OECD Labour Market and Social Policy Occasional Papers
No. 46

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https://dx.doi.org/10.1787/716472585704

OECD

Unclassified **DEELSA/ELSA/WD(2000)7**

Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development

OLIS : 10-Jan-2001
Dist. : 12-Jan-2001

English text only

DIRECTORATE FOR EDUCATION, EMPLOYMENT, LABOUR AND SOCIAL AFFAIRS
EMPLOYMENT, LABOUR AND SOCIAL AFFAIRS COMMITTEE

DEELSA/ELSA/WD(2000)7
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OCCASIONAL PAPERS

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ACKNOWLEDGEMENTS

I would like to thank Jeremy Hurst, Mark Keese, Peter Scherer and an anonymous referee for helpful comments and suggestions on previous versions of this paper. I am also grateful for comments from John Martin, Odile Sallard and Stephane Jacobzone.

SUMMARY

1. Two of the most important questions facing health policy makers in OECD countries are:

i. whether the increasing sums of money devoted to health care are yielding commensurate value in terms of improvements in health status; and

ii. whether different ways of financing and delivering health care -and, hence, health care reforms- make a difference to health.

2. This paper explores the effect of variations in the volume of health care and in certain characteristics of health systems on mortality across 21 OECD countries over the past 25 years, after controlling for certain other determinants of health status. It builds on previous research on the determinants of health outcomes in OECD countries (Or, 2000). In contrast to the earlier work, it concentrates on a non-monetary measure of health care supply – number of doctors – to avoid a number of measurement issues. It also uses a range of summary measures of mortality to assess the performance of health care systems and incorporates a number of judgmental variables to capture some basic characteristics of health care financing.

3. Given the received wisdom - that the marginal productivity of medical care is close to zero in industrialised countries - the results are surprising and encouraging for health care reforms. They suggest that over the past 25 years, increasing doctor numbers have been strongly and significantly associated with lower mortality, after allowing for other determinants of health status for which we have data. In addition, the results suggest that the relative importance of the determinants varies with the type of mortality.

RESUME

4. Deux questions primordiales auxquelles doivent faire face les responsables des politiques de santé dans les pays de l'OCDE sont:

i. Dans quelle mesure les investissements croissants dédiés aux soins en santé mènent à une réelle amélioration en terme d'état de santé; et

ii. dans quelle mesure les différents types de financement et d'approvisionnement des soins de santé – et donc, les reformes de santé – apportent une différence à la santé d'une population.

5. Le présent rapport explore l'effet des variations dans le volume des service de soins et de certaines autres caractéristiques des systèmes de santé sur la mortalité à travers 21 pays de l'OCDE sur les 25 dernières années, après un contrôle sur d'autres déterminants d'état de santé. Il poursuit la recherche sur les déterminants de l'état de santé dans les pays de l'OCDE (Or, 2000). A l'encontre de l'étude précédente, il se concentre sur une mesure non-monétaire de ressources médicales -nombre de médecin- pour éviter un certain nombre de problèmes de mesure. Il utilise également une série de mesures globales de la mortalité pour évaluer la performance des système de santé et incorpore un certain nombre de variables catégoriques afin de capter les principales caractéristiques de financement des services de soins.

6. Étant donné la tendance à penser que la productivité marginale des soins médicaux est proche de zéro dans les pays industrialisés, les résultats sont surprenants et encourageants pour les réformes des soins de santé. Ils indiquent que durant ces 25 dernières années, l'augmentation du nombre de médecins en activité est liée d'une manière significative à la réduction de la mortalité, ce après avoir contrôlé d'autres déterminants de la santé pour lesquels des données sont disponibles. Par ailleurs, les résultats suggèrent que l'importance relative des différents déterminants est liée au type de mortalité.

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1. INTRODUCTION

7. Explaining the role of health systems in determining variations in health status across countries continues to generate debate in health policy.

8. One critical question for health policy makers is whether and how health status varies with the volume of health care provided. What is the role (if any) of medical care in improving health status compared to non-medical factors? Some studies have suggested that the marginal product of health care is close to zero in industrialised countries, so medical spending could be limited without having a significant impact on health status. Other studies, however, have suggested that medical care is productive at the margin, even at the high levels of health expenditure observed in industrialised countries.

9. Another critical question is whether the institutional characteristics of health systems - the way in which health care is financed and delivered - affects health status, after controlling for other determinants.

10. This paper is intended to provide a further contribution to ongoing research into the determinants of health status in OECD countries.[1] It primarily addresses the questions of whether and how variations in health status varies with the level of health care provided, and whether the institutional set up of a health system has any impact on health performance. It also examines the relative impact of life style factors on health. The analysis in this paper builds on the previous research (Or, 2000; Or, 1997) by testing out a relatively untried measure of the volume of health care - the number of active physicians per 1000 population. It also incorporates a wide range of mortality measures and different parameters characterising the medical system.

11. The rest of this paper is organised as follows. The next section describes the long-term trends and current status of health in the OECD area, using a range of mortality indicators. Section 3 discusses the problems of measuring health care across countries, in particular the volume of health care resources, in order to assess performance. It also introduces those principal institutional features of a health system which might have an impact on the use and allocation of health resources and, hence, on health performance. Section 4 introduces the empirical model adopted to explain the variations in health status across OECD countries over the past 25 years. Section 5 presents the estimation results, and the final section discusses implications for future policy.

[1] The analysis considers only 21 OECD countries for which comparable data over time are available for health outcomes and for a range of possible health determinants. From a methodological point of view considering only OECD countries helps to reduce the range of health determinants included in the analysis. For example, the countries included in the analysis are not predominantly situated in the tropics (and so do not face a host of tropical diseases), there is almost universal access to certain minimum standards of public hygiene and they have access to similar medical techniques and procedures. Therefore, separate controls are not required for these factors.

2. HEALTH STATUS IN OECD COUNTRIES: AN OVERVIEW

Measuring health status: mortality indicators

12. There is no one ideal measure of health status which incorporates the various aspects of quality and length of life at the macro-level and which is available on a comparable basis both across countries and over time. The development of sophisticated internationally comparable measures of health, such as Disability Adjusted Life Expectancy, is still in its infancy, and this sort of data is usually not available for more than one or two years. Moreover, the difficulty of collecting comparable data on disability and other aspects of quality of life has meant that the construction of these measures involves a number of assumptions, value judgements and some estimation. Currently, most indicators of health status at the national level are based on mortality data as presented in the OECD Health Data. While these measures provide no information on the non-fatal consequences of diseases, they still provide reliable and useful information to describe the health status of populations and have the advantage of being readily available for most OECD countries and over a considerable time span.

13. Different measures of health status based on mortality data can provide a different perspective on health status of a population and may highlight some particular problems for a society. Therefore, it may be useful to examine a range of measures rather than just one overall summary measure. In this study, the relationship between medical and non-medical factors and health is examined using the following measures of health status:

- perinatal and infant mortality;
- potential years of life lost by all causes and separately for cancer and heart disease; and
- life expectancy at birth and at age 65.

14. Infant mortality and perinatal mortality rates are often used in international comparisons (see Box 1 for the definitions). They clearly summarise the health status of only one segment of the population, but the performance of a health system is often judged by its capacity to prevent deaths at the youngest ages. Perinatal mortality is considered as a particularly important indicator of the effectiveness of health care interventions during pregnancy and childbirth.

15. Potential Years of Life Lost (PYLL) before the age of 70, provides an indicator of "premature mortality". This measure is designed to focus on deaths which could be potentially avoided. Using premature mortality one can also easily disentangle individual causes of death. Investigating individual causes of premature mortality may help to better understand the causes of variations in overall rates of premature mortality and to point towards specific areas of intervention. Therefore, premature mortality is examined both for all causes (excluding suicides) and for two major causes: malignant neoplasms (ICD9 140-208) and ischaemic heart diseases (ICD9 410-414). These two causes represent more than one third of the total potential years of life lost in the OECD area (36 % for women and 30 % for men).

16. Life expectancy at birth and at different ages is one of the most established and widely available summary measures of health status. Life expectancy at age 65 provides a measure of the health status of

the elderly population and has been included in this study in order to complement the other measures which do not specifically cover this segment of the population either at all or only partially.[2]

Box 1. Definitions of health indicators

Life expectancy at birth or at a given age: Average number of years which a person at that age is expected to live under the mortality pattern prevalent in the community or country based on a given set of age-specific death rates found in life tables.

Infant mortality: The number of deaths under one year of age per 1000 live births.

Perinatal mortality: The number of deaths under seven days (early neonatal deaths) plus fetal deaths of 28 weeks of gestation or more per 1000 total births.

