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Future health expenditure in the European Union

Estimates of demographic effects

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SUMMARY

The costs of health care differ remarkably in Member States of the European Union (EU). Over the past decades they have increased considerably. This report describes developments of these costs in the current fifteen EU countries in relation to developments in their Gross Domestic Products (GDP), to inflation, etc. for the period 1960-1990 and prospectively analyses alterations in medical costs in relation to future (1990-2020) ageing and changes in population numbers.

Health care costs are age-dependent and increase strongly in persons over 65 years of age. A number of cost functions have been drawn up to calculate effects of different assumptions about the age-costs distribution on national health care costs. These functions have been extrapolated in time and applied to all EU countries, departing from one age-costs distribution which has been determined (1988) for the Netherlands.

Retrospectively, it appears that in recent years in most EU countries, including the Netherlands, the growth of health care costs per capita has followed increases in GDP per capita quite closely. After 2020, ageing will, especially for the Netherlands, become relatively more important, however, which may cause a further rise in health care costs. For the year 2020 the largest ageing-dependent increases in per capita health care costs (1990 = 1.00) are expected for Italy (1.11), Greece (1.10), Spain (1.09), Netherlands and Finland (1.08), with lesser increases in Sweden (1.00), the United Kingdom (1.01), Austria and Belgium (1.05), Denmark and Luxembourg (1.05). The average, weighted, health care costs for the EU are expected to increase (by ageing) from 1.00 in 1990 to 1.06 in 2020. These changes will, however, be small when compared to the expected changes that are related to changes in GDP. Absolute increases in costs have been estimated by additional inclusion of prospects of population growth. The observed changes become larger. The largest expected increases are expected for the Netherlands (1.27), Luxembourg (1.20), Spain (1.14), France (1.14) and Finland (1.13), with lower expected increases for the United Kingdom (1.06), Portugal (1.09), Sweden, Italy and Ireland (1.10), Germany (1.11) and Austria (1.12). In countries with a stronger demographically determined growth component, such as the Netherlands, equal increases in costs will leave less room for rises in costs by other causes.

Cost estimations for total populations are not very sensitive to the choice of demographic variants as the total number of elderly people hardly differs between the given demographic alternatives. The outcomes of the model estimations of the effects of ageing and population growth on past and future trends in health care costs as presented here are rather similar to results from other studies that have been performed for the Netherlands.

The robustness of the assumptions that the age-costs distribution will remain constant over time and will be similar for different countries is scrutinised and discussed in some detail. Epidemiological, medico-technological and socio-cultural developments may well alter the future age-costs distribution of health care costs and its comparability between countries in a non-predictable way.

SAMENVATTING

De kosten van gezondheidszorg verschillen aanmerkelijk in de lidstaten van de Europese Unie (EU). In de laatste tientallen jaren zijn zij tevens sterk gestegen. Dit rapport beschrijft de ontwikkelingen in deze kosten in de huidige vijftien landen van de EU in relatie tot ontwikkelingen in hun Bruto Binnenlandse Produkt (BBP), inflatie e.d. over de periode 1960-1990 en analyseert prospectief (1990-2020) de veranderingen in zorgkosten in relatie tot te verwachten vergrijzing en veranderingen in de bevolkingsomvang.

Zorgkosten zijn leeftijdsafhankelijk en stijgen aanzienlijk voor personen boven de 65 jaar. Een aantal leeftijd-kostenfunkties is opgesteld om verschillende veronderstellingen over de leeftijdsverdeling van zorgkosten door te rekenen. Deze funkties zijn geëxtrapoleerd in de tijd en toegepast op alle EU-landen, uitgaande van de leeftijd-kostenverdeling, die eerder voor Nederland (1988) bepaald is. Gecombineerd met bevolkingsprognoses van de VN zijn gevolgen van vergrijzing en bevolkingstoename op Europese zorgkosten geanalyseerd.

Retrospectief lijkt het er op dat in de meeste EU-landen, ook in Nederland, de stijging van de zorgkosten per capita de afgelopen jaren redelijk in de pas is gebleven met de stijging van het BBP per capita. Na 2010 zal, zeker voor Nederland, vergrijzing relatief belangrijker worden, waardoor de zorgkosten sterker kunnen stijgen. Voor het jaar 2020 wordt de grootste toename van de zorgkosten (per capita) door vergrijzing (1990 = 1.00) voorspeld voor Italië (1,11), Griekenland (1,10), Spanje (1,09), Nederland en Finland (1,08), terwijl een geringere toename gevonden wordt voor Zweden (1,00), het Verenigd Koninkrijk (1,01), Oostenrijk en België (1,05), Denemarken en Luxemburg (1,05). Het gewogen gemiddelde voor de EU stijgt naar verwachting van 1,00 in 1990 tot 1,06 in 2020. Deze veranderingen zijn echter gering in vergelijking met te verwachten veranderingen in BBP. Absolute kostenstijgingen zijn bepaald door ook voorspellingen over bevolkingsgroei mee te wegen. Verschillen zijn hierbij groter. De grootste verwachte toename vindt plaats in Nederland (1,27), Luxemburg (1,20), Spanje (1,14), Frankrijk (1,14) en Finland (1,13), met lagere toenamen voor het Verenigd Koninkrijk (1,06), Portugal (1,09), Zweden, Italië, Ierland (1,10), Duitsland (1,11) en Oostenrijk (1,12). In landen met een sterkere demografische groeicomponent, zoals Nederland, zal er, bij gelijke kostenstijging, dus minder ruimte zijn voor kostenstijging door andere oorzaken.

Kostenschattingen die betrekking hebben op totale populaties zijn niet erg gevoelig voor de keuze van een bepaalde demografische variant, omdat het aantal ouderen in de bestaande varianten nauwelijks verschilt. Variabiliteit in per capita kosten wordt veroorzaakt door verschillen per variant in de te verwachten omvang van de bevolking. De gepresenteerde, modelmatige, schattingen van de invloed van veroudering en bevolkingsgroei op historische en toekomstige trends in zorgkosten komen voor Nederland goed overeen met andere studies.

De robuustheid van de aanname dat de leeftijd-kostenverdeling hetzelfde blijft in de tijd en hetzelfde is voor verschillende landen, is nader bezien en wordt uitgebreid bediscussieerd. Epidemiologische, medisch-technologische en sociaal-culturele veranderingen kunnen de leeftijdsverdeling van de zorgkosten en de vergelijkbaarheid ervan tussen landen in de toekomst op niet-voorspelbare wijze veranderen.

1. INTRODUCTION

In recent decades the total cost of medical consumption has increased considerably in the countries of the European Union (EU) and so has their Gross Domestic Product (GDP). Per capita health expenditure varies significantly between EU countries, however, and it is affected by economic, demographic and other, intrinsic, factors. Extrapolation of factors that influence health expenditure will provide better insight into the dynamics of health expenditure in the future and comparisons between countries will facilitate a better understanding of these dynamics.

After the treaty of Maastricht Public Health has been placed explicitly on the agenda of the European Commission and comparative information on health-related issues has become increasingly important. International comparison of variations in health expenditure may provide insight into the contribution of various factors over time and may also provide a first prospective view of possible developments within the EU. The insight gained may assist health policy-makers to increase the cost-effectiveness of future medical expenditure.

The RIVM (The Dutch National Institute of Public Health and the Environment) carries out policy-supporting research for the Dutch government and for international organisations, in particular forecasting studies on environmental issues, but recently also in the public health area. This report was produced within the framework of a project entitled 'Public health forecasts in a European perspective'. It may serve as an example of a forecasting study in the field of public health which has been performed relatively quickly by using existing data and available methodology.

The costs of medical consumption in the European Union currently represent a substantial proportion of national income, on average about 8% of GDP. Both medical costs and GDP, have increased considerably in recent decades in all EU countries, but there are still large and as yet not fully explained differences in health expenditure between EU countries. Health expenditure relates to the purchase of goods and services intended to contribute to the reduction of mental and somatic health problems and functional disabilities caused by these problems. Unpaid activities such as voluntary health care and indirect costs (such as environmental pollution) or indirect benefits (such as increased working ability) are generally not included (1). Changes in health expenditure are influenced by changing definitions, by economic factors, such as changes in general price index values and in price index values for medical commodities, and by intrinsic factors, such as changes in disease patterns and medical consumption patterns over time.

Comparison between countries adds further sources of variation, however, such as differences between official exchange rates and purchasing power parity and differences in the way medical consumption is defined and measured. The latter difference makes a sound comparison of absolute values of health expenditure between countries extremely difficult.

Population growth and ageing affect the nature and volume of what is considered to be necessary health care. As the countries of the EU have gone through a period of ageing, there has already been a shift in health expenditure towards chronic diseases that are especially prevalent at older ages. Other studies on the effects of ageing on medical consumption have been performed for France and the Netherlands (2, 3) but these have used different methods.

In this report an initial analysis will be presented of differences in health expenditure between EU countries and of trends over time. After correction for the economic factors mentioned above, differences in GDP roughly correlate with major differences in health care expenditure. The remaining variation in health expenditure in the EU countries after correction for changes in GDP, can partly be explained by demographic differences, and, in particular, in ageing and population growth. For this to be applicable it is necessary to have insight into the distribution of health expenditure according to age. We will therefore use available data for the Netherlands and several assumptions on the relation of health care costs to age and moment of death to construct age-costs distribution functions for use in extrapolations into the future.

Differences in health expenditure between countries, however, cannot fully be explained by demographic and economic parameters. Other factors that may be taken into account are epidemiological factors, but this is impeded by a lack of quantitative and comparable data. Furthermore, neither the effectiveness of care can be easily considered, nor the organisation of health care.

2. DATA AND METHODS

This section will first introduce various health economic data for European countries with the relevant definitions and then elaborate upon the information and methodology that are necessary to construct age-costs distribution functions and perform demographic extrapolations.

2.1 Data

Economic and health economic data for EU countries (currently 15, see Table 1) have been taken from the 1993 OECD-CREDES database, version # 1.5 (4), a database that has been used by many other authors in this field. It includes economic, health economic and demographic data for the OECD countries for the years 1960 - 1990.

Table 1 Member States of the European Union (1996) with demographic and health economic data for the year 1990 (*source: OECD (4)*)

Abbreviation	*Country*	Inhabitants 1990 (* 1000)	GDP per capita 1990 (PPP $)	Health expenditure per capita 1990 (PPP $)	Health expenditure 1990 (% of GDP)
AUT	Austria	7718	16647	1383	8.3
BEL	Belgium	9993	16281	1242	7.6
DEN	Denmark	5140	16576	1051	6.3
FIN	Finland	4986	16532	1291	7.8
FRA	France	56735	17311	1528	8.8
GER	Germany	63253	18289	1522	8.3
GRE	Greece	10089	7440	400	5.4
IRE	Ireland	3503	10758	748	7.0
ITA	Italy	57647	16012	1296	8.1
LUX	Luxembourg	380	19323	1392	7.2
NET	The Netherlands	14944	15747	1286	8.2
POR	Portugal	9859	8321	554	6.7
SPA	Spain	38959	11738	774	6.6
SWE	Sweden	8559	16874	1455	8.6
UK	United Kingdom	57411	15943	988	6.2

The OECD has obtained most health economic data from national sources, and has made considerable efforts to enhance the comparability of the data over time and between countries. All EU countries are members of the OECD. From this database general economic data are retrieved e.g. for health expenditure, GDP, exchange rates, and general and health expenditure price indices for the European Union countries. Table 1 lists the current 15 members of the EU with a few key health economic data.

From Table 1 it is also clear that there are considerable differences in the EU with regard to GDP and health expenditure. The countries with the lowest GDP per capita, Greece, Portugal, Spain and Ireland, are also the countries with the lowest health expenditure per capita. Health expenditure expressed as share of GDP shows a much smaller range of variations, however. The relationship between national health expenditure and GDP is considered in more detail in Section 3.2.

The United Nations (5) World Population Prospects contain *population data and population-related indicators and prospects* (after 1990) for 5-year classes for all countries of the world for the period 1950-2025. All calculations presented here are based on the medium variant of these prospects (see also Section 4.1). The high and low variant have been used to indicate the sensitivity of the results to changes in the demographic assumptions. Other possible sources for population data are Eurostat (6) and IIASA (7). Reasons for not using the Eurostat data were insufficient knowledge of the extent of these data and possible compatibility problems when work of this type is extended to non-EU countries. IIASA population scenarios were found to be internally inconsistent and hence were not used.

The availability of data restricts the time period that could be considered, mainly to the period 1960-2020. For the period 1960 to 1990 measured health economic and population data were available, and for later years population data were retrieved from the UN prospects.

For the Netherlands *health care costs* for the year 1988 have been estimated by Koopmanschap (8), allocated to age, sex, health care sector, and disease categories (17 ICD chapters). The subdivision of costs into disease categories has not been used in this report (except in Appendix 3).

2.2 Data management

All data storage, calculations and graphics have been carried out using a spreadsheet program (MS EXCEL). For special calculations linear and exponential curve fitting have been used. In order to determine the constants of the cost functions (see 2.3.2) the spreadsheet tool *'Solve'* function has been applied.

2.3 Methods

There are major differences among countries in what is included in health expenditure. In the EU, for example, there are marked differences in the inclusion of institutions for care such as those for the mentally or sensory handicapped, nursing homes and so on. This makes a comparison in absolute numbers unfeasible. Therefore, in many comparisons only trends per country are considered by scaling the data to a base year (1990).

In this analysis some causes of changes in health expenditure are identified first. The empirical fact that health expenditure is largely proportional to GDP allows the use of the ratio health expenditure over GDP as a variable that hardly varies. Influences of demographic effects on this variable are considered next.

Changes in health expenditure ΔHE can be attributed to a number of causes:

- *the changing size and composition of the population*, hereafter referred to as demographic changes (ΔV_{dg}). Several, not mutually exclusive, reasons for the increase in per capita costs with age may be mentioned: first, the observed changes in the prevalence and severity of chronic diseases that occur with age. Older people suffer more frequently from chronic diseases and functional disabilities and therefore need more and also more costly health care. So the total demand for health care increases in ageing populations. Secondly, it may be argued that most of the per capita health care costs are generated in the relatively short period just before death and are relatively independent of the actual age of death. Since older people have higher death rates, their contribution to health care costs will be increased because of the higher costs associated with mortality. The absolute increase in population size is of course a demographic variable that directly increases the total health expenditure of a country;
- *epidemiological changes* (ΔV_E), i.e. increases in the age-specific incidences and/or prevalence of certain diseases, for instance caused by changing prevalence of underlying risk factors and changes in the effects of health care on disease survival;
- *increases in health care volume, independent of ageing and the growth of the population*, and independent of disease prevalence ($\Delta Vaut$). This *autonomous* increase is caused primarily by new technical possibilities (technological pressure) and by growing expectations in the population with regard to medical care (socio-cultural push);
- *changes in the prices of health care commodities* (ΔP), which differ from the price increase of consumer goods. Price changes are not only caused by market effects, but also by more expensive replacements for 'old' diagnostic and therapeutic methods, and by increases in the number of, expensive, specialist personnel involved. The cost effects of these replacements are difficult to estimate, however.

Hence the change in health expenditure, expressed in NCU, is determined by the four factors

$$\Delta HE = \Delta V_{dg} + \Delta V_E + \Delta V_{aut} + \Delta P \ .$$

The external factors (demographic and economic) ΔV_{dg} and ΔP have explicitly been taken into account, without differentiating between these factors for disease categories, however. The factors ΔV_{aut} and ΔV_E , are more difficult to establish and intrinsic to the health care system. These factors were only implicitly taken into account by taking general economic indicators into consideration.

2.3.1 Economic factors and international comparisons

Health expenditure is measured in monetary units, e.g. in National Currency Units (NCU). To compare health expenditure over time price differences must be taken into account, as well as differences in exchange rates and purchasing power and differences in the total population when comparing between countries. Therefore, health expenditure is expressed in a common unit after correction for these differences. Frequently, health expenditure is related to the *Gross Domestic Product (GDP)* which is also commonly expressed as a monetary value in NCU. Since the GDP is simple and frequently available, it is used as the principal indicator for the economy of a country.

