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How does the UK NHS compare with European standards?

A review of EU health care systems using hierarchical cluster analysis

John Nixon

DISCUSSION PAPER 182

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ABSTRACT

Objectives: To undertake a review of the EU member states' health care systems in relation to a framework of health-related variables, and to determine the position of the UK with respect to all other EU countries in the light of recent remarks by Tony Blair in arguing for the UK to move towards European standards.

Methods: Hierarchical cluster analysis, in conjunction with scatter plots, was used firstly to formulate country-cluster groups for pairs of OECD Health Data variables within the chosen framework, namely health expenditure as a share of GDP and per capita health expenditure; infant mortality and life expectancy (males and females); number of physicians and number of beds per head of population; average length of in-patient stay and in-patient admission rate. Following this a composite cluster analysis was performed using all nine variables to gain an overall country-cluster solution.

Results: The solutions reveal a strong association between the cluster country-membership and the health care mode of organisation, namely Social Insurance or NHS. The results obtained further reveal that although the UK achieves comparable health outcomes, its health care system is comparatively under-funded and under-resourced. However, the type of health care system employed needs to be taken into account when making cross-European comparisons.

Conclusions: Tony Blair is justified in seeking to increase health spending for the UK NHS which should address the problems of relative under-funding and under-resourcing and lead to a situation more in line with European standards. Hierarchical cluster analysis is a useful tool in the study of health care systems, and has a high number of potential applications in the field of health economics and other related subjects in determining criteria-specific groups.

1. INTRODUCTION

The aim of this paper is to undertake a comparative analysis of the UK NHS within the context of a review of European Union (EU) national health care systems in light of recent comments made by the UK Prime Minister, Tony Blair, who implicitly acknowledged that the UK NHS does not have sufficient supply capacity to meet all its demands, particularly in times of increased pressure on the system, as in the case of the winter flu crisis of 1999/2000. As such, he acknowledged the point that the UK spends below the EU mean on health care and argued the case for the UK to converge towards EU averages as soon as feasible [1]. The cancellation of 57,000 elective operations on the day planned for the procedure in the year to September 1999 further highlights chronic shortages within the UK NHS [2]. With this background in mind it is appropriate to review some important indicators of the UK NHS in comparison with the UK's EU partners.

In undertaking this study, hierarchical cluster analysis [3,4,5] is applied to a framework of variables, including health expenditure, which provides an overview of each country's health care system. The method has not been widely applied in the field of health management sciences or health economics but is attractive as it offers the opportunity, in this particular application, to determine discrete country-group memberships and observe associations within the context of system typology.

The health care system different EU countries operate is either *National Health Service (NHS)*, which is characterised by universal coverage, tax financing and public provision; or *Social Insurance (SI)*, which is characterised by compulsory universal coverage, financed by employer and employee contributions through non-profit insurance funds, and public and/or private providers. Of the 15 EU member states, nine operate the NHS system (Denmark, Spain, Greece, Italy, Ireland, Finland, Sweden, Portugal and the UK) and six the SI system (Austria, Belgium, Germany, France, Luxembourg and the Netherlands). These classifications are important as the phrase 'European standards' needs, as the analysis will show, to be qualified according to the system of health care adopted by a member state.

The techniques used and graphical outputs, derived from hierarchical cluster analysis, are convenient in that they can be easily assimilated and analysed by policy-makers and may therefore be usefully applied to other areas of health care management and scientific analysis. The chosen framework of variables and points addressed in this study are illustrated in the following questions:

1. How are health care systems in the EU grouped in terms of **health expenditure**, **health outcomes**, **resources** and **utilisation rates**?

2. Do any associations exist between identified groupings and health system typology and/or geographical location within the EU?

3. What is the position of the UK in relation to other countries of the EU?

The paper begins with an overview of the theory of hierarchical cluster analysis and explains some key issues that need to be taken into account when undertaking this type of non-parametric analysis. This is followed by a description of the study methods, the results of the analysis in general and then specifically in relation to the position of the UK NHS with respect to EU averages. Key messages and findings are discussed before coming to the conclusions regarding the use of hierarchical cluster analysis and relevant policy implications derived from the results.

2. THEORY OF HIERARCHICAL CLUSTER ANALYSIS - AN OVERVIEW

In general terms, cluster analysis is a technique that allows the analyst to group cases according to their degree of 'similarity'. It is a method utilised within many disciplines, for example in biology it is used to classify animals and plants, known as numerical taxonomy. In medicine, cluster analysis is used to identify diseases and their stages, and in marketing it can be used to identify people with similar buying habits. The principal goal of cluster analysis, therefore, is to identify homogenous groups or clusters which can inform the researcher regarding patterns in relation to measures of similarity.

Hierarchical clustering techniques can be subdivided into *agglomerative* methods which proceed by a series of successive fusions of the *n* variables into groups, or *divisive* methods, which separate the *n* individuals successively into finer groupings. These hierarchic classifications may be represented by a two-dimensional diagram known as a *dendrogram* which illustrates the fusions or divisions that occur at each successive stage of the analysis. This process is illustrated and fully explained in the study methods and Figure 1.

In this study *agglomerative* methods are used which means that variables relating to the health care systems of the fifteen countries of the EU are successively fused from 15 separate cases into a single cluster containing all 15 cases. This can be summarised by the following procedure which provides an outline of hierarchical clustering technique [4].

START: Clusters C_1, C_2 .....,C_n each containing a single individual.

1. Find the nearest pair of distinct clusters, say C_i and C_j, merge C_i and C_j,

   delete C_j and decrement the number of clusters by one.

If number of clusters equals one then stop, else return to 1.

2.1 Linkage methods

A number of techniques are available which can be used to link clusters within the agglomerative process. The simplest is the *single linkage*, otherwise known as the *nearest neighbour* technique. Within the agglomerative process the distance between two clusters used to determine new combined clusters is the distance between their two closest points. Therefore, the distances of other members of either cluster are not taken into account but only the two cases (one from either cluster) which are closest.

A second commonly used technique is that of *complete linkage*, or *furthest neighbour*. In this method, the distance between two clusters is calculated as the distance between their two furthest points (again, one case from either cluster) and determines the process of fusing groups.

Other commonly used methods include the *group-average* linkage technique. In this method the average distance between two clusters is calculated and forms the basis of new fusions. Thus, taking an example, if cluster **A** has two cases (1 and 2) and cluster **B** has three cases (3, 4 and 5) then the average distance, d, between cluster A and B would be:

$$\mathbf{d_{AB} = (d_{13}+d_{14}+d_{15} +d_{23}+d_{24}+d_{25})/6} \quad \text{where } d_{13} = \text{distance between cases 1 and 3, etc.}$$

Other methods include the *centroid* technique which takes the mean score of all members of each cluster as the point of reference, *median* clustering, and *Ward's* method. The latter uses an error sum-of-squares criterion, ESS, to minimise information loss in the fusion process.

