IJE vol.33 no.4 © International Epidemiological Association 2004; all rights reserved.
Advance Access publication 28 July 2004
International Journal of Epidemiology 2004;**33**:710–717
doi:10.1093/ije/dyh099

REVIEW

Adult mortality: time for a reappraisal

Emmanuela Gakidou,[1] Margaret Hogan[1] and Alan D Lopez[2]

Accepted 19 December 2003

Background In many countries, little is known about adult mortality rates. New innovations are necessary to develop reasonable estimates from available information. One readily available resource is household survey data. While birth histories collected in surveys have produced reasonable estimates of child mortality, the use of sibling survival data collected in similar household surveys has not been comprehensively analysed, largely because of concerns of underreporting.

Methods This paper uses sibling survival schedules from 29 Demographic and Health Surveys (DHS) to generate estimates of under-5 mortality and of the summary measure of adult mortality 45q15—the probability of dying between ages 15 and 59. These are then compared with UN child and adult mortality estimates.

Results Sibling history data collected in these household surveys seems to contain adequate information to estimate adult mortality rates, though there are problems with underreporting. The correlation coefficient between UN estimates and DHS estimates is 0.74 for adult mortality, indicating a strong relationship between the two but suggesting there may be underreporting of adult deaths in the survey data.

Conclusions Further investigation is necessary to determine the usefulness of household survey data for the estimation of adult mortality. New survey instruments like the World Health Survey have incorporated questions to help correct for underreporting in sibling histories. Further analyses need to be carried out in countries where vital registration data are also available, to determine how well household survey data do in estimating adult mortality and whether improvements in the survey instrument adequately correct for underreporting of deaths.

Keywords Adult mortality, household surveys, vital statistics, sibling survival

The principal focus of global public health efforts over the past several decades has been on improving child health and survival, and there is no question that continued investment in child health care provision and community development should remain a priority. Each year, an estimated 10.9 million children die before the age of 5 years, the vast majority of them from diarrhoeal disease, pneumonia, perinatal causes, malaria, and measles.[1] Much of this is preventable, through intervention programmes focused on major childhood diseases. These have proved remarkably successful, at least for some diseases (particularly measles), over the past couple of decades. Global child mortality has declined from an estimated 14.6 million in 1985[2] to less than 11 million currently, although the progress has been uneven in different populations, with only marginal declines in child mortality in Africa (10–20% since 1980) compared with elsewhere.[3]

Part of the success in reducing child mortality must surely lie with the increased efforts to monitor child mortality levels over the past few decades through systematic application of direct and indirect methods to data on survival of children routinely collected in censuses and surveys. Several methodological advances now allow the indirect assessment of child mortality from direct evidence on children ever born and children surviving.[4,5] The wealth of data on child mortality (defined as the risk of death between birth and age 5) for the four largest developing countries (India, China, Brazil, and Indonesia) is shown in Figure 1. From these rich data sources, it is possible to establish current levels of child mortality with reasonable certainty.

[1] Evidence and Information for Policy (GPE/EBD), World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland.

[2] School of Population Health, The University of Queensland, Brisbane, QLD 4006, Australia.

Correspondence: Alan D Lopez, School of Population Health, The University of Queensland, Public Health Building, Herston Road, Herston, Brisbane, QLD 4006, Australia. E-mail: a.lopez@sph.uq.edu.au

