PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Estimating the Size of the HIV Epidemic by Using Mortality Data

Anna McCormick

Phil. Trans. R. Soc. Lond. B 1989 **325**, 163-173
doi: 10.1098/rstb.1989.0081

Phil. Trans. R. Soc. Lond. B **325**, 163–173 (1989) [163]
Printed in Great Britain

ESTIMATING THE SIZE OF THE HIV EPIDEMIC BY USING MORTALITY DATA

By ANNA McCORMICK

PHLS Communicable Disease Surveillance Centre, 61 *Colindale Avenue*, *London NW9 5EQ and Office of Population Censuses and Surveys*, *St Catherines House*, 10 *Kingsway*, *London WC2B 6JP*, *U.K.*

Evidence that more people are dying as a result of HIV infection than is reflected by the number of deaths among reported cases meeting the WHO definition of AIDS is derived from mortality data. Ninety-five causes of death likely to be associated with HIV infection were selected. Standardized mortality ratios due to these causes increased for single men aged 15–54 years from 100 in 1984 to 118 in 1987. The age, sex, marital status, temporal and geographic distribution of these excess deaths suggest that they are HIV-associated. It is estimated that 58% of excess deaths due to HIV-related causes were among cases reported to the CDSC AIDS Surveillance Programme in 1987. Some of these deaths may have been among HIV-positive people who did not meet the WHO definition at the time of death. There is a need for surveillance to be extended to include HIV-positive people who die before meeting the WHO definition if the full extent of the HIV epidemic is to be identified.

1. Introduction

The epidemic of human immune deficiency virus type 1 (HIV-1) infection in England and Wales is monitored by using data from sources described in this volume and elsewhere (McCormick 1987). Identification of cases depends upon voluntary reporting of positive laboratory tests for HIV and on people with acquired immune deficiency syndrome (AIDS) meeting the World Health Organisation (WHO) definition (Centres for Disease Control 1987). Additional cases are identified from death entries on which AIDS or HIV infection is certified as a cause of death. It is uncertain how many of these fulfil the WHO definition of AIDS unless the doctor signing the medical certificate of cause of death subsequently responds to an invitation to report the case to the PHLS Communicable Disease Surveillance Centre (CDSC).

Data published monthly by the Department of Health presenting the number of deaths include only those deaths known to have occurred among people meeting the WHO definition who have been reported to the CDSC AIDS surveillance programme. Universal use of the standard WHO definition allows comparison with data collected in other countries. There is evidence, however, that there may be nearly as many deaths again among people who are infected with HIV, who have developed AIDS but have not been reported to the CDSC programme, or who have died as a result of their HIV infection without developing AIDS.

Reported causes of death among people who are HIV-positive but do not fulfil the WHO definition of AIDS include bacterial pneumonia (Selwyn *et al.* 1988; Stoneburner *et al.* 1988; Wilkes *et al.* 1988), pulmonary embolus (Selwyn *et al.* 1988; Wilkes *et al.* 1988), bacteraemia (Krumholz *et al.* 1988), various cardiac conditions (Wilkes *et al.* 1988) including endocarditis (Afessa *et al.* 1988; Galli *et al.* 1988), myocarditis and pericarditis (Marche *et al.* 1988;

Anderson *et al.* 1988), myocardial infarction (Galli *et al.* 1988) and cardiomyopathy (Zasso *et al.* 1988), febrile episodes (Periman *et al.* 1988), metabolic problems (Chirgwin *et al.* 1988), cerebral haemorrhage (Selwyn *et al.* 1988), suicide (Afessa *et al.* 1988; Rajs *et al.* 1988; Marzuk *et al.* 1988) and drug overdose (Selwyn *et al.* 1988; Afessa *et al.* 1988; Galli *et al.* 1988), gastrointestinal haemorrhage (Selwyn *et al.* 1988; Afessa *et al.* 1988), peptic ulcer (Wilkes *et al.* 1988), gastroenteritis (Moreno *et al.* 1988), pancreatitis (Wilkes *et al.* 1988), acute renal tubular necrosis (Wilkes *et al.* 1988) and many cancers (Galli *et al.* 1988; Kahn *et al.* 1988; Tirelli *et al.* 1988; Holtzman *et al.* 1988). For some deaths due to these and other causes, though occurring in people with AIDS, the stated cause(s) of death on the medical certificate may not have included AIDS or HIV infection. Most studies of mortality have been carried out on cohorts of men known to have been HIV-positive. Other than in England and Wales (McCormick 1988) no studies have been published that attempt to identify trends in the general or selected groups of the population for causes other than AIDS that were likely to be associated with HIV infection.