2.2. Distance measures

A number of distance measures exist in determining the above described linkages which provide their own weighting to the data. The most commonly used method is the *squared Euclidean* distance in which the distance between two items is the sum of the squared differences between the values for the items (based, therefore, on Pythagoras' theorum):

$$\text{Distance (A,B)} = \sum_i (A_i - B_i)^2$$

Sometimes simply the *Euclidean* distance is adopted, which is the square root of the sum of the squared differences between the values for the items:

$$\text{Distance (A,B)} = \sqrt{\sum_i (A_i - B_i)^2}$$

Other measures include the *Chebychev* distance metric in which the distance between two items is the maximum absolute difference between the values for the items, the *City-block* or *Manhattan* distance, which measures the distance between two items as the sum of the absolute differences between the values for the items, and the *Minkowski* method in which the distance between two items is the *p*th root of the sum of the absolute differences to the *p*th power between the values for the items. The method is also able to deal with binary data, incorporating *chi-square* and *Phi-square* measures amongst others based on the familiar measures of association for contingency tables.

2.3. Data standardisation

Before utilising hierarchical cluster analysis it is necessary to consider the relative scaling of the data to be included as any distance measure will reflect primarily the contributions made by variables with the largest units. This issue is further explained in the methods section and illustrated throughout the paper. However, researchers should be aware that a number of approaches can be taken, which should be considered before carrying out hierarchical cluster analysis. The options include converting, for example, all data to *z scores*, to a *mean* of one, to a *maximum* of one, to *binary* values *above/below* a certain threshold, amongst others [6,7].

The investigator therefore has a range of options which can be employed in determining how groups can be achieved. As such a degree of subjectivity is inevitable when undertaking hierarchical cluster analysis but this can be minimised by adopting a systematic approach.

Having provided this brief overview of the theoretical issues relating to the application of hierarchical cluster analysis, it is now possible to proceed to the study methods which explain the rationale behind the choice of the specific techniques adopted in this paper. The discussion addresses some of the key issues, advantages and limitations relating to the application of these techniques.

3. STUDY METHODS

The present fifteen countries of the EU are identified in tables and outputs by their associated abbreviations; A = Austria, B = Belgium, D = Germany, DK = Denmark, E = Spain, F = France, FIN = Finland, GR = Greece, I = Italy, IRL = Ireland, L = Luxembourg, NL = the Netherlands, P = Portugal, S = Sweden and UK = the United Kingdom. Using OECD Health Data [8] a number of key variables, consistent with the study framework, as shown in Table 1, were chosen as the basis for the cluster analysis.

The analysis broadly divides the data describing each country's health system into **four** categories as shown below (numbers in brackets here relate to variables in Table 1):

a. **Expenditure** variables which measure the level of financial commitment each member state of the EU has towards spending on health care. The raw data collected were **percentage of GDP spent on health care (1) and per capita spending on health care in Purchasing Power Parities (PPP$) (2).** These variables are selected as proxies for the economic 'inputs' of each health care system.

b. **Health Outcome** variables which provide global measures of the health of the relevant population. The variables used are **infant mortality per 100 live births (3)**, **life expectancy at birth (females) (4)** and **life expectancy at birth (males) (5).** These outcomes, as is commonly the case in cross-national studies, are used as proxies for the outputs of each health care system.

c. **Resource** variables which give some indication of how well each system is resourced and therefore act as a proxy for issues such as supply capacity and speed of access to treatment. The variables used are **number of physicians per 10,000 head of population and (6)** and **number of beds per 1,000 of population (7).**

d. **Utilisation** variables which include average in-patient **length of stay (8)** and in-patient **admission rate (%) (9).** These variables are used to proxy the patient usage of each health care system.

These data were analysed using the software package SPSS for Windows.

Table 1 Health care framework of variables - EU countries (1995)

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	H.E.*	H.E.**	Infant	Life exp.	Life exp.	No. of	No. of	In-patient	Admiss.
Country	% of GDP	Per capita	Mortality	(females)	(males)	Phys.	Beds	LOS	rate
A	7.9	1634	0.54	80.1	73.5	26.6	9.3	10.9	24.7
B	8	1665	0.7	80	73.3	37.4	7.6	11.5	19.8
D	10.4	2134	0.53	79.5	73	33.6	9.7	14.2	20.7
DK	6.4	1368	0.55	77.8	72.5	29	4.9	7.5	20.4
E	7.6	1075	0.55	81.2	73.2	41	4	11	10
F	9.9	1972	0.5	81.9	73.9	29.4	8.9	11.2	22.7
FIN	7.7	1373	0.4	80.2	72.8	27.7	9.3	11.8	25.4
GR	5.8	703	0.81	80.3	75.1	38.8	5	8.2	13.6
I	7.7	1507	0.62	80.8	74.4	17	6.4	10.5	16
IRL	6.4	1106	0.63	78.5	72.9	17.2	5	7.2	15.5
L	7	2206	0.5	79.5	72.5	22.3	11.1	15.3	19.4
NL	8.8	1728	0.55	80.4	74.6	25.2	11.3	32.8	11.1
P	8.2	1035	0.74	78.6	71.5	29.9	4.1	9.8	11.3
S	7.2	1360	0.41	81.5	76.2	30.7	6.3	7.8	18.5
UK	6.9	1246	0.6	79.7	74.3	15.6	4.7	9.9	23

Source: OECD/CREDES, OECD Health Data 97. A Software for the Comparative Analysis of 27 Health Systems (OECD/CREDES, Paris, 1997).

**H.E. = total health care expenditure. **H.E. = total health care expenditure in Purchasing Power Parities, PPS($).*

3.1. Clustering strategy

Having collected the data it was considered optimal to examine pairs of variables from each of the first four categories above using scatter plots to obtain an overall picture and to test the way in which cluster analysis techniques would classify each country. To test the clustering of the **composite solution,** which involved the use of all variables in the chosen framework simultaneously, it was not possible to produce a scatter plot as all nine variables were used in the cluster analysis. The procedure adopted is described in detail as follows:

i. Select, in turn, two variables from each classification. For each pair of variables conduct hierarchical cluster analysis.

iii. Determine, from the dendrogram, the optimal groupings (based on the point at which the re-scaled distances become 'large').

iv. Construct a scatter plot based on the number of groups in (iii), using the hierarchical cluster analysis grouping variable (produced automatically by SPSS).
v. Conduct cluster analysis on all nine variables to derive a composite solution which provides an inclusive dendrogram output.

The distance measure employed was the **squared Euclidean distance** as it was cited in the literature as being the most commonly used approach and was suitable for the chosen variables as they are all continuous by classification.

In order to ensure that the scale for each variable did not unduly distort or create bias in the results, therefore, the question of standardisation of the chosen variables needed to be addressed.

3.2. Data standardisation strategy

One common problem associated with cluster analysis, as identified in the theory section above, is the disproportionate influence some variables can have on the final solution due to differences in scale. For example if we consider **infant mortality** in its raw form as a low fraction per 100 live births and compare it with **number of beds**, which is given in tens per 1000 of population, then clearly the latter will have more influence than the former if clustering is determined by a distance measure. For this reason, before cluster analysis was performed, all variables were standardised to a **mean of one.**

3.3. Data grouping

In order to combine the benefits of scatter plots and hierarchical cluster analysis, as outlined above, groups were based on the dendrogram outputs of the cluster analysis. The dendrogram shows the rescaled squared Euclidean distances (coefficients) and the process of combining cases (countries) and as such provides a good indication as to the appropriate number of clusters to choose. The issue of how many clusters to employ generates debate in the literature but guidance suggests that an appropriate number will be achieved once the squared Euclidean distances start becoming ‘large’ and more distinguishable [5]. In this study the dendrogram outputs enable a suitable number of clusters to be chosen but also facilitate easy analysis of smaller numbers of clusters, particularly two group solutions which are of special interest in determining if classifications exist around homogeneity according to health care typology.

