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An economic analysis of ischaemic heart disease in Switzerland

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Aims Direct and indirect costs of ischaemic heart disease were assessed in Switzerland, for the period 1988–1993, in order to evaluate the economic consequences of more intensive treatment of the disease and of the decreasing mortality from ischaemic heart disease in the working population.

Methods and Results A societal perspective was taken for a prevalence-based assessment of the direct (total resources consumed by outpatients and inpatients) and indirect (due to morbidity, invalidity, and premature death, using the human capital approach) costs. The results showed the total costs were 21 million US dollars per 100 000 population in the year 1993 (47% direct, 53% indirect costs). The largest components were the direct costs of inpatient care and indirect costs due to premature death (each approximately 25% of the total). Trends showed a large increase in direct costs (+9% per year, constant dollars). Indirect costs stabilized or decreased slightly due to the reduction of work losses.

Conclusions Today's medicine and preventive measures have proven effective for ischaemic heart disease, although such remedies have required increasingly large financial resources. However, society benefits because indirect costs decrease, although this gain does not compensate for all direct costs.
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Key Words: Ischaemic heart disease, mortality, direct costs, indirect costs, gain to society, Switzerland.

Introduction

Changes in mortality patterns from ischaemic heart diseases in Switzerland in past decades have been characterized by a remarkable decrease in the mortality of the population below the age of 65 years, while overall ischaemic heart disease mortality stayed constant[1,2]. This has been observed in many other developed countries[3]. The underlying processes involve, in all probability, changes in lifestyle, preventive measures, advanced diagnostic and therapeutic procedures in medicine, and other unknown factors. The socio-economic consequences of these changes in mortality, however, have not been described in detail.

The objective of this study was to assess (i) the trend in the economic costs of the disease as a result of the more intensive utilization of health care services and more frequent use of new technologies (higher direct costs); and (ii) the changes in economic costs to society owing to the decreased mortality in the working population (smaller work losses, i.e. lower indirect costs).

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Methods

The entire cost-of-illness study was performed from a societal perspective. The values of all major resource elements consumed and of productivity lost were estimated for patients afflicted by ischaemic heart disease (ICD classes 410–414). The assessment of the economic cost of ischaemic heart disease was prevalence-based. It included direct and indirect costs of the illness, which were estimated for the year 1993 (annual costs). The results were contrasted with the analysis obtained 5 years earlier[4].

Direct costs of outpatient and inpatient care, and inpatient rehabilitation

Outpatient care

The estimates of the direct costs elements (see Table 1) were derived from information on the average number

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of patients in outpatient care (in the year of interest), the frequency of physician contact, the interventions per (average) physician visit (consultations, diagnostic tests), the drugs prescribed (per visit) and the costs thereof. Data provided by the IMS[5] allowed for a nationwide estimate of the number of ischaemic heart disease patients and physician-prescribed drugs. IMS data were based on nationwide surveys from representative samples of physicians (stratified samples, n=820).

There were no existing statistics on the type and frequency of medical care in doctors' surgeries per visit by ischaemic heart disease patients. Thus, written interviews conducted by an expert panel of practising physicians provided estimates of the average number of visits (per year) by patients in the ICD classes 410–414 (first diagnosis) and the medical interventions (per visit). The panel of 30 physicians was selected by the Chief Medical Officers of the States, one eastern and one western (Canton of St. Gallen and of Vaud), in which the physicians were practising. GPs as well as specialists (in internal medicine and cardiology), aged between 40 and 60 years, were questioned. Their information could be verified, in part, by data obtained from the IMS.

The costing of the office visits, individual laboratory tests, chest X-rays etc. was based on the official reimbursement tariffs in use throughout the country[6]. The reimbursement rates represent accurate proxies to the real costs[4]. (The unsubsidized tariffs are agreed upon by the medical associations, and insurers, and are approved by the government.)

Reckoning the total annual costs followed the general rule of: number of patients treated × frequency of physician visits × number of interventions (per visit) × costs per intervention × costs of drugs*.

Inpatient care

The database of the Swiss National Hospital Association (VESKA)[7] was used to identify hospitalized cases, their average length of stay, and the number of in-hospital deaths (all with primary discharge diagnosis ICD 410–414, sex- and age-specific). The statistics were based on information from 45% of all hospitalizations in the country such that extrapolation (to the population) could be done without introducing large uncertainties.