First a few definitions will be given that primarily concern GDP but that are also applicable to health expenditure. They are predominantly used in the following chapters to carry out the corrections for the differences mentioned above. Use of *per capita GDP* circumvents undesirable differences caused by differences in population numbers. The *nominal GDP price index* or price index of production goods is calculated by taking the price mix for a base year as equal to 100. Data for this general price index were derived form the OECD data. Correction of GDP for price inflation is performed by dividing GDP by this price index. This means that the *value* of the GDP is transformed into the *volume* of the GDP measured in the NCU of a base year (e.g. 1985, consistent with OECD (4)). The term volume is used since we can now compare volumes over time, expressed in a constant NCU. An equivalent expression for volume of GDP is GDP in *constant prices*.

In order to compare GDP over time and between countries, all quantities have been expressed in *purchasing power parities (PPP)*. In this approach the relative value of two currencies is determined by a long-term equivalence of costs of purchasing an identical basket of goods and services in all countries. Again, the data are derived from the OECD. Differences in price levels between countries are thus erased to a certain extent (4). By the use of this PPP approach, short-term, currency-change-related, variations, that are caused by exchange parity changes can be avoided. PPP have been calculated in an arbitrary currency, as a rule the US dollar. They are 'base country invariant' and transitive (for a more detailed discussion see Gerdtham and Jönsson (9)).

With a few adaptations, the same definitions can be applied to health expenditure. The *price index for health expenditure* is defined in the same way as the general price index, now using the prices of a basket of medical goods and services. The ratio of the health expenditure price index to the GDP price index, the *relative price index for health expenditure*, is an indicator for the variation in the prices of health expenditure as compared to the variation in total production prices.

The volume of health consumption is obtained by dividing health expenditure by its nominal price index. The conversion from expenditure to volume requires a simple calculation, but the determination of the factors is complicated. The calculation of the price of the basket of medical goods and services may give different results for different countries, because of the fact that the contents of the basket of medical goods and services varies considerably between individual countries. Changes in medical practice will also influence the basket of goods and services. If the replacement of some technique by a more expensive one is not taken into account in the price index for health expenditure, the resulting increase in health care expenditure will be attributed to a volume increase in health care.

In order to compare health expenditure between EU countries, all quantities were expressed in purchasing power parities (PPP). The use of PPP to compare health expenditures between countries has been advocated by many authors (9, 10, 11).

2.3.2 Estimating the influence of ageing on health expenditure

When age composition and cost distribution over ages are known, the health expenditure dependency on demography can be calculated. A distribution of health expenditure over age classes must be known or estimated to be able to calculate demographic effects (ΔV_{dg}). Below three different age distribution functions for health care costs are defined. To project age-dependent cost data into the future, demographic developments must also be known and some data and methods related to demographic extrapolation are discussed first.

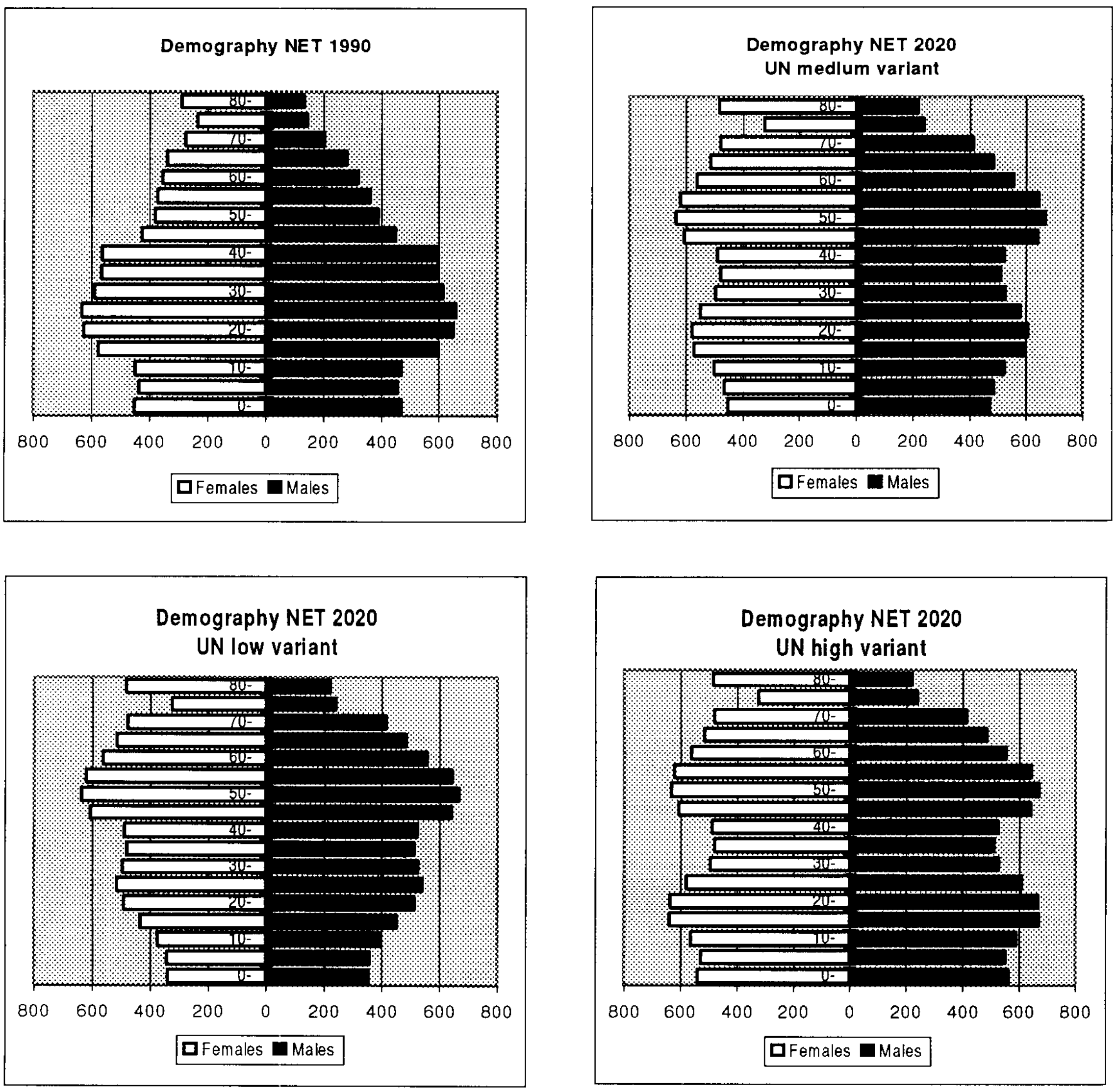

Figure 1 Demography of the Netherlands, 1990 and 2020

2.3.2.1 Demographic developments

The composition of a population can be projected into the future by extrapolating data for birth rates, mortality and migration. Once this future composition is known, the division of health care costs over ages enables calculation of changes in health expenditure caused by demographic changes. To incorporate inherent uncertainties, demographic projections are often given in three variants, called low, medium and high, which differ mainly in estimated birth rates. To illustrate demographic changes that are currently occurring in Western and Northern European countries, we will take the Netherlands as an example.

The composition of the population in 1990 and the three predicted compositions for the year 2020 are shown in Figure 1. The baby boomers of the years between 1945 and 1970 are at a working age in 1990 and will start to fill the age classes of the elderly after 2010. A secondary effect is visible in the medium and high variants, which have assumed a higher number of births from baby boomers in their fertile years. The Dutch demographic structure is a typical example of an unbalanced population, in which the proportion of older people increases because of the past decline in natality. For the age division of a so-called 'stable' population see Figure 2.

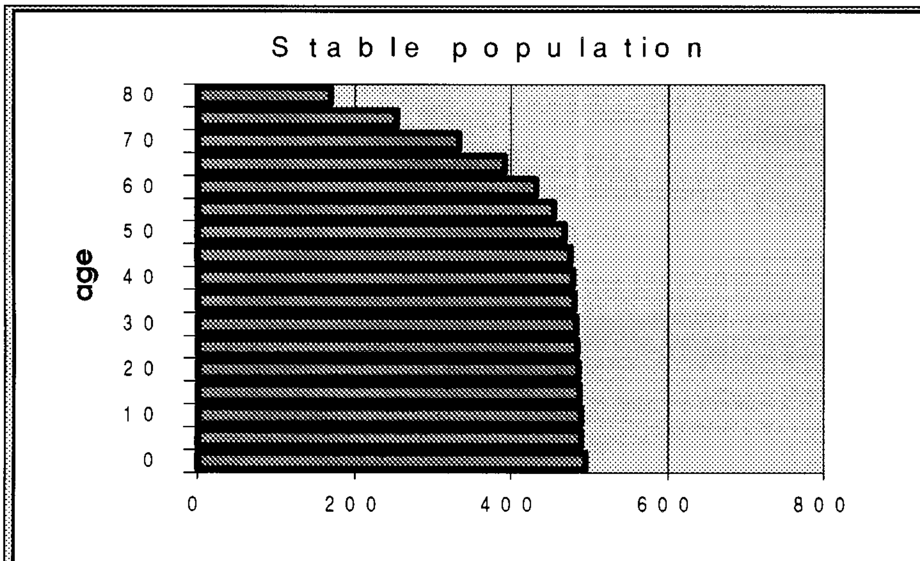

Figure 2 Stable population

For the purpose of comparison we use a model of a population, referred to as "stable population". It has the following characteristics:

- **the occupancy of age groups is constant over time (dynamic equilibrium);**
- **the mortality in each age group[1] follows closely the Standard Death Rate (SDR) for the Netherlands as reported by the WHO (WHO 1993).**

2 The mortality has been calculated from the normal cumulative distribution function to represent the S-shaped mortality in the higher age regions, to which a fixed mortality for all age groups and an extra mortality for age group 0-5 have been added.

Since mortality differences are small in the three variants, the largest differences will obviously be present in the lower age groups. This means that the extent of ageing is almost independent of the variant chosen: in all variants there is a substantial increase in the number of older people in 2020, and even more so in later years. The *percentage* of the elderly, however, does depend on the variant that is chosen.

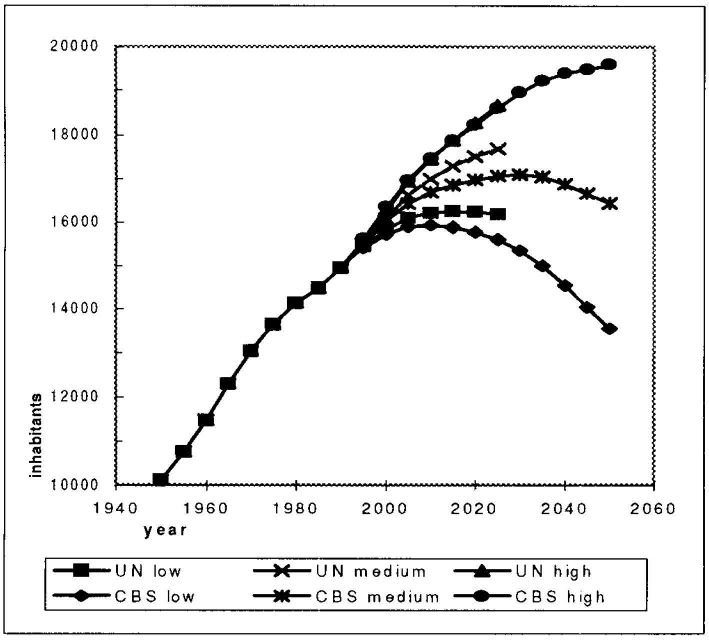

Figure 3 UN and Dutch (CBS) population projections

For estimates of the future populations of all EU countries we have used the medium variant of the United Nations World Population prospects (5). The total population numbers given by the UN for the Netherlands were compared with the low, middle and high scenario of Statistics Netherlands (CBS). Comparison between the UN and CBS prospects shows differences for the medium and low variants, but these differences are smaller than those between the UN variants.

2.3.2.2 Age dependence of health care costs

Koopmanschap (8) has calculated the distribution of total health care expenditure in the Netherlands over various age groups (0-5, 5-10,...,80 and higher), by gender, by disease classes and by selected health care sectors for the year 1988. In the following we have only used the data as they were divided over age classes and gender (4).

From *Figure 4* we note slightly enhanced costs for children up to 5 year, an increase for females between 20 to 35 years, probably related with pregnancy and birth costs and a considerable, faster than linear, rise in costs per head for both men and women over 65 years, which illustrates how ageing affects health care expenditure.

There are, as we mentioned before, two, non-exclusive, explanations for this rise in costs with age. The first one is the increased prevalence of chronic diseases connected with higher ages(13), the second one is that mortality increases with age and it is the period immediately before death that causes high costs(14).

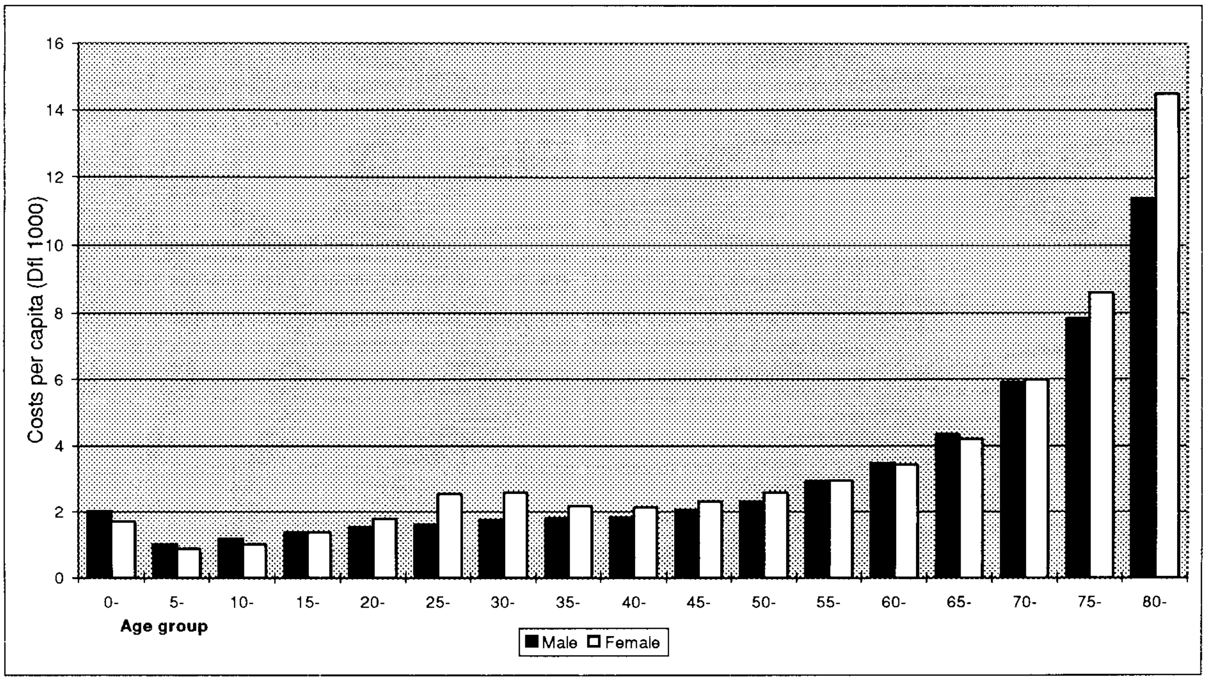

Figure 4 The distribution of per capita health care expenditure in the Netherlands over age and gender for 1988

Health expenditure differences that are caused by changes in the age and sex composition of the population have been extrapolated by establishing cost functions that yield the health costs per person which are dependent on age and sex . Per country health expenditure can then be estimated by multiplying the value of the cost function by the relative or absolute number of people within each age and sex class. Because of intercountry differences in health care costs and/or their attribution, results have been scaled for each country to one base year (1990). Cost functions have been derived by fitting a number of constants in such a way that the 1988 values for the Netherlands are reproduced.