3.4. Linkage method

The chosen linkage method was the **average linkage within groups** criterion. There is a wide range of clustering methods available, some of which were tested on the data. However, some limitations exist in, for example, the single linkage method or ‘nearest neighbour’ as described in the theory section. The chosen strategy has the advantage of taking into account all possible pairs of cases in the resulting clusters. The method combines clusters so that the average distance between all cases in the resulting cluster is as small as possible and is therefore considered to be a more reliable and inclusive approach to adopt.

Thus, by utilising a progressive approach of initially using scatter plots for two selected variables within each data classification and using cluster analysis to remove the subjectivity of classifying countries, followed by cluster analysis using all nine variables, it was possible to gain confidence in the methods such that the results obtained had an intuitive as well as a statistically relevant means of obtaining the resulting groups.

4. RESULTS

The results are presented firstly by indicating the initial clustering using the selected outputs of the cluster analysis, based on the two chosen variables under each category of health expenditure, health outcomes, health resources and health care utilisation, followed by the composite cluster analysis using all nine variables. For each phase, the dendrogram and scatter plot are given as these provide the best means of understanding, in an inclusive way, the process of grouping countries according to re-scaled (Euclidean squared) distances. For the composite solution, only the dendrogram is provided as scatter plots are not possible on more than two variables at a time.

4.1. Health expenditure

The results of the cluster analysis for health expenditure are shown in the dendrogram of Figure 1 and scatter plot of Figure 2. Examination of the dendrogram confirms that a four cluster solution is optimal at a rescaled distance of approximately eight. The resulting groups, as shown in Figure 2, are:

Group 1 Austria, Belgium, Italy and the Netherlands.

Group 2 France, Germany.

Group 3 Denmark, Finland, Greece, Ireland, Portugal, Spain, Sweden and the UK.

Group 4 Luxembourg.

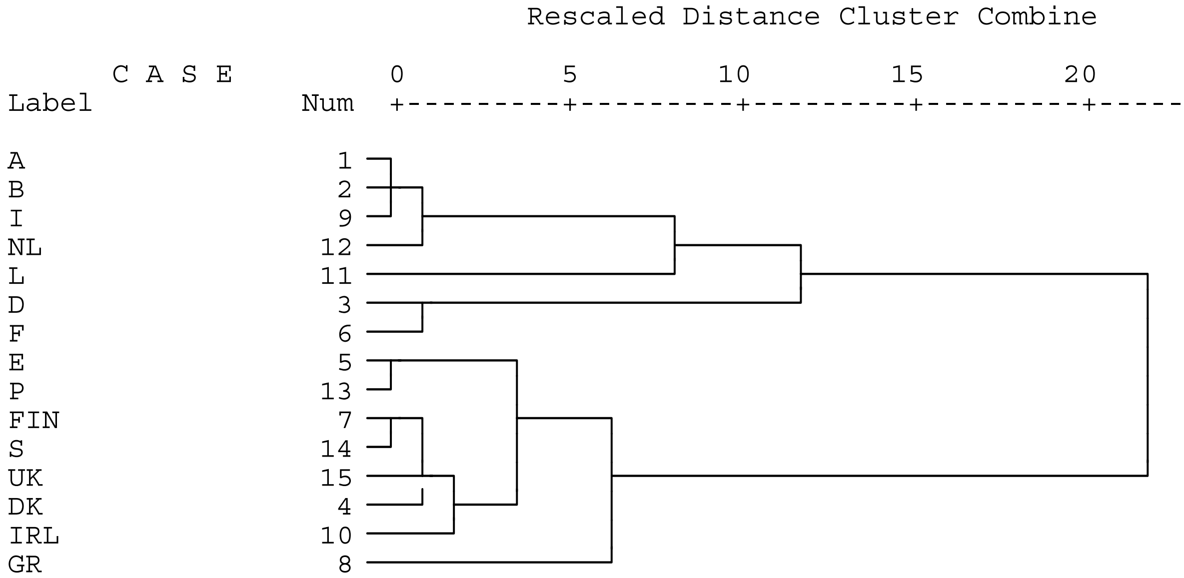

Figure 1: Dendrogram for health expenditure

The clustering produced indicates that there are wide variations between EU countries in terms of the amount spent on health care. In summarising these results we can see that group 2 countries both spend more in terms of health expenditure as a percentage of GDP and, with the exception of Luxembourg in Group 4, spend more per capita on their citizens.

Group 2 achieves fairly similar spending levels in terms of percentage of GDP, but per capita spending achieved is somewhat higher than group 3 countries. It is interesting to note that apart from Italy, group 1 and group 2 contain countries with an SI model of health care provision.

Group 3, on the other hand, is made up of countries that have National Health Systems, with Ireland being somewhat of an exception in that it is classified as being publicly financed but with a high proportion of private provision [9]. The dendrogram shows that if a five group solution were taken, Greece would form a group on its own as it allocates the lowest percentage of GDP and also achieves the lowest levels of per capita spending. It is also interesting to note that a number of countries spend very similar amounts in terms of percentage of GDP, but due to the level of their GDP and the size of their populations, achieve wide variations in terms of per capita spending, with, for example, Portugal spending 8.2% of its GDP on health care but only achieving $1035 per capita, whereas Denmark spends 6.4% as a percentage of GDP but achieves $1368 in terms of per capita expenditure.