The percentage of patients and the average length of stay in critical care (in CCUs, cardiac care units) of patients with acute myocardial infarction were obtained from a special study analysing the treatment schedules of ICD-410 cases in two Swiss States[8]. The study also contained information on the average percentage of patients referred to special rehabilitation after acute myocardial infarction.

The number of major interventions carried out were available from the Swiss Society of Cardiology which regularly publishes the total number of procedures performed in the country. In this study, those performed most frequently i.e. coronary arteriographies, PTCAs (percutaneous transluminal coronary angioplasty) and CABGs (coronary artery bypass grafting)[9,10] were taken into account.

Table 1 Major socio-economic cost components with main elements of direct and indirect costs. Direct non-medical costs are not listed

Direct costs	
Direct medical costs	
Outpatient care	Costs of physician visits including diagnostic test
	Cost of drugs
	Cost of emergency referral to hospital
Inpatient costs	Cost of general care in hospital including basic care, usual tests and drugs, hotel services
	Cost of critical care
	Costs of frequent and costly interventions (coronary arteriography, PTCA, CABG)
	Cost of (inpatient) rehabilitation
Indirect costs	
Productivity losses	Due to morbidity
	Due to disability; partial and total
	Due to premature death
Psychosocial costs	

PTCA=percutaneous transluminal coronary angioplasty; CABG=coronary artery bypass grafting.

Information on individual cost elements were not generally available but could be obtained by extrapolating calculations carried out by the Cantonal Hospital of St. Gallen, Switzerland (personal communication). The cost structures of this medical centre were typical of the majority of Swiss hospitals (treating ischaemic heart disease patients[11]). Cost data on rehabilitation were obtained directly from the administrators of the major rehabilitation centres in Switzerland[12].

The following formula was used to calculate total costs*: Inpatient costs=[number of patients × average length of stay on the ward × cost of inpatient day on the ward+number of patients in the CCU × average length of stay in CCU × cost of CCU day]+ [number of procedures × cost of procedure].

Indirect costs due to morbidity, partial and total disability, and premature death

The elements of indirect cost (Table 1) were evaluated using the human capital approach. Thus, productivity losses (to society) were calculated on the basis of the incomes foregone, assuming that loss of productivity is approximated by loss of wages[13,14]. The current value of lifetime earnings foregone due to premature death was calculated using the generally accepted method of discounting (with a discount rate of 4%).[14]

The information relevant to the calculations of indirect costs originated from the annual mortality figures by WHO[1], national statistics on disability due to

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Table 2 Growth in use of health care services by ischaemic heart disease patients (ICD 410–414) in Switzerland, standardized to a population of 10^5. Number of office visits, hospital discharges (first diagnosis of ischaemic heart disease), total number of coronary angiographies, percutaneous transluminal coronary angioplasties (PTCA), and coronary artery bypass grafts (CABG), together with the population in Switzerland, from 1988 to 1993[5,7,9,10,17] are shown

	Year		
	1988	1990	1993
Office visits (per 10^5 of the population)	1475	1752	1950
Hospital discharges (per 10^5 of the population)	493	524	655
Coronary angiography (per 10^5 of the population)	ca 150	185	252
PTCA (per 10^5 of the population)	24	34	65
CABG (per 10^5 of the population)	39	51	62
Population in millions	6·6	6·75	6·9

ICD 410–414[15], and information on absenteeism due to ischaemic heart disease. Absenteeism resulting from ischaemic heart disease could be estimated on the basis of (sex-specific) data furnished by the National Railroad Company, the SBB (personal communication). The SBB employed about 37 000 workers, in all trades and professional groups, representing approximately 1·5% of the total labour force.

Information on partial and total disability (number of cases, degrees of disability) was made available by the National Social Security office (National Disability Insurance Office)[15]. It is to be noted that those data also comprised information on (non-salaried) housewives afflicted by the disease who of course were taken into account.

In addition, the national statistics on (age- and sex-specific) income distributions (based on Social Security payments being a fixed percentage of wages) and on labour force participation rates[16] were introduced into the calculations. When attaching a dollar value to the work of housewives, the average income of women (in the labour force) was used (for lack of a generally accepted method of assessing). The national statistics on (age- and sex-specific) mortalities due to all causes (life tables) were also used[17].

