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Trends in "avoidable" mortality in Sweden, 1974–1985

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Abstract

***Study objective*—The aim was to analyse trends in "avoidable" mortality in Sweden, and to contribute to the methodology of avoidable mortality as an index of the quality of care.**

***Setting and participants*—All deaths of Swedish citizens and other residents in Sweden during the period 1974–1985 were analysed as to causes of death between ages 0 and 64 years.**

***Measurements and main results*—Total mortality delined during the 12 year period studied. Avoidable causes of death were grouped into preventable and treatable causes according to Rutstein's classification. In men, treatable diseases declined more during the 12 year period studied than did total mortality. When lung cancer was excluded, preventable diseases declined for both sexes. Certain avoidable causes of death decreased compared to total mortality, while some others showed an increase. The death rate increased for some avoidable causes of death such as pneumonia other than viral. In women death rates increased for chronic bronchitis and emphysema as well as for malignant neoplasms of trachea, bronchus, and lung, while for boys aged 1–14 years bronchitis NOS and asthma showed an increasing death rate.**

***Conclusions*—The study indicates that the avoidable mortality method is sensitive enough to describe important changes in the mortality pattern. The explicit definition of treatable and preventable causes of death constitutes a methodological development in epidemiological analysis of this type. Further studies on the quality of care should combine this method with other methods examining the structure and process of health care.**

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Several studies since 1983 have analysed differences in avoidable mortality based on judgements about whether the causes of death are amenable to intervention by medical care.[1] Trend analyses have shown that mortality from these avoidable causes declined more than other causes of death. These results have been the basis for a discussion on the impact of the health care system on mortality results. The importance of health care for the declining mortality of these conditions has been emphasised.[2–4]

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These studies emanate from a method of studying the quality of medical care suggested by a working group on preventable and manageable diseases chaired by David D Rutstein in 1976.[5] It was based on the tradition of using avoidable mortality such as perinatal and maternal mortality as negative indices of health and as a starting point for the evaluation of health care. They presented a list of "unnecessary untimely death", considered amenable to medical intervention, and attempted to indicate whether the conditions were preventable or treatable. The occurrence of cases or critical increases in rates of these causes of death is a warning signal, a sentinel health event, indicating that the quality of care may need to be improved.

The concept of "avoidable mortality" grew out of the work done by the Working group on Preventable and Manageable Diseases.[6] Charlton *et al* introduced the term "avoidable". They stated that the Rutstein list included diseases for which mortality is largely avoidable given appropriate medical intervention. They did, however, decide to select causes from the list that were regarded as most amenable to medical intervention (excluding conditions whose control depends mainly on prevention).[7]

The epidemiological studies on avoidable mortality have been based on different selections modified from the original Rutstein list of "unnecessary untimely death".[1–4] Machenbach *et al* have concluded in a review that part of this could be due to a divergence of opinion on the avoidability of the different conditions.[1] The empirical use of the complete original list of potentially avoidable causes of death should, however, be of methodological interest.

The objective of this study was to provide a trend analysis of potential avoidable mortality in Sweden using as a basis the list produced by Rutstein's working party, and to further contribute to the development of the method.

Methods

Data from the Swedish register of causes of death were analysed. The register is based upon the death certificates issued by doctors following all deaths of Swedish citizens. The certificate states the underlying cause of death and up to six contributory causes. The causes of death were manually coded at the National Central Bureau of Statistics according to the guidelines in ICD–8, published by the WHO.[8] In addition there were certain specifically Swedish coding rules, somewhat modified in 1981.[9] The coded causes of death were fed into a national cause of death register.

Table I The mean number of deaths per 100 000 (the death rate) and the age standardised yearly change in death rate (trend) in Sweden, 1974–85, by age and sex.