This paper describes how mortality data for England and Wales have been used to estimate the full extent of HIV infection severe enough to cause death, and the possible short fall in the number of cases identified when the WHO definition of AIDS is used as the criterion for acceptance.

2. Evidence for more deaths due to HIV infection than reflected in reported number of deaths among cases of AIDS

2.1. *Standardized mortality ratios (SMRs)*

SMRs for all causes of death for both men and women aged 15–54 years in England and Wales have fallen from 100 in 1980 to 83.3 for men and 84.7 for women in 1987 (figure 1).

Every death entry in which AIDS or HIV is mentioned is coded ICD 279.1 (deficiency of cell-mediated immunity) unless an underlying cause of death unlikely to be associated with HIV infection is stated. To study the possible effect of HIV infection, 95 causes of death were selected because they are included in the WHO definition of AIDS, or because they have been mentioned on the certificates of persons known to have had AIDS. These causes, which include ICD 279.1, were considered to be possibly HIV-related. SMRs for these causes alone for men who never married aged 15–54 years have increased from 100 in 1984 to 109 in 1985, 113 in 1986 and 118 in 1987 (figure 2, table 1).

Comparable figures for women who never married are 99 in 1985, 103 in 1986 and 101 in 1987. For men of all marital states other than those who never married, SMRs are 100 in 1985, 102 in 1986 and 99 in 1987 (table 2). The baseline was taken as 1984 because a change at the beginning of 1984 in the method of coding underlying cause of death makes comparison with previous years by selected causes invalid. SMRs for men who never married aged 15–54 years due to the same HIV-related ICD codes indicate however that death rates fell between 1980 and 1983 (table 3). No data on marital status was recorded on death entries during 1981.

2.2. *Rates by 5-year age groups*

For men who never married aged 15–49 years, mortality rates due to HIV related causes have increased in each 5-year age group since 1984 (table 4). The increase between 1984 and 1987 was greatest in 30–34 year olds (43%) but also high for 35–39 year olds (38%) and 40–44

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

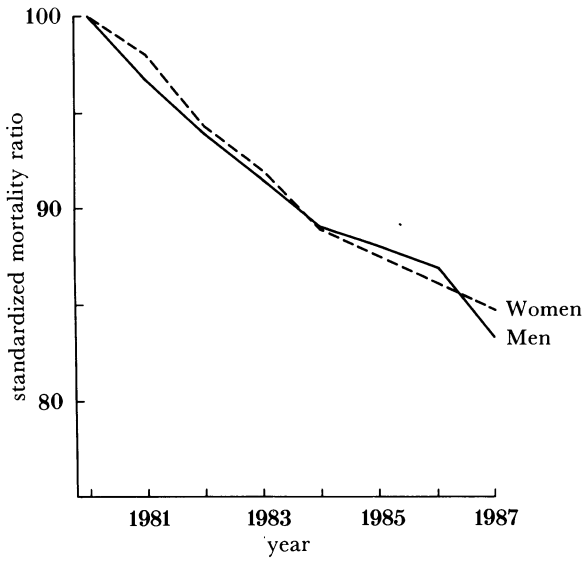

FIGURE 1. Standardized mortality ratios, all causes, all marital states, aged 15–54 years.

