IUSSP XXIV General Population Conference
Salvador, 18-24 August 2001,
Session S17, P 17.8

Demographic Methods of Standardisation Needed for Valid Cross-national Comparison of Disability – free Life Expectancy

Samir Guha Roy

Indian Statistical Institute
Population Studies Unit
203 B. T. Road, Kolkata-700 035
India
Tel./Fax : 91 33 577 6032

S17 Disability

Title of the Abstract : Demographic methods of standardisation needed for valid cross-national comparison of disability –free life expectancy (P.17.8)

Author : Samir Guha Roy

Address : Indian Statistical Institute, Population Studies Unit, 203 B. T. Road, Kolkata – 700 035, India. Tel./Fax : 91 33 577 6032. E-mail: sgroy@isical.ac.in

Abstract : The concept of disability-free life expectancy has been promoted as a health indicator by REVES, Paris. But the problems of response bias, observer variation, lack of homogeneity in the data, and different stages of epidemiological transition are some of the issues to be addressed in any international comparison.

The paper points out while discussing the problems of cross-national comparability of health expectancies, little attention has been drawn to the difference in the age structure of the populations being compared. Like mortality and morbidity, disability is also a function of age. It addresses the issue of validity of the standardised values as measures of composition-controlled relative values . The method decomposes the observed difference in disability rates between the countries (or time-periods) into (age) composition component and rate component subject to satisfying the consistency criterion, that is, total effect = rate effect + age effect. The paper describes a procedure which generates internally consistent result for two cases, one when two population are involved and the other when more than two populations are considered.

On an Aspect of Cross - national Comparisons of Health Expectancy

Samir Guha Roy
Indian Statistical Institute

Common methods for collecting and analysing data on disability in populations of different countries have relied on cross - sectional household surveys and censuses. It is true that the World Health Organization (WHO, 1980) provides an unifying framework in the form of an International classification of Impairments, Disabilities, and Handicaps (ICIDH). But the classification that distinguishes between the three levels at which disease consequences are observed is not yet well understood. There is also no universally umbrella term (Chamie, 1993). Despite ICIDH framework, confusion in concepts and definitions remains. The second problem relates to the debate in screening for disability in censuses and surveys. Experience from several studies in developed and developing countries tilts the balance in favour of disability - based screening over impairment - based screening. The major reason put forward is that the impairment - based method yields lower estimates of disability. But we suspect that this is not always true.

Since 'disability' is a subset of 'impairment' and there are impairments without any disability, the screening techniques that are disability - specific will underestimate impairments. We explain this with reference to the following matrix (n_{ij}), in which D_i denotes ith type of disability and I_j the jth type of impairment identified by well - trained investigators. The notations D_0 and I_0 denote absence of any disability and impairment, and $D_0 \cap I_0$ is their intersection.

Matrix of impairment and disability

$D \setminus I$	I_0	I_1	I_2	$\cdots$	I_q	
D_0	$D_0 \cap I_0$	n_{01}	n_{02}	$\cdots$	n_{0q}	$N_{0\cdot}$
D_1	0	n_{11}	n_{12}	$\cdots$	n_{1q}	$N_{1\cdot}$
D_2	0	n_{21}	n_{22}	$\cdots$	n_{2q}	$N_{2\cdot}$
$\vdots$	$\vdots$	$\vdots$	$\vdots$		$\vdots$	$\vdots$
D_p	0	n_{p1}	n_{p2}	$\cdots$	n_{pq}	$N_{p\cdot}$
	$N_{\cdot 0}$	$N_{\cdot 1}$	$N_{\cdot 2}$		$N_{\cdot q}$	N

Where N denotes the total population (base) and $\sum_{k=1}^{q} n_{ok} = T$ stands for impaired population without any disability. T may, however, have some handicaps. If the survey - question is based on disability, T escapes consideration resulting in under-estimation of impairment. An example may further clarify the problem. If D_0' and I_0' represent presence of disability and impairment respectively, then write

	I_0	I_0'	
D_0	60	20	80
D_0'	0	20	20
	60	40	100

The survey based on disability-specific screening obviously neglects $(D_0 \cap I_0') = 20$. Countries adopting different screening procedures are thus not strictly comparable in respect of disability - free life expectancies. For standardization, we also recommend disability - based screening, provided a sub - sample of D_0 cases (say, 1 in 12 or 14) is taken after listing of households in a sample first stage unit is completed.