	Males			Females		
Age (years)	*Death rate*	*Yearly change in death rate*	*Significance*	*Death rate*	*Yearly change in death rate*	*Significance*
<1	833·5	−30·58	‡	677·6	−16·58	†
1–14	29·1	−1·67	‡	21·2	−1·15	‡
15–44	139·1	−3·09	‡	68·7	−1·57	‡
45–64	977·2	−11·28	‡	500·7	−7·09	‡
0–64 (total)	347·4	−5·34	‡	187·7	−3·23	‡

†p<0·01; ‡p<0·001

Material from the register of causes of death covering the period 1974–85 was analysed for the country as a whole. The analysis was confined to the age group 0–64 years. The underlying causes of death, classified according to ICD–8, were analysed. The avoidable causes were grouped into preventable and treatable causes based on the list published by Rutstein *et al*. A certain grouping of avoidable causes according to the so called A list in ICD–8 was undertaken.

The trends for total mortality and the proportion of deaths with avoidable causes were analysed. A direct standardisation for age was done in the trend analyses using the average for the 12 year period in age groups 0, 1–4, 5–9, etc, as a standard. A regression analysis with the year of deaths as independent variable and the death rate or proportion as dependent variable was used. Both linear and logarithmic models were used. The significance of the yearly change (the trend) was tested using Student's two tailed *t* test. Essentially the significance of the results did not differ between the linear and the logarithmic model. Only the linear trends, the model best suited to the total avoidable group (based on R^2 values), are presented in this paper.

Linear trend analysis was possible in the case of 63 different avoidable causes of death in men and 65 avoidable causes of death in women in the age group 0–64 years. A special analysis was carried out for 10 male treatable diseases it was possible to analyse in the age group 1–14 years. SAS was used for statistical analysis.[10]

Results

The death rate for ages 0–64 years decreased during the period 1974–85 for both sexes. Table I shows this also to be true when division into different age groups was done. The highest death rates were for ages <1 year and 45–64 years.

The highest proportion of deaths with avoidable causes was for age group <1 year and the lowest for the age group 15–44 years (table II). This proportion decreased for both sexes in the age group <1 year and for males aged 15–44 years during the period studied. In other words avoidable mortality decreased more than total mortality in these age and sex groups. For boys aged 1–14 years, however, the proportion of deaths with avoidable causes increased.

For males aged 0–64 years there was a tendency (p=0·06) for the proportion of deaths with avoidable causes to decrease (by 0·11 percent units per year). For women however the proportion classified as avoidable was constant during the period.

Rutstein *et al* divided the avoidable conditions into those which were considered treatable and those which were preventable. Table III shows the proportion of deaths with preventable and treatable causes of death for ages 0–64 years. Women had a higher proportion of treatable causes than men. For men, deaths from treatable causes declined more than total mortality. The proportion of treatable causes decreased by 0·10 percent units per year, which constitutes the main part of the decrease of 0·11 percent units for total male avoidable mortality.

Deaths from malignant neoplasms of trachea, bronchus, and lung greatly influenced the results for the preventable group. For both sexes deaths from preventable causes apart from lung cancer decreased more than total mortality.

A special analysis for boys aged 1–14 years showed that the proportion of deaths with treatable causes increased. This included a significant increase in bronchitis not otherwise specified (NOS)+asthma and acute lymphatic leukaemia (table IV). The proportion of no other single avoidable cause changed significantly in this group. The death rate for bronchitis NOS and asthma increased significantly for boys aged 1–14 years (death rate 0·26; trend 0·03 per year; p=0·04).

The trends for different specific avoidable causes of death were analysed for the age group 0–64 years. Table V shows the avoidable causes of death with the most important trends (change ⩾0·01 percent units per year; p<0·01). There are

Table II The mean proportion of deaths with avoidable causes and the yearly change (trend) in that proportion in Sweden, 1974–85, by age and sex.