Potential Years of Life Lost (by ICD categories): The calculation for PYLL involves adding up deaths occurring at each age and multiplying this with the number of remaining years to live until a selected age limit. The limit of 70 years has been chosen for the calculations presented in OECD Health Data. PYLL is a measure of premature mortality which gives greater weight to deaths occurring at younger ages, which are, *a priori*, preventable.

See OECD Health Data, Sources and Methods for more detail.

17. Each measure of health status at the national level is likely to give a somewhat different picture of the extent to which health has improved over time within countries and may result in a somewhat different ranking of health status across countries at any point in time.

Trends in mortality

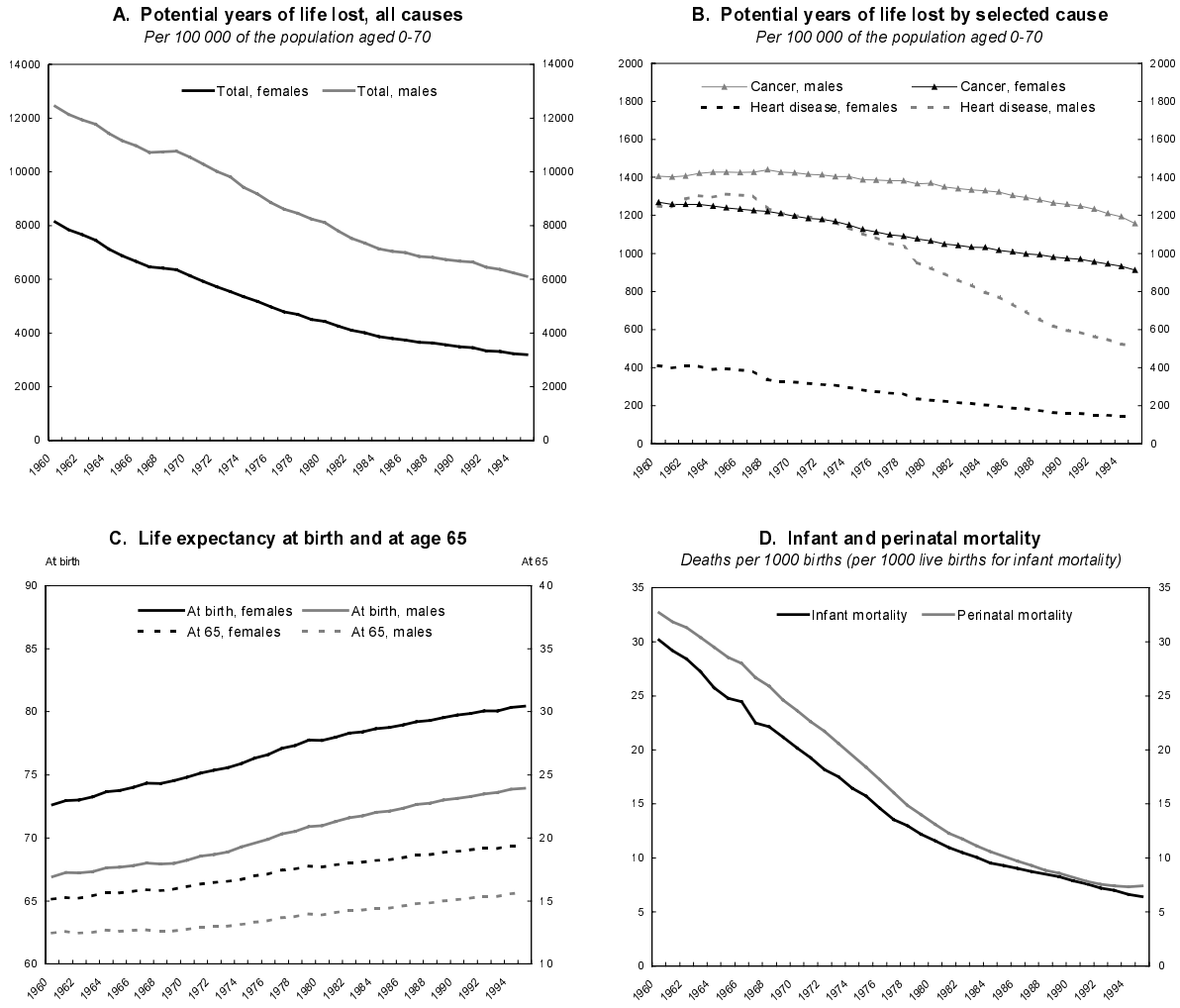
18. Trends in aggregate health status in the OECD area over the period 1960-1995 are shown in Chart 1 for a range of measures.[3] All of the measures record an improvement over the entire period. However the extent of that improvement varies across the different measures. For example, for both sexes,

[2] The premature mortality measures only cover deaths up to the age of 70.

[3] Each measure has been averaged over the 21 OECD countries included in this study. Individual country values for the PYLL and life expectancy measures have been weighted together using total population shares while those for the infant and perinatal mortality measures have been weighted together using shares of number of births.

there has been a much greater improvement in premature mortality from heart disease than from cancer (Panel B). In fact, the percentage decline in years of life lost because of heart disease over the period (66 per cent and 59 per cent for women and men, respectively) has been similar if not slightly more rapid than the decline in the total for all causes (61 per cent and 51 per cent, respectively). For both sexes, there has also been a bigger rise in life expectancy at birth than at age 65 (Panel C). This reflects the substantial fall in infant mortality rates (Panel D) which has been even steeper over the period (79 per cent for infant mortality and 77 per cent for perinatal mortality) than the decline in potential years of life lost for either women or men.

Chart 1. **Trends in different measures of health outcomes, 1960-1995, OECD average**[a]



a) Excluding Czech Republic, Hungary, Iceland, Korea, Luxembourg, Mexico, Poland and Turkey. Individual country values are weighted together using population shares for potential years of life lost and life expectancy, and shares of births for infant and perinatal mortality.
Source: OECD Health Database.

19. The separate measures by sex consistently record better status for females than for males.[4] However, the size of this gap varies both across the different measures and over time. For example, for years of life lost from all causes, there has been a steady narrowing of the gap between the sexes over time, although a large gap still remains. The size of the gap partly reflects the fact that premature mortality because of heart disease is much higher for men than for women, although this gap has narrowed considerably since the late 1960s. There is a much smaller disparity between the sexes for premature mortality because of cancer. In contrast to some improvement being recorded for men relative to women on the basis of potential years of life lost, there has been no or only little change in the gap between the sexes with respect to life expectancy. For life expectancy at birth, there has been a persistent gap between the sexes of around 6½ or more years since the late 1960s. For life expectancy at age 65, the gap actually increased marginally through to around 1980 before stabilising at just over 3¾ years.

Country disparities in mortality

20. Beneath these aggregate trends at the level of 21 countries there is considerable variation across countries. For instance, the ratio of the highest value to the lowest value across countries for each measure in 1995 was around two or more for the measures of potential years of life lost (over 6 for heart disease) and for infant and perinatal mortality (Table 1). In general, there appears to be greater variation for these measures than for the life expectancy measures, with the most variation across countries occurring for potential years of life lost because of heart disease.

21. In some instances, countries that achieve lower levels of mortality according to some measures may experience high levels on others. For example, for males, France has high level of premature mortality, but life expectancy both at birth and at age 65 are relatively high. At the same time, France performs relatively well with respect to female premature mortality. Japan achieves a number one ranking in most instances, but performs only moderately well in terms of perinatal mortality. Finland is another striking example being the most successful with respect to infant and perinatal mortality, but has one of the highest rates of male premature mortality from heart disease.

22. More generally, there is a high correlation between different measures of health status. Both premature mortality and life expectancy are highly correlated with premature and infant mortality, as the former are largely influenced by deaths among the young. The correlations across the different measures for 1995 are nearly always positive although in a few instances they are negative or only weakly correlated (Table 2). For instance, there appears to be a negative rather than a positive association between cancer and heart disease as causes of premature mortality. The rates by sex for the same measure are usually positively correlated, with the exception of premature mortality because of cancer where there does not appear to be any association between the rate for women and the rate for men. More generally, it is interesting to note that there is little correlation between different indicators of mortality for men and for women.

23. Any framework to explain or analyse the performance of health systems will need to be able to take account of these differences across the various measures in health status, both in trends over time and in the disparities across countries and between the sexes.

[4] It should be remembered that these measures of health outcomes are based on death rates and so the better outcomes for women reflect the fact that on average women tend to die at an older age than men. Other measures of health such as the incidence of disability and subjective measures of health status do not always record better outcomes for women than men at equivalent ages.

