Problems in comparative longevity

SIR RICHARD BAYLISS, KCVO, MD, FRCP
SIR CYRIL CLARKE, KBE, MD, FRCP, FRS
A. G. W. WHITFIELD, CBE, MD, FRCP
Research Unit, Royal College of Physicians, London

In previous publications we have discussed some of the factors underlying the increased life expectation of the population of England and Wales [1] and the marked sex difference in those surviving to extreme old age [2]. In the present article we compare life expectancy in England and Wales with that in other countries, particularly Japan. We then discuss some of the influences which may be responsible for the variations, and the many problems that remain unsolved.

A most surprising feature is the small range over which life expectancy differs from one country to another in the developed world (Table 1). In Hong Kong, Iceland, Japan and Switzerland, the newborn female can now anticipate a life of over 80 years, while in Australia, the Netherlands, Norway and Sweden her life expectancy is only a year less. In Canada, England and Wales, Finland, France, Germany and the USA it is more than 78 years and even in a country that is less affluent, such as Portugal, it is 76.1 years. In Central and South America and in countries behind the Iron Curtain it is only slightly lower [3,4].

Life expectancy is increasing in all developed countries. Thus, in the two years 1982–84 it rose in Switzerland by 1.1 years for females and 0.9 for males, in Portugal in the two years 1980–82 by 1.5 years for females and 1.6 for males, and in Australia, Germany and Japan in the seven years 1975–82 by more than 1.5 years for males and females. Over a longer period this change is more striking; since 1900 in France life expectancy at birth has increased by 24.2 years for males and 29.0 for females [5]. In some developing countries the trend is even more marked. In Sri Lanka, during the period 1945–47 life expectancy at birth was 43.8 years for males and 43.1 for females, in 1970–72 it was 63.8 for males and 66.7 for females. Thus, over a quarter of a century, life expectation has increased by 20 years for males and 23.6 for females with a reversal of the slightly more favourable position enjoyed by Sri Lankan males earlier in the century [6].

In all countries the newborn male has a shorter life expectancy than the female (Table 1). The range of sex difference varies; thus in Finland it is 8.3 years, in England and Wales 6.2 and in Japan 5.9. In the remaining countries it is between 5.5 and 8.0 years, except in Israel where it is only 3.3 and in Cuba, the Dominican Republic and Panama where it is 3.7, 4.0 and 4.2 respectively [3,4].

Table 2 shows the population and its distribution by age in various countries; also included are the birth and death rates, the infant mortality rate and the natural increase (ie excess of births over deaths per 1,000 of the population). In developing countries such as India, Bangladesh and Sri Lanka the birth rate and infant mortality are high and the proportion of the population aged over 65 years is small. This is in direct contrast to what obtains in the developed countries and we do not have to look far for the explanation.

In the Third World there is over-population, poverty, lack of education, inadequate medical care, reluctance to accept contraception and generally poor socio-economic conditions. The high infant mortality, which stems chiefly from poverty and lack of medical care, is insufficient to nullify the high birth rate so there is a high natural growth, and the ever-increasing population exacerbates the lack of available food and medical care. Although the low proportion of the population over the age of 65 is in part due to the high proportion of children, it is also to some extent the result of a high mortality rate and low life expectancy which arise in the main from adverse socio-economic factors. Life expectancy at birth is still less than 60 years in the WHO regions of Africa, South East Asia and the Eastern Mediterranean [3,7]. However changes are already occurring, as shown in Sri Lanka.

The progressively increasing life span in the developed world reflects continuing improvement in education, living conditions and medical care [1]. The widening gap between male and female life expectation is a further expression of the same influences and of the relative protection of the female from accident, from the hazards of war and from the killing diseases of affluence (now increasing), particularly those caused by smoking and alcohol [2]. The difference of only 3.3 years between male and female life expectancy in Israel is of particular interest and probably arises from the kibbutz pattern of living which is very similar for men and women [8]. The gender difference in life expectancy in Israel outside the kibbutz is small compared with other countries but not as low as in the kibbutz population, suggesting that the Jewish way of living favours a more equal survival of the sexes, particularly in the kibbutz.