	Males			Females		
Ages (years)	*Proportion avoidable (%)*	*Yearly change in proportion*	*Significance*	*Proportion avoidable (%)*	*Yearly change in proportion*	*Significance*
<1	61·5	−1·62	‡	58·3	−1·47	‡
1–14	20·4	0·65	‡	23·0	0·22	–
15–44	9·3	−0·19	†	15·2	0·02	–
45–64	18·8	−0·01	–	21·3	0·09	–
0–64 (total)	18·4	−0·11	–	22·1	−0·00	–

†p<0·01; ‡p<0·001

Table III The mean proportion of deaths with treatable and preventable causes of death and the yearly change (trend) in that proportion for ages 0–64 years in Sweden, 1974–85, by sex.

	Males			Females		
Type of intervention	*Proportion of deaths (%)*	*Yearly change in proportion*	*Significance*	*Proportion of deaths (%)*	*Yearly change in proportion*	*Significance*
Treatable	7·3	−0·10	†	11·7	−0·04	–
Preventable	10·8	−0·01	–	10·2	0·03	–
Treatable/preventable	0·2	0·01	–	0·1	0·01	–
All avoidable causes	18·4	−0·11	–	22·1	−0·00	–
Preventable when lung cancer was excluded	6·4	−0·11	‡	7·1	−0·16	‡

†p<0·01; ‡p<0·001

Table IV The mean proportion of deaths for certain treatable causes of death (those with increasing proportion) and the yearly change (trend) in that proportion for boys 1–14 years in Sweden, 1974–85.

ICD–8 code	*Cause of death*	*Proportion of total deaths (%)*	*Yearly change in proportion*	*Significance*
490 493	Bronchitis NOS + asthma	0·9	0·18	†
204·0	Acute lymphatic leukaemia	5·5	0·24	*
Total group of treatable causes		17·3	0·48	*
Total group of avoidable causes		20·4	0·65	‡

NOS = *p < 0·05; †p < 0·01; ‡p < 0·001

examples of avoidable causes of death with increasing as well as decreasing trends when compared to total mortality. The most substantial increase was for malignant neoplasm of the trachea, bronchus, and lung which motivated the separate analysis in the preventable group mentioned above.

For both sexes there was a clear reduction in deaths classified as diabetes without mention of complications in the year 1981, when the Swedish coding rules for diabetes were modified.[9] This cause of death did not decrease significantly in the period 1974–80 compared to total mortality and was too infrequent to permit analysis for the period 1981–85.

Changes in the death rates for avoidable causes of death with increasing trends compared to total mortality were analysed. Table VI shows the avoidable causes of death with increasing death rates during the period studied.

Table V Certain avoidable causes of death (those with the greatest change in their proportion of total deaths), their mean proportion of deaths, and their yearly change (trend) in proportion for ages 0–64 years in Sweden, 1974–85, by age and type of intervention.

ICD–8 code	*Cause of death*	*Proportion of total (%)*	*Yearly change in proportion*	*Significance*
	Males			
Treatable causes				
481–486	Pneumonia other than viral	1·408	0·071	‡
250·0	Diabetes mellitus, without mention of complications	0·246	−0·044	†
531–532	Ulcer of stomach and duodenum	0·606	−0·042	‡
016–017, 019	Some forms of tuberculosis and late effects of tuberculosis	0·238	−0·032	‡
201	Hodgkin's disease	0·257	−0·014	‡
400–404	Hypertensive disease	0·232	−0·011	†
574	Cholelithiasis	0·072	−0·009	†
Preventable causes				
162	Malignant neoplasm of trachea, bronchus, and lung	4·369	0·097	‡
430–438 with decimal 0	Cerebrovascular disease associated with hypertension	0·963	−0·062	‡
764–768, 722	Birth injury and difficult labour	0·293	−0·030	†
573, 0	Other diseases of liver	0·078	0·006	†
	Females			
Treatable causes				
481–486	Pneumonia other than viral	1·188	0·086	‡
180	Malignant neoplasm of cervix uteri	1·910	−0·060	‡
250, 0	Diabetes mellitus, without mention of complications	0·249	−0·050	†
531–531	Ulcer of stomach and duodenum	0·436	−0·033	‡
016–017, 019	Some forms of tuberculosis and late effects of tuberculosis	0·292	−0·027	‡
Preventable causes				
162	Malignant neoplasm of trachea, bronchus, and lung	3·036	0·195	‡
430–438 with decimal 0	Cerebrovascular disease associated with hypertension	1·274	−0·102	‡
760–763, 769, 773, 777–778	Other causes of perinatal mortality	0·636	−0·041	†
491, 491	Chronic bronchitis and emphysema	0·856	0·037	‡
764–768, 772	Birth injury and difficult labour	0·388	−0·034	†