A straightforward approach (equal for men and women, and in most cases ICD- and age-specific) was used to calculate indirect morbidity costs*. Indirect costs of (short-term) morbidity=average annual loss of work days per member of labour force × total number of labour force × average income per day, and indirect costs of permanent (partial or total) disability=sum of the products of [number of invalids of degree n × disability degree n × average annual income × labour force participation rate].

The algorithm used to obtain the value of future earnings lost because of premature death took into account that (i) the number of deaths due to ischaemic heart disease depends on age (WHO mortality statistics); (ii) incomes are a function of age (national income distribution); (iii) today's value of possible future incomes is less than the nominal value (discounting with a discount rate of 4%); (iv) patients dying of ischaemic heart disease would not have necessarily lived for another 10, 20 etc. more years, had they survived the disease. They may have died from other causes in 10 or 20 years (evident from life tables); (v) patients surviving the disease would not necessarily have returned to the active working force; they may have been unemployed if they would have lived longer (age distribution of labour force participation rate). The algorithm is reproduced in detail in the Appendix.

Gains in the number of potential life years due to shifts in the mortality patterns were assessed, to illustrate recent epidemiological developments, by reckoning the differences in the potential life years lost, age- and sex-specific, between 1988 and 1993. The potential life years lost by each age group were given, using the customary method, by the products of the number of premature deaths × their average life expectancy (at that age).

Sensitivity analyses

Many of the cost evaluations were based on input data subject to uncertainties or unknown variations. The order of magnitude of the uncertainties could be given accurately in some cases, approximately only in others. It was therefore important to analyse the possible influences of the uncertainties on the final figures by sensitivity analysis[18]. In particular, sensitivity of indirect costs to changes in discount rates were evaluated by varying the latter from 2% to 6%.

Results

Utilization

The volumes of health services utilization (by a population remaining constant) grew significantly, as illustrated in Table 2. The rapid expansions are mirrored in the enlarging direct costs as discussed below.

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Table 3 Number of potential life years lost per 1000 population, due to ischaemic heart disease (ICD 410–414), for men and women in Switzerland, 1987/88 vs 1993; age-specific; together with differences (1993–1987). Negative differences in life years lost represent* gains in potential life years *(bold figures). Note that some figures in the lowest age groups are uncertain due to small size of samples

	Potential life years lost per 1000 population							
	All	25–34	35–44	45–54	55–64	65–74	75–84	>84 years
Men								
1987	20·1	1·1	6·8	20·8	49·7	87·9	108·4	108·7
1993	18·0	1·3	6·3	15·9	37·3	79·5	103·3	140·0
Difference	**−2·1**	+0·2	**−0·5**	**−4·9**	**−12·4**	**−8·4**	**−5·1**	+31·3
Women								
1987	11·2	0 21	0·95	3·1	10·9	36·2	73·6	95·7
1993	11·6	0·19	1·37	4·3	9·0	32·1	72·1	118·2
Difference	+0·4		+0·4	+1·2	**−1·9**	**−4·1**	**−1·5**	+22·5

Epidemiological changes

Mortality in Switzerland due to ICD410–414 is low compared with other industrialized countries[1]. The pattern of its age distribution is very similar, however. It is noteworthy that mortality decreased considerably during the short period of 1988–1993, most markedly in the 55- to 64-year-old-age group, while the overall mortality stayed constant. Mortality in men of this age declined from about 250 to 190 (per 100 000 population), i.e. by approximately 25%. With women of the same age, mortality decreased from approximately 46 to 37 (per 100 000 population), i.e. by approximately 20%. It is significant that the improvements concern the population active in the labour force. See Fig. 1.

Direct consequences of the shift in mortality patterns are also evident when the losses in potential life years are calculated (Table 3). With men, a gain is found (survival gain) in that the potential life years lost have decreased by close to 10% in the period from 1988 to 1993. The situation is different with women. At the ages of 55–74 years, women lost fewer potential life years, while younger and older age groups showed increased losses. The sum of life years lost, in the case of Swiss women overall, increased slightly.