We have estimated the age-costs functions in three different ways:

1. by extrapolating the values for health care expenditure by age and sex (Figure 4) to other years than 1988 and to other countries than the Netherlands. This extrapolation is called the age-dependent cost function, since all of the variation has been attributed to age (and sex). It is elaborated in Section 2.3.2.3.
2. by attributing the health care expenditure of a person as much as possible to the few years before his death. The values for this 'mortality-dependent' cost function have been obtained from crude mortality rates (see: Section 2.3.2.4).
3. as functions A and B are extremes, we have also added a 'mixed' cost function that contains both an age-dependent term as well as a mortality-dependent term (age and mortality-dependent cost function (Section 2.3.2.5).

2.3.2.3 Age-dependent cost function

We assume for this cost function that the *relative* distribution of costs over age groups as determined for the Netherlands for the year 1988 is also valid for

- other countries in the EU,
- other calendar years than the year considered by Koopmanschap, and
- situations in which age-specific mortality rates and life expectancy are changing.

Comparisons by Koopmanschap et al (12) have shown that the distribution of total costs over some major disease categories is comparable for different countries (USA, Sweden, the Netherlands). This is not in contradiction with the first assumption. It is not required, moreover, that the absolute values of the distribution function should be the same at any one time and in any particular country.

The last assumption deals with the possibility that an increase in life expectancy may imply that mainly unhealthy and costly years will be added to life. This has been suggested by the Dutch Public Health Status and Forecast report (13). The increase in the total number of chronically ill patients may therefore additionally increase health care costs in an ageing population.

Under the assumptions made above, it is possible to compare relative differences in health expenditure for two population compositions (over time or over countries) by multiplying the measured or projected percentage of the population in each age and gender class for that year by the average per capita costs for that class (data: the Netherlands, 1988). Division by the total population yields the per capita health costs.

Values obtained in this way have been compared to a base year (1990), giving the relative change of health expenditure per capita caused by changes in the composition of the population. This yields the effects of demographic changes on health care expenditure per capita. The results are given in Section 4.2.

2.3.2.4 Health expenditure in relation to mortality

Analysis of data from a Dutch private health insurance company (14) showed that a considerable proportion of total health care costs are spent by patients in the years directly before their deaths. An average of NLG 6,260 in the year of death against an average of NLG 684 was quoted for all people who did not die in that year. Total health expenditure in a year may therefore be assumed to be mainly determined by the number of people dying in that year. This, in turn, implies, contrary to common sense, that early deaths of chronically ill patients would increase health care costs. For this reason, this second function is only used to give a lower limit of the influence of demographic changes.

To incorporate this assumption a cost function has been constructed that consists of two terms: a fixed amount c_1 per person, independent of age and sex, and a fixed amount c_2 per death. Inclusion of c_1 is necessary to obtain a reasonable estimate for the lower ages. So

$$HE = c_1 + c_2 p_D \, ,$$

where *HE* is the per capita health expenditure in a year as a function of age class, c_1 and c_2 are constants, and p_D is the probability for a person in that age class to die in that year. The constants c_1 and c_2 have been determined by a 'least squares' fit of this function to the distribution curve of *Figure 4* , combined for males and females, and by applying mortality data for the Netherlands (15). This has yielded: c_1 = 1.8, and c_2 = *103* (in NLG*1,000).

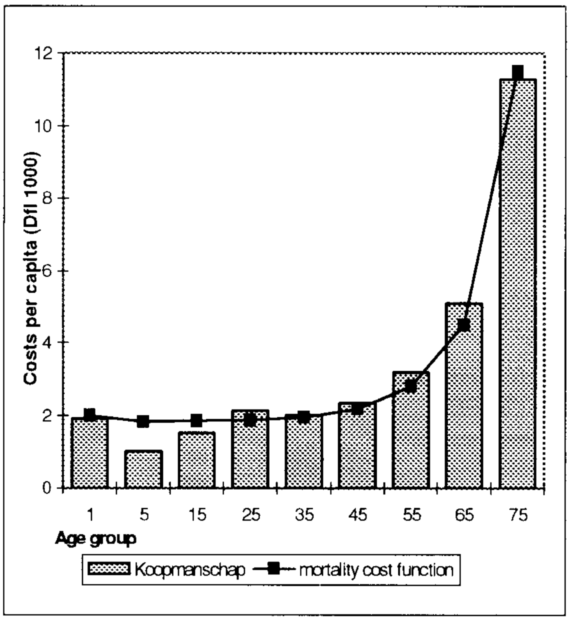

Figure 5 The cost curve according to Dutch data (1988) fitted to a mortality function

Health expenditure in any year and any country can now be calculated with this function into which age-specific mortality rates for that year and that country can be introduced, again under the assumption that other dynamic aspects of the behaviour of health care costs over time and place (countries) remains essentially the same.

It should be noted that in this approach the contribution of the costs that are connected with death make up 70% of the total health care costs that are generated during a person's life. The fact that chronic diseases have not been taken into account becomes visible (Figure 5) as an underestimation of the costs for the age group 45-75, while the mortality of neonates is, obviously, not high enough to explain the relatively high costs connected with birth.

2.3.2.5 Combination of age and mortality dependency

To obtain a function for the case in which both the increasing costs of chronic diseases with age as well as the costs of mortality are incorporated, the procedure used in Section 2.3.2.4 has been repeated to generate a cost function with four parameters, namely a constant, the costs connected with death, the costs connected with birth, and a linear function of age to incorporate the age dependency of chronic diseases:

$$HE = c_1 + c_2 p_D + c_3 p_B + c_4 A,$$

where *HE* is the health expenditure per capita in a year as a function of age class, c_1 to c_4 are constants, p_D is the probability to die in that year, p_B the probability of birth, and A the age.

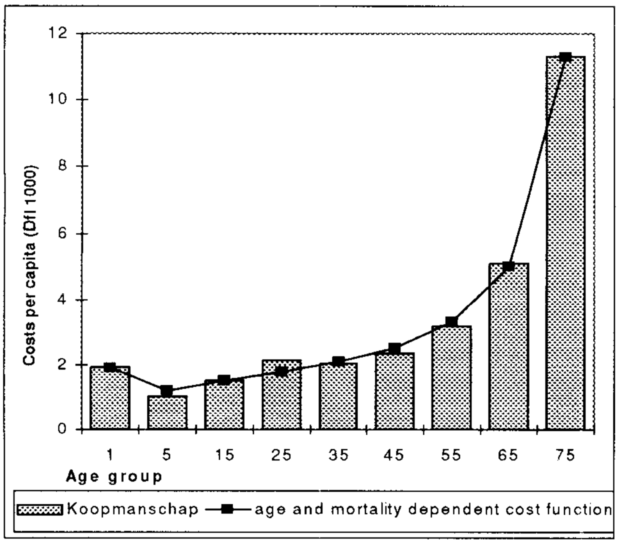

Figure 6 Fitting the cost function to four parameters

The curve of Figure 6 has been obtained with $c_1 = 0.95$, $c_2 = 89.1$, $c_3 = 3.8$, and $c_4 = 0.025$ (NLG*1000). The agreement of the resulting cost function with the original data of Koopmanschap is much better than for the second (mortality dependence) function described in Section 2.3.2.4. The relatively small deviations at 5, 25 and 45 years will probably almost cancel out.

To show the relative importance of the various contributions to health care costs in this third approach, the cost curve of Koopmanschap (*Figure 4*) has been subdivided (Figure 7) into the four elements of the function. The large contribution of costs associated with death is clearly visible. However, calculated for the total Dutch population of 1988 , the age-independent costs (general costs), the age-dependent costs and the costs associated with death are almost equal. They were (in NLG*1,000): age-independent general costs 14,063, death associated costs 11,479, birth-related costs 687, and age-dependent costs 13,250.

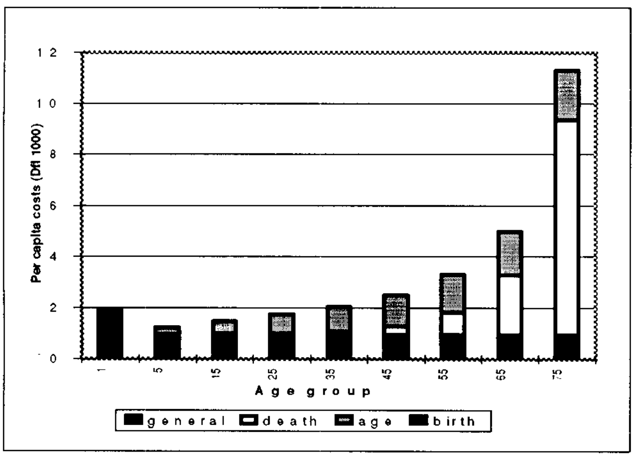

Figure 7 Assignment of cost function to various categories

3. HEALTH EXPENDITURE IN THE EUROPEAN UNION

3.1 Health expenditure

Health expenditure without inflation corrections shows major differences between countries of the EU. In 1990 the **per capita** health expenditure (expressed in US $) was $ 2296 for Sweden, and $ 356 for Greece. Differences over time are even more striking: in 1960 Spain spent $ 6, in 1990 $ 831. Table 2 presents an overview.

Table 2 Historical changes in health expenditure per capita in EU countries, without inflation correction, expressed in US $ exchange rates (data source: OECD, 1993)

	1960	1970	1980	1990
AUT	39	106	802	1699
BEL	42	107	796	1468
DEN	47	195	880	1595
FIN	45	135	698	2156
FRA	56	164	931	1853
GER	62	179	1106	1964
GRE	12	46	180	356
IRE	25	73	515	846
ITA	29	104	551	1537
LUX	N/A	132	851	1654
NET	40	154	962	1526
POR	N/A	23	150	403
SPA	6	41	320	831
SWE	88	299	1416	2296
UK	54	99	551	1059

Many of these differences are due to price differences and exchange parity differences. Therefore these data(4) will be corrected for GDP price differences and for health care price differences and transformed into PPP$. All calculations take 1990 as base year. For detailed data see Appendix 1. The *volume of health expenditure per capita* (volume: after correction for price differences in GDP and health expenditure and corrected for purchasing power differences) is given in Table 3 for the EU countries and for a EU average[2]. All countries show a gradual but varying increase, except Ireland where expenditure peaked in 1980, much smaller than in Table *2*. Growth rates for the various countries are different. This shows that price corrections are not sufficient to completely explain the increase in health expenditure per capita.

Note the fact that the Netherlands moved from first in 1970 to eighth in 1990, while France moved in the opposite direction. Denmark descended from fifth to tenth and Germany from fourth to second.

Table 3 Per capita health expenditure (constant prices) in PPP$ 1990

	1960	1965	1970	1975	1980	1985	1990	1975-1990 increment (%)
AUT	585	632	784	1066	1225	1266	1384	1.8
BEL	284	353	446	751	947	1067	1242	3.4
DEN	289	479	655	729	953	992	1051	2.5
FIN	206	349	583	812	952	1082	1291	3.1
FRA	253	381	523	760	988	1239	1528	4.8
GER	510	659	769	1120	1345	1390	1522	2.1
GRE	59	89	177	222	261	323	400	4.0
IRE	164	220	365	687	878	783	748	0.6
ITA	238	323	506	678	916	1026	1296	4.4
LUX	N/A	N/A	549	753	1058	1193	1392	4.2
NET	503	665	985	1049	1135	1183	1286	1.4
POR	N/A	N/A	170	N/A	365	423	554	3.0*
SPA	66	164	267	414	512	501	774	4.3
SWE	399	623	939	1085	1268	1354	1455	2.0
UK	322	253	506	726	817	898	989	2.1
EU	N/A	N/A	552	N/A	936	1027	1214	3.0*

* calculated for 1977-1990

[2] The EU average for a variable has been determined by calculating a weighted average of this variable for the 15 countries of the EU. As weighting factors the proportions of the population of the countries in the year under consideration have been applied.

3.2 Relationship between Gross Domestic Product and health expenditure

The ratio of health expenditure to GDP corrected for inflation specifies the proportion of domestic product spent on health care (Table 4). Usually, this ratio is calculated with the same units for health expenditure and GDP (4), so relative price differences are not taken into account. In this study we want to approximate the *volume* of health care consumption as closely as possible. Therefore, we have also corrected the data with the relative price index for health care (Table 17). This implies that the ratio depends on the base year chosen.

Table 4 Volume of health expenditure as a proportion of GDP (base year 1990)

	1960	1965	1970	1975	1980	1985	1990	1975-1990 increment (%)
AUT	9.0	8.2	8.1	9.2	8.9	8.6	8.3	-0.6
BEL	4.3	4.3	4.4	6.4	7.0	7.5	7.6	1.3
DEN	3.7	4.9	5.8	6.0	7.0	6.4	6.3	0.4
FIN	3.4	4.7	6.3	7.3	7.5	7.6	7.8	0.4
FRA	3.5	4.2	4.6	6.0	6.8	8.1	8.8	2.7
GER	6.1	6.6	6.5	8.7	8.8	8.6	8.3	-0.2
GRE	2.5	2.6	3.8	3.9	3.9	4.6	5.4	2.3
IRE	4.2	4.8	6.5	10.4	11.4	9.3	7.0	-2.5
ITA	4.1	4.4	5.3	6.4	7.0	7.4	8.1	1.6
LUX	N/A	N/A	4.5	5.7	7.2	7.3	7.2	1.7
NET	6.5	7.3	8.9	8.4	8.3	8.4	8.2	-0.2
POR	N/A	N/A	3.6	N/A	5.7	6.2	6.7	0.5*
SPA	1.7	2.9	3.7	4.7	5.6	5.2	6.6	2.4
SWE	4.8	6.0	7.7	8.0	8.9	8.7	8.6	0.5
UK	3.8	2.7	4.8	6.3	6.5	6.5	6.2	-0.1
EU	N/A	N/A	5.4	N/A	7.1	7.3	7.6	0.9*

* calculated for 1977-1990

The changes in health expenditure as a proportion of GDP are small over years and over countries, especially for the years after 1975. Poullier (1) showed the same effect, plotting the health expenditure versus the total domestic expenditure per capita. Not only are variations over time rather small after 1975, countries with a relatively low ratio such as Greece and Spain are increasing faster than other countries, which reduces the differences between all the countries. Data are too scarce to decide whether the ratios are converging.

In fact the empirical association between health expenditure and GDP has been shown by several authors who studied this relationship with linear regression techniques. A number of authors (for instance Abel-Smith (16), Kleiman (17), Newhouse (18)), used a cross-sectional analysis over various countries and have shown that income to a large extent explains the health expenditure of a country. Later analyses (such as Leu (19), Gerdtham et al.(20)) have introduced more parameters to explain the differences between countries, such as differences in funding of health care and in the composition of the population but then again GDP explains the largest part of the observed variations.

However, f or specific years there are important deviations from this empirical relationship between income and health expenditure that preclude the use of this relationship for predictions. A good example can be seen in the data for Germany (Figure 8). Before 1989 data for the BRD and the DDR are combined. Around 1980 economic growth stagnated (GDP remained constant), whereas health expenditure continued to increase for two years. This delay in health expenditure related to GDP can also be observed in other EU countries. Therefore, Getzen (21) states that health expenditure follows changes in GDP with a delay, although even does not explain all of the variation quantitatively. The dip in health expenditure in 1989 could not be observed in other EU countries, except Finland.