Table 1. Life expectancy at birth in different countries.

Continent	Country	Year	Life expectancy (years) Male	Female	Sex difference
America	Cuba	1981	72.2	75.9	3.7
	Dominican Republic	1982	70.5	74.5	4.0
	Panama	1983	72.8	77.0	4.2
	United States of America	1982	70.9	78.4	7.5
	Venezuela	1980	65.8	71.4	5.6
Asia	Hong Kong	1984	75.1	81.4	6.3
	Israel	1983	73.1	76.4	3.3
	Japan	1984	74.8	80.7	5.9
Europe	Austria	1983	69.5	76.6	7.1
	Bulgaria	1983	68.4	74.4	6.0
	Czechoslovakia	1983	66.9	74.3	7.4
	England & Wales	1981	71.8	78.0	6.2
	Finland	1983	70.2	78.5	8.3
	Germany	1984	71.3	78.1	6.8
	Hungary	1984	65.1	73.3	8.2
	Iceland	1983	73.4	80.6	7.2
	Ireland	1981	69.1	74.8	5.7
	Luxembourg	1982	68.9	76.0	7.1
	Netherlands	1983	73.0	79.8	6.8
	Norway	1983	72.8	79.8	7.0
	Poland	1984	66.8	75.0	8.2
	Portugal	1982	69.1	76.1	7.0
	Rumania	1983	66.9	72.5	5.6
	Scotland	1984	69.9	75.9	6.0
	Switzerland	1984	73.8	80.8	7.0
	Yugoslavia	1982	67.8	73.7	5.9
Oceania	Australia	1983	72.2	79.0	6.8
	New Zealand	1983	70.8	77.0	6.2

Table 2. Population, and its distribution by age, birth rate, infant mortality and natural increase in various countries in the world.

Country[a]	Year	Population (1000's)	Live birth rate per 1,000 population	Death rate per 1,000 population	Infant mortality[b]	Natural increase per 1,000 population	Age in years (%) 0–14	15–64	Over 65
India	1984	730,540	33.2	13.3	106	19.9	39.1	57.4	3.5
Bangladesh	1984	96,730	35.1	12.0	122	23.1	41.2	56.0	2.8
Sri Lanka	1984	15,606	26.1	6.2	30	20.1	35.3	60.4	4.3
Argentina	1983	29,627	23.9	8.8	32	15.1	28.2	63.2	8.6
Brazil	1983	129,660	20.9	6.2	63	14.7	40.4	56.2	3.4
Portugal	1984	10,164	14.3	10.4	21	3.9	23.8	64.4	11.9
Poland	1985	37,126	18.9	9.6	18	9.3	25.3	65.2	9.4
England & Wales	1983	49,654	12.7	11.7	11	1.0	19.9	64.8	15.2
Japan	1984	120,018	12.7	6.2	10	6.5	22.0	68.0	10.0
USA	1984	236,681	15.7	8.7	11	7.0	22.2	66.2	11.6
Canada	1984	25,150	15.0	7.0	10	8.0	21.9	68.0	10.0
Finland	1984	4,895	13.4	9.2	7	4.2	19.6	68.1	12.4
Sweden	1985	8,243	11.3	10.9	6	0.4	18.6	64.6	16.8
Denmark	1985	1,985	10.1	11.2	7	−1.1	19.6	65.7	14.7
Switzerland	1984	6,442	11.5	9.4	7	2.4	17.2	68.4	14.4
Germany	1984	61,089	9.5	11.3	11	−1.8	16.2	69.0	14.8

[a]Order dictated by degree of 'development'. [b]Deaths under 1 year per 1,000 live births.