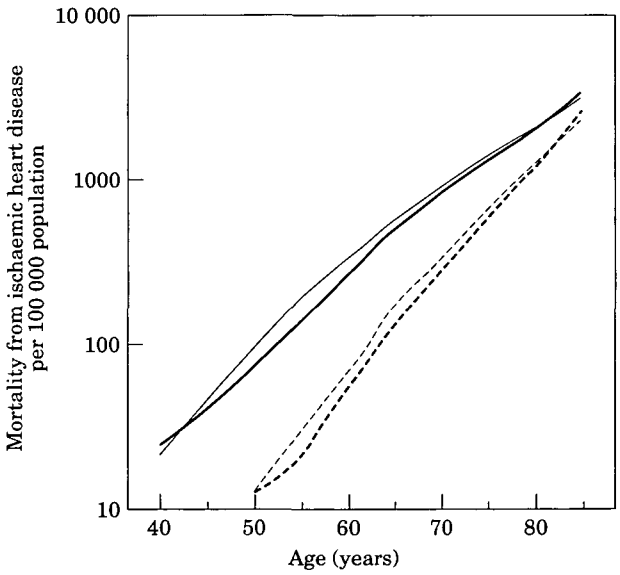

***Figure 1* Mortality (per 100 000 population) due to ischaemic heart diseases (ICD 410–414) in Switzerland, for men and women, as a function of age; for the years 1988 and 1993. Semilogarithmic plot. ——=men in 1988; ——=men in 1993; – – –=women in 1988, – – –=women in 1993.**

Economic costs of ischaemic heart disease in Switzerland

The total costs of ischaemic heart disease patients (ICD 410–414) in Switzerland in 1993 amounted to 2·1 billion Swiss Francs. This corresponded to US $ 1·42 billion (1993 dollars), taking into account the average exchange rate in 1993 of 1·45 Swiss Francs per US $[17]. In this year, the Swiss population was 6·9 million. Thus, the standardized costs were $21 million per 10^5 population.

The major cost components contributed approximately equal amounts to the total, i.e. the direct costs were $ 9·9 million per 10^5 population (47%), and the indirect costs amounted to $ 11·3 million per 10^5 population (53% of the total). The individual cost elements are listed in absolute and relative terms (percentages), together with their possible ranges, in Table 4.

Among the dominant elements determining direct costs, inpatient care was the most costly (with 57% of all direct costs) while outpatient care was less (41%). The largest element of indirect costs was due to premature deaths (46% of all indirect costs) while the contribution of production losses due to morbidity and disability were about equal (30% and 24% respectively).

The total sums could not all be analysed according to sex, age and ICD group. The main reason was that data on patients treated on an outpatient basis were not grouped accurately enough into the ICD classes for our analyses. Moreover, the work loss cases (indirect cost due to morbidity) were not available in age-specific

Table 4 Costs of ischaemic heart diseases, ICD 410–414, in Switzerland in 1993, with direct and indirect cost components, in absolute and relative terms (of subtotals); costs are given in standardized form and constant dollars (1993 US $ per 10^5 population), together with their possible range of variation

Cost elements	Ischaemic heart diseases costs in 1993		
	Absolute		
	Estimate ($ million per 10^5 population)	Range	Percentage (% of subtotal)
Direct costs			
Outpatient care	**4·1**	4·1–4·4	41
Inpatient care	**5·6**	5·6–6·2	57
Rehabilitation	**0·15**	0·15–0·18	2
Subtotal	**9·9**	9·9–10·8	100
Indirect costs			
Due to morbidity	**3·4**	3·1–3·4	30
Due to disability	**2·7**	2·7–3·1	24
Due to premature death	**5·2**	4·8–5·7	46
Subtotal	**11·3**	10·6–12·2	100
Total: direct plus indirect costs	**21·2**	20·5–23	

form. Therefore, the details on relative contributions (to the total sum) by the age groups and ICD classes could not be worked out.

Uncertainties in the original data and their influence on the results were analysed based on extensive sensitivity analyses. Costs of outpatient care were initially calculated conservatively, based on a low estimate of the number of ischaemic heart disease patients. With a (possible) 10% increase in patients, costs would grow by 7·5%. Costs of inpatient care (also assessed conservatively by taking into account the most frequent interventions, only) depended directly on the costs per inpatient day. If inpatient costs were 10% higher, total inpatient care would also increase by 10%. Indirect costs due to morbidity would vary directly with the computed work days lost. If our initial and possibly high estimate of total losses of work days was 10% too high, our cost calculation would correspondingly be 10% too high. Indirect costs due to disability were possibly underestimated by approximately 15% (because of oblique distribution of degrees of disability in the highest 'disability class'). Indirect costs due to premature death would vary with different discount rates. With a discount rate of 2%, the costs would be 9% higher than shown above. With a discount rate of 6%, costs would decrease by 7%.