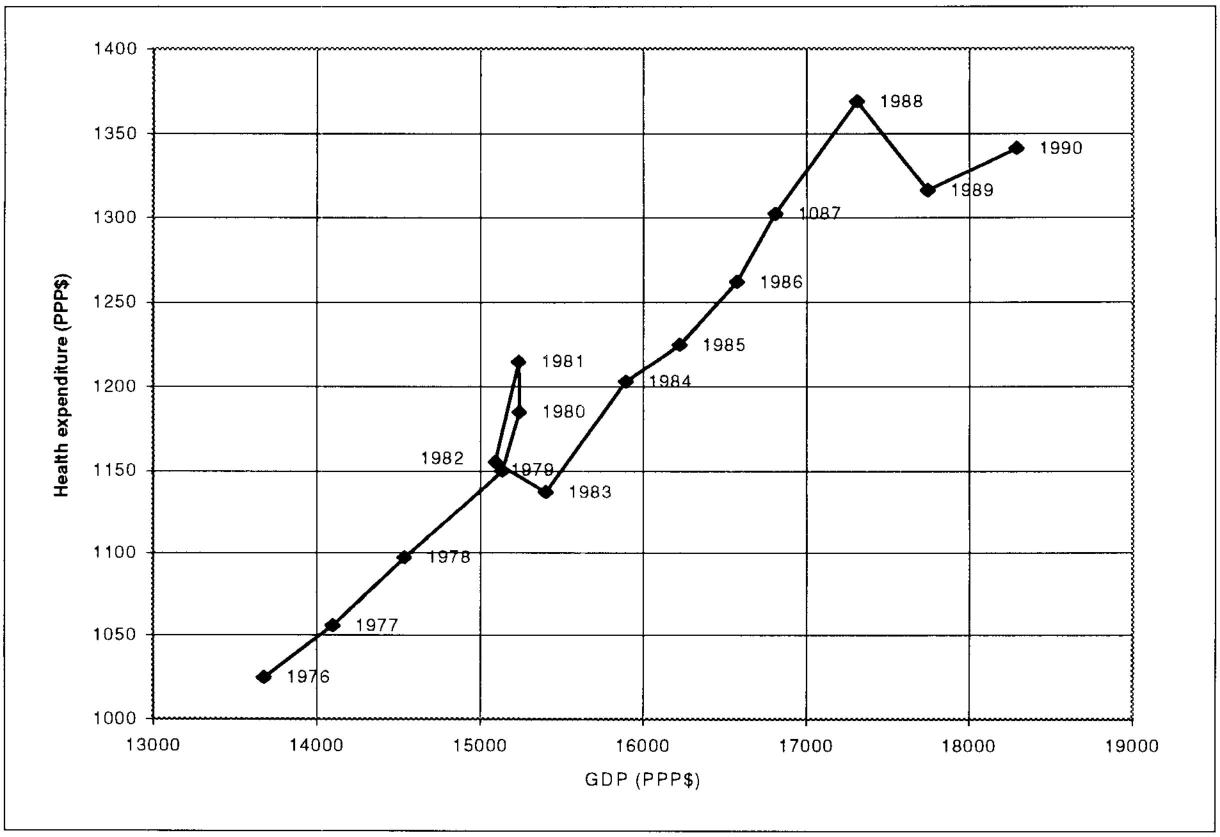

Figure 8 Health expenditure versus GDP for Germany

In Figure 9 the data from Table 4 are plotted over the years 1975-1990. Years before 1975 are not considered since the health expenditure data of many countries show a discontinuity in 1975, perhaps caused by a change in definitions. In Figure 9 we observe a more or less stable volume of health expenditure as a proportion of GDP for most of the EU countries. Exceptions are an increase for France, Greece, Italy, Portugal, and Spain, but a major decrease for Ireland, which had very high health expenditure in the 1970s. The average percentage for the European Union increased by 0.07 per year (1975-1990), mainly determined by the growth in France and Italy, countries that make a large contribution to the European average.

The less or more stable level of health expenditure as a proportion of GDP differs from country to country. There is no simple explanation for these inter-country differences. The differences between the curves of the various countries are not clear. EU countries with a lower GDP such as Greece, Spain and Portugal show an increase in health expenditure expressed as a proportion of GDP as if they are catching up with the other EU countries, but also countries with a relatively large GDP (such as Italy, France) show a marked increase. Neither the value of health expenditure itself, nor the increase in GDP, provides an indication for increase or decrease.

It may be concluded that health expenditure is not growing considerably in most EU countries, provided it is calculated per capita as a percentage of GDP including price corrections for health expenditure.

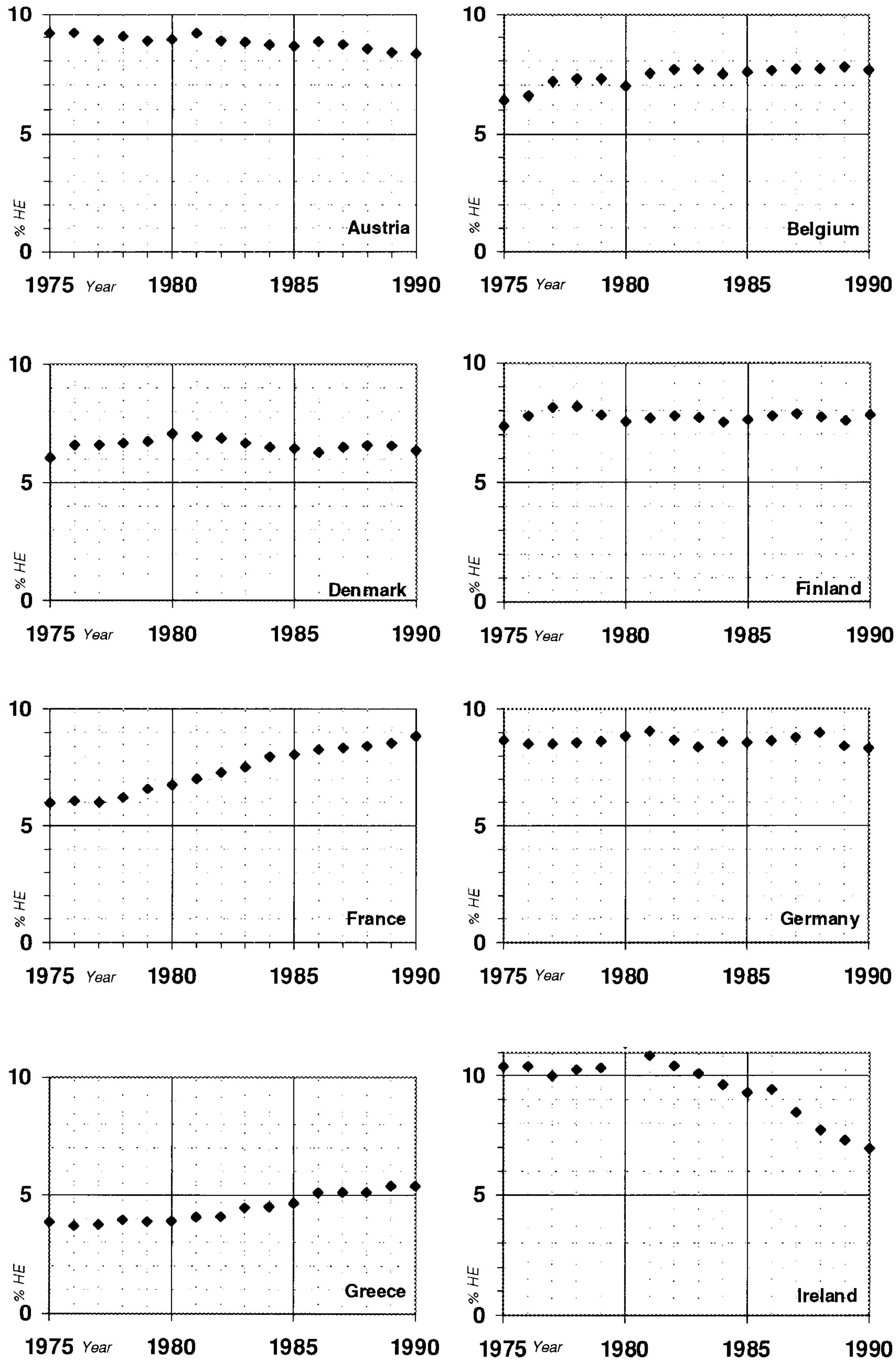

Figure 9 Health expenditure as a proportion of GDP in countries of the EU (part 1)

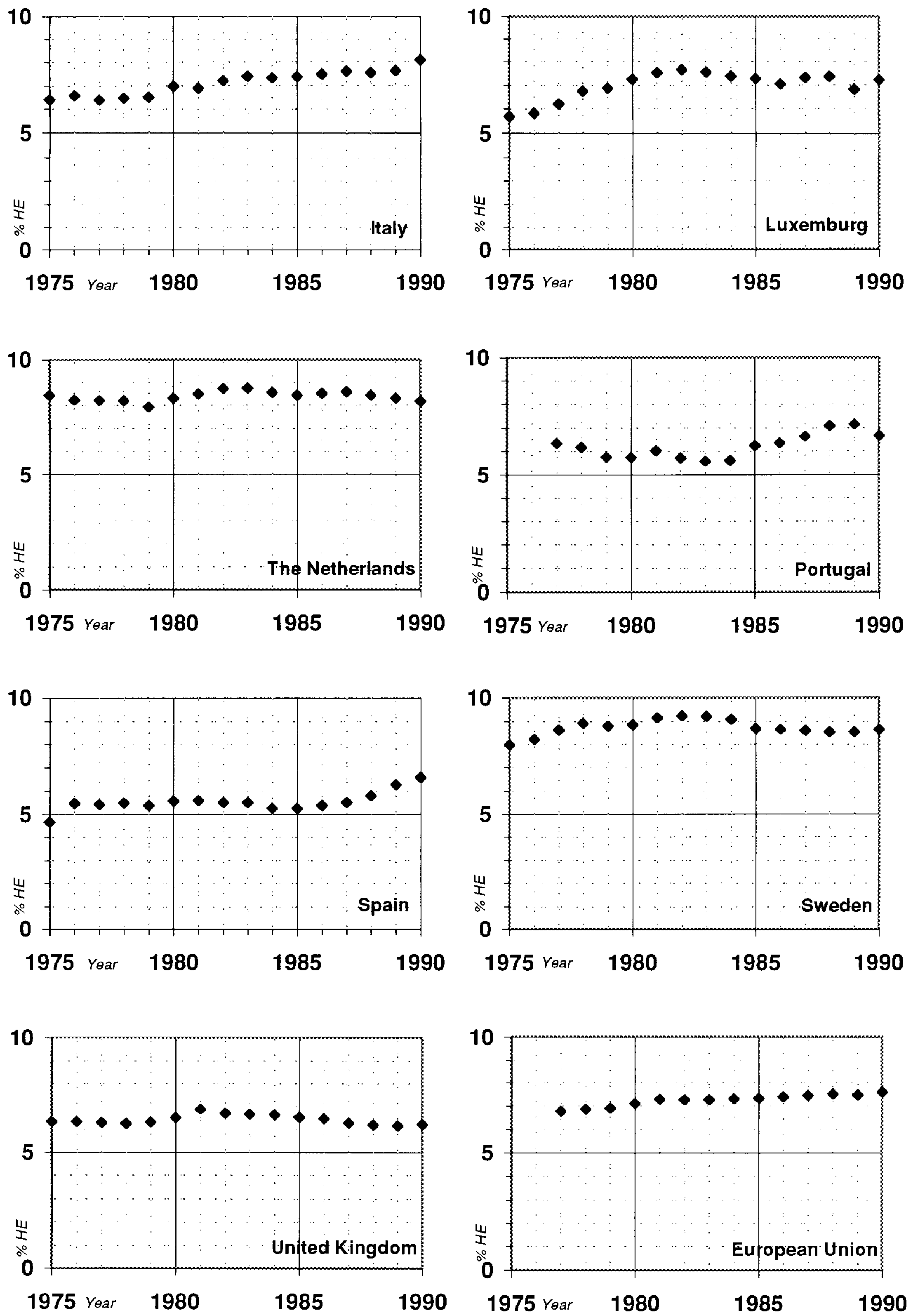

Figure 9 Health expenditure as a proportion of GDP in countries of the EU (part 2)

4. HEALTH EXPENDITURE AND DEMOGRAPHY IN THE EUROPEAN UNION

In the previous chapter per capita.health expenditure as a proportion of GDP was shown to be scarcely increasing over time. In this chapter the influence of demographic changes on the remaining variability will be considered and the influence of demographic changes on health expenditure will be examined.

4.1 Demographic changes

From the age-dependent cost distribution, given in Section 2.3.2.2, the importance of ageing for health expenditure is obvious. Therefore, the demographic changes in the EU countries will be examined first. The composition characteristics of a population can be indicated by the percentages of people younger than 20 years (*Y*), of people (*W*) of working age (20 - 64 years), and of people 65 years or older (*O*).

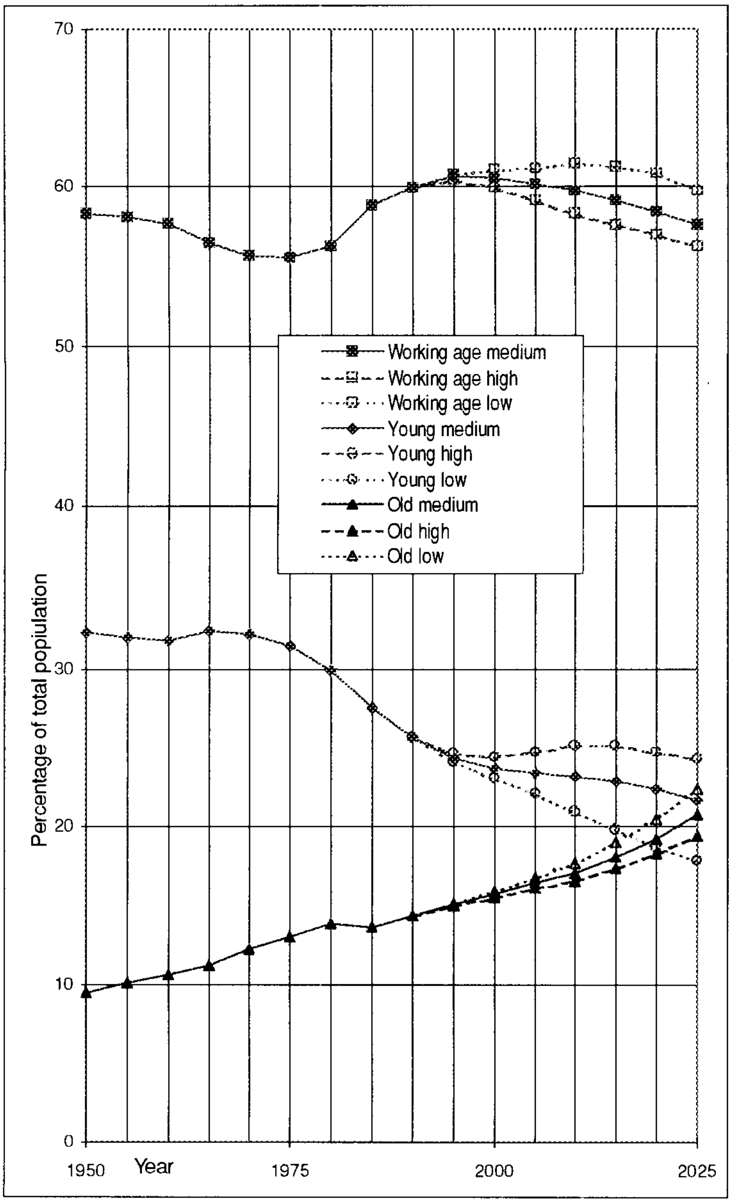

Figure 10 Population dynamics in the EU.

To a large extent *O* determines the total health expenditure of a country. For almost all EU countries (Ireland being the exception) *Y* is decreasing fast, whereas *O* is still increasing, caused by population increases in the past. For the 'stable population' (see Figure 2) with a life expectancy of 76 years, *Y* will be 26%, *W* will be 57% and *O* will be 17%. For the average EU population the development over time of *Y*, *W* and *O* is given in Figure 10, for the three UN variants. Again the variation between variants is small for old people (see also Section 2.3.2.1).

It is clear from Table 5, which gives the percentage of people older than 64 years, that the populations are ageing in all EU countries except Ireland. Countries with a relatively young population (in the years up to 1990) are Finland, Greece, Ireland, Portugal, Spain, and the Netherlands. Sweden and the United Kingdom have an almost constant percentage of older people in the years around 1990.