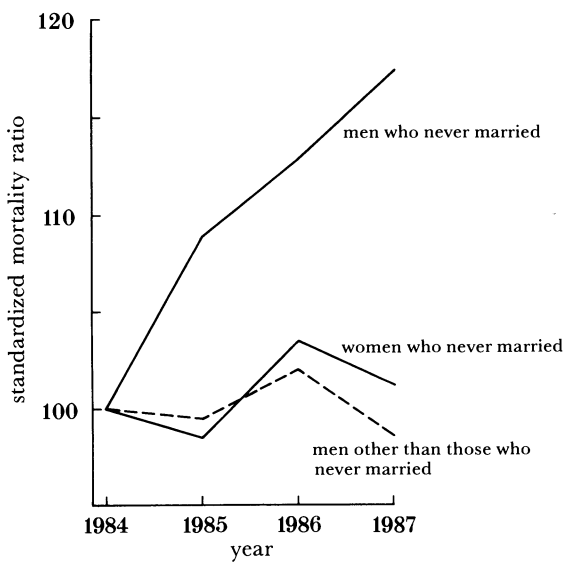

FIGURE 2. Standardized mortality ratios, HIV-related causes, marital state, aged 15–54 years.

year olds (39%). There was no similar increase among men of all marital states other than those who never married (table 4).

The age distribution at the time of death is similar to that among men with AIDS reported to CDSC who are known to have died; among these there are more deaths among 35–39 and 40–44 year olds than any other five-year age group.

2.3. *Geographical distribution*

The greatest increase in death rates, among men who never married aged 15–54 years, due to HIV-related causes between 1984 and 1987 was in North West Thames, North East Thames, South East Thames and North Western Regional Health Authorities (figure 3, table 5).

This is still true for HIV-related causes excluding deaths coded ICD 279.1, although in two of

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Table 1. Standardized mortality ratios due to HIV-related causes: men who never married aged 15–54 years, (1984–1987)

(Obs., observed; pop., population in thousands; exp., expected; 1984 = 100.)

		1984			1985	
age	obs.	pop.	exp.	obs.	pop.	exp.
15–19	282	2064.6		264	2021.5	276
20–24	370	1671.5		417	1747.2	387
25–29	232	707.1		272	769.5	252
30–34	166	329.3		211	339.5	171
35–39	146	223.0		197	231.6	152
40–44	134	143.5		157	148.7	139
45–49	175	120.3		195	121.0	176
50–54	285	119.6		275	115.6	275
total	1790	5378.9		1988	5494.6	1828
		SMR = 100			SMR = 108.8	
		1986			1987	
15–19	310	1994.6	272	309	1948.1	266
20–24	420	1794.2	397	492	1811.1	401
25–29	310	840.8	276	307	922.1	303
30–34	232	356.4	180	272	376.8	190
35–39	228	240.4	157	215	238.1	156
40–44	179	156.1	146	223	172.2	161
45–49	189	120.2	175	203	121.3	176
50–54	242	112.2	267	230	110.1	262
total	2112	5614.9	1870	2251	5699.8	1915
		SMR = 112.9			SMR = 117.54	

Table 2. Standardized mortality ratios for 95 HIV-related causes for persons aged 15–54 years by sex and marital status

(1985–1987; 1984 = 100.)

	1984	1985	1986	1987
men who never married	100	108.9	112.9	117.5
women who never married	100	98.5	103.5	101.2
men (other than those who never married)	100	99.5	102.0	98.6

Table 3. Standardized mortality ratios due to HIV-related causes: men who never married aged 15–54

(1980–1983; (1980 = 100); Obs., observed; pop. population in thousands; exp., expected.)

	1980		1982			1983		
age	obs.	pop.	obs.	pop.	exp.	obs.	pop.	exp.
15–19	321	2069.6	334	2117.8	328.5	346	2108.2	327.0
20–24	338	1352.9	372	1492.0	372.8	378	1578.4	394.3
25–29	269	566.8	280	615.2	292.0	265	654.6	310.7
30–34	195	306.5	206	314.0	199.8	180	318.8	202.8
35–39	158	172.6	153	200.7	183.7	186	213.4	195.3
40–44	164	133.4	153	134.2	165.0	140	137.7	169.3
45–49	195	126.5	216	120.8	186.2	194	120.2	185.3
50–54	351	132.8	295	127.8	337.8	261	124.3	328.5
total	1991	4861.1	2009	5122.5	2065.7	1951	5255.6	2113.3
	SMR = 100		SMR = 97.3			SMR = 92.3		