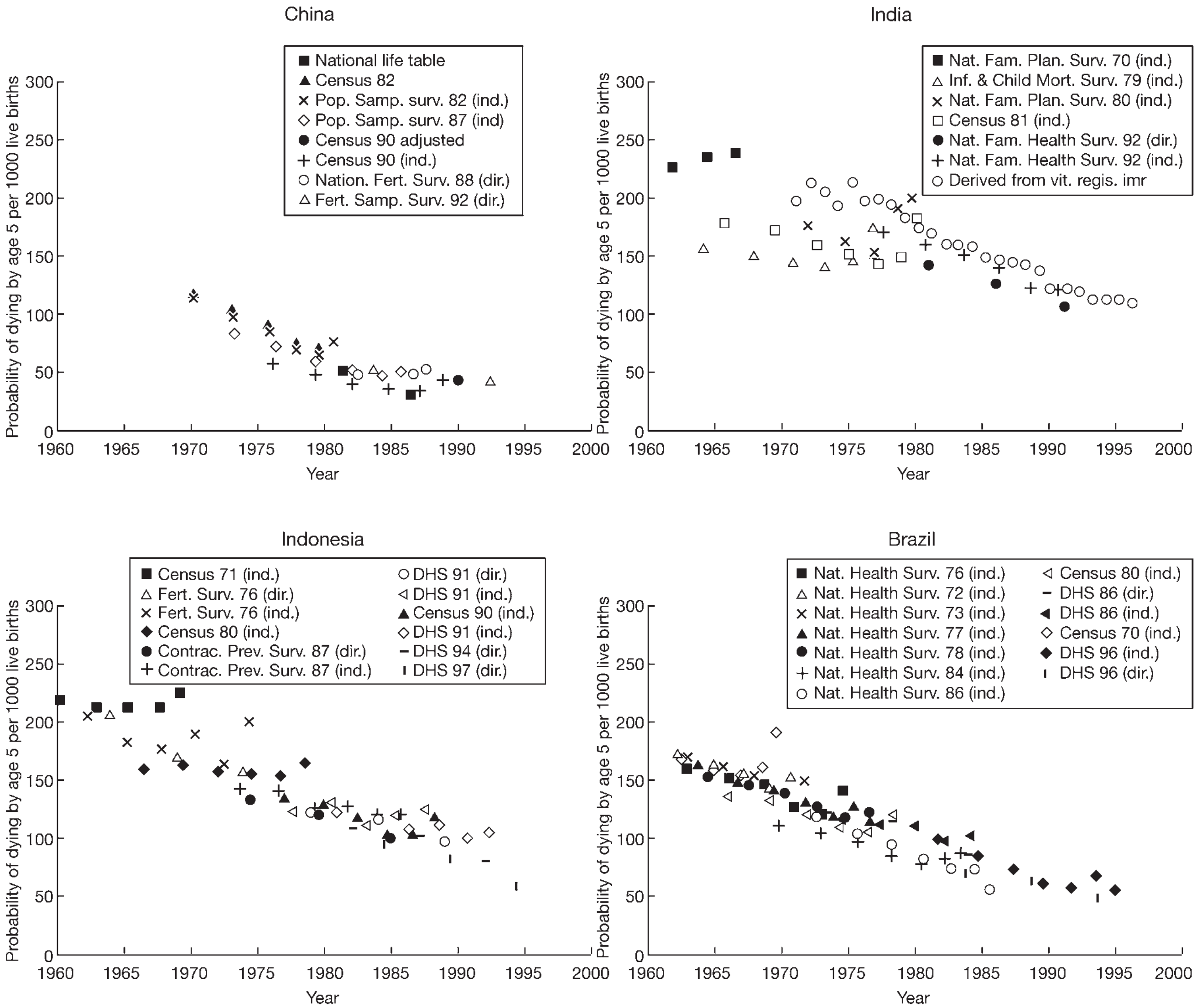

Figure 1 Data sources available for child mortality estimation in the four largest developing countries

Regrettably, knowledge about levels of adult mortality has not kept pace with these developments. Health development policies are, or should be, concerned with improving health and survival across the lifespan. As this segment of the population increases, with fewer children dying each year, the concept of preventing premature death must similarly adapt from a singular focus on preventing child death to a broader concern with preventing premature child *and* adult death. Yet despite attempts by some authors to stress the need for greater public health focus on adult health,[6,7] it has taken the advent of a massive new epidemic (human immunodeficiency virus [HIV]/AIDS) which primarily affects young adults to galvanize support for adult health as a key international health priority. The imperative for greater international focus on improving the health of adults extends well beyond HIV. Recent comparative analyses of the leading causes of risk factor burden worldwide identified high blood pressure, tobacco, and alcohol among the top five, along with unsafe sex. Virtually all premature deaths and disabilities these risk factors cause occur among young and middle aged adults.[8]

Yet, despite the large and growing importance of disease and injury burden among adults, in many countries there remains vast uncertainty about levels of adult mortality, let alone cause. The lack of a reliable baseline against which to monitor programme effectiveness is a serious impediment to effective public health action to reduce the main killers of young adults. In this paper, we outline the current state of knowledge on levels of adult mortality and propose new methodological approaches which we believe have the potential to yield plausible adult mortality rates from routinely collected survey data on sibling survival.

Main sources of data on adult mortality

Reliable, timely estimates of age-sex-specific death rates remain the cornerstone of health information systems. Undoubtedly,

Table 1 World Health Organization categorization of mortality data sources by region

WHO region	No. of countries				
	CAT I	CAT II or III	CAT IV	CAT V	% of deaths worldwide
AFR	2	5	32	7	19
AMR	20	13	2	0	11
EMR	4	5	11	2	7
EUR	41	10	0	0	18
SEAR	1	4	4	1	25
WPR	6	13	8	0	20
WORLD	74	50	57	10	100
% of deaths covered	24	48	25	2	

CAT I. Complete vital statistics (coverage 95%+).

CAT II or III. Incomplete vital statistics or sample registration and surveillance systems.