Table 5 Percentage of people of 65 and older in the countries of the EU

	1960	1970	1980	1990	*2000*	*2010*	*2020*
AUT	**12**	**14**	**15**	**15**	*16*	*17*	*19*
BEL	**12**	**13**	14	**15**	*16*	*17*	***20***
DEN	11	12	14	**16**	*15*	*17*	***21***
FIN	7	9	12	13	*15*	*16*	***21***
FRA	**12**	**13**	14	14	*16*	*16*	***20***
GER	**12**	**14**	**16**	**15**	*15*	***18***	*19*
GRE	8	11	13	14	***17***	***19***	***21***
IRE	11	11	11	11	*12*	*13*	*16*
ITA	9	11	13	14	***17***	***19***	***21***
LUX	11	12	13	13	*15*	*16*	*19*
NET	9	10	12	13	*13*	*14*	*18*
POR	8	9	10	13	*15*	*16*	*17*
SPA	8	10	11	13	*16*	*17*	*18*
SWE	**12**	**14**	**16**	**18**	***17***	*17*	***20***
UK	**12**	**13**	**15**	**16**	*15*	*16*	*18*
EU	11	12	14	14	*16*	*17*	*19*

Legend: **bold** above EU average for that that year; *italic* projected values

To compare age distributions between countries, we use the ratio (O/Y) of the population older than 64 years to the population younger than 20 years. This ratio gives an indication of the composition of a population. It is smaller than 0.65 for young populations (such as Ireland). These ratios, computed from population data and prospects for the period 1960 to 2020, are given in Table 6. The ratio of the O/Y ratio for 2020 and 1990 is given as an indicator for the relative ageing rate. Arranging the countries of the European Union by decreasing ratios, we find the sequence Sweden, United Kingdom, Austria, Germany, Belgium, Denmark, Luxembourg, the Netherlands, Portugal, France, Spain, Finland, Italy, Ireland, Greece. It is expected that ageing will be even more pronounced in the years after 2020, although inherent increasing uncertainties prohibit a reliable numerical indication.

From Table 6 the following conclusions can be drawn:

- All EU countries are ageing, but in Ireland there is a considerable delay;
- The main effects of ageing for all countries become apparent in 2010 and later;
- The onset and rate of the ageing process differ for the various countries. Countries such as Austria, Belgium, Germany, Sweden and the United Kingdom started the ageing process earlier than countries such as Finland, Greece, the Netherlands, Spain and Portugal;
- Sweden and the United Kingdom have the lowest current ageing rates in the EU.

Table 6 The ratio of older (≥65) to younger (<20) segments of EU populations

	1960	1970	1980	1990	2000	2010	2020	2020/ 1990
AUT	**0.40**	**0.45**	**0.53**	**0.63**	***0.67***	***0.76***	***0.87***	*1.39*
BEL	**0.41**	**0.43**	**0.51**	**0.60**	***0.69***	*0.72*	***0.89***	*1.48*
DEN	0.32	**0.40**	**0.51**	**0.64**	*0.65*	*0.70*	***0.95***	*1.48*
FIN	0.19	0.27	0.42	0.52	*0.58*	*0.65*	***0.90***	*1.72*
FRA	**0.36**	**0.39**	**0.46**	0.50	*0.60*	*0.65*	*0.85*	*1.69*
GER	**0.40**	**0.46**	**0.58**	**0.64**	***0.68***	***0.84***	***0.90***	*1.40*
GRE	0.24	0.34	0.43	0.52	***0.78***	***0.91***	***0.97***	*1.86*
IRE	0.28	0.28	0.27	0.31	*0.38*	*0.45*	*0.56*	*1.83*
ITA	0.29	0.34	0.43	0.56	***0.83***	***0.89***	***1.00***	*1.77*
LUX	**0.39**	**0.41**	**0.50**	0.56	*0.62*	*0.70*	*0.89*	*1.58*
NET	0.24	0.28	0.37	0.48	*0.53*	*0.55*	*0.78*	*1.60*
POR	0.21	0.25	0.30	0.45	*0.63*	*0.68*	*0.75*	*1.66*
SPA	0.23	0.27	0.30	0.48	***0.71***	***0.73***	*0.81*	*1.69*
SWE	**0.40**	**0.49**	**0.62**	**0.73**	*0.65*	*0.66*	*0.84*	*1.16*
UK	**0.39**	**0.41**	**0.52**	**0.60**	*0.59*	*0.62*	*0.78*	*1.28*
EU	0.33	0.38	0.46	0.56	*0.66*	*0.73*	*0.86*	*1.54*

Legend:		
	0.65	value higher than for a stabile population (0.65)
	bold	above EU average for that year
	italic	projected values

4.2 Demographic effects on health expenditure

The effects of demographic changes on per capita health expenditure were calculated using the cost functions that have been defined in Section 2.3.2.

For age-dependent per capita health expenditure the results are given in Table 7 for the countries in the EU for the period 1960-2020. Some countries in which there has been a large increase over time are: Finland, Greece, Italy and Spain, whereas the increases for Sweden and the United Kingdom are below average. This can be explained by the data shown in Table 6. The total growth in per capita health expenditure caused by changes in the composition of the population remains restricted to a maximum of 120% of the value in 1990 (Greece). The annual increment percentage calculated over the period 1960-2020 ranges between 0.24% (Ireland) and 0.62% (Greece). The yearly increments are almost the same for most countries for the periods 1960-1990 and 1990-2020, except for Ireland and Sweden. These data show that ageing in Sweden started earliest of all EU countries, whereas ageing effects in Ireland are only discernible after 1990.

Table 7 Demographic effects on health expenditure per capita: age-dependent cost function

	1960	1970	1980	1990 [1.00]	2000	2010	2020	1960-1990 Yearly increment (%)	1990-2020 Yearly increment (%)
AUT	0.90	0.92	0.96	1.00	1.01	1.05	1.10	0.4	0.3
BEL	0.90	0.92	0.95	1.00	1.02	1.07	1.12	0.3	0.4
DEN	0.85	0.89	0.95	1.00	1.02	1.04	1.12	0.5	0.4
FIN	0.81	0.86	0.94	1.00	1.04	1.09	1.16	0.7	0.5
FRA	0.91	0.92	0.97	1.00	1.03	1.08	1.13	0.3	0.4
GER	0.89	0.91	0.97	1.00	1.01	1.06	1.12	0.4	0.4
GRE	0.84	0.91	0.95	1.00	1.07	1.15	1.21	0.6	0.6
IRE	1.00	0.99	0.97	1.00	1.05	1.10	1.15	0.0	0.5
ITA	0.86	0.90	0.94	1.00	1.07	1.14	1.20	0.5	0.6
LUX	0.91	0.92	0.95	1.00	1.01	1.06	1.11	0.3	0.4
NET	0.87	0.90	0.95	1.00	1.03	1.07	1.14	0.5	0.4
POR	0.86	0.88	0.91	1.00	1.06	1.11	1.15	0.5	0.5
SPA	0.85	0.88	0.91	1.00	1.07	1.12	1.17	0.5	0.5
SWE	0.85	0.89	0.95	1.00	1.01	1.01	1.06	0.5	0.2
UK	0.89	0.91	0.96	1.00	1.01	1.02	1.07	0.4	0.2
EU	0.88	0.91	0.95	1.00	1.03	1.08	1.13	0.4	0.4

Table 8 gives the percentages of total health expenditure that is spent by older people according to this model. An increase is expected for all countries in future years, with an average increase of 20% from 1990 to 2020. This increase is caused by the increase in the percentage and by the mean age of people in the group O. At least for the medium and low variant the increase in population numbers in the group O is associated with a depletion of the younger group. Ireland and the Netherlands were in 1990 the two 'least aged' countries.

Table 8 Percentages of total health care expenditure in EU countries spent by people above 65 years of age.

	1960	1970	1980	1990	2000	2010	2020
AUT	32	37	41	41	42	44	47
BEL	32	36	39	40	43	44	48
DEN	30	34	39	42	42	44	49
FIN	22	26	33	37	39	41	49
FRA	33	36	40	40	42	44	48
GER	31	36	41	40	41	46	48
GRE	25	31	36	38	43	48	51
IRE	33	33	32	34	35	36	42
ITA	27	31	36	38	43	47	51
LUX	30	32	36	37	39	42	45
NET	27	30	34	36	38	40	45
POR	24	27	30	37	40	42	45
SPA	24	29	31	37	42	44	47
SWE	33	36	42	46	45	46	50
UK	32	35	40	42	42	43	46
EU	30	34	38	40	42	44	48

To obtain comparable results with the mortality cost function, we have used country and year-specific death rates obtained from the UN population data. The resulting changes in health expenditure are shown in Table 9. The rather strong ageing effect has decreased considerably. For some countries an absolute decrease can be observed in the period 1960-1990. This is due to the fact that the mortality-dependent cost function is a linear function of the (non-standardised) death rate. There is an increasing effect on this death rate when the population ages, but a decreasing effect when health determinants improve mortality rates. The decreasing effect is the stronger one for countries such as Austria, Belgium, France, Ireland, and Luxembourg.

Similar to the results in Table 7 Finland, Greece, Italy, the Netherlands, and Spain show a much larger increase over time, whereas the increases for Sweden and the United Kingdom are less than average.

Table 9 Demographic effects on per capita health expenditure; mortality-dependent cost function

	1960	1970	1980	1990	2000	2010	2020	1960-1990 Yearly increment (%)	1960-2020 Yearly increment (%)
AUT	1.04	1.05	1.03	1.00	0.99	0.99	1.02	-0.1	0.1
BEL	1.03	1.03	1.00	1.00	1.00	1.01	1.02	-0.1	0.1
DEN	0.93	0.95	0.98	1.00	0.98	0.98	1.03	0.2	0.1
FIN	0.97	0.97	0.97	1.00	1.01	1.02	1.06	0.1	0.2
FRA	1.05	1.03	1.01	1.00	1.00	1.02	1.03	-0.2	0.1
GER	1.01	1.03	1.02	1.00	0.98	1.00	1.03	0.0	0.1
GRE	0.93	0.96	0.97	1.00	1.02	1.07	1.08	0.3	0.3
IRE	1.10	1.07	1.01	1.00	1.00	1.00	1.03	-0.3	0.1
ITA	0.99	0.99	0.98	1.00	1.03	1.06	1.09	0.0	0.3
LUX	1.04	1.05	1.02	1.00	0.98	1.00	1.03	-0.1	0.1
NET	0.96	0.98	0.98	1.00	1.00	1.02	1.05	0.1	0.2
POR	1.02	1.01	0.98	1.00	1.01	1.02	1.03	-0.1	0.1
SPA	0.99	0.97	0.94	1.00	1.03	1.04	1.06	0.1	0.2
SWE	0.95	0.96	0.98	1.00	0.98	0.96	0.99	0.2	0.0
UK	1.01	1.01	1.01	1.00	0.98	0.97	0.98	0.0	-0.1
EU	1.01	1.01	1.00	1.00	1.00	1.01	1.04	0.0	0.0

In the third cost function, both the increasing costs of chronic diseases and the costs of mortality are included. The results, given in Table 10, lie between the results obtained with the age-dependent cost function and those derived with the mortality-dependent cost function, as could be expected. Again, Greece and Italy's health expenditures have the largest predicted growth caused by ageing, followed by Finland and the Netherlands, whereas in the United Kingdom and Sweden, where the ageing process had started much earlier, the costs per capita as determined by demography will remain almost constant over the time period considered.

Table 10 Demographic effects on per capita health expenditure: age and mortality-dependent cost function

	1960	1970	1980	1990	2000	2010	2020	1960-1990 Yearly increment (%)	1960-2020 Yearly increment (%)
AUT	1.04	1.04	1.03	1.00	1.00	1.01	1.05	-0.1	0.2
BEL	1.02	1.02	1.00	1.00	1.01	1.02	1.05	-0.1	0.1
DEN	0.92	0.94	0.97	1.00	0.99	1.00	1.05	0.3	0.2
FIN	0.93	0.95	0.96	1.00	1.02	1.04	1.08	0.3	0.3
FRA	1.04	1.02	1.01	1.00	1.02	1.04	1.06	-0.1	0.2
GER	1.01	1.02	1.02	1.00	0.99	1.02	1.05	0.0	0.2
GRE	0.89	0.94	0.96	1.00	1.04	1.09	1.10	0.4	0.3
IRE	1.10	1.06	1.00	1.00	1.02	1.03	1.07	-0.3	0.2
ITA	0.96	0.97	0.97	1.00	1.04	1.08	1.11	0.1	0.3
LUX	1.03	1.04	1.02	1.00	0.99	1.02	1.05	-0.1	0.2
NET	0.93	0.96	0.97	1.00	1.01	1.03	1.08	0.2	0.3
POR	0.99	0.98	0.96	1.00	1.03	1.04	1.06	0.0	0.2
SPA	0.96	0.94	0.93	1.00	1.04	1.06	1.09	0.2	0.3
SWE	0.95	0.96	0.98	1.00	0.98	0.96	1.00	0.2	0.0
UK	1.01	1.00	1.01	1.00	0.98	0.98	1.01	0.0	0.0
EU	1.00	1.00	0.99	1.00	1.01	1.03	1.06	0.0	0.2

4.3 Correcting health expenditure for population changes

It is not only the age composition of a population that changes over time, but also the total population number, an effect that was not yet included in the per capita estimates in the earlier tables. In Table 11 the combined effects of ageing and population growth are shown as estimated by using the combined age and mortality-dependent cost function. There are two major differences between Table 11 and Table 10. For all countries the combination of ageing and population growth results in enhanced effects on the future development of health expenditure, which is now increasing for all countries. Countries with the largest increases here are the Netherlands and Luxembourg.

Table 11 Influences on total health expenditure by estimated population composition and population increase for the age and mortality-dependent cost function (1990 = 1.00).

	1960	1970	1980	1990	2000	2010	2020	2020*	1960-1990 Yearly increment (%)	1990-2020 Yearly increment (%)
AUT	0.95	1.01	1.00	1.00	1.04	1.07	1.12	1.05	0.2	0.4
BEL	0.94	0.99	0.99	1.00	1.02	1.04	1.05	1.05	0.2	0.2
DEN	0.82	0.90	0.97	1.00	1.01	1.03	1.06	1.05	0.7	0.2
FIN	0.82	0.88	0.92	1.00	1.04	1.08	1.13	1.08	0.7	0.4
FRA	0.84	0.91	0.96	1.00	1.05	1.10	1.14	1.06	0.6	0.4
GER	0.92	1.00	1.00	1.00	1.03	1.08	1.11	1.05	0.3	0.4
GRE	0.73	0.81	0.92	1.00	1.06	1.11	1.11	1.10	1.1	0.3
IRE	0.89	0.89	0.97	1.00	1.00	1.03	1.10	1.07	0.4	0.3
ITA	0.84	0.90	0.95	1.00	1.05	1.09	1.10	1.11	0.6	0.3
LUX	0.87	0.95	0.99	1.00	1.06	1.14	1.20	1.05	0.5	0.6
NET	0.72	0.84	0.92	1.00	1.09	1.18	1.27	1.08	1.2	0.8
POR	0.88	0.90	0.95	1.00	1.04	1.06	1.09	1.06	0.4	0.3
SPA	0.75	0.82	0.89	1.00	1.06	1.11	1.14	1.09	1.0	0.4
SWE	0.83	0.90	0.95	1.00	1.03	1.04	1.10	1.00	0.7	0.3
UK	0.92	0.97	0.99	1.00	1.01	1.02	1.06	1.01	0.3	0.2
EU	0.86	0.93	0.96	1.00	1.04	1.08	1.11	1.06	0.5	0.3

* for comparison the last column of *Table 10* is repeated, i.e. demographic changes caused by composition changes only

The corrections for changes in the composition of the population shown in Table 7, Table 9, and Table 10 cannot fully explain the observed changes in absolute or per capita health expenditure from the past. The effects are much smaller than the changes in health expenditure that are associated with changes in GDP. To give an impression of the influence of demographic effects on the values for health expenditure as a proportion of GDP, we applied a retrospective correction for demographic changes, for countries for which data were available. (Table 12). The correction is performed for the year 1960 (i.e. the year that shows the largest effect since we calculated the effects of demographic changes on health expenditure relative to 1990). The 1960 factors that describe the demographic changes as quoted in Table 7, Table 9, and Table 10 have been divided by the data from Table 4. Only the age-dependent cost function shows a notable change (for most countries between 10 and 20% over the 30-year period), the effects of the mortality-dependent cost function are on average negligible (less than 5%), and the age and mortality-dependent cost function yields small corrections. The demographic corrections in Table 12 are much too small to explain the changes over time in the data of Table 4, e.g. for the difference between 1960 and 1990.