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

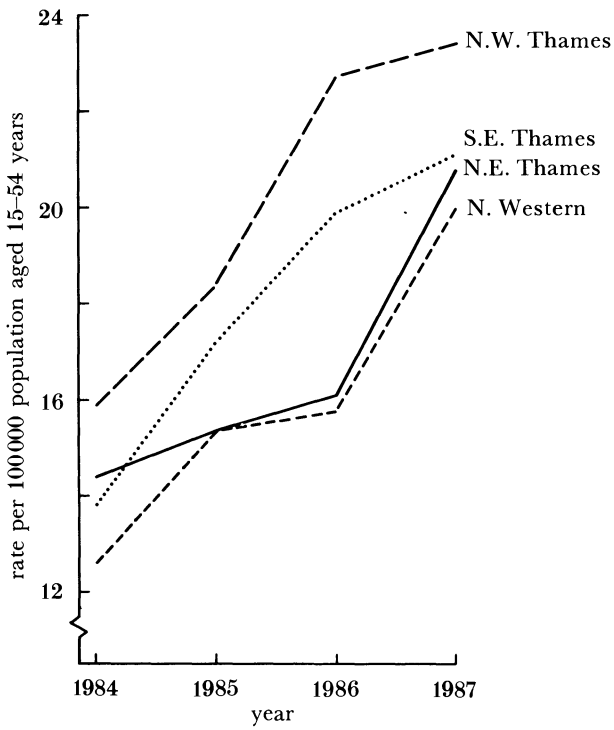

FIGURE 3. Deaths due to HIV-related causes, regional health authority of usual residence, men who never married aged 15–54 years.

TABLE 4. DEATH RATES PER MILLION POPULATION FOR 95 HIV-RELATED CAUSES: MEN AGED 15–54 YEARS, 1984–1987

	never married					all marital states other than never having married			
age	1984	1985	1986	1987	age	1984	1985	1986	1987
15–19	137	131	155	159	15–19	320	901	909	826
20–24	221	239	234	272	20–24	193	195	265	255
25–29	328	353	369	333	25–29	215	208	181	209
30–34	504	622	651	722	30–34	272	249	256	261
35–39	654	851	948	903	35–39	292	306	287	309
40–44	934	1056	1147	1295	40–44	424	413	429	384
45–49	1455	1612	1572	1674	45–49	592	590	616	596
50–54	2383	2379	2157	2089	50–54	878	878	921	857

the three Thames regions there was a decrease between 1986 and 1987, suggesting that for a higher proportion of HIV-related deaths than previously, AIDS or HIV infection was stated as the cause (figure 4). Among patients with AIDS reported to CDSC, more people who died were reported from each of the four regions mentioned above than from any other regional health authority (table 5).

2.4. *Temporal distribution*

The number of deaths among men of all marital states, and men who never married, aged 15–54 years, due to HIV-related causes has increased steadily each quarter year from the beginning of 1984 to the end of 1987 (table 6). This increase is similar to that of cases reported to CDSC by month of diagnosis (figure 5). The number of deaths among women who never

