

Chapter 13.

Economic costs - Methods

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In this online appendix, we provide detailed methodology and data sources used for the estimation of the costs of cardiovascular disease in 28 European countries.

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Methodological background

A cost of illness analysis involves the identification, measurement and valuing of all resources related to a specific illness. The perspective of the analysis is fundamental in determining which resources should be considered, and how they should be measured and valued. A health service perspective, for instance, would only consider costs imposed on hospitals and other health care providers. A societal perspective enables a wider analysis, in which all costs are considered, irrespective of who bears them or where they are incurred. Such a perspective not only includes health care costs but also those costs falling outside the health care sector, such as the opportunity costs associated with unpaid (i.e. informal) care to cardiovascular disease (CVD) patients, or productivity losses associated with premature death or morbidity. For this analysis, a societal perspective was adopted.

An annual time frame was adopted for our analysis, in which all costs due to CVD within the most recent year for which data were available were measured, regardless of the time of disease onset. All health care costs were expressed in 2015 prices, and if necessary adjusted using the health consumer price indices of each EU member state.¹ Where applicable, all national currencies were converted to Euro currency using 2015 exchange rates.²

A “top down” approach was employed to calculate the total expenditure due to CVD across the 28 European Union countries. This approach used aggregate data on morbidity, mortality, hospital admissions, disease related costs, and other health related indicators. An advantage of using this approach was the readily availability of international and national aggregate data. Given the whole spectrum of diseases under the CVD category, each with various treatment probabilities, complex incidence, and associated costs, a macro approach is likely to produce more accurate results than micro-costing of individual episodes of care.

A variety of international and national sources of epidemiological and health care utilisation data on CVD, CHD and stroke, were used. Among the sources consulted were the World Health Organization (WHO), the OECD, the Statistical Office of the European Communities (EUROSTAT), the World Bank Group, national ministries of health, national statistical institutes, large cohort studies etc. International data were used in preference to national data whenever available, as the former enable cross-country

comparisons and are less prone to potential methodological biases. When relevant data could not be obtained from national or international sources, peer-reviewed articles or national reports from governmental or professional bodies were consulted. If no data were found for a particular country, extrapolations of resource use and unit costs were performed from similar countries. A country was judged to be similar if it had similar health-care expenditure per person, life expectancy and geographical location.

The framework used to estimate health care and non-health care costs was similar to the approach by Leal et al. (2006),³ Luengo-Fernandez (2011),⁴ Luengo-Fernandez (2013),⁵ Leal et al. (2016),⁶ and Burns et al.(2016)⁷ to estimate the economic burden of CVD, cancer and dementia in the EU.

Health care expenditure

The categories of CVD health care service included were the following:

- primary care
- accident and emergency care
- hospital inpatient care (including day cases and cardiac rehabilitation services)
- outpatient care
- medications

Other categories of health service were not included, such as school/community based prevention and health education activities, and out-of-pocket expenses incurred by patients in purchasing over the counter medications, aids, home modifications, etc. These were not included in the study due to the difficulties of identifying them in the majority of countries. These excluded categories are likely to represent a small proportion of the total costs identified.

To account for private spending on health care, in countries where only public resource use was found, cost estimates were inflated using the total proportion of private spending on health care.⁸

Health care resource use

Healthcare utilisation data sources are reported in **Table 1**.

Table 1. Sources of healthcare resource use by category and country

Country	Primary care	Outpatient care	A&E	Inpatient care
Austria	9	9	9	10,11
Belgium	12	13	14	10,11
Bulgaria	15	15	16	10,11
Croatia	17	17	17	10,11
Cyprus	18-20	18-20	18-20	10,11
Czech Rep.	21	21	22	10,11
Denmark	23,24	23,24	23,25	10,11
Estonia	26,27	26,27	26	10,11
Finland	28,29	28,29	28	10,11
France	30,31	30,31	32	10,11
Germany	33,34	33,34	35	10,11
Greece	36	36	5	33
Hungary	37,38	37	39	10,11
Ireland	40	41	41	10,11
Italy	42	42	43	10,11
Latvia	44,45	44,45	46	10,11
Lithuania	47,48	47,48	49	10,11
Luxembourg	50	50	14	10,11
Malta	51	51	51	10,11
Netherlands	52	52	53	10,11
Poland	54	54	54	10,11
Portugal	55	56	57	10,11
Romania	58	58	59	10,11
Slovakia	60	60	22	10,11
Slovenia	61	62	17	10,11
Spain	63	63	63	10,11
Sweden	64,65	65	66	10,11
UK	67-71	72-75	76-80	10,11

Primary care

Primary care activities consisted of CVD-related visits to or from general practitioners (GPs). Country-specific overall visits to primary care due to all conditions were obtained for all countries (see **Table 1**).

To the total number of primary care visits we applied the proportion that was attributable to CVD using the following:

1. In Cyprus,¹⁹ Hungary,³⁸ Latvia,⁴⁵ Slovenia,⁶² and the UK,⁷¹ data were available on the proportion of primary care consultations due to CVD;
2. In Estonia²⁷ and Finland,²⁹ data were available from published studies evaluating the reasons for consultations in primary care practices;
3. In France,³¹ Germany³⁴ and the Netherlands,⁸¹ data on ambulatory care expenditure by disease group were used to derive the number of visits due to CVD by applying the respective proportion of expenditure, out of all ambulatory expenditure, to the total number of primary care visits;
4. In Sweden,⁶⁵ the proportion of outpatient care visits that was attributable to CVD, CHD and stroke was used to derive the respective number of primary care visits by applying it to the total number of primary care visits;
5. In the remaining 17 countries, the proportion of overall hospital discharges due to CVD¹¹ was applied to the total number of primary care visits.

To evaluate the proportion of primary care visits due to CHD and stroke, we obtained the proportion of CVD-related hospital discharges due to CHD and stroke,¹¹ which was applied to the total number of CVD-related primary care visits. This was undertaken for all countries except France,³¹ Germany,³⁴ the Netherlands,⁸¹ and the UK,^{69,70} where this information was available. In Sweden,⁶⁵ the proportion of outpatient care visits that was attributable to CHD and stroke was used to derive the respective number of primary care visits by applying it to the total number of primary care visits.

Hospital outpatient care

Outpatient care comprised specialist consultations taking place in outpatient wards, clinics, or patients' homes. In Sweden, we obtained the total number of outpatient visits due to CVD, CHD and stroke.⁶⁵ For the remaining countries, country-specific overall visits to outpatient care due to all conditions were obtained (see **Table 1**). To the total number of outpatient care visits we applied the proportion of care that was attributable to CVD using the following:

1. In Cyprus,¹⁹ Latvia,⁴⁵ and Slovenia,⁶² published data were available on the proportion of outpatient care consultations due to CVD;
2. In France,³¹ Germany³⁴ and the Netherlands,⁸¹ data on ambulatory care expenditure by disease group were used to derive the number of visits due to CVD by applying the respective proportion of expenditure, out of all ambulatory expenditure, to the total number of outpatient care visits;
3. In Hungary,³⁸ Finland,²⁹ and Estonia,²⁷ the proportion of primary care visits that was attributable to CVD was used to derive the number of outpatient visits due to CVD by applying it to the total number of outpatient visits.
4. In the remaining 18 countries, the proportion of overall hospital discharges due to CVD¹¹ was applied to the total number of outpatient care visits.

To evaluate the proportion of outpatient care visits due to CHD and stroke, we obtained the proportion of CVD-related hospital discharges due to CHD and stroke,¹¹ which was applied to the total number of CVD-related outpatient care visits. This was undertaken for all countries except Sweden, France,³¹ Germany,³⁴ and the Netherlands,⁸¹ where this information was available.

Accident & Emergency care

Accident and emergency (A&E) consisted of all CVD-related hospital emergency visits. In Denmark,²⁵ we obtained the total number of CVD-related hospital emergency visits. Country-specific overall visits to A&E due to all conditions were obtained for 23 countries (see **Table 1**). For four countries (Czech Republic, Greece, Luxembourg and Slovenia) no data on A&E activity was found. As a result, we used the total per capita A&E visits from similar countries. Therefore, for: 1) Czech Republic we used

estimates from Slovakia;²² 2) Greece we derived estimates from a previous multi-country regression;⁵ 3) Luxembourg we used estimates from Belgium;¹⁴ and 4) Slovenia we used estimates from Croatia.¹⁷

To the total number of A&E visits we applied the proportion of care that was attributable to CVD using the following:

1. In Bulgaria,¹⁶ published data were available on the proportion of A&E visits due to CVD;
2. In Cyprus,¹⁹ and Latvia,⁴⁵ the proportion of outpatient care visits that was attributable to CVD was applied to the total number of A&E visits;
3. In Estonia,²⁷ the proportion of primary care visits that was attributable to CVD was applied to the total number of A&E visits;
4. In France,³² a national survey of the emergency services provided data on the proportion of A&E visits due to CVD;
5. In Germany,³⁵ published data were available on the proportion of A&E visits due to CVD;
6. In the Netherlands,⁸¹ data on ambulatory care expenditure by disease group were used to derive the number of visits due to CVD by applying the respective proportions of expenditure, out of all ambulatory expenditure, to the total number of A&E care visits;
7. In the UK,⁷⁹ the proportion of emergency inpatient admissions due to CVD was applied to the total number of A&E visits;
8. In the remaining 19 countries, the proportion of overall hospital discharges due to CVD¹¹ was applied to the total number of outpatient care visits.

To evaluate the proportion of A&E visits due to CHD and stroke, we obtained the proportion of CVD-related hospital discharges due to CHD and stroke,¹¹ which was applied to the total number of CVD-related A&E visits. This was undertaken for all countries except Denmark,²⁵ the Netherlands⁸¹ and the UK,⁷⁹ where this information was available.

Hospital inpatient care

Inpatient care was estimated from the number of CVD-related days in hospital, including day case admissions. The number of days in hospital, which included day cases, was obtained for all countries by primary diagnosis of CVD, CHD and stroke.^{10,11}

Healthcare unit costs

For all countries, health care resource use was valued using country-specific unit costs, which were derived from published studies, reports, and national fee schedules.

Sources of unit costs per country and resource use category are reported in **Table 2**.

Table 2. Sources of unit costs by country and healthcare utilisation category

Country	Primary care	Outpatient care	A&E	Inpatient care
Austria	82	82	83	8
Belgium	84	84	84	85
Bulgaria	8	8	5	8
Croatia	86	86	86	86
Cyprus	87	87	87	88
Czech Rep.	89	89	5	90
Denmark	91	91	92	8
Estonia	26	26	26	26
Finland	93	93	92	94
France	30	30	95	8
Germany	96	34	96	34
Greece	97	98	97	97
Hungary	38	38	39	39
Ireland	99	99	99	100
Italy	96	101	96	102
Latvia	44	38	5	44
Lithuania	47	47	96	47
Luxembourg	103	103	103	8
Malta	51	7	104	104
Netherlands	52	52	105	81
Poland	106	107	5	106
Portugal	108	109	109	109
Romania	110	110	5	8
Slovakia	110	110	5	8
Slovenia	110	110	104	8
Spain	111	111	111	111
Sweden	112	66	66	66
UK	113	114	114	114

Expenditure on Medications

The costs related to consumption of CVD-related medication were included in the analysis. CVD-related medications were defined as those coded under the Anatomical Therapeutic Chemical (ATC) Classification Code C (Cardiovascular System).

OECD Health data provided the total CVD-related expenditure on medication for Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Slovakia, Slovenia, Spain and Sweden.¹¹⁵ For Croatia,¹¹⁶ information on CVD-related pharmaceutical expenditure was obtained from a national source. In Bulgaria,¹¹⁷ Cyprus,¹¹⁸ Latvia,¹¹⁹ Lithuania,¹¹⁹ Poland,¹²⁰ and the UK,¹²¹ information on the proportion of CVD-related expenditure out of all pharmaceutical expenditure was obtained from national sources and applied to the total pharmaceutical expenditure.^{8,115,122}

For Malta and Romania no data on CVD-related pharmaceutical expenditure was identified.

Therefore, for: 1) Malta we used the average from Cyprus,¹¹⁸ Italy,¹¹⁵ Portugal,¹¹⁵ and Spain;¹¹⁵ and 3) Romania we used estimates from Bulgaria.¹¹⁷

As only France, Germany and the Netherlands provided data on the proportion of CVD-related pharmaceutical expenditure on CHD and stroke,^{31,34,81} the proportion of pharmaceutical expenditure in these two conditions was averaged across the three countries and applied to the total CVD sales in the remaining countries.

Non-health care expenditure

The categories of non-health care expenditure included in the study were the following:

- Informal care
- Productivity losses due to mortality
- Productivity losses due to morbidity

Informal care costs

Informal care costs were equivalent to the opportunity cost of unpaid care. This opportunity cost is a measure of the amount of money that carers forgo to provide unpaid care for their spouses, friends or relatives suffering from CVD, CHD or stroke. We conservatively assumed that only people severely limited in daily activities due to cardiovascular diseases would receive informal care.

In order to estimate informal care costs due to CVD, CHD and stroke we used data from the Survey of Health, Ageing and Retirement in Europe (SHARE).¹²³ SHARE is a multidisciplinary and cross-national panel database of micro data on health, socio-economic status and social and family networks, freely available to researchers, in which all data are collected via face-to-face, computer-aided personal interviews, supplemented by self-completion paper and pencil questionnaires (**Table 3**). The SHARE target population consists of all persons aged 50 years and over at the time of sampling who have their regular domicile in the respective SHARE country. Persons are excluded if they are incarcerated, hospitalized or out of the country during the entire survey period, unable to speak the country's language(s) or have moved to an unknown address.

Table 3. WAVES and Field time available in SHARE survey

Wave	Field time
1	2004-2006
2	2006-2007
3 (SHARELIFE)	2008-2010
4	2010-2012
5	2013
6	2015

For our analysis, we used data collected Wave 2, Wave 4 and Wave 5 which included over 30,000 respondents resident in 18 EU countries (Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Spain and Sweden). Residents from Ireland and Greece were only included in WAVE 2 whereas residents from Hungary and Portugal were only included in WAVE 4 and the data collected in these two waves were combined with WAVE 5 data on the remaining 14 countries. For countries not in SHARE, we combined data from similar countries that were in SHARE to obtain estimates for the 10 remaining countries. Therefore, for Bulgaria, Latvia, Lithuania, Romania, Slovakia and Slovenia we used combined data from the Czech Republic, Estonia, Hungary and Poland. For Finland we used

combined data from Denmark and Sweden. For Cyprus and Malta we used combined data from Greece, Italy, Portugal and Spain. Finally, for the UK we used combined data from Austria, Belgium, France, Germany, Ireland, Luxembourg, and the Netherlands.

The amount of hours of informal care provided for severely limited CVD patients was estimated by calculating the sum of the age and sex-specific products of:

1) *Prevalence of CVD, CHD and stroke in the population.*

Participants in SHARE were shown a list of up to 20 health conditions and asked whether they were told by a doctor that they had any of the conditions, i.e. either currently being treated for or bothered by the condition. For this specific analysis, CVD was defined as either having suffered a heart attack (including myocardial infarction or coronary thrombosis), or having any other heart problem (including congestive heart failure), stroke or cerebral vascular disease and/or hypertension. CHD was defined as having a heart attack or any other heart problem whereas stroke was defined as having a stroke or cerebral vascular disease.

2) *Probability of being severely limited in daily activities due to CVD, CHD or stroke.*

Participants in SHARE were asked whether they had no, moderate or severe limitations in daily activities due to a health condition for the past six months at least. We undertook logistic regressions to estimate the country-specific probability of being severely limited in daily activities adjusting for age, gender, presence of CVD, CHD or stroke as well as other health conditions.

3) *Probability of receiving informal care due to CVD, CHD or stroke.*

Participants in SHARE were asked whether they received unpaid care from relatives/friends living with them or from outside the household. Using two logistic regression analyses (one for help from inside household and one for help outside the household), we estimated the country-specific probability of a respondent receiving unpaid care adjusting for age, gender, presence of CVD, CHD or stroke, limitations in daily living, and presence of other health conditions.

4) *Hours of informal care received due to CVD, CHD or stroke.*

Participants in SHARE who received informal care were further asked whether they received care: almost daily, almost weekly, almost every month, or less often. Using an ordered logistic regression we estimated the amount of informal care received after adjusting for age, gender, presence of CVD, CHD or stroke, limitations in daily living, presence of other health conditions, and country of residence. In WAVE 2 of SHARE, participants were asked about the hours of unpaid care received daily, weekly, monthly or annually. Conditional on how often they received care, the hours of care received did not vary by condition, age and gender, so, for each country, average hours of care received daily, weekly, monthly or annually were estimated without controlling for other characteristics.

5) *Hours of informal care by employment status of informal carer inside or outside household*

Participants in SHARE who received informal care were asked who provided the care (e.g. spouse, sibling, offspring, parent, friend etc...). We assumed that spouses, siblings and friends providing informal care would be in the same age group as the respondent. If care was provided by either the patients' children, their children's spouses, or unpaid volunteers then it was assumed that these informal carers would be younger than the respondent and within the working age. Using gender- and age-specific employment rates for each country,^{124,125} we determined the proportion of carers inside and outside household who were employed and allocated the hours of informal care received accordingly.

6) *Monetary value for hours of care provided.*

The average net hourly wage rate was applied to informal care provided by those carers who were employed. Annual earnings were obtained,¹²⁶ and then adjusted to hourly wage rates, assuming there were 230 working days each year, and each day consisted of 8 hours of work. For those carers in retirement, unemployed, or economically inactive, the national hourly minimum wage was applied.¹²⁷ For those countries with no official minimum wage rate (Austria, Cyprus, Denmark, Finland, Italy and Sweden), the worst paid sector in the economy was proxied as a minimum wage.¹²⁸

Mortality losses

The costs associated with lost productivity due to mortality comprised the foregone earnings from premature death due to CVD, CHD or Stroke. Age and gender specific deaths due to each of the three cardiovascular disease categories were obtained for all countries from EUROSTAT.¹²⁹

For all countries we assumed an initial working age of 15. The number of working years lost due to premature mortality was estimated both for males and females combining the previous information together with the number of deaths broken down by age and gender. Number of working years lost was then multiplied by gender-specific average annual gross earnings.¹²⁶ However, this estimate would overestimate these costs as not everyone will be employed. Therefore, age- and gender-specific employment rates for each of the 28 countries were applied to the potential foregone earnings due to premature mortality.^{124,125}

As these productivity costs would be incurred in future years, all future foregone earnings were discounted using a 3.5% rate per annum following current UK HM Treasury recommendations.¹³⁰

Morbidity losses

The costs associated with lost productivity due to morbidity were the costs associated with absence of work due to CVD, CHD and stroke. Morbidity losses could occur due to: individuals taking absence from leave for a defined period of time; or due to individuals being declared incapacitated or disabled due to their condition, and therefore leaving the labour market. **Table 4** details all sources used to obtain temporary and permanent absence from work due to CVD.

Table 4. Sources used to obtain morbidity losses, by country

Country	Temporary absence from work	Permanent absence from work
Austria	131	131
Belgium	132,133	134
Bulgaria	135,136	59,136
Croatia	17,62	17,137
Cyprus	138,139	138,140
Czech Rep.	141,142	90,142
Denmark	143,144	144,145
Estonia	26,146	146,147
Finland	148,149	149
France	150,151	152,153
Germany	34	34
Greece	138,139	138,140
Hungary	136,154	136,154
Ireland	155,156	157,158
Italy	159,160	42,161
Latvia	146,162	146,163
Lithuania	47,146	146
Luxembourg	164,165	50,165
Malta	51,160	51,161
Netherlands	166	166,167
Poland	136	136,168
Portugal	139,169	140,170
Romania	136,171	59,136
Slovakia	142,172	142,172
Slovenia	62	137
Spain	139,150	140,173
Sweden	144,174	144,175
UK	156	158

Temporary absence from work due to sickness

Country-specific overall annual days of sickness leave due to all conditions was obtained for 27 countries (see **Table 4**). For Cyprus no information on days of sickness leave was found and we used the proportion of sickness days per worker from Greece.¹³⁸

To the total number of days of sickness leave, we applied the proportion that was attributable to CVD, which was available in Austria,¹³¹ Belgium,¹³³ Czech Republic,¹⁴² Estonia,¹⁴⁶ France,¹⁵¹ Germany,³⁴ Italy,¹⁶⁰ Luxembourg,¹⁶⁵ Netherlands,¹⁶⁶ Poland,¹³⁶ Slovenia,⁶² Spain,¹³⁹ Sweden,¹⁴⁴ and UK.¹⁵⁶ For Finland¹⁴⁹ we used the proportion of overall permanent absence from work due to CVD.

For countries where we could not establish the proportion of sickness leave attributable to CVD, we used proportions from other countries. Therefore, for:

- 1) Bulgaria, Hungary and Romania we used estimates from Poland;¹³⁶

- 2) Cyprus, Greece and Portugal we used estimates from Spain;¹³⁹
- 3) Croatia we used estimates from Slovenia;⁶²
- 4) Denmark we used estimates from Sweden;¹⁴⁴
- 3) Ireland we used estimates from the UK;¹⁵⁶
- 4) Latvia and Lithuania we used estimates from Estonia;¹⁴⁶
- 5) Malta we used estimates from Italy;¹⁶⁰ and
- 6) Slovakia we used estimates from the Czech Republic.¹⁴²

Except for Austria,¹³¹ the Czech Republic,¹⁴² France,¹⁵¹ Germany,³⁴ Slovenia,⁶² and the UK^{156,176} where the proportion of sickness leave/incapacity attributable to CHD and stroke was available, for all other countries the proportion of CVD days due to CHD and stroke was obtained by assuming that this would be the same as the proportion of overall days in hospital due to CHD or stroke in the working age population.¹⁰ We hypothesised that the higher the number of days spent in hospital, the higher the number of working days lost due to illness.

Permanent absence from work due to incapacity or disability

Country-specific information on the numbers of working-age individuals receiving incapacity or disability benefits and not being able to work conditions was obtained for 26 countries (see **Table 4**). For two countries (Bulgaria and Cyprus) no information on disability/incapacity pensions was found. As a result, we used the proportion of invalidity cases per worker from similar countries. Therefore, for: 1) Bulgaria we used estimates from Romania;⁵⁹ 2) Cyprus we used estimates from Greece.¹³⁸

To the total number of incapacity or disability cases, we applied the proportion that was attributable to CVD, which was available in Austria;¹³¹ Belgium;¹³⁴ Finland;¹⁴⁹ France;¹⁵³ Germany;³⁴ Italy;¹⁶¹ Luxembourg;¹⁶⁵ Spain;¹⁴⁰ Slovenia;¹³⁷ Spain;¹⁴⁰ and the UK.¹⁵⁸

For Estonia,¹⁴⁶ the Netherlands,¹⁶⁶ Poland,¹³⁶ and Sweden,¹⁴⁴ we applied the proportion of temporary absence from work that was attributable to CVD. For countries where we could not establish the proportion of permanent absence from work attributable to CVD, we used proportions from similar countries using the methodology to estimate the temporary absence from work due to sickness.

For those countries where the proportion of permanent absence from work attributable to CHD and stroke was unavailable, the proportion of CVD days due to CHD and stroke was obtained by assuming that this would be the same as the proportion of overall days in hospital due to CHD or stroke in the working age population.¹⁰

Valuing absence from work

The average annual earnings identified when estimating informal care and mortality costs were converted to average daily earnings. The product of working days lost and average daily earnings provided the productivity losses associated with CVD, CHD and stroke morbidity. However, absent workers after a certain period are likely to be replaced at work by other workers, and so the total morbidity loss as computed above is likely to be an upper limit of the “real” loss from CVD, CHD and stroke. Hence, we estimated the “friction period”, i.e. the period of employee’s absence from work due to illness before the individual is replaced by another worker, which is estimated to be 90 days in Europe.¹⁷⁷ Therefore, for all new permanent cases of disability/incapacity, and/or the average spell of temporary sickness leave was more than 90 days, only the first 90 days of absence from work were assigned a monetary value.

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