The explanation of the smaller sex differential in Cuba, the Dominican Republic and Panama is likely to be the predominantly agrarian way of life for both sexes. Non-aggressive and temperate influences operate in the Amish community in the USA and are in part responsible for male life expectation exceeding that of females [2,9], though we do not yet know how long both sexes live. Everywhere, the environment clamours for causal recog-

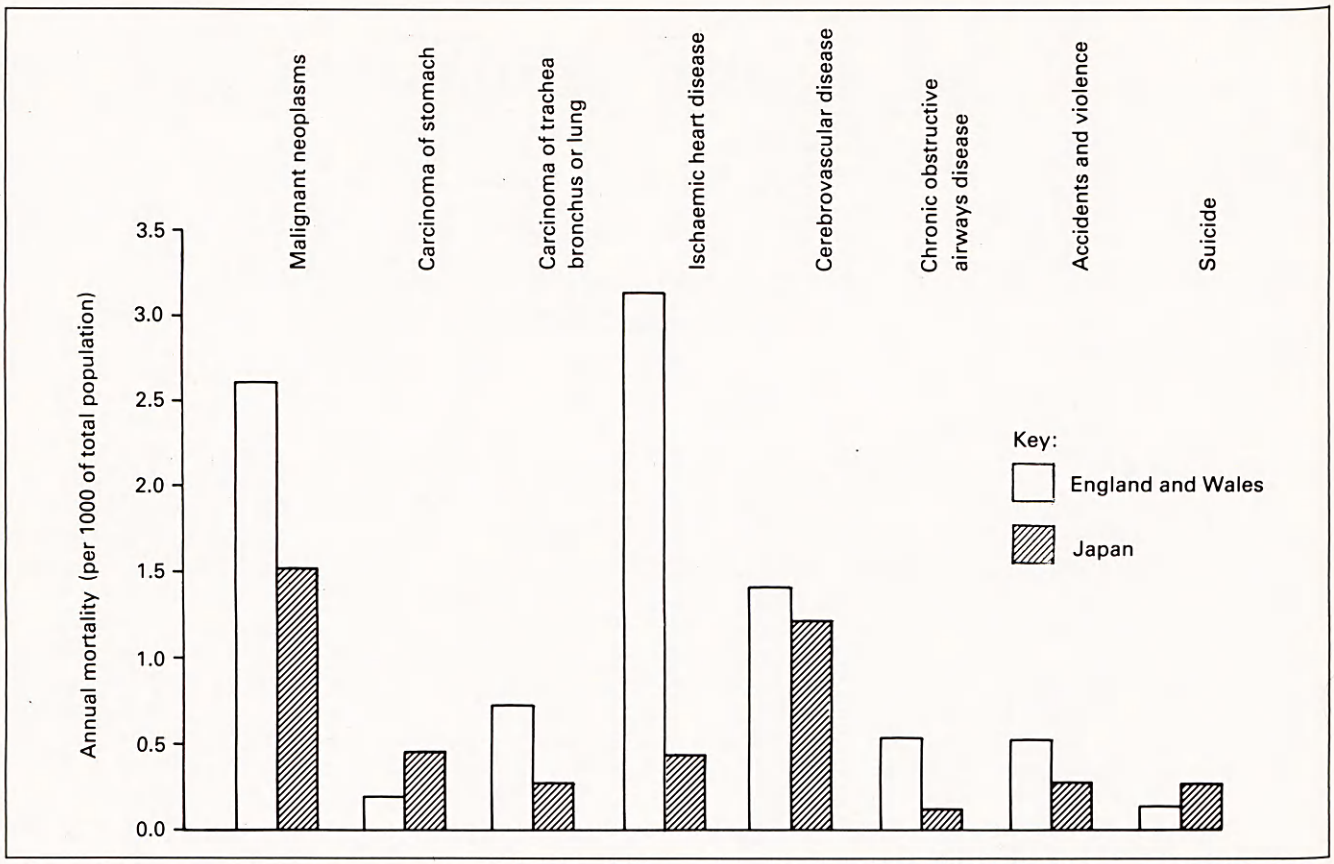

Fig. 1. *Major causes of death in England and Wales, and Japan.*

nition, though Nevo [10] invokes the founder principle for the Amish, the immigrant males 'happening to be' of tougher genetic stock.