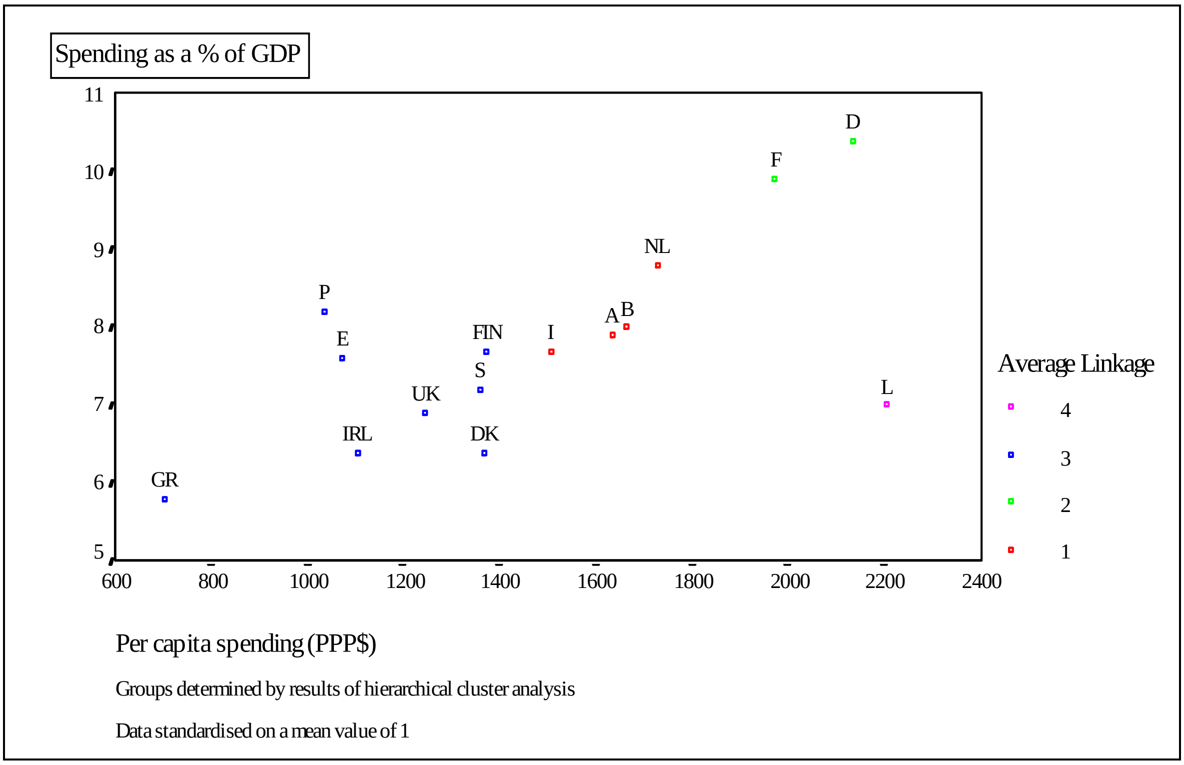

Figure 2: Scatter plot for % of GDP and Per Capita health expenditure - 1995

Luxembourg is the only member of group 4 as it spends the fourth lowest amount as a percentage of GDP, but achieves a very high value per capita of $2206, which is in fact the highest in the EU.

The results show that in general those countries with SI models tend to spend more on their health care systems and citizens, whereas less is spent by countries with NHS typologies, shown to be statistically significant in previous analysis by the author [10]: NHS countries = 7.1%, s.d = 0.74; SI countries = 8.67%, s.d. = 1.29 for percentage of GDP, significant at $p<0.05$ (ANOVA); NHS countries = 1197 PPP$, s.d. 244.63, SI countries = 1889.8 PPP$, s.d. 248.4, significant at $p<0.05$ level for per capita PPP$ (ANOVA). This is likely to be due to the fact that NHS models are much more centralised and, therefore, they may benefit from exploiting economies of scale and are able to exercise more controls over spending when compared with de-centralised and often more liberal SI models of operation. However, in spite of countries spending similar percentages on health care within the four groupings, wide variations exist in relation to per capita spending which is a reflection of the purchasing power and strengths of currencies, preferences in health care expenditure, the size of a country's population and its GDP income. Luxembourg provides the most striking example of this feature as outlined above.

Finally in this section, it is worth noting that if a two group solution is taken at a rescaled Euclidean distance of 15 as shown in the dendrogram of Figure 1, Luxembourg, France and Germany (SI countries) are joined with the predominantly SI group and the remaining group is made up of NHS countries, providing further confirmation of the NHS/SI divide in health care expenditure.

4.2. Health Outcomes

The results of the cluster analysis for health outcomes (infant mortality and female life expectancy) are shown in the dendrogram of Figure 3 and the scatter plot of Figure 4. Infant mortality against life expectancy (males) are similarly shown in the dendrogram and scatter plot of Figures 5 and 6, respectively.

Examination of the two dendrograms reveals that a four cluster solution is optimal at a rescaled distance of approximately 7-8. The resulting groups in both cases are:

Group 1 Austria, Denmark, France, Germany, Italy, Ireland, Luxembourg, the Netherlands, the UK and Spain.

Group 2 Belgium and Portugal

Group 3 Finland and Sweden.

Group 4 Greece

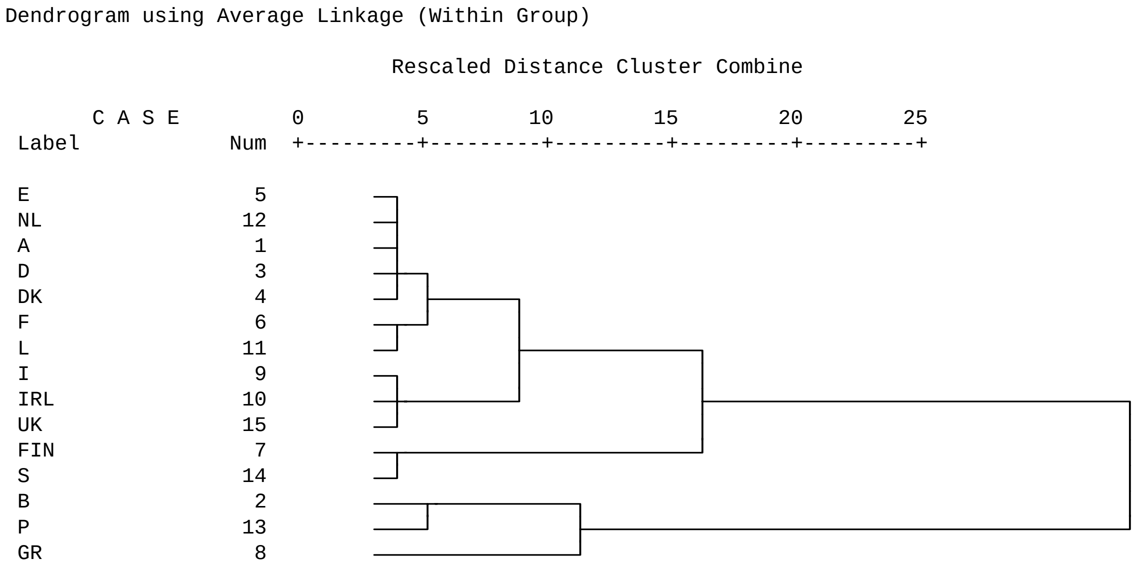

Figure 3: Dendrogram for health outcomes - infant mortality and life expectancy (females)

Interesting variations are also observed in relation to these groupings. Group 1 is made up of the vast majority of countries (10) with no strong association with the type of health care system employed by members of this group. The cluster analysis for group 1 has selected countries with low to medium levels of infant mortality, but a fairly wide range of female life expectancies with France at the top of this group (approximately 82 years for French women) and Denmark at the bottom (approximately 78 years).

Group 2 is made up of only two countries, Belgium and Portugal, with higher rates of infant mortality and life expectancy at a little over 80 years for Belgium and a little under 79 years for Portugal.

Group 3 is made up of two Scandinavian countries, Sweden and Finland, with very low levels of infant mortality and life expectancies among the highest in the EU (especially Sweden in second and first place respectively).

Group 4 is made up of Greece on its own, largely due to the fact that its infant mortality rate is the highest in the EU, although life expectancy for Greek women is about average for the EU as a whole.