Table 12 Health expenditure per capita as a proportion of GDP (1960), with and without retrospective corrections for demographic changes

	1960				1990
	no correction	correction			base year
		age-dependent	mortality-dependent	age and mortality-dependent	
AUT	9.0	10.0	8.6	8.6	8.3
BEL	4.3	4.8	4.2	4.2	7.6
DEN	3.7	4.3	3.9	4.0	6.3
FIN	3.4	4.2	3.5	3.7	7.8
FRA	3.5	3.8	3.3	3.3	8.8
GER	6.1	6.9	6.0	6.0	8.3
GRE	2.5	3.0	2.7	2.8	5.4
IRE	4.2	4.2	3.8	3.9	7.0
ITA	4.1	4.8	4.1	4.2	8.1
NET	6.5	7.5	6.8	7.0	8.2
SPA	1.7	2.0	1.7	1.8	6.6
SWE	4.8	5.6	5.0	5.1	8.6
UK	3.8	4.3	3.8	3.8	6.2

Although the corrections in Table 12 are small, the age-dependent corrections reduce the observed unexplained increase in health expenditure as a percentage of GDP in the diagrams of Figure 9. If we apply the demographic corrections to the average values for the EU countries, however, (see: Table 13), the magnitude of the effects of the age-dependent cost function on the EU average is almost the same as the observed increase in health expenditure as a proportion of GDP between 1975 and 1990. However, it does not follow logically that the increase in health expenditure (as a proportion of GDP) for the EU, which remains after the calculations in Chapter 3, might to a large extent be explained by demographic changes, since the individual countries that compose the average show a rather variable behaviour in this respect.

Table 13 Health expenditure as a proportion of GDP (average for the European Union) after corrections for demographic effects

	no correction	age-dependent	mortality-dependent	age and mortality-dependent
1980	7.27	7.65	7.23	7.35
1985	7.50	7.68	7.51	7.57
1990	7.74	7.74	7.74	7.74

4.4 Influence of various variants of population prospects

The results for future years shown in the above sections have been obtained with the medium variant of the UN prospects. To investigate the sensitivity of the results for different population prospects, calculations have been repeated with the low and high variants and the age-dependent cost function. Although the numbers of old people are not very different in the various variants, the total populations are different and hence the per capita results. The changes in total health expenditure, i.e. for the total population, are hardly affected, however, by the choice of the variant. The results for the Netherlands are shown in Table 14.

Table 14 Comparison of the low, medium and high variant of population prospects on age-dependent health expenditure (total and per capita) for the Netherlands (1990 = 1.00)

	health expenditure per capita			health expenditure total		
Year	Low	Medium	High	Low	Medium	High
1990	1.00	1.00	1.00	1.00	1.00	1.00
2000	1.04	1.03	1.03	1.10	1.11	1.12
2010	1.09	1.07	1.05	1.19	1.21	1.23
2020	1.19	1.14	1.11	1.29	1.33	1.36

4.5 Extrapolating beyond 2020

People born in 1955 will reach the age of 65 in 2020. This means that most people born during the post war 'baby boom' will in 2020 not yet be at the age to substantially contribute to health expenditure. The validity of an extrapolation after 2020 is disputable, but it does seem valid to consider the demographic developments for higher age classes as they are hardly affected by changes in birth rate and immigration over this period. Doing so, it is possible to give an initial indication of the ageing effects after 2020. This extrapolation of the UN data has been carried out for the Netherlands, which shows relatively large demographic changes. The number of old people increases considerably, but around 2050 the number of old people as well as the total population shall stabilise.

It should again be noted that only ageing effects are given - other possible effects have not been taken into account. The effects of ageing on health expenditure beyond 2020, calculated with the age-dependent cost function, are shown in Table 15. Per capita health expenditure in the Netherlands will increase in 2050 with respect to 1990 by 37% due to ageing effects. The largest contribution is health care for older people, requiring 57% of total health expenditure in 2050. Since, according to this extrapolation, the total population remains almost constant in the period between 2020 and 2050 no other demographic effects need be expected. The calculation for the other cost functions, which use mortality data, has not been given, since an extrapolation of mortality data is much more uncertain than an extrapolation of population numbers. The data in Table 15 show that the Netherlands may expect considerable ageing effects especially in the period 2010-2050.

Table 15 Estimated distribution of per capita health expenditure over time in the Netherlands by three age-categories (age-dependent cost function)

	1960	1970	1980	1990	2000	2010	2020	2030	2040	2050
HE (1990= 100)	87	90	95	100	103	107	114	120	131	138
% for Y	22	20	16	13	12	12	10	9	8	8
% for W	52	50	50	51	50	49	45	42	36	35
% for O	27	30	34	36	37	39	45	49	56	57

Legend

Y	0 - 19	(light shading)	based on UN prospects
W	20 - 64	(dark shading)	extrapolated
O	65 +		

5. DISCUSSION

Health expenditure and GDP

The strong association between growing GDP and rising health expenditure in Western European countries has been analysed by several authors. It appears that people are willing to pay a certain a proportion of their income to health-related expenses, or, more likely, that on a macro scale governments are willing to allocate a certain proportion of GDP to medical expenditure. Apparently, the level of expenditure is country or even culture and time dependent. On average, however, GDP correlates rather well with health expenditure in the countries of the European Union over the time period that we considered.

It may even be considered remarkable that health expenditure is not increasing much faster than GDP. In the view expressed by Baumol (22), GDP is generated by sectors in which productivity increases, such as manufacturing, and by other sectors where gain in productivity is hardly possible, such as the arts and health care. Increases in productivity are often associated with price increases below those reflected in the general price index. Therefore, the relative share of the value of the latter sectors will increase when the volume in these sectors remains constant. This continues up to the point where the burden becomes too great to bear. Evidently, this level has already been reached in most countries in the EU as well as in the US. As a consequence, a reduction in health care expenditure may result in a reduction in health care volume or even reduction in quality. According to this theory, however, the relative price index for health expenditure should have increased. From the results in Table 17 it is clear that such an increase has not occurred in the current EU countries over the last 30 years. Possible explanations may be that productivity gains in health care were underestimated and/or that governmental health policy measures were particularly effective.

Remaining differences in health expenditure between countries that are not associated with differences in GDP are explained by a combination of demographic and other factors. Besides differences in the rates of ageing and growth of the population of a country, other factors play a role such as differences in the amount of institutional care and home care provided, and differences in the items that national statistics bureaux consider as part of health expenditure. Cultural differences in medical consumption may also contribute considerably to differences in health expenditure between countries and over time. Influences of labour unions, of income inequality, or population density could also contribute to the explanation of observed differences.

An important question is whether the empirical relationship between GDP and health expenditure may be used to predict future health expenditure. The data presented indicate that such a prediction is not generally feasible. The following remarks seem relevant in this respect:

- there is no direct, mechanistic, relationship between GDP and health expenditure,
- there often is a time delay between changes in GDP and changes in health expenditure (Getzen, 1990),

- government policy measures are designed to influence the growth of health expenditure; the reduced growth shown in Figure 9 is the result,
- comparisons of GDP and health expenditure between countries and over time for one country are hampered by intercountry differences and by time-related changes with regard to definitions.

Next we should look into the validity and robustness of our demographic projections for health expenditure in the countries of the European Union and of our assumptions about the distribution of health care costs over gender and age.

Uncertainties in demographic projections of health expenditure

An inherent uncertainty in our estimates of future health expenditure is related to the use of demographic projections. Major influences that have affected population compositions in the past are the nation-wide introduction of birth control - giving rise to a rapid decline in birth rates - and changes in immigration and emigration rates. Since these factors are rather unpredictable and often occur quite irregularly, they cannot be accounted for completely in future studies.

Since health care costs are to a large extent attributable to older people, total health expenditure is hardly influenced by changes in demographic projections which concern the younger (birth rate changes) and middle (migration) age classes, while per capita costs will vary because of changes in total population numbers. In accordance with this we have shown that our projections are rather insensitive to the use of variable demographic 'variants'.

Uncertainties in the age-costs distribution function

A major point of consideration is the distribution of health care costs over ages and gender. The data (8) that were used to calculate our basic age-costs function contain inherent uncertainties with regard to the precise distribution of costs over age classes. About 6% of the total costs were reported as not attributable to a disease or age-class and about 20% were not attributable to a disease class. Some of the costs were distributed under certain assumptions that could also have been made differently, so as, for instance, to increase the age-dependent costs function somewhat further at older ages.

At the top end of the age-costs function we may have underestimated the relative level of costs, as we did not differentiate for the very, very old. There are indications that certain diseases will lead to cause higher per capita costs at older ages. The Koopmanschap study (8) presents such data for dementia. Costs per dementia patient increase rapidly with age, suggesting more need for expensive institutional care at older ages.

In conclusion, there remains some uncertainty about the precise shape of the age-costs distribution that should be used, even if it could be assumed to be constant under all other conditions.

When we used the age-dependent cost function for our demographic projections we made assumptions that the age-dependent cost functions obtained for men and women in the Netherlands for the year 1988 could also be extended:

- to other countries in the EU,
- to other years than the year considered, and
- to populations that are ageing and in which life expectancy is increasing.

The first assumption is not completely valid. It may depend for instance on whether those who are chronically ill, e.g., mentally-disturbed elderly, will be cared for in institutions or will remain with their families. One may assume that in countries with lower health care expenditure, and corresponding lower GDPs, less institutional care and more of the cheaper informal care is provided. Cultural differences may also apply. For the Netherlands it is known, for instance, that a relatively large number of pregnant women (30%) give birth at home, which occurs much less often in other EU countries. The second assumption does not take into account shifts over time in the pattern of care within one country, which as a result of increasing affluence or reduction of informal care may tend to put more demands on institutional care for those who are older and chronically ill. Developments in medical technology and changes in the age-specific prevalence of certain diseases may also affect the age-costs profile. The third assumption appears reasonable, since an increase in life expectancy does not automatically imply an increase in healthy life years (Ruwaard et al. 1993). Our assumption is then that people of a certain age will in the future need similar shares of the total amount of health expenditure as their predecessors did.

A second cost function that we used was based on mortality-related costs (3.2.2.2) and it certainly underestimates the effects of ageing and thereby of the occurrence of chronic diseases. It should therefore be considered an extreme. Such mortality-related age-costs profiles, can, however, at least theoretically be coupled to time series of data on mortality for different countries. Such an application of variable age-costs profiles may enhance international comparability and is an interesting point for further investigation. Here we have to conclude, however, that the application of the mortality related age-costs function is not likely to produce reliable results because this approach neglects the costs related with chronic diseases, which are strongly age-dependent.

A final assumption which is inherent to the three mentioned earlier about the age-costs distribution being constant for different countries, over time and in populations with changing health profiles, is that the difference between male and female age-costs functions will also remain constant. Gender differences such as those found for the age-costs profile for the Netherlands in 1988 are likely to be present in other EU countries as well, as they appear to be related to the different pattern of diseases for men and women. It may well be, however, that the different age-costs curves for men and women may change over time and either diverge further, or become more similar. The latter situation may arise, if life expectancy increases faster for men than for women, for instance as a result of quitting smoking cigarettes, which will reduce premature mortality fastest in men. This suggests that disease-specific trend data for costs may help improve prospective health expenditure estimates by incorporating data on changing disease incidence, prevalence or increased survival.

It is unclear to what extent the health care costs of the elderly should be connected with what is called "the high cost of dying" (see for instance Scitovsky (23)), or with age alone. A decline in elderly mortality could offset projected increases in health care expenses caused by the ageing of the population. Many authors found a sharp rise in hospital care costs in the final years before death. However, hospital usage increases with age both for the general population and for the population of survivors. Nursing home usage increases with age regardless of early death (24). This indicates that it is not only mortality but also ageing that affects health expenditure. The division in costs connected with dying and those connected with age certainly depends on the disease patterns and may also depend on medical culture and hence differ for various countries and perhaps over time.

Disease-specific differentiation and modelling health costs

Although the ageing-induced yearly increase in the total costs of Dutch medical care is expected to be relatively small up to 2020, considerably larger alterations may occur in disease-specific costs of health care and in the volume and type of care needed. Estimates of future amounts and type of health care and costs may be improved by forecasts of prevalence of specific diseases. For the Netherlands the increase in the demand for care by chronically diseased people has recently been estimated (Ruwaard, 1993). The number of patients with chronic diseases is expected to increase by between 10 and 40% over the period 1990-2010, depending on the disease in question. The estimates of the age profile of per capita costs, either for different countries or for one country over time, can be improved by attributing costs to specific disease groups and by looking for trends and differences in trends. In such analyses we may distinguish between diseases that will be present (and worsen) until the person dies, such as dementia, and diseases that may avoid further costs, either by recovery or because of premature death.

Appendix 2 presents some more detailed data from the Koopmanschap study and gives some examples of age-costs profiles for a number of diseases and groups of diseases in the Netherlands. Some diseases (dementia) show a much larger increase in costs with age than others. For some of the diseases for which the costs of care rise most strongly with age, costs also rise faster for women than for men. These data demonstrate how changes in age-specific disease prevalence or the inclusion or exclusion of a disease-specific form of care (i.e. care for the mentally retarded), might alter the shape of a national age-costs function and thereby the estimated effects of future ageing on total health expenditure.

Some final remarks

Demographic changes in the magnitude and age distribution of a population clearly exert an influence on both national income and health expenditure. For the ratio health expenditure : GDP it can be expected that nominator and denominator will at first approximation be influenced in the same way by changes in the absolute number of inhabitants. Calculation of the national health expenditure per working person (ages 20-65) instead of per capita (data not given) would show a much stronger influence of ageing on health expenditure. However, this approach is not correct for the comparison of health expenditure with GDP as the non working population also contributes to GDP, simply by consuming goods and services.

Over the period 1960-1990 we may conclude that for most of the countries in the European Union the growth rates of health expenditure have kept pace with the growth rates of GDP, while allowing for increases that are partly attributable to the effects of ageing and population growth. How the future effects of ageing on health care costs will precisely work out depends on the shape of the applied age-costs function. Projections differ marginally for age-dependent versus mortality-dependent age costs profiles. The overall effects of ageing, calculated as costs per capita, are relatively small over the time period that we considered. Extrapolation of the results found here for the period 1990-2020 up to 2050 suggests that the influence of demographic change on health expenditure will be much larger after 2020 for a number of EU countries, including the Netherlands.

This does not mean, however, that huge changes in the volume and type of health care and disease specific costs may not occur in the years ahead; on the contrary, ageing will continue to increase the numbers of chronically diseased in all European countries. In order to be able to combat and deal with this increase most effectively, it is advisable to study which diseases among older people generate most of the costs and to what extent primary, secondary and tertiary prevention may alongside more cost-effective health care can be achieved. This will contribute to both a healthier old age as well as a reduction in per capita costs. International comparison of patterns of health care consumption and costs could yield a better understanding of the observed differences in health expenditure expressed as a share of GDP. An international comparative assessment of how health care costs are established and how they are related to mortality and disease categories, and of how these relationships change over time could further improve cost projections. Projections may then inlcude policy-relevant information on priorities for tackling specific diseases.

It remains to be seen how the growing influence of the Common European market and the opportunities for international collaboration and exchanges of experience created by it will influence future health expenditure as well as general health in the European Union.

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APPENDIX 1: PRICE INDICES

Nominal price index

In Tabel 1.1 the nominal price indices (based on OECD definitions and data (4)) are given for the EU countries over the period 1960-1990. The indices vary by a factor of three (Germany) to 30 (Portugal) between 1960 and 1990. The average increment percentages (inflation percentages) are also given for the period 1975-1990.