Since the 1939–45 war Japan has been the most successful trading nation in the world; the height of the Japanese has increased and they have become more akin to western nations in their outlook and activities. Although Japan has a population 2.4 times larger than England and Wales, it has much the same birth rate and infant mortality. However, the population has a lower percentage aged over 65 than has England and Wales but this will become less evident with the increased life expectation and lower birth rate in Japan.

The main difference between Japan and England and Wales is the mortality rates. In Japan, mortality is only 6.2 per 1,000 compared with 11.7 in this country, so that our natural increase per 1,000 of the population is only 1.0 compared with 6.5 in Japan. Figure 1 and Table 3 show the major causes of death in the two countries. In England and Wales there is a very much higher mortality from ischaemic heart disease, all malignant diseases (particularly carcinoma of the bronchus), chronic obstructive airways disease and accidents and violence. Japanese mortality only exceeds that in England and Wales in carcinoma of the stomach and suicide. The high Japanese death rate from the former remains unexplained. The high suicide rate, about 20,000 deaths annually, has been recorded for the past 35 years [11,12]. Death from stroke, though generally believed to be abnormally high in Japan, is in fact less than in England and Wales [3,13].

Ischaemic heart disease, chronic obstructive airways disease and carcinoma of the bronchus are closely related to cigarette smoking but despite the proportion of smokers in Japan being far greater and of ex-smokers far less than in England and Wales [14] death from these diseases is very much less likely for the Japanese. Mortality from ischaemic heart disease in Japan is the lowest in the world and fell every year from 1968 to 1977 [15] as did the proportion of males and females with abnormal electrocardiographs from 1972 to 1980 [16]. In England and Wales, mortality from ischaemic heart disease is among the highest. Ischaemic heart disease mortality in all occupational groups in Japan is lower than in England and Wales and, though in England and Wales the social classes show widely differing smoking habits, in Japan there is no such variation between socio-economic groups [14].

The work of Gordon [17], Syme [18], and Marmot and his co-workers [19] shows a higher incidence of ischaemic heart disease in Japanese living in Hawaii and a still higher incidence in those living in California than in Japanese living in Japan. These differences suggest some environmental factor present or absent in Japan which is

Table 3. Major causes of death in various countries (actual number of deaths).

Country	Year		Deaths (all causes)	Malignant neoplasms	Carcinoma of stomach	Carcinoma of trachea, lung or bronchus	Ischaemic heart disease	Cerebro-vascular disease	Chronic obstructive airways disease	Accident and violence	Suicide
England & Wales	1983	T	577,890	131,691	10,652	34,727	155,196	69,651	24,896	23,833	4,417
		M	289,022	69,920	6,305	26,297	89,104	26,604	17,587	14,477	2,761
		F	288,868	61,771	4,347	8,430	66,092	43,047	7,309	9,356	1,658
Japan	1984	T	740,247	182,280	49,785	27,356	49,213	140,093	13,480	29,344	24,344
		M	402,220	107,175	30,876	19,877	26,837	68,262	8,614	21,223	16,251
		F	338,027	75,105	18,909	7,479	22,376	71,831	4,866	8,121	8,093
Argentina	1983	T	241,904	42,700	3,626	7,322	26,429	23,044	1,997	12,293	2,217
		M	138,504	24,693	2,387	6,379	16,312	11,981	1,347	8,767	1,674
		F	103,400	18,007	1,239	943	10,117	11,063	650	3,526	543
Finland	1984	T	45,519	9,569	969	2,052	13,422	5,471	1,241	3,667	1,183
		M	23,750	5,073	497	1,810	7,778	2,103	985	2,660	936
		F	21,769	4,496	472	242	5,644	3,368	256	1,007	247
Poland	1985	T	364,883	66,067	8,550	14,391	32,984	22,912	11,239	18,403	5,167
		M	192,813	37,026	5,395	12,229	22,328	9,769	7,981	13,295	4,242
		F	172,070	29,041	3,155	2,162	10,656	13,143	3,258	5,108	925
Portugal	1984	T	92,551	14,727	2,902	1,559	7,772	22,985	2,205	5,915	833
		M	48,459	8,084	1,727	1,232	4,375	10,271	1,348	4,424	582
		F	44,092	6,643	1,175	327	3,397	12,714	857	1,491	251
Switzerland	1984	T	58,602	15,833	1,077	2,582	9,432	6,152	1,453	4,971	1,600
		M	30,456	8,725	604	2,227	5,611	2,487	1,077	3,116	1,134
		F	28,146	7,108	473	355	3,821	3,665	376	1,855	466
USA	1984	T	1,974,797	433,795	14,293	111,393	552,786	157,710	19,442	94,082	28,242
		M	1,056,440	233,865	8,506	79,228	300,820	63,855	12,477	65,754	21,625
		F	918,357	199,931	5,787	32,165	251,966	93,855	6,965	28,328	6,617