Table 1. **Different measures of health status and country rankings, 1995**

A. Levels

	PYLL, Total		PYLL, Cancer		PYLL, Heart disease		Life exp. at birth		Life exp. at 65		Infant	Perinatal
	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Mortality	Mortality
	---------- Per 100 000 persons aged 0-69 ----------						---------- Years ----------				Per 1000 births	
Australia	2809	5122	871	1015	135	525	80.8	75.0	19.5	15.7	5.7	5.8
Austria	2885	6044	933	1106	157	627	80.1	73.5	18.7	15.2	5.4	6.9
Belgium	3175	5865	906	1246	75	349	80.2	73.6	19.6	15.1	7.0	7.7
Canada	2954	5280	941	1015	154	538	81.3	75.3	20.1	16.2	6.0	7.0
Denmark	3526	5599	1314	1129	176	554	77.8	72.6	17.6	14.2	5.0	7.5
Finland	2663	6242	797	871	138	825	80.2	72.8	18.6	14.5	4.0	5.1
France	2869	6306	828	1499	46	274	81.9	73.9	20.6	16.1	4.9	7.4
Germany	2978	5878	951	1220	140	589	79.8	73.3	18.5	14.7	5.3	6.9
Greece	2745	5605	770	1143	128	624	80.2	75.0	18.4	16.1	8.2	10.4
Ireland	3254	5617	1034	1072	235	870	78.6	73.0	17.4	13.7	6.3	9.0
Italy	2890	5517	879	1270	79	395	80.8	74.4	19.4	15.6	6.2	7.6
Japan	2254	4125	719	1028	39	142	82.9	76.4	20.9	16.5	4.3	7.0
Netherlands	2876	4626	1018	1123	140	494	80.4	74.6	18.7	14.4	5.5	8.1
New Zealand	3648	5950	1112	1028	204	745	79.5	74.2	19.0	15.4	7.0	6.1
Norway	2510	4867	970	916	132	647	80.8	74.8	19.1	15.5	4.1	5.8
Portugal	3627	8331	910	1250	108	407	78.2	71.0	17.8	14.4	7.4	9.0
Spain	2726	6203	825	1420	69	387	81.6	74.4	19.9	16.0	5.5	6.0
Sweden	2336	4011	835	786	122	536	81.3	75.9	19.7	16.0	4.1	5.5
Switzerland	2756	5329	813	1048	71	368	81.7	75.3	20.2	16.1	5.0	7.0
United Kingdom	3092	5120	1063	1077	211	799	79.4	74.1	18.3	14.7	6.0	8.9
United States	4067	7752	991	1133	224	681	79.2	72.5	18.9	15.6	8.0	7.6
Max/Min	1.804	2.077	1.828	1.907	6.050	6.131	1.066	1.076	1.201	1.204	2.050	2.039
Coefficient of variation	0.146	0.174	0.141	0.147	0.418	0.339	0.015	0.017	0.049	0.050	0.209	0.179

B. Rankings

	PYLL, Total		PYLL, Cancer		PYLL, Heart disease		Life exp. at birth		Life exp. at 65		Infant	Perinatal
	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Mortality	Mortality
Australia	8	6	8	4	11	9	7	5	8	8	12	3
Austria	11	16	12	11	16	15	14	15	13	13	9	7
Belgium	16	13	10	17	5	3	11	14	7	14	17	16
Canada	13	7	13	4	15	11	5	3	4	2	13	9
Denmark	18	10	21	13	17	12	21	19	20	20	6	13
Finland	4	18	3	2	12	20	11	18	15	17	1	1
France	9	19	6	21	2	2	2	13	2	3	5	12
Germany	14	14	14	16	13	13	15	16	16	15	8	7
Greece	6	11	2	15	9	14	11	5	17	3	21	21
Ireland	17	12	18	9	21	21	19	17	21	21	16	19
Italy	12	9	9	19	6	6	7	9	9	9	15	14
Japan	1	2	1	6	1	1	1	1	1	1	4	9
Netherlands	10	3	17	12	13	8	10	8	13	18	10	17
New Zealand	20	15	20	7	18	18	16	11	11	12	17	6
Norway	3	4	15	3	10	16	7	7	10	11	2	3
Portugal	19	21	11	18	7	7	20	21	19	18	19	19
Spain	5	17	5	20	3	5	4	9	5	6	10	5
Sweden	2	1	7	1	8	10	5	2	6	6	2	2
Switzerland	7	8	4	8	4	4	3	3	3	3	6	9
United Kingdom	15	5	19	10	19	19	17	12	18	15	13	18
United States	21	20	16	14	20	17	18	20	12	9	20	14

Source: OECD Health Database.

Table 2. **Correlations between different measures of health outcomes, 1995**

	PYLL, Total		PYLL, Cancer		PYLL, Heart disease		Life exp. at birth		Life exp. at 65		Infant	Perinatal
	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Mortality	Mortality
PYLL, Total (F)	1.00	0.73	0.64	0.27	0.58	0.32	-0.77	-0.74	-0.52	-0.45	0.69	0.35
PYLL, Total (M)		1.00	0.10	0.48	0.16	0.11	-0.52	-0.84	-0.35	-0.26	0.57	0.24
PYLL, Cancer (F)			1.00	-0.04	0.69	0.46	-0.74	-0.43	-0.62	-0.62	0.15	0.14
PYLL, Cancer (M)				1.00	-0.37	-0.46	0.00	-0.32	0.10	0.03	0.34	0.37
PYLL, Heart Disease (F)					1.00	0.88	-0.71	-0.37	-0.70	-0.55	0.33	0.18
PYLL, Heart Disease (M)						1.00	-0.60	-0.33	-0.69	-0.54	0.16	0.04
Life expectancy at birth (F)							1.00	0.81	0.93	0.81	-0.47	-0.41
Life expectancy at birth (M)								1.00	0.69	0.72	-0.37	-0.27
Life expectancy at 65 (F)									1.00	0.86	-0.34	-0.44
Life expectancy at 65 (M)										1.00	-0.08	-0.26
Infant mortality											1.00	0.66
Perinatal mortality												1.00

Source: OECD Health Database.

3. HEALTH SYSTEMS – INPUTS AND ORGANISATION

24. In order to assess the performance of health care systems in improving health status across countries, one important issue to resolve is how to define and measure health care in a comparable way.

Level of Health Inputs

25. First, a common measure of the overall volume of health resources (inputs) is required against which variations in health status can be compared. Total expenditure on health, converted into a comparable measure by Purchasing Power Parities (PPPs) for GDP, has often been used to evaluate the aggregate volume of resources devoted to health care. However, the relationship between the prices of health services and economy-wide prices, and the composition of the type of health services being provided, is likely to vary considerably across countries. Hence the use of GDP PPPs will distort the true underlying differences in the volume of health services being provided in each country. *A priori*, health-care specific PPPs should be used to eliminate the differences in health care prices across countries. However, the calculation of health-care PPPs is subject to some important limitations (see, OECD 1994) and their reliability has been questioned.

26. The choice of conversion factor for international comparisons of health care expenditure has a direct influence on the results and may be one reason for why there has been conflicting empirical evidence based on aggregate data about the impact of health expenditure on health.[5] Some studies have shown little or no impact of aggregate health expenditure on health status while others have shown a somewhat stronger positive impact.

27. It may therefore be useful to compare more direct (non-monetary) measures of the supply and the use of health care to avoid conversion issues. Here, there are basically two types of measures which can be distinguished according to whether they represent inputs to or intermediate outputs of health care. Input measures such as the stock of doctors, nurses and hospital beds, capture the level of real resources used by the health care system. Intermediate output measures such as the number of doctor consultations, hospital stays and drugs dispensed, measure the flow of activities produced or actual utilisation of the health care system. These two measures of the volume of health care may differ across countries and through time because of differences in, or changes to, productivity.

28. There are a number of studies which have used various input measures of health care to explain national variations in health status. In one of the few studies which incorporates not just one but several of these direct measures of health inputs, Or (1997) finds that the number of doctors in a country is negatively associated with premature mortality, while there appears to be no relationship between premature mortality and the number of hospital beds or total health employment (excluding doctors)[6]. The number of doctors also appears to be a significant variable in other empirical studies using cross-country, time-series data

[5] See for example, Wolfe 1986; Babazano and Hilman, 1994; Hitiris and Posnet, 1994; Elola et al., 1995; Or, 2000.

[6] These results were replicated for this study and consequently the number of hospital bed and total health personnel were dropped from the analysis.

(see, for example, Grubaugh and Santerre, 1994). However, studies based on cross-country data for one year only show conflicting results.

29. There are even fewer international studies which use direct measures of activity rates to examine the relationship between the volume of health care and health status. This is mainly due to a lack of comparable utilisation data on a cross-country, time series basis. It would also be of interest to capture country differences in the use of high technology that is involved in performing medical procedures such as cat scans or key-hole surgery. But again this is not currently possible because of data limitations.