It is well recognized that there are wide differences in disability measures in censuses and surveys so that direct cross - national comparisons are impossible to make (Robine, et al., 1994). For example, there has been lack of uniformity in such factors as the severity of the status of health, the protocol of surveys or the formulation of questionnaires. Disability - free life expectancy often ignores disability below some ill - defined threshold of moderate disability (Murray, et al., 1994). The estimate of disability is probably biased downwards because of exclusion of less severe disabilities and also lack of consideration of the fact that the group affected by disability might have higher mortality than that of the unaffected. Since no information is available on this aspect, we can only speculate that observed prevalence of disability is an underestimate owing to likely higher mortality risks of the affected. Moreover, the fact that individuals can have more than one disability of the same or different nature at the same time is often not considered in cross- sectional data sets (Guha Roy, 1995).

As we know, prevalence data and multiple-decrement life tables are required to calculate active life expectancy or disability-free life expectancy representing changes in individual functional status (e.g. bathing, dressing and eating). Both prevalence and multiple decrement active life expectancy procedure have limitations (Manton, et al.. , 1993). First, they may not accurately reflect the influence of disability on mortality. Second, functional impairment is defined using a fixed disability threshold. Many persons are only partially impaired with the degree of impairment possibly being different for each dimension of functioning. Manton and his co-authors developed a model to forecast multidimensional changes in active life expectancy within a cohort where disability is graded on each of several analytically defined dimensions of functioning.

Although WHO's ICD and ICIDH classification system has been adopted by a number of countries in recent years, international comparison of health expectancies is not yet justified due to differences in measures of disability, sampling procedures and methods of calculation for disability-free life expectancy. The most controversial of the assumptions underlying the calculation is that disability is irreversible or that the recovery of lost functions is insignificant. Moreover, disability data are often assumed to be homogeneous, but in reality they are a mixture of different levels of severity and eligibility criteria. Since epidemiologic transition has not yet been completed in all parts of the world, important differences in disability indicators may be expected between the countries.

It is thus recognised that the interpretation of chronological series on disability and cross- national comparisons are difficult due as much to the methods of calculation as to the nature of data used. In order to facilitate global comparisons, the international network of researchers on health expectancy or REVES has examined the requirements for harmonization of health expectancies. This is the first necessary step permitting geographical comparison of health expectancy and disability process. The use of comparable sampling techniques and repetition of the same methods would allow comparisons to be made over a period of time.

However, little consideration has been made regarding different stages of demographic transition in different countries, which may make the comparison of health expectancies, between countries less meaninigful. In this context we may note that like mortality and morbidity, disability also depends on age structure of a population. Age - standardized rates of disability rather than crude rates should therefore be compared between any two periods or countries. While several studies have made specific recommendations on cross-national comparability, they have not adequately addressed the question of validity of the standardized rates as measures of composition - controlled relative rates.

Age differential of prevalence rates

The observed difference between the overall prevalence rates for any two periods or countries may be decomposed exactly into (age) composition component and rate component, provided age-adjusted and rate-adjusted prevalence rates of disability are internally consistent, that is, total effect = rate effect + age effect. A simple direct standardization by using a single population as the 'standard' may not necessarily pass this test. In this paper, we describe briefly a procedure which generates internally consistent result.

The problem of inconsistency in the adjusted rates can be demonstrated with reference to Indian population and prevalence rates for visual disability tabulated by 5 - year age groups for the years 1981 and 1991. Based on these data, and using the population of 1971 as the 'standard', the crude prevalence rate, the rate - adjusted and the age - adjusted prevalence rates are worked out and shown in Table 1.

Table 1. : Crude prevalence rates of visual disability per 100, 000 population and the corresponding adjusted rates (with 1971 population age distribution as 'standard') : India, 1981 and 1991

Year	Prevalence rate of visual disability		
	Crude rate	Rate - adjusted	Age - adjusted
1981	38	40	34
1991	25	30	23
Difference	13	10	11

The inconsistency in the adjusted rates for the two years lies in the fact that whereas the age effect and the rate effect add up to 21, the difference between the observed or crude prevalence rates (the so-called total effect) is 13. For a standardization method to ensure internal consistency, the age effect and the rate effect must add up to the total effect. The problem of inconsistency remains if the population other than the populations being compared is used as the 'standard'. When there are only two populations, the problem of inconsistency in the adjusted rates can be easily resolved by using the average of the two populations as the 'standard' (Kitagawa, 1955). We describe procedures which yield internally consistent results for two cases, one when only two populations are compared and the other when more than two populations are considered.