T = Total; M = Male; F = Female.

responsible for the relative immunity to ischaemic heart disease in native Japanese. Marmot suggests that this may be because in Japan management and workers share responsibility, whereas in the USA the chairman or managers bear the stresses and strains and are more susceptible, particularly if they have a type A personality. Stress is a dubious factor in the aetiology of disease but Marmot makes a rather compelling case. The higher incidence of coronary artery disease in Japanese Americans, though in part attributable to higher serum cholesterol, blood pressure and tobacco consumption, is also to some extent due to their adoption of the American way of life [20–23].

Table 3 and Figures 2 and 3 compare mortality caused by the major lethal diseases in England and Wales with that in Argentina, Finland, Poland, Portugal, Switzerland and the USA, from all of which apparently accurate information is available. The mortality from ischaemic heart disease, carcinoma of the bronchus and chronic obstructive airways disease is much higher in England and Wales than in any of these other countries, where tobacco consumption is equally high. We are driven to the suggestion that the inhabitants of England and Wales are more susceptible to the harmful effects of smoking, possibly due to a combination of atmospheric pollution and tobacco, or to the different types or preparation of the tobacco used. Neither Argentina, Finland, Poland, Portugal, Switzerland nor the USA are as densely populated as England and Wales but pollution in Japanese cities is great.

Another possible explanation is the variability in diagnosis and death certification between countries. Because Great Britain led the way in condemning smoking, it may be that there is over-diagnosis of ischaemic heart disease in England and Wales and there could be an element of truth in the feeling that the Royal College of Physicians encourages single issue fanaticism.

If we could solve the riddle of the gender differences, many of the unexplained features of longevity would doubtless be clarified, but at present environmental influences appear at least as or more important than genetic factors. However, from birth to the eighth decade more males than females die each year and in the first decade smoking, the prime adverse environmental influence, is not obviously operative against the male. There are therefore probably biological differences.