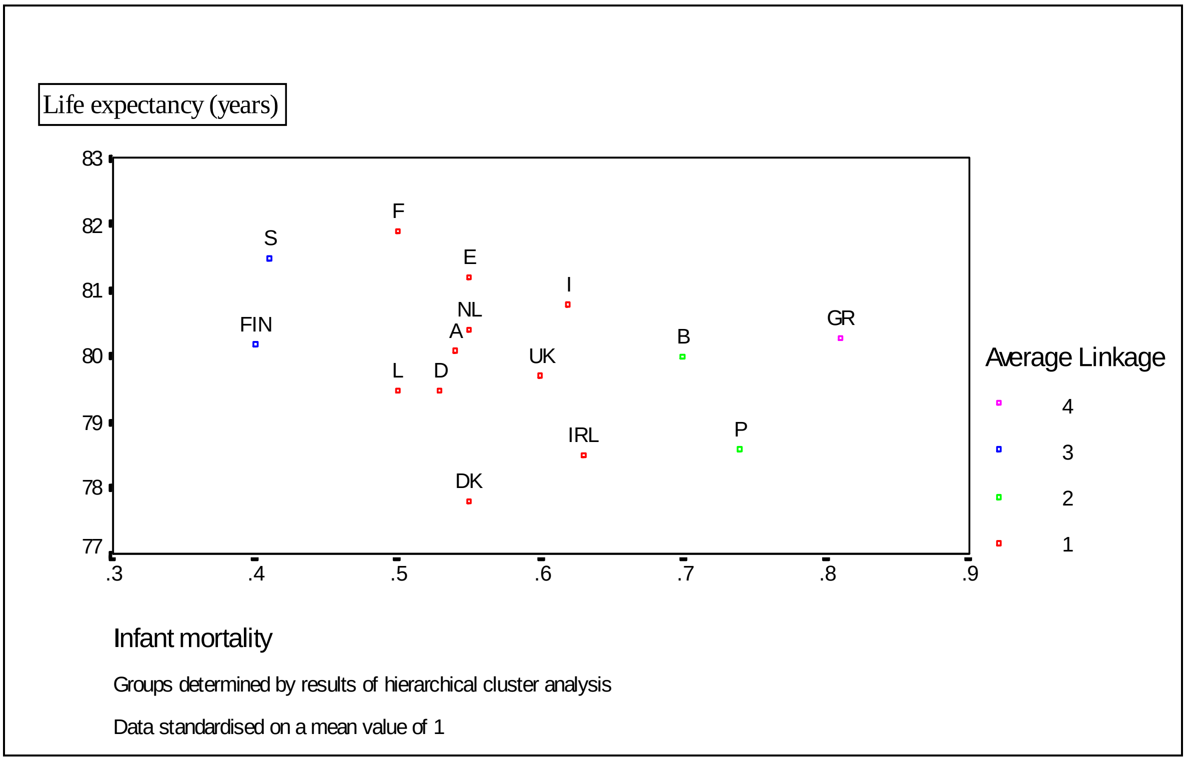

Figure 4: Scatter plot for infant mortality and life expectancy (females) - 1995
Note: Infant mortality is given per 100 live births. Life expectancy is at birth.

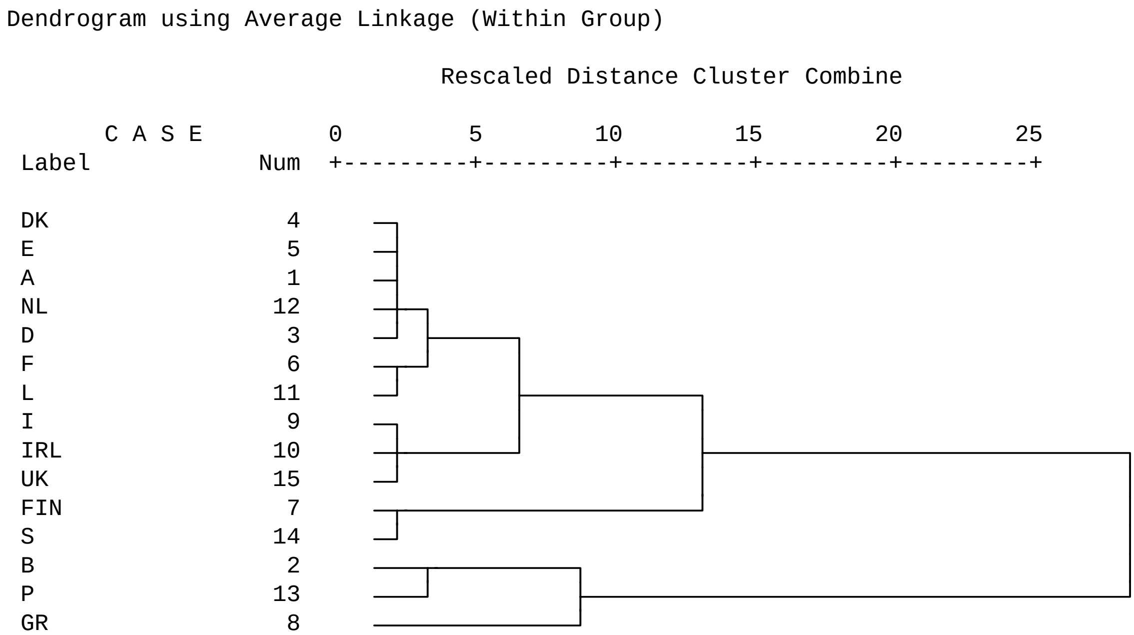

Figure 5: Dendrogram for health outcomes - infant mortality and life expectancy (males)

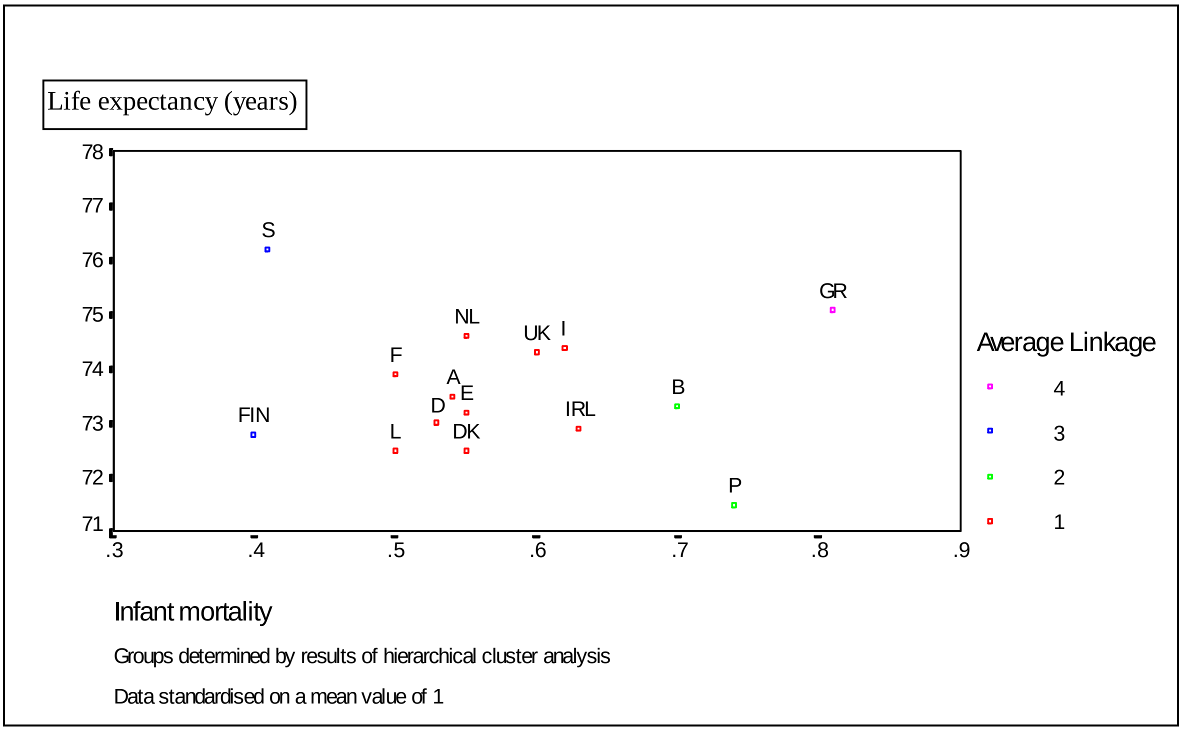

Figure 6: Scatter plot for infant mortality and life expectancy (males) - 1995
Note: Infant mortality is given per 100 live births. Life expectancy is at birth.