†p < 0·01; ‡p < 0·001

Discussion

TRENDS IN AVOIDABLE MORTALITY

Studies of trends in death rates for different causes of death and total mortality are an important part of the epidemiological monitoring of public health. Public health reports published in Sweden have included these kinds of data.[11] In this study trends for avoidable mortality according to Rutstein *et al* have been analysed. Analyses of mortality trends from conditions that are considered to be amenable to intervention by health care may have a special role to play in the analysis of public health development.

Mortality trends have been the starting point for discussions about the relative importance of the preventive and therapeutic activities of health services.[12–15] For instance, a connection in time has been demonstrated between such activities as screening for cancer of the cervix and the testing for and treatment of hypertension, and reductions in mortality from these conditions.[13 14] Some studies have also tried to estimate the fraction of the decline for which health care has been responsible.[14–16]

Other studies have used mortality trends for certain conditions to question the importance of medical care.[17 18] Levine *et al* have criticised this view, emphasising instead the potential impact of health services on public health.[19]

The studies referred to started with an empirical analysis using the results as a starting point for discussion about the role of health care. The avoidable mortality method differs since it is based on conditions that are classified in advance as amenable to health care intervention. Donabedian has formulated principles for explicit and implicit criteria.[20] An explicit criterion is specified before the assessment is done, as is the case for avoidable mortality.

Studies on avoidable mortality trends have been based on explicitly classified causes of death.[1–4] This study goes further, in that the explicit subdivision into preventable and treatable causes of death has been empirically applied, which has given interesting results. For males mortality from treatable causes declined more than total mortality. For both sexes the same was true of preventable mortality when lung cancer was excluded.

Some studies have combined the avoidable mortality method with a discussion of linkage to changes in health care. Mackenbach *et al* have compared time trends for certain avoidable causes of death with activities in health care and found a faster decrease in mortality for avoidable causes of death such as cerebrovascular disease, Hodgkin's disease, and carcinoma of the cervix when new methods were introduced in health care.[1 21]

Results from mortality trend analysis must be interpreted with caution but are of importance when public health is studied. Studies on avoidable mortality trends should be a basis for hypotheses about the effect of health services on public health. The introduction of explicity classified avoidable causes of death constitutes a new development in the methodology of this field.

INDICATORS OF THE OUTCOME AND QUALITY OF HEALTH CARE

Rutstein's working group had a different starting point for their list of avoidable mortality. In their

Table VI Certain avoidable causes of death with increasing death rates, their mean death rate, and yearly change in death rate (trend) in Sweden, 1974–85, by sex.

ICD–8 code	Cause of death	Death rate	Yearly change in death rate	Significance
	Males			
481–486	Pneumonia other than viral	4·982	0·163	†
573·0	Other disease of liver	0·272	0·018	*
	Females			
162	Malignant neoplasm of trachea, bronchus, and lung	5·701	0·266	‡
481–486	Pneumonia other than viral	2·231	0·120	†
491, 492	Chronic bronchitis and emphysema	1·607	0·042	*

*p < 0·05; †p < 0·01; ‡p < 0·001

opinion the occurrence of, or agglomeration of, deaths from these conditions are "sentinel health events", that is, warning signals that indicate poor quality of health care, motivating a review and evaluation of these deaths.