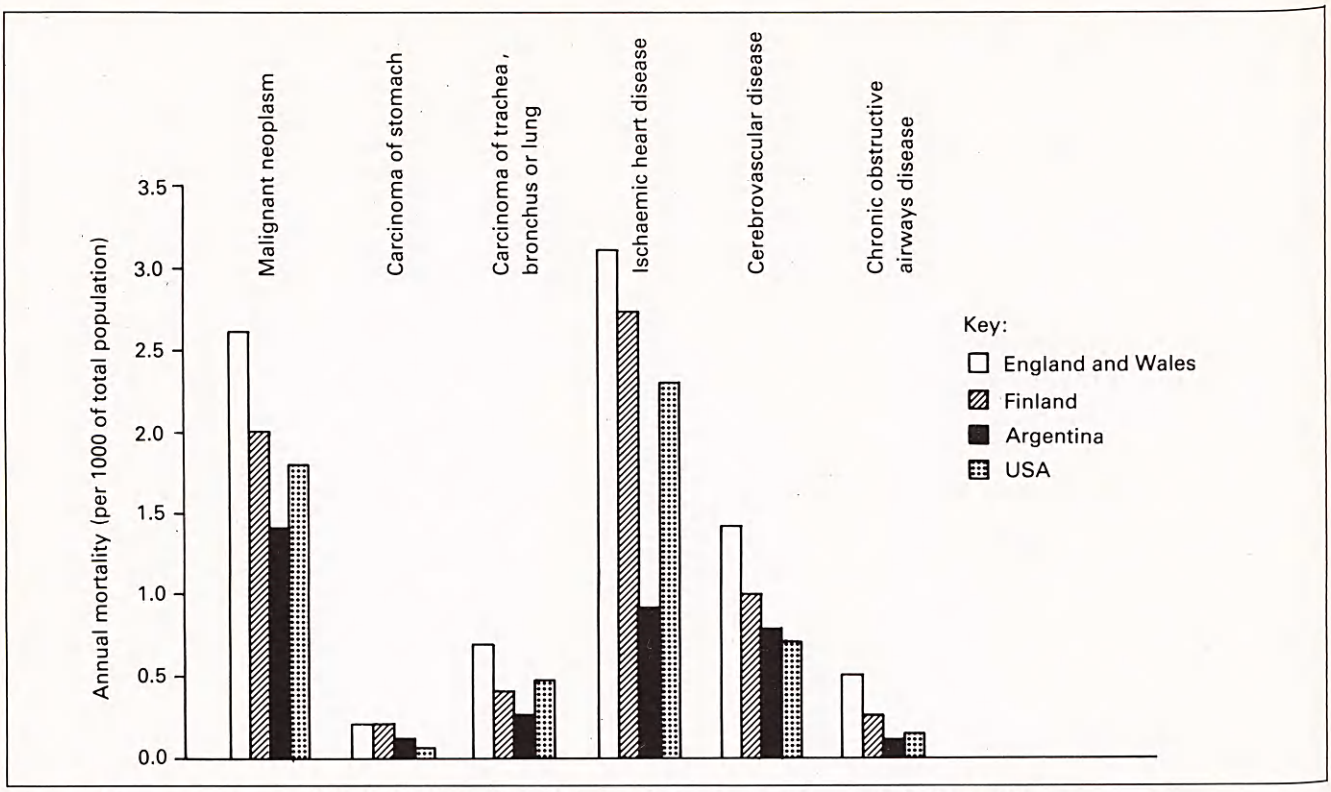

Fig. 2. *Some major causes of death in England and Wales, Finland, Argentina and the United States.*