30. Therefore, this study concentrates on the number of doctors per capita to capture variations in the level of health inputs across countries. While doctors are only one health care resource, they do represent a key input for the production of health care in any health system. Doctors generally take the lead in diagnosing illness and in prescribing treatment. Moreover, it is usually doctors who are the agents of technological change in the system - responsible for introducing the new medical technologies which are likely to be the source of increases in the marginal effectiveness of medical care over time.

Health System Characteristics

31. The level of health inputs is only one aspect of a health system. Institutional arrangements which regulate access to health care, and the method of payment for health services, may also have a bearing on health status. While the relationship between these arrangements and total expenditure on health has been a major issue for research, their impact on health status has been little explored. Therefore, the analysis in this paper includes a number of variables to capture the effect of these arrangements. The different arrangements that are taken into consideration are discussed below.

32. The split between the public and private financing of health services may influence access to, and use of, medical resources by different social groups. There is some evidence of a positive impact of public funding on overall mortality and morbidity rates (Leu, 1986; Babazano, 1994; Or, 2000). Public financing and provision of services is likely to increase the chance that patients can afford services which are otherwise too expensive, thus contributing to the "fairness" of the system. It is therefore important to test the impact of public financing on health outcomes, while controlling for the level of health inputs.

Box 2. Ambulatory care -- Methods of paying doctors and referral practices

Principal payment methods used to fund doctors:

Fee-for-service: Under fee-for-service (FFS) arrangements, doctors are remunerated for each item of service they provide. Doctors have full discretion over the level and mix of services they supply. Fee levels are usually negotiated centrally when health insurance is public, sometimes with the possibility of "extra billing" by the individual practitioners. Under fee-for-service arrangements doctors have financial incentives to increase the volume and price of services they provide. In a market in which consumers are not fully informed, that may inflate costs without improving health status.

Salaries: The advantages of a system where doctors are remunerated on a wage and salary basis are known to be easier financial planning and cost control (OECD, 1994; Maynard 1986). Salaries are globally negotiated between physicians' associations and the central governments. In salaried systems general practitioners have little financial incentive to compete for patients. It might be difficult to motivate doctors –especially the ones who have reached the top of the scale- to act on patients' true interest. Patients might suffer from lack of appropriate attention and choice as well as inappropriate referral to secondary providers, as doctors might like to minimise the time spent with each patient. Despite these concerns, there is no empirical study suggesting a low diagnostic quality by salaried doctors. While it is suggested that salaried doctors tend not to maximise their patient turnover (Hickson et al. 1987), there is no direct evidence of the use of salary arrangements on the overall use of health services by patients and/or on their health status.

Capitation: Capitation is a method of payment often used in primary care. Doctors receive an annual fixed payment in advance for each patient in their list. Payments are often adjusted for patient's age. The main advantage claimed for this method is that when it is combined with patient choice of doctor, it motivates doctors to practice in a way that encourages patients to join their list. Meanwhile, funders can control the overall level of payment. It is also argued that this type of per-capita payments might encourage more preventive activities because the doctor's income is independent of the number of consultations for a given patient (Donaldson and Gerard, 1992). The disadvantages of this system are that guaranteed payment might encourage doctors to choose only low-cost (low risk) patients and/or to reduce their financial and time costs by under-serving them, by prescribing more and by increasing referral to hospitals.

Referral practices:

Gatekeeper: One of the traditional arrangements for preventing over-use of expensive specialist and hospital services, involved the use of primary doctors as the "gateway" to such services. In many OECD countries, such as the UK, the Netherlands, Australia and Italy, the primary care sector has been organised around general practitioners being gatekeepers of the system. Except in emergencies, direct patient access to secondary care is rare and a GP referral is needed. The impact on utilisation of health care services of this type of arrangements has not been much studied. In terms of cost containment, OECD (1994) reported that "gatekeeping" can lower overall expenditure on in-patient care. The impact of the 'restricted' services on health is supposed to be close to zero. It is however possible that this restriction on the consumers choice might result in under-consumption (unmet needs) of health services otherwise beneficial to health status.

33. Doctors are not only the primary health care resource in any country, but they are also the principal allocators of health care resources. That is why the main features of each country's health system are shaped by the specific policies that are in place for regulating physicians' practices and their way of managing resources. The institutional features of a health system include the different schemes for reimbursement (fee for service or fixed payment, etc.) as well as physician referral practices (direct or indirect access to specialists). Box 2 provides more details on the different instruments employed to control the supply of ambulatory care.

34. Hospitals are also important providers of health care. Clearly, funding arrangements for hospitals and for doctors services provided within hospitals can play an important role in determining the level, quality and price of health care services. These arrangements are summarised in Box 3.

Box 3. Secondary care -- Methods of paying hospitals

Global budgeting: This is often the principal payment method in systems where the government is the major provider (as well as the funder) of hospital services (for example in the United Kingdom, prior to 1991, and in Spain). Hospitals receive an annual budget to cover all their service costs, except capital spending. It is often argued that while block funding provides a relatively direct way of containing cost, it provides few incentives for producers to improve the efficiency, quality and level of their services. Perverse incentives may also arise, if the budget level is set too low by the funder.

Bed-day payments: With this method, overall funding is capped by hospital capacity. Hospitals are paid a flat rate fee per occupied bed. As in the case of global budgets, funding decisions do not incorporate information on relative cost or quality of treatment methods. Suppliers might face incentives to lower patient turnover and prolong length of stay to offset the high initial costs of treatment.

Fee-for-service: Hospitals are paid for individual services provided. This method is used mostly in systems with multiple insurers. Specialists can be paid on a fee-for-service basis both in public and private hospitals. The possible weakness of this system is low cost-control on macro level, as providers will have incentives to raise the quantity and price of services provided. On the other hand, this system may contribute to increased competition between suppliers on the basis of higher quality.

4. MODELLING HEALTH STATUS: DATA AND METHODOLOGY

35. The empirical analysis uses a panel of 21 OECD countries covering the years 1970-1995[7]. Most data come from OECD Health Data files. The data on occupational status have been derived from various editions of the ILO *Yearbook of Labour Statistics* and from national surveys.

36. Variations in health status across countries and over time are explained using the following general equation:

$$H_{it} = \alpha_i + X_{it}\beta + \varepsilon_{it}, \qquad (1)$$

where H is a measure of health status, X is a vector of independent variables influencing health, and ε is the error term. The subscripts *i* and *t* refer to country and time, respectively. β, vector of the coefficients is assumed to be constant across countries and over time.

37. Essentially, health status is considered to be the output of a transformation process where the inputs are the medical system, as well as a range of non-medical factors. Following health production theory and the evidence from previous empirical work (Or 1997, 2000), the factors determining health can be classified into four major groups: the level of medical care inputs, medical care institutions, determinants potentially amenable to public health interventions and background variables. Distinguishing the role of each of these different factors in determining health status may help to provide guidance for health policy makers.[8]

38. As discussed before, the number of doctors will be used to measure medical care input across countries. Two other input variables (number of hospital beds and total health employment) are dropped from the analysis, as they appear to have no significant impact on health status . The main institutional features of the medical system included in the regression analysis are the mode of financing care (public/private) and the type of reimbursement and access arrangements that are employed in primary and secondary care (as presented in Boxes 2 and 3).

39. Alcohol and tobacco are well known individual lifestyle risk factors for health. These are two main areas where active "public health interventions" can play an important role in promoting health status as recommended by WHO.

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7 The Czech Republic, Hungary, Iceland, Korea, Luxembourg, Mexico, Poland and Turkey are not included in the analysis because of insufficiently long time-series data for some variables.

8 This approach differs somewhat from the one adopted in the *WHO World Health Report 2000* where health outcomes are modelled only as a function of total health expenditures and human capital (educational attainment). While the WHO approach attempts to measure the overall performance of the health system in each country, it is not designed to cast light on the relative importance of different aspects of the health system in improving health. The WHO approach also involves estimating a health "frontier" rather than a standard production function as adopted in this paper.

40. At the same time there are a number of "background" factors for which the health system can not be held directly responsible. The background variables controlled for in the regression analysis are income (GDP), occupational status and air pollution. GDP controls for differences in economic development and it is reasonable to expect a positive impact on health as higher income results in better nutrition, housing, schooling, etc. The share of white-collar workers in the total work force is introduced as a proxy measure of occupational status and education. The shift from blue-collar to white-collar jobs may represent an improvement of working conditions as well as in the level of education of work force, and thus should have a positive impact on health.[9] As has been well established by various epidemiological studies, air pollution is expected to have a negative impact on health.[10] The complete list of explanatory variables included in the estimations is presented in Box 4[11].