Standardization method

Case I. When two populations are compared

Let Y_1 and Y_2 be the overall prevalence rates of disability in population 1 and population 2, so that

(1) $Y_1 = \sum_j p_{1j}\, r_{1j}$ and $Y_2 = \sum_j p_{2j}\, r_{2j}$,

Where pij is the proportion of population and rij is the prevalence rate in age group j in population i, i = 1, 2 and $\sum_j p_{ij} = 1$.

Using the average of the two populations as the 'standard', the adjusted prevalence rates are

(2) $R_{1.2} = \sum_j \frac{p_{1j} + p_{2j}}{2}\, r_{1j}$ and $R_{2.1} = \sum_j \frac{p_{1j} + p_{2j}}{2}\, r_{2j}$

(3) $S_{1.2} = \sum_{j} \frac{r_{1j} + r_{2j}}{2} p_{1j}$ and $S_{2.1} = \sum_{j} \frac{r_{1j} + r_{2j}}{2} p_{2j}$,

Where $R_{i.k}$ is the age - adjusted prevalence rate and $S_{i.k}$ is the rate - adjusted prevalence rate for population i, when it is being compared with population k. It is easy to verify that

(4) $Y_2 - Y_1 = (R_{2.1} - R_{1.2}) + (S_{2.1} - S_{1.2})$

(5) that is, Total effect = Rate effect + Age effect.

Case II. **When more than two populations are compared**

When there are N populations, internally consistent age - adjusted and rate - adjusted prevalence rates of disability can be obtained by expressing the adjusted rates in terms of the adjusted rates corresponding to all pairwise comparisons as shown in equations (2) and (3). These expressions are

$$(6) \quad R_{1.23......N} = \frac{\sum_{k=2}^{N} R_{1.k}}{N - 1} + \frac{\sum_{i=2}^{N} \left[\sum_{k=1,i}^{N} R_{i.k} - (N - 2) R_{i.1} \right]}{N (N - 1)}$$

$$(7) \quad S_{1.23......N} = \frac{\sum_{k=2}^{N} S_{1.k}}{N - 1} + \frac{\sum_{i=2}^{N} \left[\sum_{k=1,i}^{N} S_{i.k} - (N - 2) S_{i.1} \right]}{N (N - 1)},$$

Where $R_{i.k}$ and $S_{i.k}$ are defined as in (2) and (3), $R_{1.23......N}$ is the age - adjusted prevalence rate and $S_{1.23......N}$ is the rate - adjusted prevalence rate for population 1 when populations 1, 2, 3, ..., N are being compared simultaneously.

The first expressions in equation (6) and (7) are the averages of all possible age - adjusted prevalence rates in population 1 when only two opulatons are compared at a time.

The second expressions provide the correction terms needed to make the age-adjusted prevalence rates in population 1 based on N populations internally consistent.

The adjusted prevalence rates for any other population can be obtained from formulae (6) and (7) by interchanging the subscripts.

The two strong points in favour of using the standardization approach are - (i) it produces internally consistent adjusted rates between any two populations, and (ii) it uses computational formulae (6) and (7) which put an end to the continuing debate as to which one of the actual populations should be used as the 'standard'.

References

Chamie, Mary, 1993, Overview of trends in morbidity and disability in aging research : evidence from censuses and surveys. Proceedings of the Seminar on Health and Mortality Trends Among Elderly Populations: Determinants and Implications, Sendai City Japan, IUSSP.

Guha Roy, S., 1995. Sub-national comparisons of disability indicators : The Indian example, Proceedings of the 50th Session of the International Statistical Institute, Beijing, China, August 1995.

Kitagawa, E.M., 1955, Components of a difference between two rates, Journal of the American Statistical Association, 50(272), 1168-1194.

Manton, K.G., Stallard, E., and Liu, K.,1993, Frailty and forecasts of active life expectancy in the United States. In K.G. Manton, B.H Singer and R.M. Suzman (ets.), Forecasting the Health of Elderly Population, New York : Springer-Verlag : 59-181

Murray, C.J.L. and Lopez, A.D (eds), 1994, Global Comparative Assessments in the Health Sector, World Health Organization: 55-68.

Robine, J.M., Romieu, I., Cambois, E., van de Water HPA and Boshuizen, H.C., 1994, Contribution of the Network on Health Expectancy and the Disability Process, World Health Report (WHR 95), World Health Organization.

World Health Organization, 1980. International Classification of Impairments, Disabilities, and Handicaps- A Manual of Classification Relating to the Consequences of disease, Geneva, WHO..