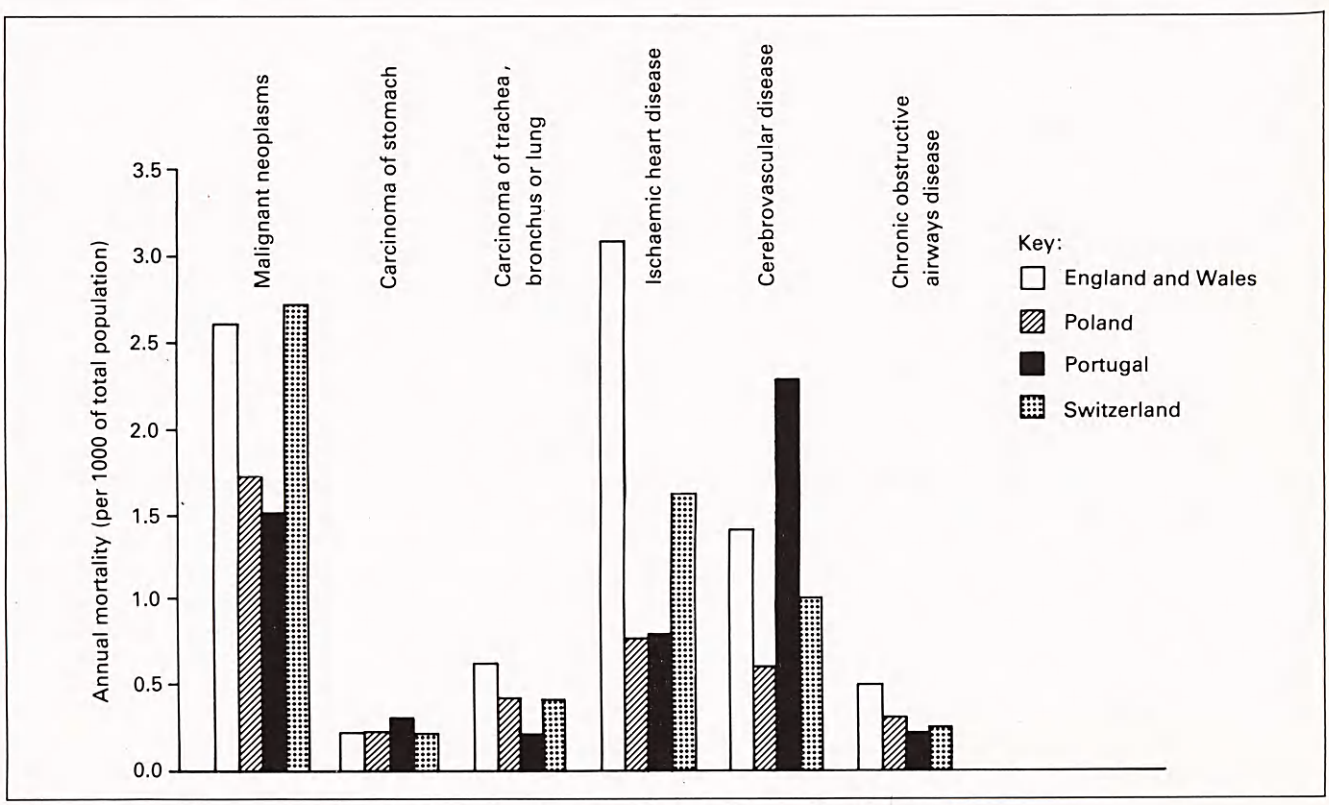

Fig. 3. *Some major causes of death in England and Wales, Poland, Portugal and Switzerland.*

Paradoxically, throughout the world more males than females are born and stillbirths in England and Wales have shown a marked male preponderance. In 1984, there were 1,967 males in a total of 3,643 stillbirths giving a male:female ratio of 1.2:1 [24].

Previously, the view was that the conception rate favoured males, but recently external fertilisation of human eggs showed a 1:1 gender ratio, though the numbers (7 females and 6 males) were too small for any conclusions to be drawn [25]. However, *in vitro* fertilisation will exclude immunological and other intrauterine factors that might act differentially against one gender.

The sex of abortuses is a source of confusion. Males were thought to be the commoner because the Barr body was lacking but this can be the result of maceration, and when the chromosomes were grown the sex ratio veered in the female direction so more girls were spontaneously aborted. The problem is occasionally confounded by maternal rather than aborted tissue being karyotyped and this inevitably gives a female excess [26]. With such contradictory evidence, it is clear that much more information is required as to what exactly occurs at fertilisation.

As matters stand at present, it seems that early in pregnancy the male is more protected than the female but may be more at risk in the outside world. Here, environmental factors, including habits, may switch the ratios in favour of the female.

The Japanese difference may be solved by further studies of, for example, HLA phenotypes and the apolipoproteins—or of dietetic habits. However, in spite of the care which has apparently been taken to make the data comparable in both countries, it is well known that records are difficult to assess and death certificates may be highly erroneous. We have certainly found this in Great Britain where differences in autopsy rates, availability and quality of notes, and death certification are marked [27–33], particularly so in ischaemic heart disease [34]. In babies said to have died from rhesus haemolytic disease we found that the death certification by the house officer or the coding by the Office of Population Censuses and Surveys were inaccurate in one-quarter of cases nine years ago, but, as a result of annual monitoring, accuracy has improved markedly. Increasing the accuracy and comparability of records may prove more rewarding than other more complex and expensive approaches. With more reliable data we should be on firmer ground when discussing differences between countries as regards causes of death.