The picture is repeated for infant mortality and life expectancy (males) in terms of the groups identified by the cluster analysis, although life expectancies differ somewhat in a number of countries when comparing men with women. For example, although French women live the longest in the EU, French men appear down the scale at an age close to the EU mean. Greek men, on the other hand, live longer compared with the remainder of the EU (second place) in comparison with Greek women. Swedish men live longer than men in any other country by a long way, but Finnish men, although in the same health outcomes group as Sweden, have a life expectancy somewhat below the EU mean.

The dendrograms of Figures 3 and 5 show that if a three group solution were to be taken, Greece would be joined to group 2 with Belgium and Portugal. The main dividing factor in these analyses is that of infant mortality, which has wide variations across the EU. In particular, Finland and Sweden (approximately 0.4) have values half that of Greece (0.8), with Portugal and Belgium not far behind this (approximately 0.75 and 0.7, respectively). Due to the data standardisation undertaken, it can be seen that the figure for infant mortality in Greece is 100% higher than that of Sweden, whereas life expectancies have differences of approximately 5% across the minimum and maximum values in the EU. In other words the variation in infant mortality is much higher than the variation of life expectancy.

4.3. Resources

The results for health care resources are shown in the dendrogram and scatter plot of Figures 7 and 8 respectively. Examination of the dendrogram reveals that a four cluster solution is optimal at a rescaled distance of approximately 9. The resulting groups are:

Group 1 Austria, Belgium, France, Finland and Germany.

Group 2 Denmark, Greece, Portugal, Spain and Sweden.

Group 3 Italy, Ireland and the UK.

Group 4 Luxembourg and the Netherlands.

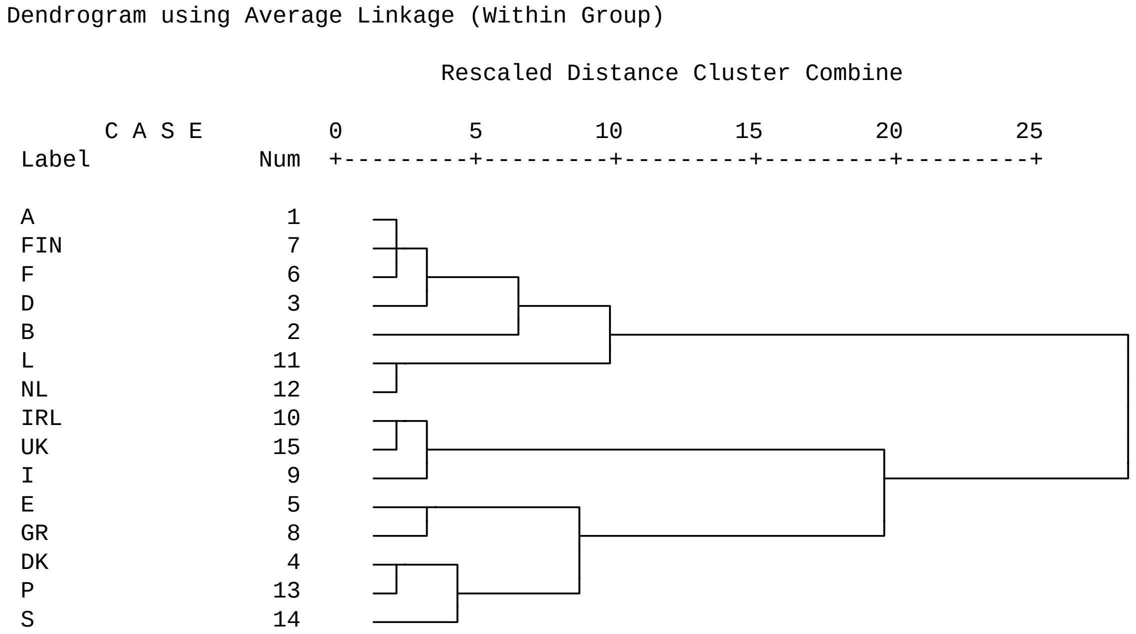

Figure 7: Dendrogram for number of physicians and number of beds

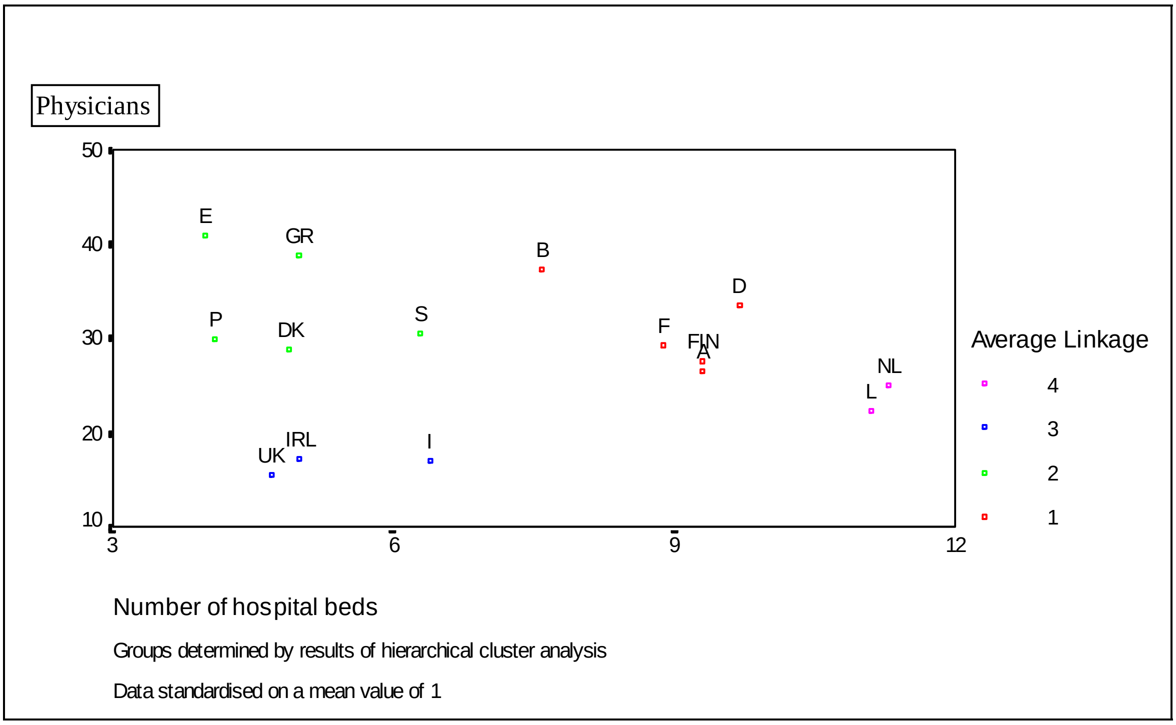

Figure 8: Scatter plot for number of physicians and number of beds - 1995
Note: Physicians per 10,000 of population. Number of beds per 1000 of population.