CAT IV. Child mortality estimated from surveys and censuses.

CAT V. No recent data on child or adult mortality.

AFR. African Region.

AMR. American Region.

EMR. Eastern Mediterranean Region.

EUR. European Region.

SEAR. South East Asia Region.

WPR. Western Pacific Region.

Source: [10] Lopez AD, Ahmad OB, Guillot M *et al. World Mortality in 2000: Life Tables for 191 Countries*. Geneva: World Health Organization, 2002, p. 3.

the most reliable source of data for calculating mortality rates is a functioning vital registration system which records the fact of death, as well as the age and sex of the decedent, for all or almost all deaths. Based on data provided to the WHO each year by countries, some 74 of the 191 (now 192) Member States in 2000 had what might be termed complete and reliable vital registration systems in 2000.[9] In conjunction with mid-year population estimates, age-specific death rates for these countries, covering about one-quarter of the 55.7 million deaths estimated to have occurred in that year, can be readily determined. WHO has categorized mortality data sources as presented in Table 1.[9]

Incomplete vital registration and sentinel surveillance

In addition to these countries with complete vital registration systems, virtually all other governments maintain some form of vital registration of births and deaths, although the coverage varies greatly across countries. Very few countries in Sub-Saharan Africa (South Africa is the notable exception) have estimated coverage levels for vital events of more than 50%, and most are well below this level. There exist demographic techniques[5,10–12] which allow one to assess the completeness of registration of adult deaths based on certain assumptions about the stability of population growth rates and migration. For a further 46 countries, vital registration is considered sufficiently complete to permit application of these methods. The extent of under-registration of deaths varies considerably, but is typically of the order 20–25% for the Central Asian Republics, but much lower (5–10%) in countries such as Guatemala and the Republic of Korea.[9] In several large populations including Brazil and Egypt, vital registration appears to be performing reasonably satisfactorily, capturing 80–85% of all deaths. These ratios can then be applied to registered deaths to estimate adult mortality rates, adjusted for such underreporting.

In some large populations, particularly India and China, complete or virtually complete vital registration is unlikely to be a reality for many years. However, for both of these populations, systems of sentinel surveillance yield remarkably good estimates of age-specific death rates. In India, the Sample Vital Registration System (SRS) covers a random sample of about 6 million people or about 0.6% of the population, and collects data on vital events in these sample populations. Estimates using the indirect demographic techniques mentioned above suggest levels of completeness for adult death registration of about 85%.[13] In China, a representative sample of 145 Disease Surveillance Points (DSP) covering villages and urban districts provides annual mortality data on about 10 million people, with an estimated completeness of coverage of about 80% (higher in urban areas).[9] Systems such as these are also operating in Bangladesh and Tanzania, and yield reasonably reliable information on about 36% of deaths occurring worldwide.

Regrettably, very little is reliably known about levels of adult mortality for the remaining 67 Member States of WHO, comprising 27% of the world's population (by comparison, there is substantial uncertainty about child mortality in only a handful of countries, representing about 2% of the world's population). Data on parental or sibling survival have been collected in some surveys, but this has not been systematic, nor have conventional demographic techniques for analysing survey data on adult mortality generally yielded plausible results. There thus remains substantial uncertainty about levels of adult mortality for about half the countries of the world, either because there is no reliable survey evidence, or because methods for correcting vital registration data for incompleteness are essentially subjective, requiring considerable judgement as to the choice of data points on which to base the assessment.

This uncertainty is appropriately reflected in country and global estimates of adult mortality. A convenient index for measuring adult mortality is the probability of dying between ages 15–60 or 45q15 in life table notation. Levels of risk of adult death at these ages vary for males from about 10% in Japan, Australia, and New Zealand to 60% in Southern Africa, where the HIV epidemic is most pronounced, and from about 5% to 55% for females. Globally, there are an estimated 15.7 million deaths at ages 15–59, which by any standards must be considered premature. But perhaps more to the point is the very substantial uncertainty around these estimates. In Sub-Saharan Africa, for example, and particularly where mortality rates from HIV/AIDS are high, there is extraordinary uncertainty about the true level of adult mortality, often as high as 30–50%.[9] This uncertainty is unacceptable if public health programmes to control the leading causes of adult death are to be monitored appropriately. The following section of the paper outlines some possible methodological approaches to reducing this uncertainty by more reliably correcting for under- and mis-reporting of deaths.