Box 4. Definitions of variables

Doctor	Number of active physicians per 1000 population.
Pubexp	Share of public expenditure in total health expenditure.
Ambwage	Dummy variable, one for countries with wage and salary as dominant means of payment in primary care, zero otherwise. Values between 0 and 1 represent the proportion of physicians which are paid on a wage or salary basis.
Ambffs	Dummy variable, one for countries with fee-for service as dominant means of payment in primary care, zero otherwise. Values between 0 and 1 represent the proportion of physicians which are paid on a fee-for-service basis.
Ambcapit	Dummy variable, one for countries with capitation as dominant means of payment in primary care, zero otherwise. Values between 0 and 1 represent the proportion of physicians which are paid on a capitation basis.
Gatekeeper	Dummy variable, one for countries with physicians acting as gatekeepers, zero otherwise.
Hosgloba	Dummy variable, one for countries with global budget and bed-day as dominant means of payment in secondary care, zero otherwise. Values between 0 and 1 represent the proportion of hospitals which are paid on global budgets.
Hosffs	Dummy variable, one for countries with fee-for-service as dominant means of payment in hospital care, zero otherwise. Values between 0 and 1 represent the proportion of hospitals which are paid on a fee-for-service basis.
GDP	Gross Domestic Product per capita, US$, 1993 price levels and PPP for GDP.
Occupation	Share of white-collar workers in total work force.
Alcohol	Consumption of alcoholic beverages, litres per population aged 15 and over.
Tobacco	Consumption of tobacco, grams per head of population aged 15 and over.
NOx	NOx emissions per capita, kg.

[9] The use of a direct measure of educational attainment based on years of schooling or level of education completed is precluded in this study by the absence of time-series data on a comparable cross-country basis.

[10] See, for example, Derrienic *et al.* (1989); Sunyer et al. (1991); Dockery and Pope (1994); and ORS (1994).

[11] See Table A.4 for coefficients of correlation between explanatory variables.

41. The same specification is used to estimate the range of mortality rates presented above (infant mortality, perinatal mortality, standardised, sex specific PYLL and life expectancy at age 65). These measures have been selected to cover the health of different groups within each country's population and for certain specific causes of death. As already mentioned, each indicator gives a different weight to death occurring at different ages and provides a different perspective on health status. In order to keep the tables to a more digestible size it was decided not to include separate results for life expectancy at birth as these results were quite similar to the ones reported for overall premature mortality.

42. For each measure, apart from prenatal and infant mortality, the model is estimated for men and women separately. A feasible generalised least square (GLS) method is used to correct for cross-section heteroscedasticity and for autocorrelation specific to each unit (country). The robustness of the results is tested using different specifications and estimation techniques including fixed-effect OLS estimations (see Annex). In order to control for the possible impact of multicollinearity between institutional variables (methods of paying doctors, hospitals, etc.), the equations are also estimated with one of the variables in each group of dummy variables omitted. These results are also presented in the Annex.

43. Possible dynamic effects are not considered in these equations. The inclusion of a lagged dependent variable in this type of analysis where the true dynamic structure is difficult to determine *a priori* can easily introduce error into the estimation results. Moreover, in panel data estimations, the implementation of dynamic models is still in development. Besides, previous work (Or, 2000b) showed that including simple lags of the explanatory variables did not alter qualitatively the main results of the same equations estimated without lags.

5. RESULTS OF THE REGRESSION ANALYSIS

44. Table 3 reports the results of the GLS estimations as specified above. In reading this table, it should be born in mind that, except for life expectancy at age 65, negative coefficients indicate a negative relationship with mortality, hence a positive impact on health.

Premature mortality (Columns 1 and 2)

45. The results reported in Columns 1 and 2 indicate that the impact of health care, as measured by doctors per capita, on premature mortality appears to be relatively large and significant for both men and women. While the coefficient of "doctor" is visibly lower for men compared with women, it is still the second most important variable (after occupation) in terms of explaining variations in premature mortality across countries and over time. According to the results in Columns 1 and 2, a 10 per cent increase in doctors, holding all other factors constant, would result in a reduction in premature mortality of almost 4 per cent for women and about 3 per cent for men.

46. A larger share of public financing of health care is also associated with lower rates of premature mortality. The coefficients are similar for both sexes. This might reflect the likelihood that publicly funded systems provide a more equitable service provision, and the fact that most prevention programs, such as cancer screening and/or education programs for a healthy life style, are mainly funded by the public sector in most countries.

47. In terms of the institutional set up for funding arrangements, the only (weakly) significant variable in both equations is the one measuring whether countries have fee-for service arrangements in hospital care ("hosffs"). Countries employing these arrangements appear to have higher rates of premature mortality compared to the ones having "global budgeting". In the equation for female premature mortality, "capitation" is also weakly significant. The negative coefficient suggests that the countries which reimburse their doctors by capitation have been more successful in reducing premature mortality. While this result is not directly confirmed by the equation for men, the positive coefficient on the "ambwage" is consistent with this argument, i.e. salary and wage arrangements in primary care tend to be less efficient than other arrangements. However, as discussed in the appendix dealing with robustness of these results, the estimates of the individual effects of the various institutional variables do appear to be quite sensitive to different measures of health status and different estimation methods. Clearly, further research is called for before the impact on health of specific system features can be firmly established.

48. Turning to non-medical factors, the variable "occupation" appears to be the most important determinant of premature mortality for both sexes. A number of studies have pointed to wide inequalities in illness and death across social categories in most OECD countries.[12] Despite the improvements in working conditions, even today fatality rates tend to be much higher in blue-collar occupations than in white-collar ones. In interpreting these results, it is also important to bear in mind that this variable may be

[12] See for example, Feinstein, 1993; Christiansen, 1994; Helmert and Shea, 1994; Benzeval *et al*, 1995.

acting as a proxy for educational attainment. Increased level of educational attainment has gone hand-in-hand with a rise in white-collar jobs in workforce in all OECD countries.

49. Economic growth (GDP) is also one of the most important factors behind the reduction in premature mortality both for men and women with a similar magnitude. This is consistent with the theory that economic development improves health through its contribution to a better quality of life, with improved housing conditions, sanitation, road safety, public hygiene, nutrition, etc.

50. The results also confirm that there is a positive relationship between alcohol and tobacco consumption and premature mortality. It would appear that the impact of alcohol consumption on male premature mortality is slightly more pronounced. It is interesting to observe that the impact of air pollution on premature mortality appears to have been as important as that of tobacco consumption over the past 25 years, in industrialised countries.

Table 3. **Estimates of the determinants of health outcomes**

	Premature Mortality		*Life Expectancy at 65*		*Perinatal*	*Infant*	*PYLL-Heart Diseases*		*PYLL-Cancer*	
Variable	Women	Men	Women	Men	*mortality*	*mortality*	Women	Men	Women	Men
Doctor	-0.3761 **	-0.2751 **	0.1005 **	0.1007 **	-0.5777 **	-0.6447 **	-0.6583 **	-0.5730 **	-0.1846 **	-0.0176
Pubsh	-0.1251 **	-0.1595 **	0.0045	-0.0116	-0.1485 *	-0.2319 **	0.0982	0.1537 *	0.0023	-0.0145
Ambwage	-0.0515	0.1005 **	-0.0028	0.0034	-0.2548 **	-0.0383	0.0141	-0.2056 **	-0.0698 **	-0.1061 *
Ambffs	-0.0059	0.0016	0.0025	0.0072	-0.0446	-0.0073	-0.0581	-0.0409	0.0042	-0.0180
Ambcapit	-0.0368	-0.0013	-0.0040	-0.0033	0.0248	-0.0255	0.0326	0.0207	-0.0264 *	-0.0208
Gatekeep	0.0314	0.0085	0.0022	-0.0116	-0.1299 **	-0.0326	0.0767	-0.0356	0.1046 **	0.0193
Hosffs	0.0622	0.0757 *	0.0146	-0.0103	-0.0218	-0.0077	0.2523 **	0.1014 **	0.0620 **	0.0603 **
Hosgloba	0.0035	-0.0131	0.0100	0.0024	0.0018	-0.0450	0.0996 **	0.0194	-0.0101	-0.0320 *
GDP	-0.2415 **	-0.2640 **	0.0969 **	0.0919 **	-0.4458 **	-0.4888 **	-0.5243 **	-0.4398 **	-0.1705 **	-0.1995 **
Ocupation	-0.4004 **	-0.4297 **	0.0836 **	0.0476 *	-0.6138 **	-0.7593 **	0.4782 **	0.3323 **	0.0849 *	-0.1267 **
Alcohol	0.1134 **	0.1731 **	-0.0137 *	-0.0220 *	0.1124 **	0.1934 **	0.0449	0.0139	0.0247	0.0982 **
Tobacco	0.0876 **	0.0636 **	-0.0180 **	-0.0339 **	0.2002 **	0.1402 **	0.2687 **	0.2822 **	0.0785 **	0.1130 **
Nox	0.0813 **	0.0933 **	-0.0083	-0.0145 *	0.0042	0.1046 **	0.2927 **	0.3141 **	0.0646 **	0.0330 **
Intercept	11.6396 **	12.6359 **	1.7225 **	1.9360 **	8.4055 **	9.4545 **	5.0463 **	6.0397 **	7.4364 **	8.3716 **
Chi2(13)	965	1449	1874	661	1009	1116	647	767	783	958
LL	1383	1410	2064	1937	1072	1097	996	1118	1451	1462

* significant at 5 per cent level; ** significant at the 1 per cent level.