When considering these results some interesting findings are evident. For example, although a four group solution has been selected, the dendrogram shows that the two group solution selects all countries in the bottom half of the dendrogram which have National Health Systems, and all the top half countries are, with the exception of Finland, SI systems. The dividing factor here is the number of beds which is lower, Finland aside, in the NHS countries. In the case of Portugal and Spain, for example, the number of beds is approximately one quarter of the Netherlands and Luxembourg, which make up group 4 in the cluster analysis. The NHS countries are divided, however, by the number of physicians, with countries of group 3, namely Italy, Ireland and the UK, having values well below half of other NHS countries such as Greece and Spain. Other SI countries and Finland in group 1, have middle to high numbers of beds and middle range numbers of physicians. Luxembourg and the Netherlands also have middle range numbers of physicians.

4.4. Utilisation

The results for utilisation levels are shown in the dendrogram and scatter plot in Figures 9 and 10 respectively. Examination of the dendrogram reveals that a three cluster solution is optimal at a rescaled distance of approximately 7. The resulting groups are:

Group 1 Austria, Belgium, Finland, France, Germany, Luxembourg and the UK.

Group 2 Denmark, Greece**,** Ireland, Italy, Spain, Portugal and Sweden.

Group 3 The Netherlands.

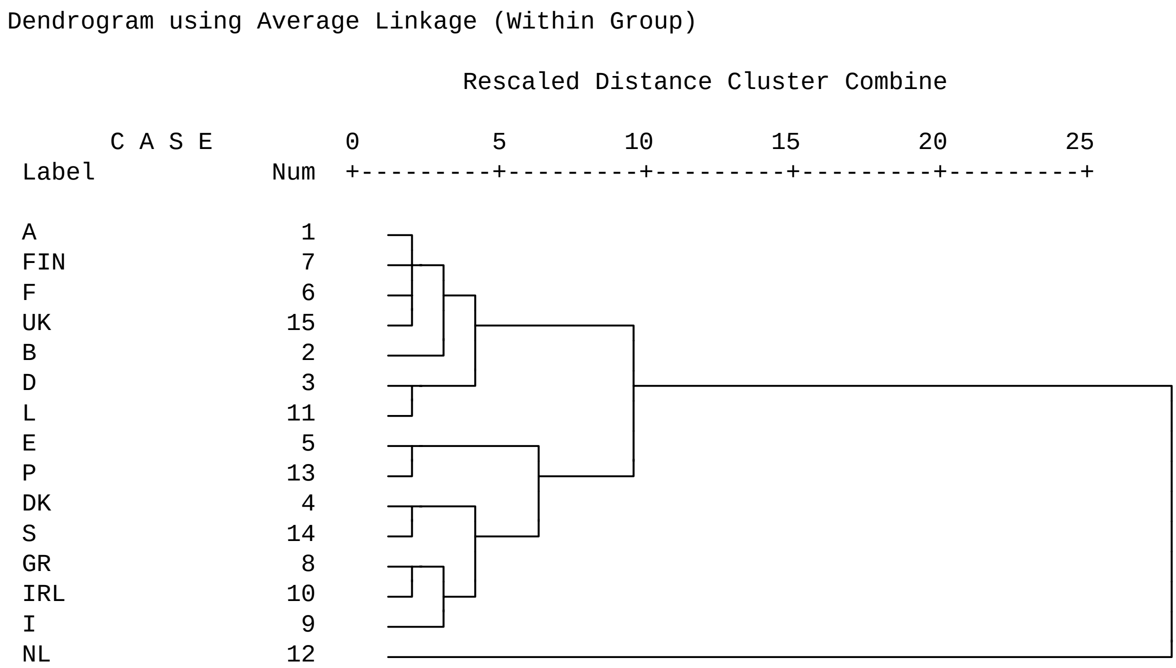

Figure 9: Dendrogram for average length of stay and admission rate

In terms of utilisation levels, the scatter plot of Figure 10 shows that Group 1 is made up of a majority of SI countries, with the UK and Finland from the NHS countries. Interestingly, group 2 is homogenous as it contains all the remaining NHS countries, which are characterised by lower admission rates and shorter lengths of stay, although Denmark and Sweden as Scandinavian countries have much higher admission rates than the Southern Mediterranean countries of Spain, Portugal and Greece.

The situation of the Netherlands, in a group entirely on its own, seems to suggest that the way in which data for average length of stay are collected from the Netherlands is somewhat different from the rest of the EU. With a very low admission rate of 11.1% (the second lowest in the EU), it has a length of stay, at 32.8 days, equal to three times the EU mean for this variable. Further investigation will be needed to explain such a discrepancy as the data appear to be an outlier for the Netherlands. It is likely that the Netherlands includes in its definition of 'in-patient' long-term institutional care which other countries do not.

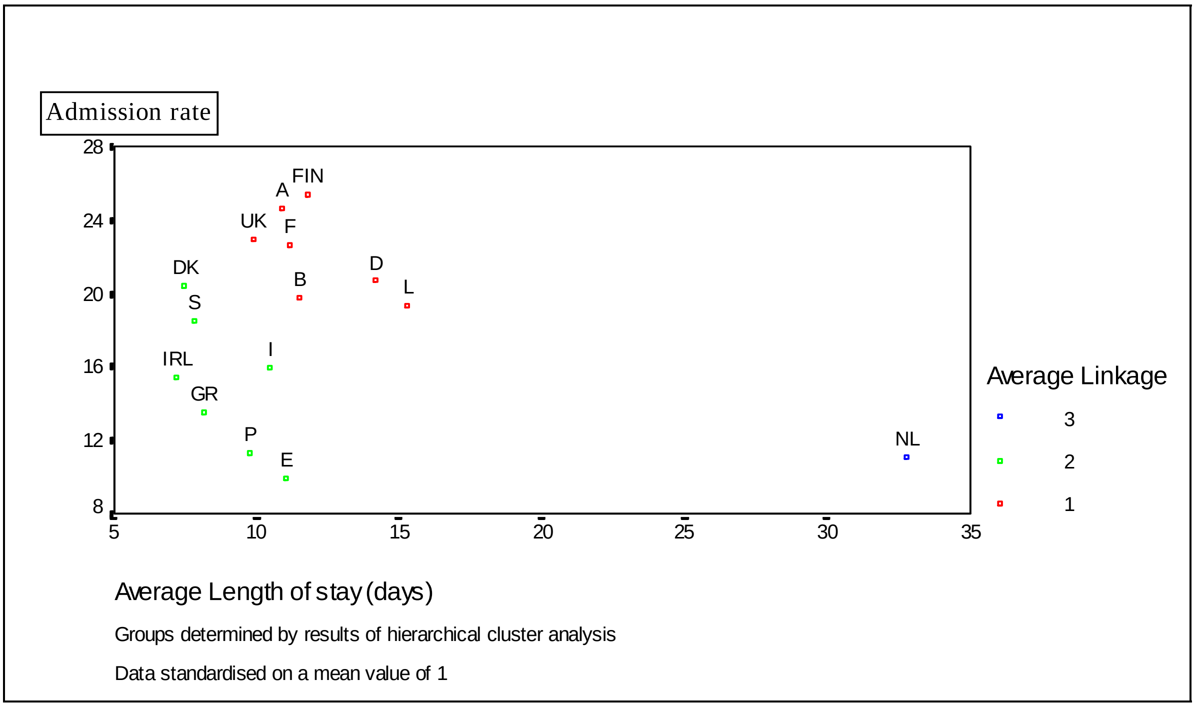

Figure 10: Scatter plot for utilisation rates in the countries of the EU - 1995
Note: Admission rate (%). Average in-patient length of stay in days.