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

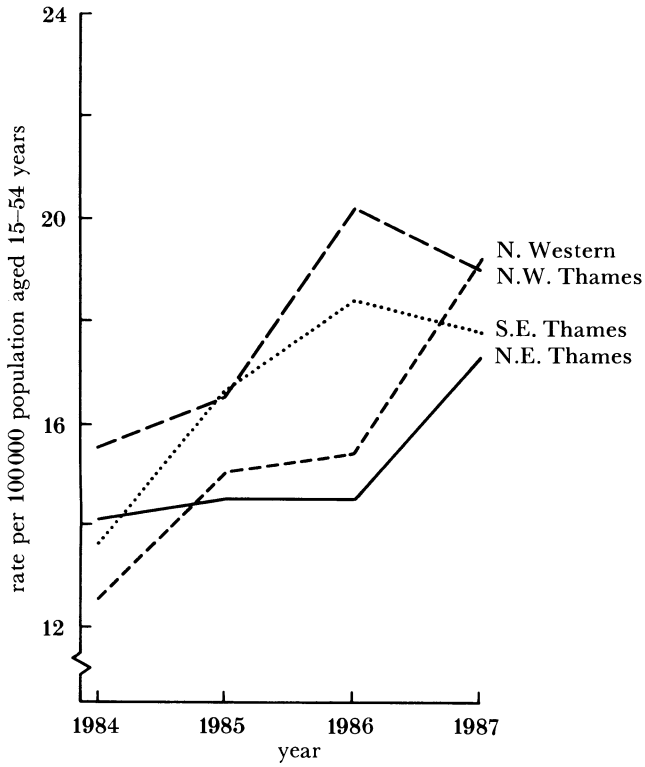

FIGURE 4. Deaths due to HIV-related causes excluding ICD 279.1, regional health authority of usual residence, never-married men aged 15–54 years.

married also increased slightly between 1984 and 1987 but for all men except those who never married there was little change.

2.5. *Comparison of observed and expected deaths*

The number of excess deaths due to HIV-related causes in 1985, 1986 and 1987 compared with 1984 was obtained by adjusting for population changes such that

$$\text{excess deaths} = (\text{observed deaths}_i - \text{observed deaths}_0) \times \text{population}_i/\text{population}_0,$$

where $0 = 1984$ and $i = 1985$, 1986, or 1987.

Compared with 1984, among men who never married aged 15–54 years, there was an estimated excess of 159 deaths in 1985, 243 in 1986 and 354 in 1987 (table 7). There was no similar excess among men of marital states, other than those who never married, between 1985 and 1987. Among women who never married there was an estimated deficit of 11 in 1985, and an excess of 19 in 1986 and 11 in 1987, compared with 1984.

2.6. *Patients reported to CDSC who did not fulfil the WHO definition at the time of death*

Doctors are asked to report to CDSC only those patients who meet the WHO definition of AIDS. Nevertheless, by the end of June 1988, 28 patients who had died as a result of HIV infection had been reported to CDSC but have not been included in the surveillance scheme because they did not meet the WHO definition. This may be the tip of the iceberg because doctors would not be expected to report cases that they did not believe fulfilled the definition.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

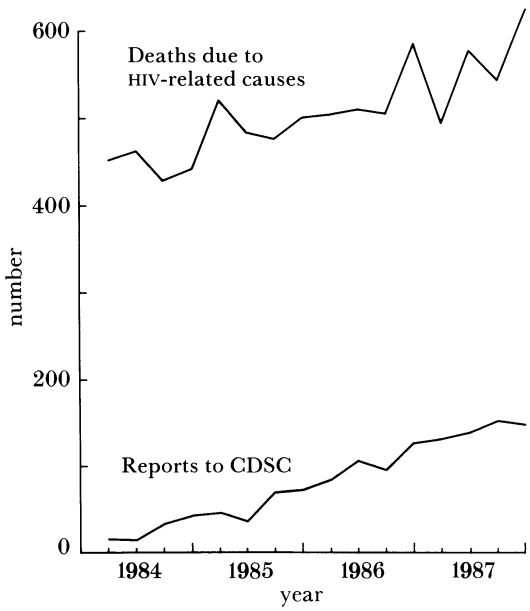

FIGURE 5. Deaths due to HIV-related causes, quarter year of registration, men who never married aged 15–54 years. Reports of AIDS cases to CDSC, quarter year of diagnosis.

TABLE 5. DEATH RATES PER 100000 POPULATION DUE TO 95 HIV-RELATED CAUSES BY REGIONAL HEALTH AUTHORITY (RHA) OF USUAL RESIDENCE, NEVER-MARRIED MEN. DEATHS AMONG CASES OF AIDS REPORTED TO CDSC BY REGIONAL HEALTH AUTHORITY OF REPORTER, ALL AGES, MEN AND WOMEN