Life expectancy at age 65 (Columns 3 and 4)

51. A slightly different picture emerges when considering life expectancy at age 65. For older people, medical care appears to be the most important determinant of health for both sexes. The results suggest that a 10 per cent increase in doctors, all else being equal, would increase life expectancy at 65 by 1 per cent (i.e. 1.8 months for men and 2.4 months for women).[13]

52. The other important determinants of health at this age appear to be income and occupation/education with similar coefficients in magnitude. The share of public health expenditure, on the other hand, is no longer significant. This might be due to the fact that in many countries health services for the elderly are organised in different social schemes than for the rest of the population. Elderly people often have special concessions in terms of their access and use of health care. Even in countries where public health spending is relatively low such as the US, access to health care for elderly is better assured than the rest of the population.

53. The health system variables also do not appear to have a significant impact on the health of the elderly. In the same way, some of these instruments, such as fee-for-service payments might become irrelevant to elderly, as in some countries they are subject to special arrangements. While the existence of a "gatekeeper" is still relevant for this age group, it does not appear to have a significant impact on their health.

54. Both alcohol and tobacco consumption appear to have a significant impact on life expectancy at age 65, and this is slightly more pronounced for men. However, the relative impact of alcohol and tobacco is smaller compared to that on premature mortality. A small but significant negative impact of air pollution on life expectancy of this age group is also confirmed for men.

Perinatal and infant mortality (Columns 5 and 6)

55. The results for perinatal and infant mortality are similar to the results for premature mortality. Both for perinatal and infant mortality the number of doctors per capita appears to be the second most important variable (behind occupation). The coefficients suggest that, all else equal, a 10 per cent increase in the number of doctors would result in almost a 6 per cent decrease in perinatal mortality and a 6½ per cent decrease in infant mortality.

56. In addition, public financing also appears to be a significant factor in reducing both infant and perinatal mortality. It should be noted that, for perinatal mortality, the coefficient of public share doubles when the institutional dummy variables are dropped from the equation (see Annex Table A.1).

57. With respect to the health system institutional variables, however, there is less similarity between the results. In terms of perinatal mortality, countries with primary physicians reimbursed by a salary and acting as gatekeepers for secondary care appear to perform better. These results are not confirmed for infant mortality.

58. As to the non-medical factors, in both equations the impact of the occupation variable is particularly large and significant. Holding all other factors constant, a 10 percent increase in the share of

[13] Based on the average --across the countries in the sample-- of life expectancy at 65 of 15.6 years for men and 19.5 years for woman in 1998.

white-collar workers in the workforce implies a 6 per cent reduction in perinatal mortality and more than a 7 per cent decline in infant mortality. Per capita GDP appears to be the third factor of importance (after occupation and doctors) in both equations with similar coefficients.

59. The impact of tobacco consumption on perinatal mortality is particularly strong. A 10 per cent increase in tobacco consumption implies about a 2 percent increase in perinatal mortality, all else held constant. Alcohol consumption has also a significant impact on prenatal mortality, but the coefficient is smaller. For infant mortality both alcohol and tobacco consumption appear to be significant risk factors with relatively strong coefficients.

60. Perinatal mortality does not appear to be significantly related to air pollution, while infant mortality is. The results suggest that a 10 per cent increase in NOx emissions, all else equal, results in more than a 1 per cent increase in infant mortality. It is interesting to note that this corresponds to the lower end of the range suggested by most epidemiological studies (see for example, ORS, 1994; Dockery and Pope, 1994).

Causes of premature mortality (Columns 7 to 10)

61. Columns 7 and 8 present the estimations of PYLL due to ischeamic heart diseases for women and men respectively. The last two columns of Table 3 correspond to estimations of PYLL due to cancer.

62. With respect to *heart diseases*, health care (i.e. the number of doctors per capita) appears to be the most important factor behind the reduction in premature mortality. The coefficients are highly significant both for women and men. The results suggest that a 10 per cent increase in the number of doctors, holding all other factors constant, would lead to almost a 6 per cent reduction in premature mortality by heart diseases for men and 6½ per cent for women. As mentioned earlier, mortality reductions for this cause of death have been particularly important in the last 30 years in all countries (see Chart 1, Panel B). A recent study by Cutler and Kadiyala (1999) looking into factors behind this progress also suggests that advances in medical knowledge and intervention explain more than one fourth of the reduction in cardiovascular diseases in the United States.

63. Public financing, on the other hand, does not appear to have played a significant role in explaining the reduction of premature mortality due to this specific cause. The coefficient is significant but has a “wrong” sign for men. The only consistently significant instrumental variable is “hosffs” with a positive coefficient. The results suggest that, countries with fee-for-service arrangements in secondary care appear to have higher premature mortality.

64. Somewhat surprisingly the impact of the variable for occupation on the rate of premature mortality by heart diseases is contrary to what might be expected. The coefficient is positive and significant both for men and women. While this result is not robust to changes in the method of estimation (see the appendix on robustness), it still raises questions as to the relationship between occupational, educational and life-style changes. For example, there is some evidence from health surveys suggesting that long hours of office work are associated with an increase in risk factors (low exercise, high alcohol consumption, etc.) which might lead to health problems (Schofield, 1996).

65. It is also interesting to see that air pollution together with tobacco consumption is a major determinant of premature mortality by heart diseases. The results suggests that, holding all other factors constant, the impact of a 10 per cent increase in NOx emissions is similar to that of a 10 percent increase in tobacco consumption which leads to about a 3 percent increase in premature mortality by heart disease. Alcohol consumption, on the other hand, does not appear to be a significant factor.

66. Considering the equations for *malignant neoplasm*, the impact of health care on premature mortality appears to be different for men and women. For women, the number of doctors per capita is one of the major factors –-together with GDP per capita-- behind the reduction in the premature mortality by cancer, while for men it is not significant. However, this variable is significant for men when health system dummies are dropped from the equations, but the coefficient is only half as large as the one for women (see Annex Tables A.1 and A.2). This result for women is robust across different estimations, and might suggest that medicine has made relatively more progress, in the last 25 years, in areas where women are concerned (e.g. in treating breast cancer as opposed to prostate cancer and lung cancer). Clearly, the equations presented here are too broad to verify specific hypothesis of this kind, but it would be interesting to pursue this further.

67. A positive coefficient for "hosffs" is also confirmed in these equations, suggesting that countries with fee-for-service arrangements in the hospital sector have higher rates of premature mortality by cancer. The impact of "gatekeeper" is also significant for women, implying that countries with doctors acting as gatekeepers to secondary care have higher female premature mortality for women. This result is not confirmed for men.

68. As for heart disease, the estimated impact of occupation on cancer mortality is difficult to interpret. The coefficient is not significant for women, and has a positive sign for men. Further research with separate and more detailed occupational data for men and women might be warranted to investigate the relationship between new work patterns and specific diseases. Both alcohol and tobacco consumption appear to have a more significant impact on male premature mortality because of cancer than on female premature mortality. While a negative relationship between air pollution and cancer mortality is also established by these equations, the impact is relatively small compared to that on heart diseases.

6. DISCUSSION AND CONCLUSIONS

69. This paper adds to the debate over the benefits of health care in OECD countries by providing some new evidence on the role of medical care systems in determining mortality, after allowing for the role of risk factors amenable to public health interventions and other non-medical determinants.

70. Over the past three decades, health status in all OECD countries has improved significantly. This progress has not been entirely uniform across countries and across different indicators of health status, and despite some convergence there are still substantial disparities across countries in health status. The factors behind these patterns are no doubt more complex and varied than the ones identified in this study, but nevertheless a number of interesting results can be listed.

71. First, the findings reported above suggest that the contribution of the volume of health care - or, more specifically, of the number of active physicians - to reducing mortality in OECD countries is substantial. This result is consistent across different health indicators and robust between different estimation techniques (see Annex). Previous econometric work (Or, 2000) suggested that the impact of real health expenditure on premature mortality was small and, in the case of men, statistically insignificant. The finding of a much larger impact for doctor numbers, here, may arise because there is less correlation between doctor numbers and other determinants of health status, such as GDP per capita, than between health expenditure per capita and these other determinants.