Rutstein *et al* defined quality as "the effect of care on the health of the individual and of the population".[5] Donabedian has discussed the conceptual structure of quality of care.[22] He states that the quality of care should be related to different components of health care.[22 23] *Structure* denotes, for example, the material and human resources and the organisational structure, *process* denotes the activities in giving and receiving care, and *outcome* denotes the effects of care on the health status of the individual and the population. Quality as defined by Rutstein is equivalant to only one component of quality as defined by Donabedian, namely outcome.

The evaluation of the method and its results comprises two steps. The first step consists of analysing whether the conditions are indicators of the outcome of health care. As mentioned above, this analysis of the role of health care has previously been performed when discussing empirical results. The avoidable mortality method, however, starts with explicitly classified conditions that are considered amenable to intervention by health care and therefore should indicate outcome of care.

The basis of the list of avoidable conditions is of essential importance. What is the evidence for the potential outcomes? What is the potential outcome—that is, what fraction of the mortality from these conditions could be avoided?[24] To what extent is there consensus? Rutstein's working group did not publish any review of published reports as a basis for their list of conditions.[1 5] Other investigators have improved this by publishing references as a basis for the selection of conditions for empirical analyses.[3 7 25–27]

The second step consists of an analysis of whether the indicators of health care outcome reflect the quality of care. In quality assessment there is a tradition of studying outcome.[28] Donabedian came to the conclusion that outcome measures tend to have low specificity as a basis for inferences about the quality of care. Many factors other than medical care influence health. In many situations, however, it is more important that the outcome measures have a high degree of sensitivity, reflecting differences and changes in care[23] This is in accordance with the "sentinel health events" idea discussed here.

It would be advisable to combine studies of avoidable mortality with other methods to shed light upon the connection between avoidable mortality and quality of health care. Donabedian stresses the importance of studying the linkage between outcome and other components of health care (such as the process of care) to validate an assessment of the quality of care. In monitoring systems, however, indicators are of value as a means of "screening" cases that require scrutiny as to the quality of care. "The failure to make the distinction between final assessment and provisional screening seems to have caused the greatest misunderstanding." Outcomes should often be used not as final judgements on the quality of care but as triggers that initiate the review leading to a final judgement. This kind of review consists predominantly of an assessment of process and sometimes a search for structural factors that may have contributed to deficiencies in care.[23]

This study indicates that the method is sensitive in the sense that important changes in avoidable mortality have been shown. Certain avoidable causes of death decreased compared with total mortality, while some others showed an increase. The death rate increased for avoidable causes of death such as pneumonia other than viral. The results for pneumonia should be interpreted with caution since it could include immunologically comprised individuals, eg, patients with cancer.[5] According to the Swedish rules, however, further information is collected when pneumonia is mentioned as the underlying cause of death in the death certificate for people under 80 years.[9] In women death rates increased for chronic bronchitis and emphysema as well as for malignant neoplasm of trachea, bronchus, and lung, while for boys aged 1–14 years bronchitis NOS and asthma showed an increasing death rate. Death rates for certain avoidable causes of death should been seen as "sentinel health events" and "triggers" that initiate further studies.

The sensitivity of the method may vary with the selection of causes of death. In this study the analysis is based on the complete list published by Rutstein *et al*. Other studies are based on a selection of these conditions. Analyses including only decreasing trends may lead to limited conclusions.[3] The results in this study vary with age group and sex. The original publication by Rutstein *et al* makes no comments on the need for analysis according to sex. Several studies (such as the EC study) have chosen not to make such a division.[3 7 25 26] The results from this study show the importance of analysing by sex.

Another important methodological question concerning mortality trend analysis is the reliability of causes of death by time. There are certain difficulties when the classification and coding rules are changed. This is most obvoius when a new version of the ICD is introduced. In Sweden the same version of ICD (ICD–8) has been used for the period covered by this study. The Swedish coding practice for some causes of death changed in 1981. In this study that change influenced the results for diabetes, for which a great reduction in the registration of diabetes without the mention of complications has been shown for 1981. No other shift of level of this kind has been found in the results shown.

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