Changes in costs of ischaemic heart disease 1988–1993

The analysis of changes in the costs of ischaemic heart disease during the 5 year period from 1988 to 1993 was based on an earlier illness costing study for the year 1987/88[4] as well as new calculations. The striking result was that the two major components, i.e. direct and indirect costs, showed significantly different behaviour.

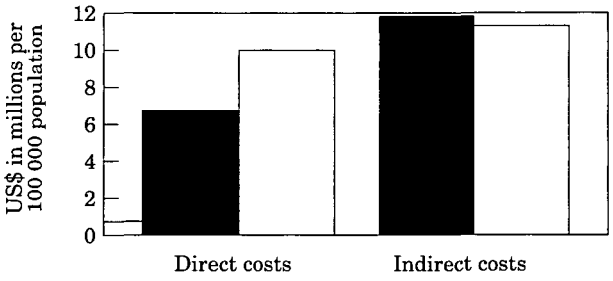

Figure 2 **Cost development 1988–1993 for ischaemic heart disease (ICD 410–414) in Switzerland. The strong increase in direct costs and the decrease in indirect costs are shown. The data shown are 'constant dollar' values. ■=1988; □=1993.**

Direct costs grew rapidly while indirect costs receded slightly (in real terms, cf. Table 5 and Fig. 2). In constant dollars (i.e. in 1993 dollars), one finds an increase in direct costs of +57% over the period of 5 years (or ca+9% per year) vs a small decrease in indirect costs of approximately −4% (ca. −0·7% per year).

Direct costs increased at a disproportionately high rate. Comparison with the expansion of total health costs in the country (for all diagnoses) showed the following. Total costs (in current dollar values) for outpatient care (all diagnoses) grew at an annual rate of approximately 6% per year[17], vs ca. 15% per year for ischaemic heart disease. Costs of inpatient care for all diseases increased by +9·5%[19] per year, while ischaemic heart disease patient cost increased at ca. +13·5% per year.

The sum of indirect costs decreased by a small amount. Costs due to morbidity and to premature death both declined (by approximately −2% per year). Some of this gain was compensated for by the increasing costs

Table 5 Comparison of costs of ischaemic heart diseases (ICH 410–414) in Switzerland in 1988–1993 together with percentage changes, in constant (1993) dollars, standardized per 10^5 population. The main cost elements of both direct and indirect costs are also shown (costs of inpatient care including rehabilitation costs)

	Development of costs of ischaemic heart diseases		
	Costs		Increase in real terms (% per year)
	1987/88 (constant million $ per 10^5 population)	1993	
Direct costs			
Outpatient care	2·5	4·1	
Inpatient care	3·8	5·8	
Total direct costs	6·3	9·9	+57
Indirect costs			
Due to morbidity	3 8	3·4	
disability	2·3	2 7	
premature death	5 6	5·2	
Total indirect costs	11·7	11·3	−4

due to disability (ca. +3% per year), however. Indirect costs due to disability grew, probably because of the survival of younger patients suffering from severe ischaemic heart disease.

Discussion

Three significant processes were investigated in this study: (i) the decrease in mortality of the young (accompanied by increases in mortality of the old); (ii) the increasing financial resources consumed by the treatment and care of ischaemic heart disease, the so-called direct costs; and (iii) the decrease in the losses, or a gain in production to society, as expressed by the indirect costs.

Clearly, the advent of new medical interventions and new treatment modalities, together with expanding supply (e.g. more cardiological institutions as in the case of Switzerland), have had strong effects on the direct costs showing high rates of growth. This was underscored by the fact that inpatient care costs increased significantly although the volume of inpatient days decreased (shorter length of stay compensating for higher numbers of hospitalized cases).

Concomitantly, decreases in mortality in the population under 65 years of age resulted, first, in higher prevalence (incidence staying approximately constant) and, secondly, in lower work losses. The reduction in productivity losses in turn resulted in a decrease in indirect costs. It should be noted, however, that the (relative) decrease in indirect cost is not sufficient to compensate for the very rapid rise of direct economic costs of the ischaemic heart diseases.

One important goal of medicine is to reduce temporary and permanent morbidity due to ischaemic heart disease and to postpone premature death. The calculations presented show that the goal is reached in parts. Society is gaining economically due to decreasing productivity losses. It cannot be resolved, however, to what extent medical care contributed to the development. Assessments relating to this question were published by Goldman[20]. Analogous studies do not exist in Switzerland.

The judgment of the significance of the message conveyed by the estimate of ischaemic heart disease costs obviously also depends on questions regarding the power of the disease costing method as employed here, and the quality of the data analysed.

Disease costing is an established field of health economics. The main problems and arguments about methodology have been largely resolved since the beginnings of formal economic investigations in the 1950s[13,20,22]. One possible point of contention may be the use of the human capital approach. The method, however, allows for estimates of economic losses to society (and nothing more). As such, it has its established position and has been the method of choice with most health economists. Alternative approaches to indirect costs like those of 'willingness to pay' and 'willingness to accept' methods suffer from the disadvantage that they are difficult to apply and that the results depend (among others) on the wealth of the individuals questioned. This has been discussed extensively in the literature[13,14].

Completeness; comparisons

First, the cost elements evaluated in the study covered the major areas in which (financial) resources are consumed. Some of the additional elements were omitted. Among the direct costs all those relating to residential care (special technical aids, vocational rehabilitation and the like) were not taken into account for lack of data allowing for nationwide statistics (and estimates). The same holds for direct cost of outpatient rehabilitation.

Among the elements of indirect costs time losses (e.g. for travel to physicians office) or losses of income and time of the family of the patient were omitted.

Intangible (psycho-social) costs were not assessed, either. Obviously, fear, suffering, and sorrow due to the illness may weigh heavily. They affect the quality of life of patients and their families significantly. While these consequences of the disease can be rated, compared and weighed against each other (e.g. for utility analyses) they cannot be expressed in monetary terms. It was considered beyond the scope of this study to look into the developments in this area.

The precision of some cost elements (e.g. outpatient care, absenteeism) was not as high as with others (e.g. inpatient care), but they could not be improved because of lack of nationwide statistics. Sensitivity analysis, while giving insight into the degrees of uncertainty involved did not affect the final conclusion, however.

The cost of ischaemic heart disease has been investigated intensely in many countries for obvious reasons. To our knowledge, however, there are no recent studies on trends and analyses of direct vs indirect costs, such as that by Rice *et al.*[22].

Nevertheless, Rice's and Scitovsky's work[22–25] provide useful bases for special comparisons. In their work the ratio of direct to indirect costs showed strong increases. The reason was because direct costs of (all) cardiovascular diseases rose more rapidly (by a factor of 3 in 8 years) than indirect costs which were growing more slowly (+80% in 8 years). This differs from the results of the current investigation, which covered a later period in time, and related to Switzerland where indirect cost stabilized or even decreased because of the reduction in work loss.

Recently published studies had different endpoints in that resource utilization for specially selected diagnostic groups by particular, special treatment modalities were analysed[20,26–30]. Our study differed in that it was 'institution-oriented' and covered all medical acts for all cases in the ICD 410–414 groups. Direct comparisons could be quite misleading.

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Appendix

Algorithm for indirect costs

The indirect costs were equalled to the current value of all future incomes foregone (E_{tot}) by the ischaemic heart disease cases dying prematurely, corresponding to the sum of (the current values of all future) incomes (E_j) lost of the age groups in the working population. Formally:

$$E_{tot} = \sum_{j=1}^{j=j_{max}} N_j \times E_j$$

where N_j=number of premature deaths at the age j (due to ICD 410–414)

E_j=current value of expected future earnings forgone by the ischaemic heart disease cases dying at the age j.

The current value E_j of the expected incomes was calculated as follows, per individual (dying prematurely) at the age of j:

$$E_j = \sum_{k=j}^{k=k_{max}} \frac{s_k + s_{k+1}}{2s_j} \times \frac{1}{(1+r)^{10(k-j)}} \times e_k \times l_k$$

where s_k=survival rate at the (average) age k

k=index of age group; k_{max} covers age group 56–65 years for men, 56–62 years for women

r=discount rate

e_k=labour force participation rate at the (average) age k

I_k=average earnings of the age group k in 10 years; multiplied by 0·5 in the first decade.

The second equation takes into account that premature deaths occur, in the average, at the mid-age of each age group.