72. It has been part of the received wisdom - based partly on research published 20 or 30 years ago, using cross sectional data - that the marginal impact of health care on health is low in industrialised countries. What could account for the higher estimates reported above? A first point to make is that the use of a large panel data set improves the estimations compared to the previous cross sectional empirical work. At the same time it is possibile that doctor numbers are a good proxy for the volume of medical care as a whole and that more medical care, even at the high levels found in most OECD countries, is good for health. Another possibility is that doctors are a particularly effective input to health care. A third possibility is that the number of doctors or the growth rate of doctors is linked to the rate of diffusion of new medical technology and that new medical technology is more effective than old technology.

73. There has been enormous progress in medical technology over the past 30 years. In the United States, a recent study suggests that a third of the reduction in cardiovascular diseases can be attributed to the improvements in medical care (Cutler and Richardson, 1997; Cutler and Kadiyala, 1999). Similarly, examining the evolution of specific causes of premature mortality, numerous studies in Europe have consistently found that the causes of death for which there are effective medical treatments have fallen at a faster rate than other deaths.[14]

74. There would be strong policy implications if the finding about the importance of doctors in generating health outcomes were shown to be robust, following further research. Many OECD countries control the number of doctors who are allowed to enter training or to practice. The planned number of doctors has often been decided more on the basis of cost than on the basis of benefits. The findings

[14] For example, Poikolainen and Eskola (1986),Mackenbach et al. (1988), Jougla et al. (1987).

reported above are likely to be of interest to countries which do not control numbers of doctors as well as to those which do.

75. Secondly, the findings reported above suggest that the characteristics of medical care systems, investigated so far, are less important than variations in the number of doctors in affecting mortality. There is confirmation of earlier findings that the higher the public share of health expenditure the lower is perinatal, infant and premature mortality. In addition, the results of this paper point to fee-for-service arrangements in the hospital sector as not being necessarily conducive to better health. One possible explanation for this could be the fact that in systems where hospital funding is based on fee-for-service, hospital costs are usually controlled through regulated competition. It has been suggested that competitive initiatives (in the form of HMOs), which only regulate care on the basis of price, achieve cost savings mainly through reductions in the quantity of services provided rather than in the prices of services. These cost savings might be achieved through 'cream skimming' and/or at the possible expense of patient outcomes (Donaldson and Gerard, 1992). Systems functioning under global budgets might have a more integrated approach to health outcomes. However, the analysis presented in this paper should only be seen as an exploratory investigation of the role of funding mechanisms on health outcomes. It is important to develop better and more detailed data on these institutional aspects of health systems to establish more clearly the links between major health reforms and health performance. Meanwhile, it should be noted that the characteristics of health care systems might have also a considerable impact on health expenditure (OECD, 1995).

76. Thirdly, the results confirm that there is a significant potential for public health initiatives such as anti-smoking and anti-drinking campaigns to improve health status. While it is not surprising to find a negative impact on health of well known risk factors such as alcohol and tobacco consumption, the weight of these factors in determining overall health performance at the national level is sobering. For example, in the case of perinatal mortality, the coefficient of tobacco consumption corresponds to half the coefficient of economic development. The variables included in this analysis represent only two major areas for public intervention. Clearly, the scope for educative and preventative measures is much larger. For example, there is accumulating evidence both on the importance of dietary patterns for health and on the increasing prevalence of obesity in many OECD countries[15]. Clearly, an effective health policy framework has to recognise the role for public health with well defined objectives.

77. Finally, the results set out above confirm also that it is important to recognise that a wider range of socio-economic and environmental factors influence a country's health performance. The overall economic well-being of a country is clearly an important factor in improving health status. While there might be a diminishing return to scale in terms of health for richer countries (as argued by Wilkinson, 1992, and Heerink, 1994), this return is still significant. One possible adverse side-effect of economic growth is suggested by the finding of a significantly negative impact of air pollution on health. Occupational status also appears to play a key role as a determinant of health status but has often been overlooked in previous studies. It is well established that there are considerable health inequalities across social-economic classes, but the reasons for these differences are less well identified. Education is an important component in this relationship, as it determines many of the decisions which affect the quality of life: choice of job, ability to adopt a healthy life style, effective use of medical care, etc.

78. While the analysis put forward in this paper contributes to the identification of major factors behind variations in health performance in OECD countries, the theoretical and empirical framework proposed here can be developed further in several dimensions. For example, no attempt has been made to improve model specification and functional form or to recognise dynamic effects, such as allowing for lags

[15] See for example, Lehingue et al. (1996), Corrao et al. (1995), Ekoe et al (1992), O'Connor (1992), Manson et al. (1995).

in the impact of various explanatory factors on health. Further work is also required to incorporate quality of life aspects into health status measures, and to refine the explanatory variables representing not only the medical system, but also life style, social and environmental factors. For example, income inequalities have been shown to be associated with health inequalities. Also, it would be interesting to examine separately for men and women variations in medical-care consumption, education, life-style, etc. Finally, a more thorough analysis of the impact of different institutional factors would also be of direct relevance to policy.

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ANNEX

ROBUSTNESS OF THE ESTIMATIONS

79. In order to establish the robustness of the estimated coefficients presented in Tables 3 a range of sensitivity analyses has been conducted.

80. The introduction of a set of health system dummy variables is likely to increase the possibility of multicollinearity between the exogenous in the estimated equations. This seems to be a problem particularly for variables which do not have much variation over time such as the public share of health expenditure. To verify the stability of other explanatory variables, all of the equations were estimated without any health system dummy variables (see Table A.1).

81. The results are remarkably stable for overall premature mortality and life expectancy at age 65, while the impact of public share of health expenditure becomes significant for perinatal mortality. Another notable exception is that health care (doctors) becomes significant for preventing male premature mortality by cancer when institutional factors are not included.

82. The overall significance of the health system variables was tested using a classical F-test. The results of the F-test suggest that the institutional variables are jointly significant in explaining health status. However, the high collinearity between the institutional variables might make it difficult to isolate the real impact of each individual variable on health. As already mentioned, the magnitude and sign of the coefficients on the institutional variables are generally sensitive to the estimation technique used and to different specifications. While multicollinearity causes no bias in the estimated coefficients, and has little effect on the overall significance of the regression or on the estimates of any noncollinear variables, it becomes difficult to identify the separate effects of each of the collinear variables in an equation (Studenmund, 1992; Judge *et al*., 1980).

83. Therefore, for each equation the sensitivity of the results was also tested by dropping one of the variables in each subgroup. More specifically, in the equations presented in Table A.2, two variables – wage and salary payment for doctors (Ambwage) and fee-for-service in hospitals (Hosffs) – have been dropped. As expected, the coefficients of "hosglobal" goes up slightly in most equations but the difference is not significant except for male premature mortality (all causes). The significance and relative size of the other variables appear to be little affected, except for the variable "gatekeeper" which also appears to have a significantly positive impact on premature mortality in contrast to being insignificant when all of the institutional variables are included.

Table A.1. **GLS estimates of the determinants of health outcomes without medical system dummies**

	Premature Mortality		*Life Expectancy at 65*		*Perinatal*	*Infant*	*PYLL-Heart Diseases*		*PYLL-Cancer*	
Variable	Women	Men	Women	Men	*mortality*	*mortality*	Women	Men	Women	Men
Doctor	-0.3794 **	-0.2886 **	0.1012 **	0.1109 **	-0.5634 **	-0.6445 **	-0.5836 **	-0.5189 **	-0.1976 **	-0.0962 **
Pubsh	-0.1388 **	-0.1513 **	-0.0071	-0.0217	-0.2832 **	-0.2070 **	0.1767	0.1403 *	0.0501	0.0123
GDP	-0.2378 **	-0.2710 **	0.0912 **	0.1006 **	-0.4167 **	-0.4570 **	-0.5273 **	-0.3658 **	-0.1342 **	-0.1825 **
Ocupation	-0.3863 **	-0.4332 **	0.0922 **	0.0366 *	-0.5413 **	-0.7678 **	0.4363 **	0.4446 **	0.0588	-0.0187
Alcohol	0.1390 **	0.1469 **	-0.0081	-0.0117	0.1187 *	0.1928 **	0.0780	0.0410	0.0610 **	0.1575 **
Tobacco	0.1004 **	0.0609 *	-0.0170 **	-0.0356 **	0.2814 **	0.1121 **	0.2555 **	0.3383 **	0.1015 **	0.1073 **
Nox	0.0690 **	0.0993 **	-0.0081	-0.0168 *	-0.0220	0.0761 *	0.2480 **	0.2719 **	0.0756 **	0.0104
Intercept	11.4991 **	12.6988 **	1.7836 **	1.9224 **	7.6907 **	9.3165 **	5.1801 **	4.5502 **	6.7507 **	7.7446 **
Chi2(7)	727	740	2198	579	905	1248	304	351	396	543
LL	1380	1416	2072	1936	1064	1098	1002	1124	1441	1431

* significant at 5 per cent level; ** significant at the 1 per cent level.