RHA	HIV-related causes 1984	1985	1986	1987	deaths by end 1987 among cases reported to CDSC
Northern	10.3	13.7	14.4	13.9	22
Yorkshire	13.4	16.1	13.5	14.1	13
Trent	11.6	12.1	11.0	11.6	8
East Anglia	9.1	11.5	12.8	12.9	12
N.W. Thames	15.9	18.4	22.7	23.4	275
N.E. Thames	14.4	15.4	16.1	20.8	137
S.E. Thames	13.8	17.2	19.9	21.1	66
S.W. Thames	17.7	16.1	15.8	17.2	27
Wessex	10.9	12.2	11.7	13.4	13
Oxford	11.5	12.3	11.4	9.8	12
South Western	12.2	13.1	13.3	13.1	18
West Midlands	11.7	11.8	14.5	12.9	15
Mersey	14.5	14.8	18.5	15.4	12
North Western	12.6	15.4	15.8	20.0	29
Wales	12.7	12.8	13.7	15.3	14

2.7. *Medical certificates stating AIDS as cause of death for persons not reported to CDSC*

Doctors who mention AIDS or HIV on the medical certificate of cause of death for a person who has not been reported to CDSC are invited to report him or her. However, despite this active follow-up in 1985 to 1987, 31 death entries mentioning AIDS or HIV for people never reported to CDSC also mentioned lymphoma, Kaposi's sarcoma, encephalopathy or an opportunistic infection, suggesting that the case would meet the WHO definition. For a further 67

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Table 6. Deaths due to 95 hiv-related causes by quarter year of registration

(Persons aged 15–54 years by sex, 1984–1987.)

	men who never married			
	1984	1985	1986	1987
1	453	522	506	496
2	464	485	512	580
3	430	478	507	547
4	443	503	587	628
total	1790	1988	2112	2251

	women who never married			
	1984	1985	1986	1987
1	158	166	159	160
2	148	132	159	157
3	120	131	161	164
4	158	159	155	154
total	584	588	634	635

	men (except those who never married)			
	1984	1985	1986	1987
1	914	902	913	926
2	859	902	894	924
3	880	866	849	784
4	903	864	957	893
total	3556	3534	3613	3527

Table 7. Observed and expected excess deaths due to 95 hiv-related causes for persons aged 15–54 years by sex and marital status 1985–1987 compared with 1984

(observed, *o*; expected, *e*)

	never married men				
	population (thousands)	observed, *o*	expected, *e*	excess, *o*–*e*	
1984	5378.9	1790	—	—	
1985	5494.6	1988	1829	159	
1986	5614.9	2112	1869	243	
1987	5699.8	2251	1897	354	
				total	756

	all men except never-married				
1984	8280.7	3556	—	—	
1985	8273.7	3534	3553	−19	
1986	8252.5	3613	3544	69	
1987	8253.1	3527	3544	−17	
				total	33

	never-married women				
1984	4105.8	584	—	—	
1985	4209.8	588	599	−11	
1986	4325.1	634	615	19	
1987	4390.4	635	624	11	
				total	19

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

unreported cases, AIDS or HIV was mentioned on the death entry, either alone or with some other condition that is not included in the current WHO definition.

3. Estimation of completeness of reporting

Comparison between the number of deaths identified from death entries and deaths among cases reported to CDSC is more likely to be accurate for men who never married than for all men. Men who never married form the largest group of AIDS cases. They are a minority among men in the population aged 15–54 years and trends are therefore less biased for this group by deaths due to the 95 selected causes that are unrelated to HIV infection.

Between 1985 and 1987, there was an excess of deaths among men who never married aged 15–54 years of 756 compared with 1984. Over the same period there was an excess of deaths to men reported to be single or for whom the marital status was not known aged 15–54 years of 408 among patients with AIDS reported to CDSC compared with 1984. This suggests that only 54% of deaths due to HIV-related causes were among people with AIDS meeting the WHO definition reported to CDSC (table 8). However, during 1987 alone the proportion of cases reported to CDSC was 58%. The figure of 65% for all marital states between 1985 and 1987 compares favourably with the results of an earlier study (McCormick 1988) that suggested that only 42% of men dying from HIV infection were reported to CDSC. The improvement in reporting is largely due to active follow-up of death entries on which AIDS or HIV is mentioned, for patients not reported to CDSC at the time of death. Although this started in May 1987, retrospective follow-up increased the number of cases reported who had died in previous years.