Estimating adult mortality from household surveys

Several indirect methods for estimating levels of adult mortality have been proposed, but it is difficult to validate these methods because there is little overlap in the types of data available for countries with good vital registration and those with less complete systems.[14] Indirect methods generally rely on census and survey data, and include, but are not limited to:

Deaths in the past 12 months

A number of censuses and household surveys include questions on number of deaths in the household in the 12 or 24 months prior to the interview. This method often suffers from underreporting of events and, when based on household surveys, does not yield large sample sizes.[15,16]

The widowhood method

This method estimates mortality rates based on the survival of a respondent's first husband or wife. Several problems accompany this method, including the exclusion of younger and later spouses (particularly in polygamous societies), the exclusion of unmarried adults,[17] the difficulty of clarifying between ever-widowed and currently widowed,[18] the likelihood that in some cases, particularly in high HIV countries, the mortality of spouses will be related,[18] and the necessity of a large sample size.[14,19–21]

The orphanhood method

This method estimates mortality rates based on the survival of a respondent's parents.[22] This method has several limitations, including the underreporting of deaths among parents who died when their children were quite young (the 'adoption' effect),[23] and the necessity of a large sample for any kind of meaningful mortality estimate. It also does not include parents with no surviving children.[4,14,17,22,24–25] Timaeus[18] reports that several applications of the method have generated reasonable estimates, but particularly in East African countries, the estimates are much lower than expected, especially for young respondents.

The sibling survivorship method

Hill and Trussell[24] first developed this method of estimating adult mortality from the proportion of deceased siblings of a survey respondent. In an effort to estimate maternal mortality, this method was varied slightly to become the sisterhood method, proposed by Graham *et al.*,[17] and a number of studies have estimated maternal mortality via this method.[26–32] The basic method for estimating adult mortality (rather than maternal) has not been applied as widely.[17,33] While this method suffers from drawbacks, including the assumption that sibling group size does not affect survival,[17] and the risks that respondents may not know about siblings that died before they were born or when they were very young,[18] or that siblings may lose touch or be forgotten, or their vital status unknown, there are convincing reasons that this method is a possibility for estimating adult mortality. At the very least, its usefulness should be further explored, as this paper attempts to do. By limiting observations to those siblings who have reached adulthood, the assumption that sibling group size does not affect survival is more reasonable.[33] Another major advantage of this method is that a relatively small number of respondents can lead to a sizeable dataset.[34]

All of the methods mentioned above suffer from a similar drawback, that being a time reference problem. Events recorded could have occurred at any point during the lifetime of the respondent or even before the respondent was born. While dates and times of death are sometimes recorded, they often suffer from recall biases. One option is to limit the period of analysis to the 5 or 10 years immediately preceding the census or survey. While this leads to more recent estimates that are less prone to bias, it also greatly decreases the sample size, making it difficult to arrive at meaningful age- and sex-specific death rates. Limiting the observation period may only be an option for sibling survival data, as the sample sizes are usually large enough that analyses can be performed on a subset of the full data.

The Demographic and Health Surveys (DHS) contain a maternal mortality module which can be used to estimate adult mortality based on sibling survivorship information. For several countries, the DHS collects complete sibling histories; that is, information on all children born to the respondent's mother, including the current age of living siblings, and the age at death and years since death of dead siblings (Macro International 2003). Because of the inclusion of dates and ages, the sibling survivorship method can be extended to include sex- and age-specific death rates, and can also be used to attempt to limit the time reference to some specified period prior to the survey.

Stanton *et al*.[19,35] have completed two assessments of DHS maternal mortality indicators, a selection of which can be used for adult mortality estimates. Their 1997 Macro International report analysed data quality for 14 countries, and a later 2000 paper analysed data for 13 countries. They conclude that the basic demographic variables (sex, age of living sibling, and age at death) are virtually complete. Stanton *et al*. also report that for age at death, none of the data-quality indicators examined among reported events were of lesser quality for distant periods than those from the most recent period.

There are several types of recall problems associated with these data, including older respondents forgetting events of the distant past, and younger respondents not reporting on events that happened before they were born or when they were still very young.[19] This results in general underreporting of mortality in the past.[24,36,37]

Stanton and colleagues compare DHS adult mortality estimates with UN general mortality indicators and DHS child mortality indicators. They find that the DHS adult estimates are somewhat lower on average than the UN estimates, and reasonably consistent with child mortality estimates. Stanton *et al*. conclude that the proportion of events affected by recall issues is much greater than with child mortality.

Strategies to improve information on adult mortality

Of the available indirect methods, questions on survival of all siblings (not just sisters) has been least utilized, and may provide a promising method to estimate adult mortality in settings with poor vital registration systems. This method has the added advantage that if individuals gave accurate accounts of sibling deaths, historical information on changes in mortality could be derived from a simple cross-section. However, it seems clear that reporting methods would have to be substantially improved before these data were used for historical mortality estimation.