Table A.2. **GLS estimates of the determinants of health outcomes with some medical system dummies omitted**

	Premature Mortality		*Life Expectancy at 65*		*Perinatal*	*Infant*	*PYLL-Heart Diseases*		*PYLL-Cancer*	
Variable	Women	Men	Women	Men	*mortality*	*mortality*	Women	Men	Women	Men
Doctor	-0.3784 **	-0.2777 **	0.1014 **	0.1102 **	-0.5860 **	-0.6505 **	-0.6468 **	-0.4950 **	-0.2019 **	-0.0427
Pubsh	-0.1300 **	-0.1653 **	-0.0005	-0.0162	-0.2019 **	-0.2178 **	0.1828 *	0.1109	0.0363	-0.0270
ambffs	0.0069	-0.0015	0.0075	0.0073	0.0427	0.0011	-0.0177	-0.0002	0.0387 **	-0.0170
ambcapit	-0.0318	-0.0112	-0.0025	-0.0044	0.0670 *	-0.0203	0.0387	0.0411	-0.0066	-0.0195
gatekeep	0.0601 *	-0.0231	0.0019	-0.0124	-0.1262 **	-0.0302	0.0395	-0.0841 *	0.0939 **	0.0293
hosgloba	-0.0177	-0.0477 **	0.0011	0.0057	-0.0169	-0.0404	0.0166	-0.0584 *	-0.0570 **	-0.0619 **
GDP	-0.2329 **	-0.2769 **	0.0923 **	0.0889 **	-0.4168 **	-0.4836 **	-0.4388 **	-0.3777 **	-0.1719 **	-0.1994 **
Ocupation	-0.3878 **	-0.4314 **	0.0896 **	0.0430 *	-0.5440 **	-0.7470 **	0.5002 **	0.3937 **	0.1329 **	-0.0766
Alcohol	0.1302 **	0.1974 **	-0.0105	-0.0204 *	0.1214 **	0.1957 **	0.0918 *	0.0435	0.0290	0.1131 **
Tobacco	0.0857 **	0.0419	-0.0173 **	-0.0362 **	0.2506 **	0.1394 **	0.2901 **	0.3279 **	0.1012 **	0.1171 **
Nox	0.0699 **	0.0957 **	-0.0087	-0.0160 *	-0.0051	0.1001 **	0.2228 **	0.2660 **	0.0680 **	0.0245
Intercept	11.5381 **	12.9494 **	1.7611 **	2.0110 **	7.5928 **	9.2968 **	3.9019 **	5.1346 **	6.9502 **	8.2537 **
Chi2(11)	903	797	1781	763	868	1102	351	348	592	833
LL	1381	1406	2072	1939	1066	1098	1002	1123	1444	1451

* significant at 5 per cent level; ** significant at the 1 per cent level.

84. The robustness of the GLS estimations was also tested by a number of practical tests (as suggested by Sayrs, 1989) such as dropping countries and years one by one from the sample as well as, separately, all of the years before 1975 followed by all of the years after 1990. The results of these tests are not shown but are available on request. Generally the estimated coefficients are little affected apart from in a few notable cases. When the years after 1990 are dropped, tobacco consumption becomes insignificant for male premature mortality. In terms of countries being dropped, the share of public expenditure becomes insignificant for perinatal mortality and female premature mortality when the US is dropped from the sample. Similarly, public expenditure does not appear to be significant for female premature mortality when Japan is dropped from the sample.

85. In order to provide a more direct comparison with the results of previous empirical work, (OR, 1997, 2000) Fixed Effect OLS estimates are also presented in Table A.3. The institutional dummies are dropped for these estimations, since they are highly collinear with the country dummies that are included in a Fixed Effect model. In general, these results are quite similar to the GLS estimates. The coefficient on alcohol in a number of instances becomes insignificant or has the wrong sign. The public share of health expenditure becomes highly significant for both male and female life expectancy at 65 and it becomes the second most important factor for reducing overall premature mortality, as well as perinatal and infant mortality.

86. While the estimations presented in Table A.3 do not correct for heteroscadasticity and autocorrelation, it is important to verify the robustness of the estimations with a more basic specification. If the exogenous determinants of health that are identified in this paper actually affect health status with a lag then both the correction for autocorrelation in the GLS results and the use of a “fixed effects” specification might bias the estimated coefficients towards zero. Therefore, simple OLS estimates were also carried out as a final check of robustness. These results are available on request. In qualitative terms the results are little changed.

Table A.3. **Fixed effects estimates of the determinants of health outcomes without medical system dummies**

	Premature Mortality		*Life Expectancy at 65*		*Perinatal*	*Infant*	*PYLL-Heart Diseases*		*PYLL-Cancer*	
Variable	Women	Men	Women	Men	*mortality*	*mortality*	Women	Men	Women	Men
Doctor	-0.2855 **	-0.2537 **	0.1334 **	0.0954 **	-0.6631 **	-0.4112 **	-0.3069 **	-0.2839 **	-0.1370 **	-0.0740 **
Pubsh	-0.4311 **	-0.2774 **	0.1141 **	0.1166 **	-0.8939 **	-0.5804 **	-0.1786	-0.0945	-0.1947 **	0.0455
GDP	-0.3809 **	-0.4283 **	0.1169 **	0.1306 **	-1.0073 **	-0.6984 **	-0.6132 **	-0.6215 **	-0.2069 **	-0.1544 **
Ocupation	-0.6550 **	-0.4193 **	0.0597 **	0.0965 **	-0.3068 *	-1.2072 **	-0.2418	-0.1372	-0.0994 *	-0.0934
Alcohol	0.0361	0.0014	0.0306 **	0.0118	0.0705	0.1547 **	0.0970 *	0.1305 **	-0.0507 **	-0.1232 **
Tobacco	0.1114 **	0.2535 **	-0.0283 **	-0.0839 **	0.3320 **	0.1690 **	0.6404 **	0.8056 **	0.0445 **	0.2129 **
Nox	0.1387 **	0.1518 **	-0.0310 **	-0.0439 **	0.1499 **	0.1999 **	0.2160 **	0.3094 **	0.1073 **	0.0521 **
Intercept	14.9924 **	13.3757 **	1.1923 **	1.2313 **	14.2851 **	13.9861 **	6.9606 **	6.0344 **	9.6366 **	7.2793 **
R^2 within	0.92	0.91	0.91	0.89	0.91	0.93	0.83	0.85	0.81	0.64
F	804	787	776	623	742	944	366	405	315	131

* significant at 5 per cent level; ** significant at the 1 per cent level.

Table A.4. **Pairwise coefficients of correlation between explanatory variables**

	Doctor	Pubsh	GDP	Occupation	Alcohol	Tobacco	Nox	Hosffs	Hosgloba	Gatekeep	Ambffs	Ambwage	Ambcapit
Doctor	1												
Pubsh	-0.0356	1											
GDP	0.4245*	0.0344	1										
Occupation	0.2760*	0.2108*	0.8393*	1									
Alcohol	0.1160*	-0.0621	0.0692	-0.0599	1								
Tobacco	-0.0253	-0.2882*	-0.0457	-0.0936*	0.2763*	1							
Nox	0.1434*	-0.0577	0.4750*	0.6261*	-0.0497	-0.1015*	1						
Hosffs	-0.1388*	-0.1951*	0.3143*	0.2896*	0.1190*	0.3202*	0.1061*	1					
Hosgloba	0.0864*	0.2092*	-0.3698*	-0.1846*	-0.1760*	-0.3378*	0.1431*	-0.8083*	1				
Gatekeep	-0.1281*	0.2331*	-0.3182*	-0.1902*	0.0229	0.0122	-0.0108	-0.1669*	0.2732*	1			
Ambffs	-0.0742	-0.1768*	0.2778*	0.1518*	0.1433*	0.3669*	0.1188*	0.3915*	-0.4032*	-0.2622*	1		
Ambwage	0.0465	0.0445	-0.2655*	-0.2089*	-0.2381*	-0.4838*	-0.0819	-0.3571*	0.3182*	-0.1278*	-0.6226*	1	
Ambcapit	0.0451	0.2765*	-0.0599	0.007	-0.1756*	-0.0871*	-0.0142	-0.2371*	0.2734*	0.5246*	-0.5339*	-0.2069*	1

* significant at 5 per cent level.

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