Table 1.1 Nominal price indices (1990=100) (data converted from OECD (4))

	1960	1965	1970	1975	1980	1985	1990	1975-1990 increment (%)
AUT	25	31	37	53	69	87	100	4.3
BEL	23	27	33	50	65	86	100	4.8
DEN	12	16	23	38	57	83	100	6.8
FIN	10	12	17	31	50	75	100	8.1
FRA	14	17	21	33	54	84	100	7.7
GER	31	37	45	61	75	88	100	3.3
GRE	4	4	5	9	19	47	100	17.3
IRE	8	11	14	26	52	87	100	9.5
ITA	6	8	9	17	37	72	100	12.8
LUX	23	25	34	46	63	86	100	5.4
NET	23	30	39	60	81	95	100	3.5
POR	3	4	4	7	19	52	100	19.0
SPA	5	7	10	18	41	70	100	12.4
SWE	12	15	19	29	48	71	100	8.6
UK	10	12	15	27	54	76	100	9.2

Relative price index for health expenditure

Prices for health goods and services are not constant over time even when they are calculated with respect to the nominal price index. The *relative price index for health expenditure* (i.e., the deviation of the prices for health care from the general price level) is listed in Table 1.2 for the EU countries and the EU average. There are notable differences between these countries. A few (Austria, Belgium, Germany and the Netherlands) show increases in health care prices relative to the general price index over the period 1960-1990, for others the relative price index for health expenditure remains stable within a bandwidth of 90-110%, which means that the price development of health care is not very different from the development of prices of general goods. However, France and Greece show marked decreases.

The behaviour of the price level of health care is different from the behaviour of the overall price level. Goods and services are - on average - more expensive in countries with a high GDP, but this relationship does not hold for health care prices (9). Drawing too many conclusions from the data in Table 1.2 is dangerous, moreover. Market mechanisms have only a minor influence on medical consumption and prices. Health is considered one of the most valuable assets, so on the micro level the demand is hardly influenced by prices. On the other hand, the influence of the government on prices may well be considerable. Looking at the data it appears that at least a number of European governments have been successful in curbing health care prices in their countries.

Table 1.2 Relative price indices for health expenditure (data converted from OECD (4))

	1960	1965	1970	1975	1980	1985	1990	1975-1990 increment (%)
AUT	49	58	67	80	89	94	100	1.5
BEL	80	91	92	93	95	99	100	0.5
DEN	99	99	104	107	96	98	100	-0.4
FIN	115	104	91	86	86	95	100	1.0
FRA	122	124	125	117	112	105	100	-1.0
GER	79	78	90	94	95	101	100	0.4
GRE	115	119	106	106	112	105	100	-0.3
IRE	94	91	86	78	81	88	100	1.7
ITA	88	98	97	95	98	95	100	0.4
LUX	N/A	N/A	90	99	94	93	100	0.1
NET	60	60	68	90	97	95	100	0.7
POR	N/A	N/A	87	N/A	103	112	100	1.0*
SPA	89	87	99	104	100	108	100	-0.2
SWE	98	93	93	99	106	102	100	0.1
UK	102	155	93	87	89	92	100	1.0

* calculated for 1977-1990

Comparison of health cost price indices between countries and over time is risky. Comparisons over time in one country meet with the problem of how to handle substitution of treatments. Moreover, for different countries the package of what is considered to belong to health care differs (see Section 2.3.1). Therefore, the data in Table 1.1 have to be interpreted with some care. However, on visual inspection of the data, there seems to be no clear association between increasing health care price indices and increasing ratios of health expenditure over GDP.

APPENDIX 2: A DISCUSSION OF HEALTH EXPENDITURE TRENDS FOR THE NETHERLANDS

A comparison with other trend data for health expenditure in the Netherlands

Our model estimates of the variation in Dutch health expenditure under the influence of demographic effects may be compared with figures from a report that has been issued by the Dutch Ministry of Health (25). This 'Zuinig met Zorg' (ZMZ) report has been prepared by an official task force on health care volume control and cost reduction and it discussed health care efficacy. The ZMZ report contained an appreciation of historic Dutch health expenditure growth rates and the attribution thereof to a number of causes for the period 1973-1993 (25)

Table 2.1. Average yearly increase in economic and health care variables (Netherlands)

Economic variable	total growth(%)	volume growth (%)	nominal growth (%)
Health Expenditure	8.0	2.3	5.6
GDP	6.4	2.3	4.0
Difference	1.6	0.0	1.6
Real growth *	3.9	---	---

* Real growth defined as volume increase in HE (health expenditure) plus nominal HE increase minus nominal GDP growth, or: total increase in HE minus nominal increase in GDP.

The ZMZ report estimated a volume increase in health expenditure which is equal to the volume increase of the GDP. This implies that the difference (1.6%) between total growth rates of health expenditure and GDP growth rates is fully explained by price mutations. The real growth as defined in the ZMZ report (3.9%) is the sum of health care price increases and the volume increases of medical care.

As shown in Table 2.1 the ZMZ report has divided total health expenditure changes in a nominal and a volume part. The nominal part is attributable to inflation (price differences). Volume growth has been divided into parts that are caused by ageing and population growth, which - taken together - explain two thirds of the volume increase, further by income increases, which allow health care consumers to demand and pay for more care, and finally by some miscellaneous factors (Table 2.2). Among the latter are factors such as changing household compositions, which may influence the availability of informal care, developments in medical technology and some general social and cultural factors.

Table 2.2. Attribution of average yearly health care volume increases to demographic and other factors (Netherlands).

Contributing factors	Yearly increase (%)	
	ZMZ report(1972 - 1993)	**Cost model (1975 - 1990)**
Total volume growth (%)	**2.3**	**2.0**
Population growth	0.7	0.6
Ageing effects	0.7	0.5
Income improvements	0.1	---
Miscellaneous factors	0.8	0.9

Table 2.2 presents a comparison of the results of one of our cost models and the data that were reported, but not documented in any detail, in the ZMZ report. It is for instance not clear from the ZMZ report how the demographic effects were estimated. The results are quite comparable as far as the effects of ageing and population growth are concerned.

The OECD data that we used in our study quote for the Netherlands a yearly relative price increase for health care of about 0.7% while the ZMZ report finds 1.6%. The costs included in both calculations are not similar however, as the ZMZ report included the costs for home help, for family homes for the mentally retarded, for day nurseries, for handicapped people and for old peoples homes.

Although the time periods to which the data pertain and the input data used are not exactly similar the estimates for the demographic parts of the explained variability in health expenditure for the Netherlands are remarkably similar. The ZMZ report states a possible other method to calculate the volume growth which might result in a lower total volume growth, which would make the resemblance even better. As far as our modelling results are concerned this may again point to the robustness of the age-costs function that we discussed elsewhere in this report.

Conclusions

Our model-derived estimates of the demographic components of health expenditure growth for the Netherlands has also been found by others. This may reflect the validity of the mathematical cost-functions that were used and adds confidence to the results of our demographic projections into the next century.

One of the general conclusions from the available international data is, that, on average, the countries of the European Union have succeeded rather well in keeping the growth of health expenditure in pace with the rises in GDP, especially over the past few decades, while allowing for some growth that may be accounted for by demographic developments, such as ageing and total population growth. A major contributing factor, which influenced health expenditure over the period 1960-1990 for the Netherlands, may well have been the absolute growth of the population by 30%. This is much more than the absolute growths of other EU countries, such as Germany (19%), Denmark (12%), The UK (10%) or Belgium (9%). In comparison with other countries the Netherlands was still a relatively young country, even in 1990, with only 12.5% of the population over 65 years of age. So, our conclusion for the European Union that health expenditure has been well managed may hold especially for the Netherlands. A further growth of Dutch health expenditure beyond the growth rate of the GDP may be expected, however, as ageing will continue to affect total health expenditure, especially so after 2020.

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APPENDIX 3: DISEASE SPECIFIC INFLUENCES ON AGE-COSTS PROFILES

In the main body of this report we have computed possible effects of demographic changes on future health expenditure under the assumption that the age-costs distribution is constant over time within one country and similar in all EU countries. These are assumptions that are subject to question as we already indicated in the discussion. This appendix serves to illustrate the potential variability of the age-costs distribution as caused by specific diseases and as derived from the available data for the Netherlands (Koopmanschap et al., 1991). This will demonstrate that the availability of more disease specific, but internationally comparable, health expenditure data may further improve the results of model studies to estimate future health expenditure.

Sources of variability of the age-costs relation

Even when no changes in age-specific prevalence of diseases would have occurred over time, ageing has already caused a substantial shift in total numbers of patients mainly towards chronic diseases in most Western European countries. This has caused major changes in the total and disease specific costs for medical care and in the types of care and medical specialities that are most needed. As many chronic diseases are associated with variable risk factors (such as: dietary behaviour and its consequences, alcohol intake, smoking, physical inactivity, etc.) there is an inherent variability in the incidence and prevalence of many chronic diseases over time and also between countries. This may lead to variations in the overall age-costs distribution for a country if disease specific costs are distributed differently over age for different diseases. A major question is therefore whether disease specific costs show a large variability in the rate of increase of the costs with age.

In addition, ageing in Western European countries has been developing differently for men and women and significant sex-specific differences in disease prevalence and mortality exist. It is not impossible, however, that the age-distributions of male and female disease prevalence and/or life expectancies will shift towards or away from each other in the future. This may change the average age-costs function for a country over time. A second question is therefore whether the disease specific rates of costs increase with age vary largely between men and women.

We will present some examples of the variability of disease specific age-costs profiles for the Netherlands and show gender differences to illustrate their potentially variable influence on the overall age-costs function for a country.

Age-costs distributions and gender

The distribution of health expenditure by age-group was not identical for men and women in the Netherlands (1988) (Figure 3.1). The higher costs for women than for men in the age-group between 20 and 44 years are the result of higher costs for pregnancies and childbirth's. Higher costs are also seen for women over 80 than for men, which is partly explained by the fact that the women in this group are on average older than the men. Here too, however, we may want to look for disease-specific differences. Another part of the explanation of variations in the age-costs profiles for older men and women may be that older women have much more often then men of the same age lost their partners and lack possibilities to obtain home care, while, inversely, older men still have their, generally younger, wives, who may substitute some of the more expensive forms of health care.

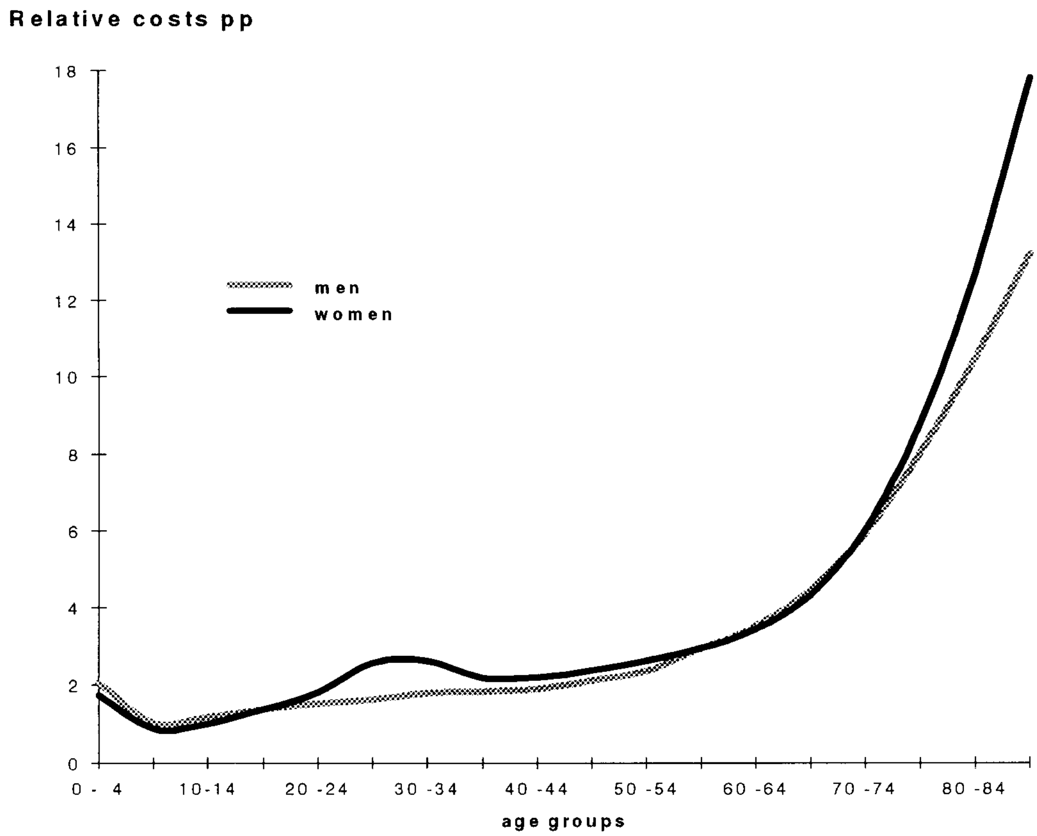

Figure 3.1. Difference in age dependence of total health expenditure for men and women (the Netherlands, 1988).

When we look into age-costs distributions for specific disease categories later, we will demonstrate that for a number of diseases significant male-female differences exist, but not for all diseases or all age-groups.

Age-costs distribution for disease groups

In the study by Koopmanschap the costs of health care have been attributed to seventeen large disease groups (the ICD-9 headgroups), to a number of age-categories (see Table 3.1) and also to a selected group of 40, smaller, disease categories. The data in Table 3.1 give per capita disease costs (guilders per head for a particular age group) and the figures in brackets give the values relative to the (average) total costs per head for all ages.

Table 3.1. Average absolute and relative (in brackets) per capita health expenditure by five age categories for various diagnose groups (Netherlands, 1988).

Diagnose groups	0-19	20-44	45-64	65-79	80+	Total	% of total
Neuro-psychiatric	176 (0.33)	531 (0.99)	492 (0.92)	832 (1.56)	3265 (6.10)	535 (1.0)	19.9
Cardiovascular	4 (0.02)	30 (0.13)	277 (1.18)	1023 (4.37)	2306 (9.85)	234 (1.0)	8.7
Digestive system	158 (0.77)	192 (0.93)	199 (0.97)	307 (1.49)	544 (2.64)	206 (1.0)	7.7
Musculo skeletal	48 (0.26)	143 (0.76)	232 (1.24)	413 (2.21)	1043 (5.58)	187 (1.0)	6.9
Neoplasms	9 (0.07)	36 (0.29)	184 (1.50)	503 (4.09)	678 (5.51)	123 (1.0)	4.6
Accidents	60 (0.52)	61 (0.53)	88 (0.76)	279 (2.41)	1057 (9.11)	116 (1.0)	4.3
Other groups	449 (0.73)	467 (0.76)	486 (0.79)	1313 (2.14)	2767 (4.51)	613 (1.0)	22.8
Not/never attributable	428 (0.63)	534 (0.79)	790 (1.16)	1290 (1.90)	2194 (3.23)	679 (1.0)	25.2
Total (costs/head)	1332 (0.49)	1994 (0.74)	2748 (1.02)	5960 (2.21)	13854 (5.14)	2693 (1.0)	100.0

Source: Koopmanschap et al., 1991.

The six largest disease categories in Table 3.1, taken together, comprise about 60% of total health expenditure. It is also remarkable that a substantial part of the total costs (25%) has not been attributed to a specific disease category. The relative per capita costs for all disease categories together are, on average (see total costs/head) five times higher in people over 80 years old than for the average person, but this difference may be significantly larger for particular disease groups (see: 'cardiovascular diseases' and 'accidents').

Figure 3.2 depicts relative age-costs data for neuro-psychiatric, cardiovascular and musculo-skeletal diseases and for the total costs. It is clear that cardiovascular diseases cause relatively high costs at higher ages, as compared to neuro-psychiatric diseases. Musculo-skeletal diseases appear to be divided according to a pattern that is similar to the one observed for the total costs.

Again, however, we should scrutinise these data as some of the large disease categories are made up from a number of distinctly different disease groups, which may have variable age-costs distributions and gender differences.

We will illustrate the variability in disease and sex-specific age-cost distributions by looking at the age-costs functions for subgroups within the neuro-psychiatric disease group and, first, at the male-female differences for musculo-skeletal diseases.