This analysis uses 34 DHS with modules on sibling survival in the women's questionnaire. The respondents are nationally representative samples of women of reproductive age (usually 15–49 years of age). Table 2 provides a list of countries, survey years and sample sizes where this module is available.

These modules collect information on complete 'sibling histories'; that is, respondents are asked about all siblings born to the same mother, their age (both number of years and year of birth), sex and vital status at the time of the interview. For siblings who have died, information is collected on the year and age at death, as well as the number of years ago the death occurred. This information is then used to produce person-years lived and number of deaths in 5-year age groups, for males and females separately, and for 5-year time periods, the latest of which is the 5 years preceding the interview year. The respondents themselves are excluded from this analysis to minimize selection bias, as they are selected on the basis of being alive.

Death rates for each 5-year age-sex group from the DHS are underestimates of the true rates, mainly due to recall bias on the behalf of the respondents. To estimate the magnitude of the recall bias, the DHS death rates need to be compared with a gold standard or a more accurate estimate of adult mortality. Clearly, the main limitation in validating the DHS death rates is that these data exist where vital registration data are not available. While not a 'gold standard', UN estimates can be treated as one basis for comparison. For their routine demographic estimation, the UN uses inter-censal survival, the growth–balance equation and the number of deaths by age and sex to estimate adult mortality. UN Population Division estimates of mortality by age and sex from 1950 to 2000 are used as comparators in this

Table 2 Demographic and Health Surveys (DHS) with maternal mortality module by year and sample size, and estimated 45q15 from sibling survival data

Country	Year	Sample size	UN estimate Year	45q15 DHS sibling survival Male	45q15 DHS sibling survival Female
Benin	1996	5491	1996	0.210	0.137
Brazil	1996	12 612	1996	0.184	0.076
Burkina Faso	1998	6445	1998	0.264	0.169
Cameroon	1998	5501	1998	0.206	0.143
Central African Republic	1995	5884	1995	0.321	0.224
Chad	1997	7454	1997	0.163	0.121
Cote d'Ivoire	1994	8099	1995	0.282	0.177
Eritrea	1995	5054	1995	0.200	0.146
Guinea	1999	6753	1995	0.194	0.142
Indonesia	1994	28 168	1995	0.110	0.063
Indonesia	1997	28 810	1997	0.156	0.101
Madagascar	1997	7060	1997	0.226	0.145
Malawi	1992	4849	1997	0.319	0.226
Malawi	2000	13 220	1997	0.472	0.343
Mali	1996	9704	1996	0.178	0.103
Namibia	1992	5421	1997	0.312	0.131
Niger	1992	6503	1997	0.185	0.105
Nigeria	1999	7647	1995	0.139	0.084
Peru	1996	28 951	1996	0.141	0.086
Peru	2000	27 843	1996	0.116	0.054
Philippines	1998	13 983	1998	0.167	0.078
Philippines	1993	15 029	1998	0.167	0.074
Senegal	1993	6310	1998	0.122	0.090
Togo	1998	8569	1998	0.207	0.129
Uganda	1995	7070	1995	0.437	0.286
United Republic of Tanzania	1996	8120	1996	0.275	0.140
Zambia	1996	8021	1996	0.499	0.326
Zimbabwe	1994	6128	1995	0.310	0.189
Zimbabwe	1999	5907	1995	0.462	0.317

analysis. Their estimates may be inaccurate for each country, but in this analysis we assume that across the set of countries the UN data provides an unbiased estimate of adult mortality.

Figures 2 and 3 show for child and adult mortality, respectively, the relationship between UN estimates and estimates derived from the DHS sibling survival module. For children, Figure 2 shows the under-5 mortality rate for male and female children separately. The correlation coefficient between the UN and the DHS estimates is 0.67. For most countries the DHS estimates for child mortality are higher than the UN, but at high levels of mortality the UN suggests a higher level of child mortality than the DHS.

Figure 3 shows the relationship between DHS and UN estimates for a summary index of adult mortality, 45q15, which refers to the probability of dying between the ages 15 and 59. The correlation coefficient between the two sets of estimates is 0.74. Unlike with child mortality, for adult mortality estimates from the DHS are lower than the UN for all countries. The strong relationship between the two sets of estimates indicates that despite underreporting, overall sibling history data appears to contain useful information about levels of adult mortality.