Table 8. Excess deaths as a percentage of excess deaths reported to CDSC for men aged 15–54 years by marital status 1985–1987 compared with 1984

(Among cases reported to CDSC, (*a*); from 95 HIV-related causes on death entries, (*b*).)

	all marital states			never-married		
	(*a*)	(*b*)	% reported	(*a*)	(*b*)	% reported
1985	55	136	40.4	53	159	33.3
1986	179	298	60.1	150	243	61.7
1987	253	317	79.8	205	354	57.9
total	487	751	64.8	408	756	54.0

4. Conclusion

There is evidence from abroad and in England and Wales that deaths have occurred due to HIV infection to persons who have not developed AIDS meeting the WHO definition. This is apparent from reports from clinicians and pathologists, and from mortality data. The temporal, geographic, age, sex and marital status distribution of increasing mortality rates due to possible HIV-related causes of death is similar to that among cases of AIDS reported to CDSC, and suggests that the trend is associated with HIV infection. The trend in mortality data derived from death certification is more marked than in deaths among people with AIDS reported to CDSC.

It is possible that only 54% of the excess deaths due to HIV-related causes in 1985–1987 identified from death certification are among cases reported to CDSC who are known to have

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

died. This is likely to be an underestimate because it has been assumed that the 1984 baseline would remain the same in subsequent years. However, between 1980 and 1983 the standardized mortality rate for HIV-related causes fell from 100 to 92 for men who never married aged 15–54 years. It could be expected that the downward trend in deaths due to HIV-related causes but unrelated to HIV infection would have continued beyond 1983. The difference therefore between the observed and expected number of deaths in 1984–1987 is almost certainly greater than that estimated. Forward extrapolation of SMRs beyond 1983 by using 1980 as the baseline is not possible owing to the change in coding policy that resulted in approximately 11% of deaths that would have been coded to HIV-related causes before 1984, being assigned to codes other than HIV-related causes after the beginning of 1984.

The shortfall in the number of cases reported to CDSC may be (*a*) because not all diagnosed AIDS cases have been reported to CDSC, (*b*) AIDS cases have died without being diagnosed, or (*c*) HIV-positive persons have died before developing AIDS. If the size of the predicted epidemic is based only on the number of cases of AIDS reported to CDSC, the result may be an appreciable underestimate of the true picture.

References

Afessa, B., Delapenha, R., Greaves, W., Barnes, S., Saxinger, C. & Frederick, W. 1988 Clinical and epidemiologic differences between deceased AIDS and non-AIDS HIV seropositive patients (abstract). In *Proceedings of the 4th International AIDS Conference, Stockholm*, vol. 2, p. 203.

Anderson, D., Vinatea, M., Macher, A., Lopez, E., Lasala, G. & Virmani, R. 1988 Myocarditis at necropsy in patients with AIDS from mainland United States and Puerto Rico (abstract). In *Proceedings of the 4th International AIDS Conference, Stockholm*, vol. 1, p. 403.

Centres for Disease Control 1987 Revision of the CDC case definition for acquired immunodeficiency syndrome. *Morbidity Mortality weekly Rep.* **36** (suppl.), 1S.

Chirgwin, K., Rao, T. K. & Landesman, S. H. 1988 High HIV seroprevalence in patients with chronic renal failure (abstract). In *Proceedings of the 4th International AIDS Conference, Stockholm*, vol. 1, p. 402.

Galli, M., Carito, M., Cruccu, V., Zampini, L., Ciacci, D., Villa, A., Pacini, S., Zaini, G., Corsi, L., Codini, G., Saracco, A. & Lazzarin, A. 1988 Causes of death in I.V. drug abusers: a retrospective survey on 4883 subjects (abstract). In *Proceedings of the 4th International AIDS Conference, Stockholm*, vol. 2, p. 191.

Holtzman, D., Trapido, E. J., Mackinnon, J. A., Freeman, L. W., Harris, C. C., Sims, J. & Witte, J. J. 1988 AIDS and cancer: findings from a statewide registry match (abstract). In *Proceedings of the 4th International AIDS Conference, Stockholm*, vol. 2, p. 216.