Acknowledgements

We are grateful to an anonymous donor for a grant to support the research on longevity which we are carrying out with the Royal Holloway and Bedford New College.

References

1. Clarke, C. A. (1986) *Journal of the Royal College of Physicians,* **20,** 122.
2. Bayliss, R. I. S., Clarke, C. A. and Whitfield, A. G. W. (1986) *Journal of the Royal College of Physicians.* **20,** 290.
3. *World Health Statistics Annual 1985* (1985). Geneva: WHO.
4. *WHO Chronicle* (1982) **36,** 234.
5. Lopez, A. D. and Hanada, K. (1982) *World Health Statistics Quarterly,* **35,** 202.
6. Lopez, A. D. (1984) *WHO Chronicle,* **38,** 217.
7. *World Health Statistics Quarterly* (1982) **35,** 2.
8. Leviatan, U. and Cohen, J. (1985) *Social Science and Medicine,* **21,** 545.
9. Hamman, R. F., Barancik, J. I. and Lilienfeld, A. M. (1981) *American Journal of Epidemiology,* **114,** 845.
10. Nevo, E. (personal communication 1986).
11. *Japan Statistical Year Book 1983.*
12. *The Japan Times,* 27 June 1986.
13. *OPCS Mortality Statistics England and Wales 1983.*
14. Kagamimori, S., Iibachi, Y. and Fox, J. (1983) *World Health Statistics Quarterly,* **36,** 119.
15. Pisa, Z. and Uemura, K. (1982) *World Health Statistics Quarterly,* **35,** 11.
16. *Summary of National Survey on Circulatory Disorders.* (1980) Ministry of Health and Welfare, Japan.
17. Gordon, R. (1967) *Public Health Reports,* **82,** 973.
18. Syme, S. L., Marmot, M. G., Kagan, A., Kato, H. and Rhoads, G. (1975) *American Journal of Epidemiology,* **102,** 474.
19. Marmot, M. G., Syme, S. L., Kagan, A., *et al.* (1975) *American Journal of Epidemiology,* **104,** 225.
21. Marmot, M. G. (1981) In *Foundations of psychosomatics.* Chichester: John Wiley.
22. Marmot, M. G., Kagan, A. and Kato, H. (1980) In *Epidemiology of arterial blood pressure.* London: Martinus Nijhoff.
23. Marmot, M. G., Syme, S. L., Sacks, S. T. and Kwok, L. W. (1979) *Excerpta Medica,* **476.**
24. OPCS Birth Statistics, England and Wales 1984.
25. Angell, R. R., Templeton, A. A. and Aicken, R. J. (1986) *Human Genetics,* **72,** 333.
26. Hassold, T., Quillen, S. D. and Yamane, J. A. (1983) *Annals of Human Genetics,* **47,** 39.
27. Clarke, C. A. and Whitfield, A. G. W. (1978) *British Medical Journal,* **2,** 1063.
28. Alderson, M. R., Bayliss, R. I. S., Clarke, C. A. and Whitfield, A. G. W. (1983) *British Medical Journal,* **287,** 444.
29. Clarke C. A. and Whitfield, A. G. W. (1982) *Journal of the Royal College of Physicians,* **16,** 152.
30. British Thoracic Association (1984) *Thorax,* **39,** 505.
31. Clarke, C. A. and Whitfield, A. G. W. (1979) *British Medical Journal,* **1,** 1665.
32. Clarke, C. A. and Whitfield, A. G. W. (1983) *Journal of Obstetrics and Gynaecology,* **3,** 144.
33. Clarke, C. A. and Whitfield, A. G. W. (1984) *Journal of Obstetrics and Gynaecology,* **4,** 218.
34. Phillips, R., Carson, P. H. M., Haites, N. E. *et al. Quarterly Journal of Medicine* (In Press).