The main limitation of using information collected this way appears to be the undercounting of events of sibling death,

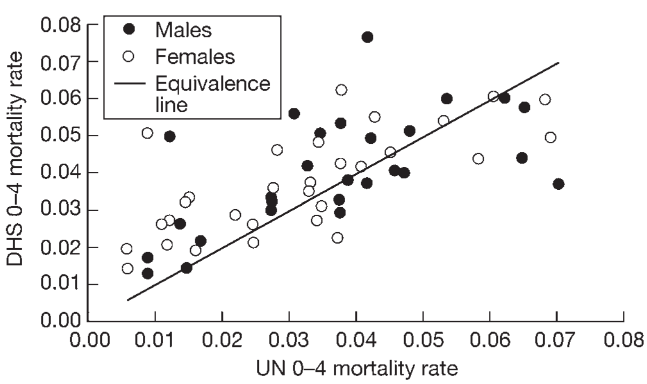

Figure 2 Relationship between Demographic and Health Survey (DHS) sibling survival and UN estimates[a] for under-5 mortality

[a] See Table 2 for reference year of DHS and UN estimates.

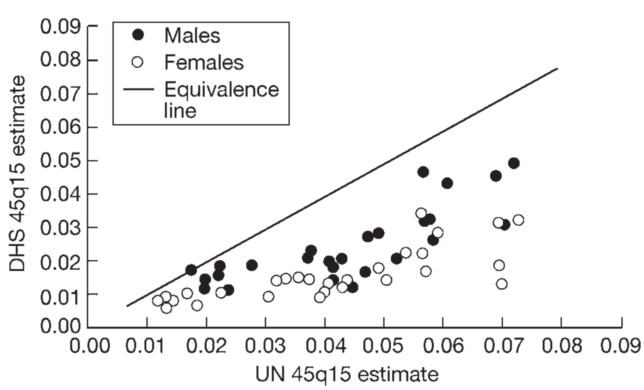

Figure 3 Relationship between Demographic and Health Survey (DHS) sibling survival and UN 45q15 estimates[a]. Males and females

[a] See Table 2 for reference year of DHS and UN estimates.

which lead to age-sex specific mortality rates that are too low. The way forward with this type of mechanism for collecting information on levels of adult mortality in settings where vital registration systems are very poor or non-existent may be to improve the questionnaire design. To improve estimates derived from sibling histories, the questions may need modification. They could be expanded to collect information on covariates that might predict accuracy of recall, such as time of last contact with sibling, distance between the residences of the siblings, frequency of family gatherings where information on family members' well-being might be exchanged, etc.

As an attempt to correct for the underreporting of deaths in sibling histories, the WHO recently developed the World Health Survey questionnaire which collects information on time of last contact between siblings along with the standard sibling survival schedule, including for each sibling of the respondent their name, sex, date of birth, and age at death if not alive (see www.who.int/whs for more information). The World Health Survey, fielded in 2003, will provide the opportunity to revise the mortality rates based on sibling histories in three ways. First, information on time of last contact between siblings can be used to censor the data. The survival status of each sibling will be assumed to be known with certainty only at the time of last contact with the respondent. Second, as some of the countries that are participating in the World Health Survey are countries with good vital registration or sample registration systems (like India, for example), a validation of mortality rates collected through household surveys will be feasible against a 'gold standard' type of registration system. Third, the World Health Survey includes respondents of both sexes above the age of 18. It will provide the opportunity to test whether recall is related to the sex of the respondent, and expand information on recall as a function of age of the respondent, as the number of age groups included will be much broader than the reproductive age groups included in the DHS. It is hoped that this experience with analysis of sibling histories will then strengthen the basis for assessing recall bias as a function of time since survey, age, and sex of the respondent, and lead to techniques to correct for it.

Household surveys provide the only way, at present, to get timely information on the impact of new health problems, such as HIV/AIDS, particularly in countries without elaborate monitoring systems. This adds to the reasons why it is important to understand the functional relationship between sibling history and true death rates. If techniques to correct the biases associated with recall of sibling death are developed, this relatively easy way to collect information on adult mortality can be used to monitor current mortality and time-trends in death rates. In addition, some verbal autopsy questions can be incorporated to attempt to determine cause of death from major causes. For example, if a reliable and valid verbal autopsy instrument existed for determining deaths due to HIV/AIDS, mortality from AIDS in high prevalence countries could be monitored using sibling history techniques. However, it must be recognized that adding additional modules or questions to a household survey translates into a need for more resources, more training, and perhaps dropping other relevant questions from the instrument.

These methods are not precise, nor can they be given the quality of survey data on mortality. Yet they offer what could perhaps be a promising means of obtaining reasonable estimates of adult mortality levels for the 100 or so countries where there are no reliable data from routine sources. As a minimum, this direct evidence should greatly reduce uncertainty about adult death rates in developing countries and provide a baseline against which the impact of disease control programmes can be assessed. Global health policy will be poorly served if we are as ignorant about adult mortality in 10 years hence as we are today.

Acknowledgements

The authors wish to thank the National Institutes on Aging (PO1 AG17625-01) for research support.

KEY MESSAGES

- The current state of knowledge regarding levels of adult mortality is unacceptably low in many countries in the world.
- The value of sibling survival data for estimating adult mortality has not been adequately studied.
- Using data from the Demographic and Health Surveys, this paper suggests that sibling survival schedules contain moderate information content regarding adult mortality levels, but further study is required to help correct for underreporting problems.
- Modifications to the sibling survival questionnaires, such as those incorporated in the World Health Surveys related to time of last contact, may lead to improvements of adult mortality estimates derived from household surveys.

References

[1] Murray CJL, Lopez AD. Mortality by cause for eight regions of the world: Global Burden of Disease Study. *Lancet* 1997;**349:**1269–76.

[2] Lopez AD. Causes of death in industrial and developing countries: estimates for 1985–1990. In: Jamison DT, Mosley WH, Measham AR, Bobadilla JL (eds). *Disease Control Priorities in Developing Countries*. Oxford: Oxford University Press for the World Bank, 1993, pp. 35–50.

[3] Ahmad OB, Lopez AD, Inoue M. The decline in child mortality: a reappraisal. *Bull World Health Organ* 2000;**78:**1175–91.

[4] United Nations. *Manual X: Indirect Techniques for Demographic Estimation*. New York: United Nations, 1983.

[5] Trussell TJ. A re-estimation of the multiplying factors for the Brass technique for determining childhood survivorship rates. *Popul Stud* 1975;**29:**97–108.

[6] Feachem RGA (ed.) *et al*. *The Health of Adults in the Developing World*. Oxford; New York; Toronto; Melbourne: Oxford University Press for the World Bank, 1992.

[7] Murray CJL, Lopez AD (eds). *The Global Burden of Disease: a Comprehensive Assessment of Mortality and Disability from Diseases, Injuries, and Risk Factors in 1990 and Projected to 2020*. Cambridge, USA: Harvard University Press on behalf of WHO and the World Bank, 1996.

[8] World Health Organization. *Reducing Risks: Promoting Healthy Life*. Geneva: World Health Organization, 2002.

[9] Lopez AD, Ahmad OB, Guillot M *et al*. *World Mortality in 2000: Life Tables for 191 Countries*. Geneva: World Health Organization, 2002.

[10] Bennett NG, Horiuchi S. Mortality estimation from registered deaths in less developed countries. *Demography* 1984;**21:**217–33.

[11] Hill K. Estimating census and death registration completeness. *Asian Pac Pop Forum* 1987;**1:**8–24.

[12] Preston SH, Coale AJ, Trussell J, Weinstein M. Estimating the completeness of reporting adult deaths in populations that are approximately stable. *Popul Stud* 1980;**46:**179–202.

[13] Bhat M. Estimating life tables for India in the 1990s. (WHO unpublished document, 2000).

[14] Hill K. Methods for measuring adult mortality in developing countries: a comparative review. Research Paper No. 01.13. 2000. Harvard Burden of Disease Unit; National Institute on Aging Grant 1-PO1-AG17625. The Global Burden of Disease 2000 in Aging Populations.

[15] Timaeus I. Adult mortality. *Demographic Change in Sub-Saharan Africa*. National Academy of Sciences, 1993, pp. 218–35.

[16] Feeney G. The impact of HIV/AIDS on adult mortality in Zimbabwe. *Popul Dev Rev* 2001;**27:**771–80.

[17] Graham W, Brass W, Snow RW. Estimating maternal mortality: the sisterhood method. *Stud Fam Plann* 1989;**20:**125–35.

[18] Timaeus I. Measurement of adult mortality in developing countries: a comparative review. *Popul Index* 1991;**57:**552–68.

[19] Stanton C, Noureddine A, Hill K. An assessment of DHS maternal mortality indicators. *Stud Fam Plann* 2000;**31:**111–23.

[20] Singh R. *Estimation of Adult Mortality from Widowhood Data for India and its Major States*. Mumbai, India: International Institute for Population Sciences, 2000.

[21] Malaker CR. Estimation of adult mortality in India: 1971–81. *Demography India* 1986;**15:**126–36.

[22] Brass W, Hill K. *Estimating Adult Mortality in Africa from Orphanhood*. Proceedings of the International Population Conference. Liège: International Union for the Scientific Study of Population, 1973.

[23] Timaeus I. Estimation of adult mortality from orphanhood before and since marriage. *Popul Stud* 1991;**45:**455–72.

[24] Hill K, Trussell J. Further developments in indirect mortality estimation. *Popul Stud* 1977;**31:**313–34.

[25] Timaeus I. An assessment of methods for estimating adult mortality from two sets of data on maternal orphanhood. *Demography* 1986;**23:**435–50.

[26] Shahidullah M. The sisterhood method of estimating maternal mortality: the Matlab experience. *Stud Fam Plann* 1995;**26:**101–06.

27 Danel I, Graham W, Stupp P, Castillo P. Applying the sisterhood method for estimating maternal mortality to a health facility-based sample: a comparison with results from a household-based sample. *Int J Epidemiol* 1996;**25:**1017–22.

28 Garenne M, Friedberg F. Accuracy of indirect estimates of maternal mortality: a simulation model. *Stud Fam Plann* 1997;**28:**132–42.

29 Chiphangwi JD, Zamaere TP, Graham W, Duncan B, Kenyon T, Chinyama R. Maternal mortality in the Thyolo district of southern Malawi. *East Afr Med J* 1992;**69:**675–79.

30 Wirawan DN, Linnan M. The Bali indirect maternal mortality study. *Stud Fam Plann* 1994;**5:**304–09.

31 Walraven GEL, van Dongen PWJ. Assessment of maternal mortality in Tanzania. *Br J Obstet Gynaecol* 1994;**101:**414–17.

32 Shiferaw T, Tessema F. Maternal mortality in rural communities of Illubabor, Southwestern Ethiopia: as estimated by the 'sisterhood method'. *Ethiop Med J* 1993;**31:**239–49.

33 Bicego G. Estimating adult mortality rates in the context of the AIDS epidemic in sub-Saharan Africa: analysis of DHS sibling histories. *Health Transit Rev* 1997;**7(S2):**7–22.

34 Timaeus I, Graham W. Measuring adult mortality in developing countries: a review and assessment of methods. WPS 155. 1989. Population and Human Resources Department: The World Bank. Policy, Planning and Research; Population, Health and Nutrition: Working Papers.

35 Stanton C. DHS maternal mortality indicators: an assessment of data quality and implications for data use. 1997. Calverton, MD, Macro International. DHS Analytical Reports No. 4.

36 Blacker JGC, Brass W. Experience of retrospective enquiries to determine vital rates. In: Moss L, Goldstein H (eds). *The Recall Method in Social Surveys*. London: University of London Institute of Education, 1983, pp. 48–61.

37 Zaba B. *Measurement of Emigration Using Indirect Techniques*. Liège: Ordina Editions for IUSSP/CELADE, 1985.

IJE vol.33 no.4
Advance Access publication 28 July 2004

International Journal of Epidemiology 2004;**33**:717–718
doi:10.1093/ije/dyh235

Commentary: On reappraisal of adult mortality

PN Mari Bhat

Due to the development of indirect estimation methods for estimating infant and child mortality from some simple questions asked routinely in censuses and surveys, and collection of detailed birth histories in some sample surveys, there has been marked improvement in the information on levels and trends in child mortality in the developing world.[1] But unfortunately, the same cannot be said about levels and trends in adult mortality. In recent years, the spread of the human immunodeficiency virus (HIV)/AIDS epidemic has brought the paucity of data on adult mortality into sharp focus. Although the United Nations does provide estimates of adult mortality for all the developing countries, in only about one-third of the countries is such information based on vital registration.[2] The estimates derived from indirect information, such as on orphanhood, have been found useable in only 4% of the countries. For about one-third of developing countries the adult mortality levels are arrived at from the estimates of child mortality by assuming age patterns of mortality contained in 'model' life tables. The model life tables synthesize the relationship between mortality rates at different ages observed in countries that had reliable data on age- and sex-specific mortality rates. Although they may be useful in approximating the level of adult mortality for the time periods for which estimates of child mortality are available, the assumed high correlation between the levels of adult and child mortality could become too restrictive when ascertaining trends, especially in populations affected by the HIV/AIDS epidemic.

It is in this context that Gakidou and colleagues recommend collection and analysis of sibling survival data.[3] It should be noted that there are two alternative methods of estimating adult mortality from this information. The 'indirect' method, developed originally by Hill and Trussell[4] and revised subsequently by Timæus and others,[5] uses data only on the proportion of surviving siblings by respondent's age. The data collected in the maternal mortality module of the Demographic and Health Surveys (DHS) had additionally included data on current age of surviving siblings, age at death, and time period of those who have died. Data of this type permit the direct estimation of mortality rates by age for any time period in the past, and it is this data and the method that Gakidou and others discuss in their paper. The advantage of the direct method is that it is not affected by assumptions about the age patterns of fertility and mortality made in the indirect method, but could be sensitive to errors in the detailed data used in the estimation. Neither of these methods has been extensively used and hence

Institute of Economic Growth, University Enclave, Delhi 110 007, India. E-mail: mari@ieg.ernet.in