Kahn, J., Desmond, S., Bottles, K., Kaplan, L., Abrams, D. & Volberding, P. 1988 Incidence of malignancies in men at San Francisco general hospital during the HIV epidemic (abstract). In *Proceedings of the 4th International AIDS Conference, Stockholm*, vol. 2, p. 328.

Krumholz, H. M., Lo, B., Hadley, K. & Sande, M. A. 1988 Community-acquired bacteraemia in AIDS patients; presentation and outcome (abstract). In *Proceedings of the 4th International AIDS Conference, Stockholm*, vol. 1, p. 399.

Marche, C., Trophilme, D., Mayorga, R., Lafont, A., Vilde, J. J. & Matheron, S. 1988 Cardiac envolvement in AIDS. A pathological study (abstract). In *Proceedings of the 4th International AIDS Conference, Stockholm*, vol. 1, p. 403.

Marzuk, P. M., Tierney, H., Tardiff, K., Gross, E. M., Morgan, E. B., Hsu, M.-A. & Mann, J. J. 1988 Increased risk of suicide in persons with AIDS. *J. Am. med. Ass.* **259**, 1333–1337.

McCormick, A. 1988 Trends in morbidity statistics in England and Wales with particular reference to AIDS from 1984 to April 1987. *Br. med. J.* **296**, 1289–1292.

McCormick, A., Tillett, H., Bannister, B. & Emslie, J. 1987 Surveillance of AIDS in the United Kingdom. *Br. med. J.* **295**, 1466–1469.

Moreno, A., Mallolas, J., Latorre, X., Gatell, J. M., Miro, J. M., Mensa, J., Valls, M. E., Gonzalez, J., Ribalta, T. & Soriano, E. 1988 Infectious gastroenteritis in AIDS patients (abstract). In *Proceedings of the 4th International AIDS Conference, Stockholm*, vol. 1, p. 404.

Periman, D. C., Fenn, M., Nyquist, P. & Harris, C. 1988 Hospitalized febrile episodes in HIV-1 infected largely intravenous drug using patients (abstract). In *Proceedings of the 4th International AIDS Conference, Stockholm*, vol. 1, p. 400.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Rajs, J., Karlsson, T. & Eklund, B. 1988 HIV-related deaths outside hospital in Stockholm (abstract). In *Proceedings of the 4th International AIDS Conference, Stockholm*, vol. 2, p. 207.

Selwyn, P. A., Schoenbaum, E. E., Hartel, D., Klein, R. S., Davenny, K. & Friedland, G. 1988 AIDS and HIV-related mortality in intravenous drug abusers (abstract). In *Proceedings of the 4th International AIDS Conference, Stockholm*, vol. 2, p. 193.

Stoneburner, R., Laussucq, S., Benezra, D., Sotheran, J. & Des Jarlais, D. 1988 Increasing pneumonia mortality in NYC, 1980–1986: Evidence for a larger spectrum of HIV-related disease in intravenous drug abusers (abstract). In *Proceedings of the 4th International AIDS Conference, Stockholm*, vol. 1, p. 411.

Tirelli, U., Tourani, J. M., Vaccher, E., Foa, R., Raphael, M., Toladano, M., Pedersen, C., Rezza, G., Monfardini, S. & Andrieu, J. M. 1988 A report of 53 patients with HIV-associated Hodgkin's disease in Europe (abstract). In *Proceedings of the 4th International AIDS Conference, Stockholm*, vol. 2, p. 327.

Wilkes, M. S., Fortin, A., Felix, J., Godwin, T. & Thompson, W. 1988 The utility of the autopsy in acquired immunodeficiency syndrome (abstract). In *Proceedings of the 4th International AIDS Conference, Stockholm*, vol. 2, p. 307.

Zasso, J.-F., Lafont, A., Chappuis, P., Chalas, J., Sayegh, F., Darwiche, H. & Camus, F. 1988 Non obstructive cardiomyopathy and selenium deficiency in AIDS (abstract). In *Proceedings of the 4th International AIDS Conference, Stockholm*, vol. 1, p. 400.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES