaths recorded in the active reporting system exceeded those recorded in the census as the reporting system captured, for example, perinatal deaths, bodies brought for burial, especially in the rural areas, and deaths of homecoming sick who moved in and died between censuses. Most bodies brought for burial in Hai were of non-residents, while in Morogoro Rural District around 30% of bodies were of residents who had gone for treatment outside the study area. In adults (ages 15-59) the exclusion of bodies brought for burial and homecoming sick resulted in a 79% to 93% agreement between the number of census and active reporting system deaths. Name matching has until now proved difficult.⁷

DATA ANALYSIS

"Adults" were defined as men and women between the ages of 15 and 59 years. This age group includes almost all those in society who are economically productive, biologically reproductive, and responsible for the support of children and elderly dependants.³

The mortality data were based on deaths ascertained in the study areas between 1 June 1992 and 31 May 1995. Bodies of non-residents brought for burial were excluded from the numerator. Homecoming sick were, however, included based on our definition of a resident. In Morogoro 238 (10.8%) of 2207 deaths in adults were of the homecoming sick and in Hai 285

Figure 2—Distribution of age at death (percentage) and population structure of project area compared with distribution of age at death and population structure in England and Wales

(19.2%) of 1488 deaths. (In Dar es Salaam the problem of homecoming sick is a much smaller problem. Movement of very sick people is generally out of the city to rural home areas). The denominator populations were based on the number of people known (based on the information collected at the censuses) to be resident in the three study areas on 30 November 1993, the mid-point between 1 June 1992 and 31 May 1995. It should be noted therefore that the denominator is a mid-point estimate of the total adult population and includes, for example, any homecoming sick identified in the censuses and known to be alive on the mid-point date. Age and sex specific mortalities are presented for adults in the three areas. Overall mortality for men and women in each area was age adjusted by using the age structure of the 1991 population of England and Wales.⁸ The rates are not based on probability samples but on monitoring the entire populations of three contrasting areas. For this reason

we did not feel it appropriate to undertake tests of significance, although we have provided confidence intervals on the crude and age adjusted rates.⁹ Life table analysis¹⁰ with death rates by 5 year age groups was used to compute the probability of death between the ages of 15 and 59 years ($_{45}Q_{15}$).

Results

Distribution of age at death—Figure 2 shows the percentage distribution of age at death and population structures of the three project areas compared with England and Wales.⁸ The distribution of age at death was similar in all three project areas and contrasted significantly with age at death in England and Wales. In Dar es Salaam almost 10% of all deaths occurred in the 25 to 29 year age group.

Age specific and age adjusted mortality—Between 1 June 1992 and 31 May 1995 4929 deaths were recorded in men and women aged 15-59 years in the three study areas. The number of deaths and death rates by 5 year age groups for men and women are shown in table 1 and compared with mortality in adults in England and Wales. Mortality in men, directly age adjusted to the 1991 male population of England and Wales, was 13.2, 9.7, and 18.1 per 1000 population per year in Dar es Salaam, Hai District, and Morogoro Rural District, respectively (table 1). Corresponding rates in women in the same areas were 13.3, 6.8, and 14.5 per 1000 per year. These rates compare with 2.5 per 1000 per year in men aged 15-59 in England and Wales in 1991 and 1.5 in women. Mortality rose progressively with age in men in all study areas, except in those aged 55 to 59 in Hai when it dropped slightly. In women in all study areas rates rose progressively with age up to 34 years but thereafter tended to plateau or fall slightly.

Sex differences in mortality—In Dar es Salaam rates were higher in women between 15 and 39 years but thereafter were higher in men. In Hai District mortality was higher in men in all age groups except those aged 25 to 29 years. In Morogoro rural district rates were higher in women between 20 and 34 years but in all other age groups rates were higher in men.

Relative differences between rates in Tanzania and rates in England and Wales—The greatest relative difference in mortality in men between the study areas and England and Wales was observed in all three study areas in the age group 30 to 34 years. In Dar es Salaam, Hai District, and Morogoro Rural District the mortality in this age group was 11.8, 9.8, and 15.8 times as high as rates in England and Wales (table 2). From 35 to 39 years and above the relative difference

Table 1—Rates (numbers of deaths for three year period) per 1000 population per year by age and sex in three study areas. Rates for England and Wales in 1991 shown for comparison

Detail	Dar es Salaam		Hai District		Morogoro Rural District		England and Wales	
	Men	Women	Men	Women	Men	Women	Men	Women
Age (years):								
15-19	1.8 (19)	3.1 (40)	1.9 (45)	1.6 (38)	6.6 (103)	5.1 (81)	0.7	0.3
20-24	4.8 (55)	6.5 (89)	4.8 (68)	4.4 (78)	9.0 (92)	12.8 (161)	0.9	0.3
25-29	9.0 (99)	12.0 (135)	7.5 (90)	8.3 (133)	12.7 (125)	15.6 (169)	0.9	0.4
30-34	11.8 (101)	16.6 (123)	9.8 (110)	9.4 (129)	15.8 (135)	17.4 (160)	1.0	0.5
35-39	12.6 (93)	16.6 (91)	10.4 (97)	7.4 (90)	21.3 (144)	16.4 (130)	1.4	0.8
40-44	18.1 (88)	16.7 (56)	13.0 (99)	7.6 (69)	20.4 (119)	14.0 (95)	2.1	1.3
45-49	21.7 (80)	18.4 (44)	15.2 (103)	6.9 (53)	27.7 (150)	17.2 (114)	3.4	2.2
50-54	17.9 (47)	11.7 (18)	15.7 (99)	6.8 (51)	30.2 (157)	16.6 (97)	5.9	3.6
55-59	28.3 (46)	19.4 (19)	12.9 (76)	8.8 (52)	27.4 (111)	14.9 (63)	10.1	5.9
Crude rates	10.2 (628)	10.4 (615)	8.1 (787)	6.1 (693)	15.9 (1136)	13.4 (1070)		
(95% confidence interval)	(8.8 to 11.5)	(9.0 to 11.8)	(7.2 to 9.1)	(5.3 to 6.9)	(15.0 to 16.8)	(12.6 to 14.2)		
Age adjusted rates*	13.2	13.3	9.7	6.8	18.1	14.5	2.5	1.5
(95% confidence interval)	(11.1 to 15.2)	(11.0 to 15.6)	(8.5 to 11.0)	(5.9 to 7.8)	(17.0 to 19.2)	(13.6 to 15.4)		

*Directly age adjusted to 1991 male and female England and Wales populations.

in rates declined until 55 to 59 years when rates in Dar es Salaam, Hai District, and Morogoro Rural District were 2.8, 1.3, and 2.7 times greater than the rates in the United Kingdom.

In women relative differences in mortality between Tanzania and England and Wales were greater than in the men. The greatest rate ratios were observed in the age groups 25 to 34 years in Dar es Salaam and Hai District and 20 to 29 years in Morogoro Rural District. In the age group 25 to 29 years the rates in Dar es Salaam, Hai, and Morogoro Rural Districts were 30.1, 20.9, and 39.0 times higher, respectively, than in England and Wales in 1991 (table 2). From 35 years the relative differences between the rates declined and in the 55-59 year age group they were 3.3, 1.5, and 2.5, respectively.

Probabilities of death—Table 3 shows the percentages of men and women aged 15 who would die before the age of 60 if current age specific mortalities applied. These ${}_{45}Q_{15}$ s for the three areas are compared with recently published estimates⁵ for developed and developing regions of the world including sub-Saharan Africa. The figures range from 26% for women in Hai to 58% for men in Morogoro. Apart from Hai District the ${}_{45}Q_{15}$ s are higher in the study areas than recent estimates.

Discussion

There was no gold standard against which completeness of ascertainment of deaths or accuracy of denominators could be measured. We are aware of the special difficulties associated with ascertainment of deaths in infants, but the death of an adult in a village is difficult to miss as a substantial proportion of the village will be involved in the mourning rituals. We consider therefore that the ascertainment of adult deaths in rural areas was reasonably complete. In the city adult deaths can more easily be missed as many patients with

terminal illness travel to their home areas before death. Most deaths in this category, however, should have been identified through repeat census rounds. During each round the enumerators are provided with a printed form containing the names of each household member at the time of the previous census and were expected to account for the current status of each person during subsequent rounds. With regard to accuracy of the denominator we have now carried out six censuses in Dar es Salaam and four each in Hai and Morogoro. There is a high agreement in the denominator estimates from each census for Dar es Salaam and Hai. In Morogoro there has been a 20% to 25% increase in the size of the denominator between the first and most recent census. Part of the study area, close to Morogoro town, is becoming rapidly urbanised and this is likely at least partially to account for the increase. We have described before the difficulties of matching people in the study areas.⁷ This is a problem we are working to resolve. If we are able to resolve it a more formal assessment of ascertainment of both numerator and denominator will be possible by periodically sampling well defined parts of the study areas: by matching people identified through the census and mortality surveillance with those identified in the sample an estimate of ascertainment could be made.¹¹

ADULT MORTALITY: A DISTURBING PROBLEM

The mortality of adults in the three study areas conveys a bleak picture, especially in Dar es Salaam and Morogoro Rural District. Mortality, for example, was over 40 times higher in 20 to 24 year old women in Morogoro than in the same age women in England and Wales (table 2). There is a dearth of mortality statistics from sub-Saharan Africa. The 1993 annual statistical report published by the World Health Organisation, for example, contains no age and sex specific data on mortality for any country in Africa apart from Mauritius.¹² Most countries, including Tanzania, do have national vital registration systems but coverage is very poor due primarily to social and financial restraints. Available information on levels of mortality, especially in children, comes mainly from censuses and special surveys. Attempts have been made in the past to determine mortality through longitudinal studies in specific populations¹³ but most provided little information on adult mortality.

Recent estimates of adult mortality in sub-Saharan Africa have tended to rely on the construction of plausible models by utilising model life tables, such as those produced by Coale and Demeny.¹⁴ These life tables are based on European populations at different stages of demographic transition, and the assumption made in using them is that the current low income countries have similar mortality patterns to those of European countries 100 years ago or so.

Overall for the 45 years between the ages of 15 and 59 mortality was higher in men than in women in Hai and Morogoro. This is in keeping with many other studies both in established market economy and low income countries, where rates in men are generally higher than rates in women throughout all age groups. In the Dar es Salaam study area, however, mortality was higher in women than men in all age groups from 15 to 39, and in Morogoro women's rates were higher between 20 and 29 years.

Data on cause of death have not yet been fully analysed, but HIV disease and maternal mortality probably account for this loss of survival advantage in young women. Preliminary analysis of causes of mortality during the first three years of mortality monitoring has shown that in all three project areas HIV disease was the leading cause of death in adult women. In Dar es Salaam maternal mortality was the

Table 2—Ratios of age and sex specific rates in three study areas to rates in England and Wales in 1991

Detail	Dar es Salaam		Hai District		Morogoro Rural District	
	Men	Women	Men	Women	Men	Women
Age (years):						
15-19	2.5	10.2	2.8	5.4	9.4	17.0
20-24	5.3	21.9	5.3	14.5	10.0	42.6
25-29	10.0	30.1	8.4	20.9	14.1	39.0
30-34	11.8	33.2	9.8	18.8	15.8	34.8
35-39	9.0	20.7	7.4	9.4	15.2	20.5
40-44	8.6	12.8	6.2	5.8	9.7	10.8
45-49	6.4	8.3	4.5	3.1	8.2	7.8
50-54	3.0	3.2	2.7	1.9	5.1	4.6
55-59	2.8	3.3	1.3	1.5	2.7	2.5
All (age adjusted*)	5.3	8.9	3.9	4.5	7.2	9.7

*Directly age adjusted to 1991 male and female England and Wales populations.

Table 3—Estimates of ${}_{45}Q_{15}$ (percentage of those aged 15 who would die before their 60th birthday if current mortality applied throughout their adult lives) for three study areas compared with recently published estimates for sub-Saharan Africa and other country groups

Area or country	Men	Women
Dar es Salaam	47	45
Morogoro Rural District	58	48
Hai District	37	26
Established market economies	15	7
Formerly socialist economies of Europe	28	11
Latin-America and the Caribbean	23	16
Sub-Saharan Africa	38	32

Key messages

- Little is known about the level and causes of adult mortality (15 to 59 years) in sub-Saharan Africa
- Adult mortality is currently being measured in one urban and two rural areas of Tanzania
- Survivors of childhood continue to experience high mortality throughout adult life
- Mortality was generally higher in men but was higher in women aged 15 to 39 years in Dar es Salaam and in women aged 25 to 29 in the two rural areas
- While childhood mortality in sub-Saharan Africa remains a major problem, mortality in young adults may now be equally serious in many areas in the region and deserving of increased attention by the policy makers

second most common cause and the fourth in Hai District and Morogoro Rural District. In adult men HIV disease was the leading cause of death in Dar es Salaam and Hai, whereas in Morogoro Rural District "acute febrile illness" (mainly malaria, we think) was the leading cause with injuries and HIV disease ranked second and third, respectively.

There were large differences in the ${}_{45}Q_{15}$ between the three areas as well as between men and women in each area. The differences between the areas illustrate the difficulty of describing an overall mortality pattern (and by inference an overall interventions package) for Tanzania as a whole. The differences in ${}_{45}Q_{15}$ are consistent with differences in the socioeconomic status of the areas, with Morogoro Rural District being the poorest, followed by Dar es Salaam and Hai. Differences in mortality in the under 5s (per 1000 live births), estimated by using a modified method of Brass as part of the 1988 national census⁶ and by ourselves (unpublished observations), also tend to reflect the differences we have found in adult mortality between the three areas. This limited comparison illustrates the coexistence of high infant and adult mortality in the study areas.

NEED TO RECONSIDER CURRENT HEALTH POLICIES

The high levels of adult mortality in the study areas refute the suggestion that a person surviving the rigours of childhood in a developing country has a probability of survival similar to that in a developed country. The ${}_{45}Q_{15}$ levels in this study also tended to be higher than those recently estimated from models for sub-Saharan Africa, which were 38% for men and 32% for women.

These results lead us to question the appropriateness of the proportion of health expenditure currently spent on programmes to prevent infant and child mortality and the concomitant neglect of adult mortality, which is also likely to be largely preventable. Clearly it would be contrary to the empirical evidence to argue that infant and child mortality are not important in low income countries. They generally remain at levels much higher than in established market economy countries. It is time, however, to achieve a balance. By focusing more attention on the adult population "we can hope to improve its health status and productivity and ultimately the quality of life of the entire population."¹⁵

The current pattern of resource allocation dates from the 1960s, when the governments of newly independent countries in sub-Saharan Africa, including Tanzania, moved the emphasis away from pro-

tecting the health of colonial administrators and plantation and mine workers towards the previously neglected area of child and maternal health. This is not a call to push the health resource pendulum away from children and towards adults. The ideal would be to increase the resources available in Tanzania and similar countries for programmes aimed at improving the health of the whole population. Health resources are not likely to increase in the foreseeable future. We therefore seek to encourage debate about the fairest, as well as the most effective and efficient ways, to apportion the scarce resources available between adult and child health needs.

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Conflict of interest: None.

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Correction

Infectious diseases: an ecological perspective

An editorial error occurred in this paper by Mary E Wilson (23-30 December, pp 1681-4). The last sentence in the third paragraph on p 1681, from which words were omitted, should read: "AIDS, recognised as a distinct clinical syndrome in 1981, has reached every country of the world, and the cumulative worldwide total of infected people could reach 30-40 million by the year 2000."