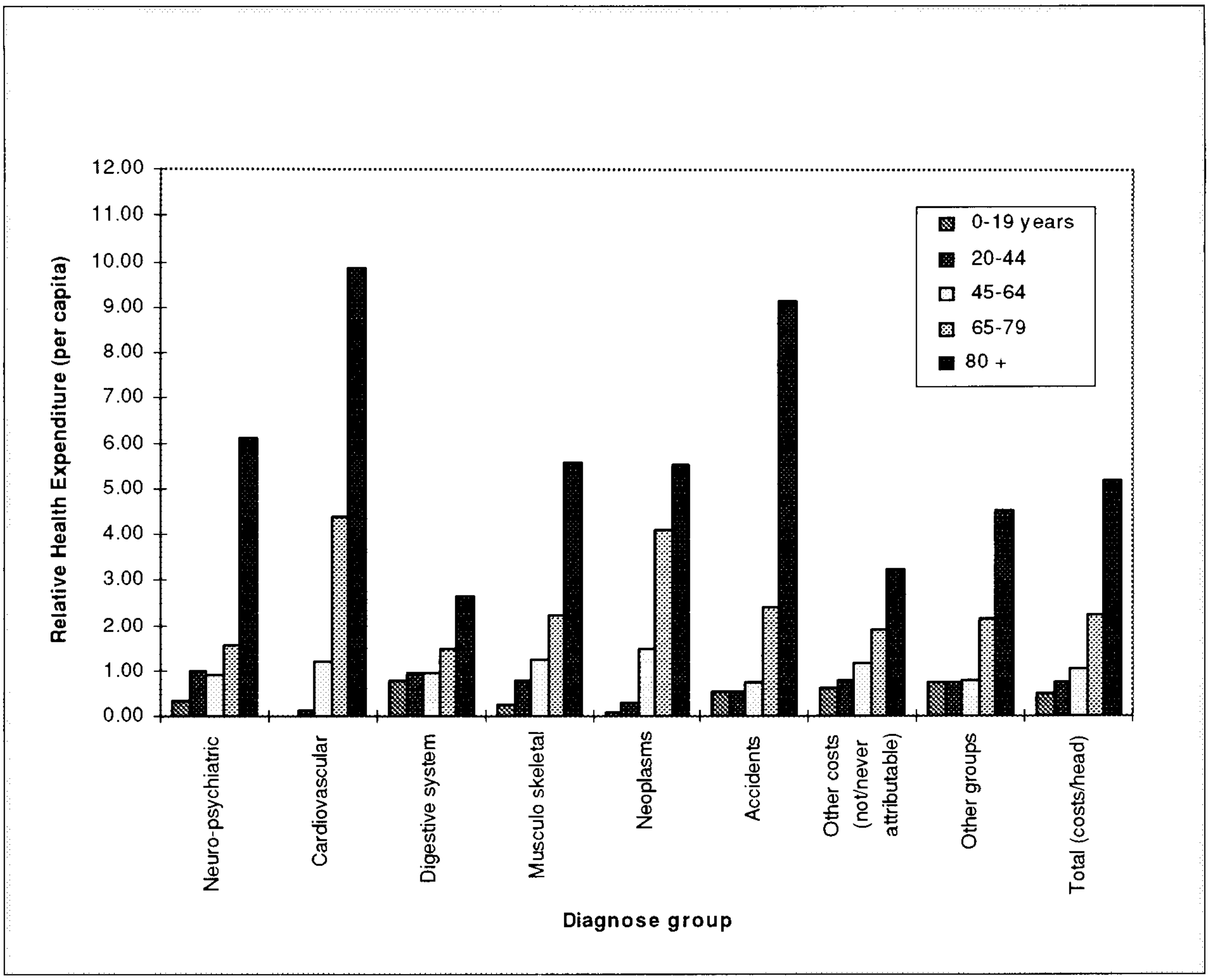

Figure 3.2. Relative costs of medical care by age group for several disease categories (men and women combined).

Gender specific age-costs profiles for specific disease categories

From Figure 3.3 it is immediately clear that the relative costs (per percent of the population within a particular age group) for musculo-skeletal diseases are remarkably similar for men and women up to the age of forty, but that the costs for women thereafter increase much faster than for men, resulting in a twofold difference at higher ages. The underlying factor is presumably osteoporosis, which has a genetic gender link, and its consequences, such as fractured hips, which consequently occur much more frequently in women than in men.

For other diseases similar male-female differences in age-costs profiles are observed. Occasionally, these differences are expressed as a parallel increase in costs with age for men and women, which may reflect a similar but several years later onset (incidence) of the disease in men than in women, as can be observed for cardiovascular diseases.

Next we will demonstrate that one disease category may contain several diseases with different age-costs profiles.

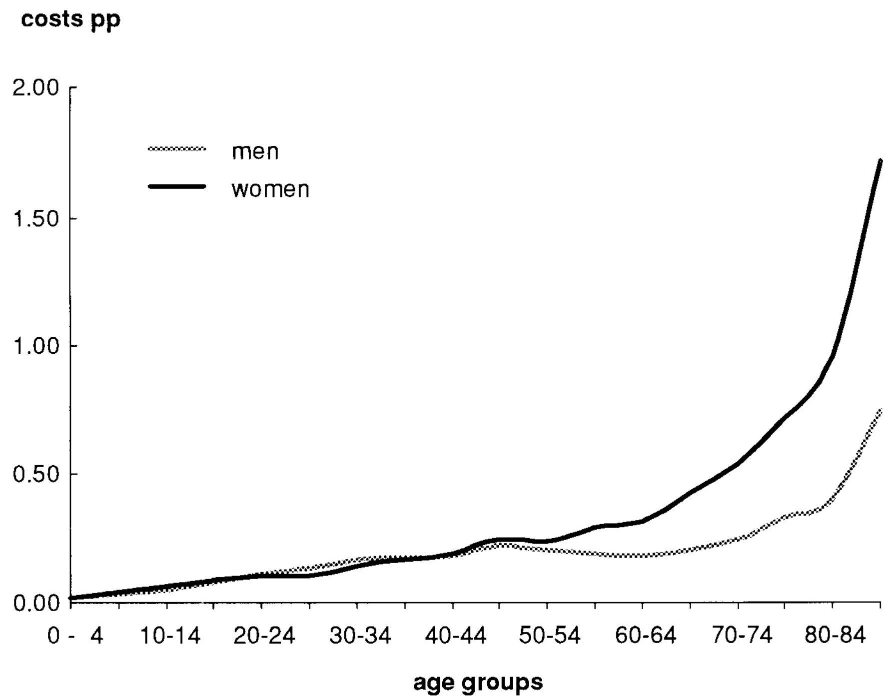

Figure 3.3. Difference in age specific costs profiles for men and women: musculo-skeletal diseases.

Additional variability in the age-costs distribution within one disease category.

For our purpose we have split the disease category neuro-psychiatric diseases into mental retardation, dementia and other neuro-psychiatric diseases. From Figure 3.4 it is immediately clear that the three sub-categories have substantially different age-costs distributions. Mental retardation has a nearly flat distribution, while the costs for dementia show a very extreme rate of increase with age. If we look at gender differences we find for dementia that the costs (pp) for women are substantially higher than for men, while we see the opposite for the costs generated by mental retardation.

For mental retardation (Figure 3.5a) it may be assumed that these differences are caused by the known higher prevalence of mental retardation (as measured in institutions) in men than in women (Ruwaard & Kramers, 1993).

For dementia (Figure 3.5b) there are indications that the prevalence in women may be higher than in men, but it has also been suggested that the higher costs of care for female dementia patients are caused by the fact that old men suffering from dementia may still have (generally younger) partners to take care of them at home, while women of the age at with dementia becomes prevalent are widowed and lack these facilities for home-care, necessitating more expensive institutional care.

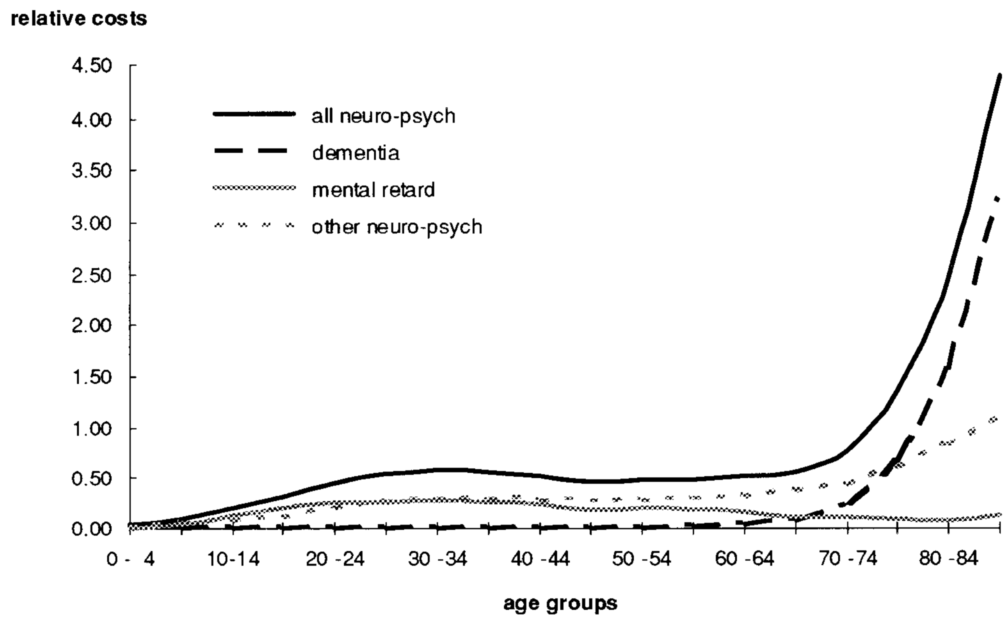

Figure 3.4. Age dependence of health expenditure for neuro-psychiatric disease sub-categories.

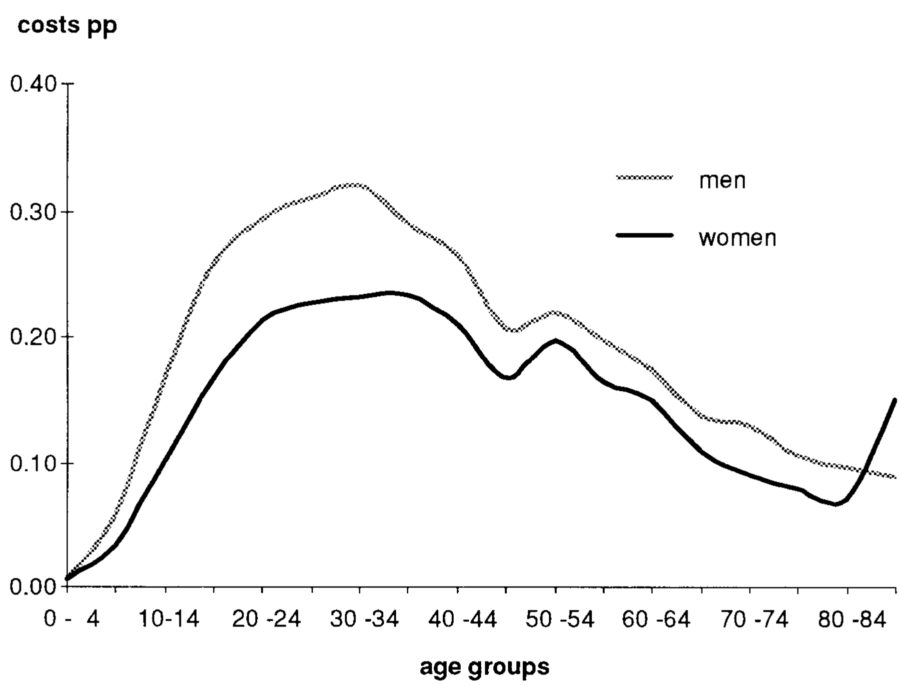

Figure 3.5a. Male-female difference in health expenditure on mental retardation.

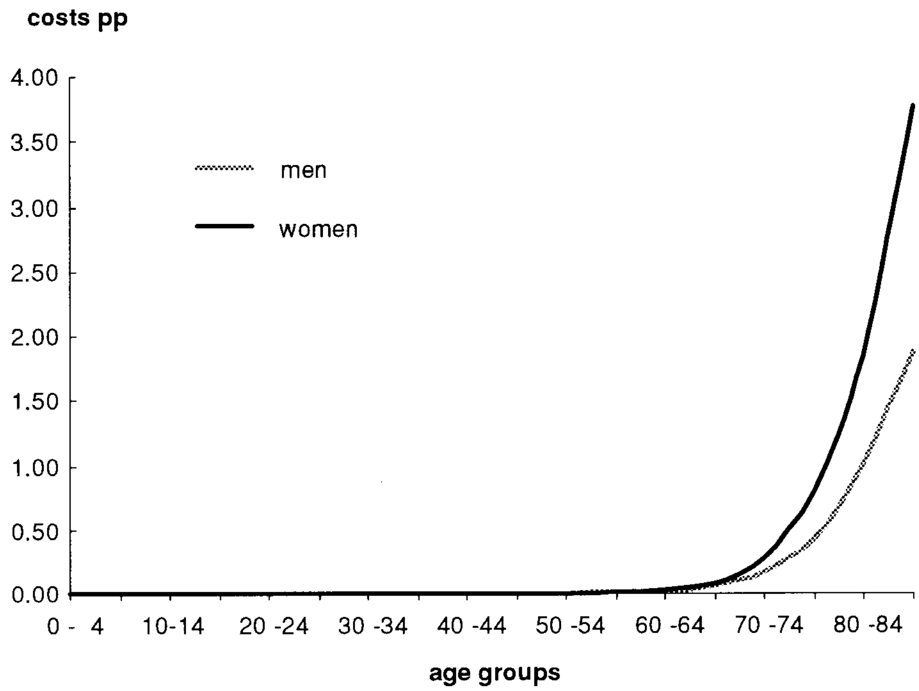

Figure 3.5b. Male-female health expenditure difference for dementia.

Conclusions and discussion

From the above examples it has becomes obvious that the age-costs profiles for the health expenditure of a country may well be subject to changes over time as age-specific prevalence of diseases may change over time. In addition, there are clear gender differences, which may, again, be caused, by gender differences in disease prevalence. These disease specific factors must be added to other factors, such as genetic and socio-cultural factors, technological and socio-economic factors that influence health expenditure. International differences in health expenditure may therefore partly be caused by differences in disease prevalence and thereby by other factors, the determinants of health, which cause the differences in incidence, prevalence and mortality.

It is well known (see: Ruwaard et al., 1994; Verschuren et al., 1995) that some of the larger disease categories, i.e. cardiovascular diseases (ischemic heart disease and cerebrovascular disease), certain lung diseases (COPD) and a subset from the group of cancers are strongly influenced by lifestyle factors such as diet and alcohol intake, but especially by smoking. These factors may vary in prevalence between countries (and by sex and age) and they may be influenced by socio-cultural developments and health policy measures. As comorbidity is increasingly prevalent at advancing ages, however, lowering the prevalence of a specific disease by preventive measures may not result in the complete reduction of health expenditure as the costs for other diseases may continue to be present or even increase.

International comparability of health expenditure data may suffer from disease specific differences in age-costs distributions too. Health expenditure as caused by mental retardation, for example, with its rather high total costs, but 'flat' age-costs profile is not in all countries fully included in the total costs of health care and large variations also exist for the inclusion of costs caused by psychiatric diseases. Differences between countries in the definition of what belongs to health care and what does not may well add substantially to the variability in age-costs profiles between countries. Further harmonisation and comparison of international health expenditure data is therefore necessary to obtain valid, internationally comparative data on health care use that will be relevant for internationally positioned health policy.

All these observations also call for the inclusion of available data, preferably time-series, on determinants of health and on the prevalence of diseases and associated health care use and costs into mathematical models, to estimate future health expenditure and its underlying causes and dynamics in more detail. The inclusion of data on the effectivity of preventive and curative measures may provide health policy makers with the necessary information to make choices for the future.

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