With the exception of the Netherlands, therefore, it is possible to state that, in general, SI models of health care are associated with higher admission rates and longer lengths of stay in comparison with NHS modes of delivering health care.

4.5. Composite solution

The result of the cluster analysis containing all nine variables is shown in the dendrogram of Figure 11. Examination reveals that a three cluster solution is optimal at a rescaled distance of approximately 15. The resulting groups are:

Group 1 Austria, Belgium, Finland, France, Germany, Luxembourg.
Group 2 Denmark, Greece, Italy, Ireland, Portugal, Spain, Sweden and the UK.
Group 3 The Netherlands

The composite solution provides a summary cluster analysis taking into account all nine variables. The results show a clear association with the typology of the health care systems employed by each country, and perhaps of equal interest, countries are often fused at the earlier stages of the cluster analysis according to geographical location.

Group 1, apart from the Netherlands, contains all the countries in the EU with SI models of delivery, plus Finland. As the previous analyses have confirmed, Finland has many of the characteristics of SI countries even though it has a National Health System.

Group 2 is, with the exception of Finland, made up of all the NHS countries of the EU. Particularly within this group we observe that the initial fusions are based on geographical location with, for example, Denmark and Sweden being clustered at an early stage; the UK, Ireland (and Italy) being fused slightly later but joined with Sweden and Denmark at the same distance at which Spain, Portugal and Greece are clustered. Before this latter fusion occurs, Spain and Portugal are clustered into a single group.

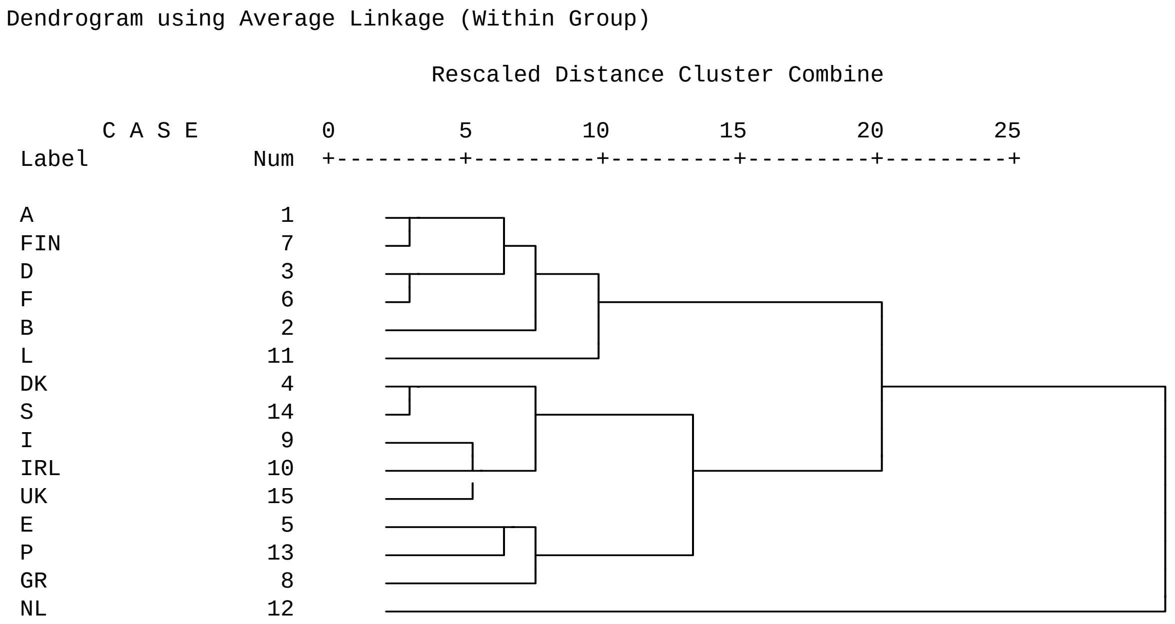

Figure 11: Dendrogram for composite solution

The Netherlands appears in a group of its own, perhaps influenced by the variables, number of beds and average length of stay which were both two to three times higher than the EU mean. For this reason, further analysis will be needed to confirm the reliability and consistency of OECD data although it is likely, given the analyses presented here, that the Netherlands would be placed within the SI countries.

5. THE CASE OF THE UK

The figures provided below are derived from the OECD Health Dataset for the year 1995 [9]**.**

If we examine the position of the UK within the context of the findings reported above, it is possible to conclude that at the policy level (share of GDP) of health expenditure the UK, as an NHS country, allocates less than SI countries and is somewhat below the EU mean at 6.9% (EU mean = 7.7%). For expenditure per head, the UK is again below the EU mean with a figure of PPP$ 1246 compared with PPP$ 1474. Therefore the results for health expenditure confirm the view of Tony Blair in that the UK has got some catching up to do to reach EU averages. However, as an NHS country, the UK compares a little more favourably in comparison with other NHS countries in the EU for share of GDP (mean for all NHS countries = 7.1%), and slightly better than other EU NHS countries for per capita health spending (mean for all NHS countries = 1197 PPP$). This latter point reveals the UK’s relative economic strength in comparison with other NHS countries in the EU.

In terms of health outcomes, the UK belongs to a group of heterogeneous countries (some NHS and some SI) with outcomes in the middle range. For infant mortality the figure for the UK is 0.6 per 100 live births whilst the EU mean is also 0.6. In terms of life expectancy at birth for females, the figure for the UK is 79.7 years and the EU mean is 80.0 years, whilst for men the figure for the UK is 74.3 years and the EU mean is 73.6 years. Therefore although the UK spends lower than EU mean levels in terms of health expenditure, it achieves outcomes which are almost exactly equal to the EU mean. This finding tends to support the view that the UK has a technically efficient health care system with below average economic ‘inputs’ but average health ‘outputs.’

When we examine the resources available to the UK NHS, however, stark differences are noted. In terms of the number of physicians per 10,000 of population, the UK is in the group at the bottom of the EU with a figure of only 15.6 compared with the EU mean of 28.1. For number of beds, again the UK is well below the EU mean (third from bottom) with a figure of 4.7 per 1000 population compared with the EU mean of 7.2. When these figures are taken into consideration it is perhaps self-evident that the UK NHS should have supply-side difficulties in coping with demand-side crises such as winter flu outbreaks, and is associated with long waiting lists and elective surgery postponements.

When examining utilisation rates a pattern is in evidence which is consistent with the above data. For average in-patient length of stay the figure for the UK is 9.9 days, whilst the EU mean is 12.0. This is consistent with the strategy of seeking increased efficiency through greater throughput and a reduction in length of stay, a well known phenomenon within the UK NHS. The view that the UK NHS is, however, treating more patients than ever before is borne out by the final variable, in-patient admission rate, which for the UK is 23% compared with an EU mean of 18.1%.

Thus the overall picture for the UK NHS in comparison with its EU partners is that it is spending less than average on health (but not in comparison with other EU countries with National Health Systems), achieving average health outcomes, is well below average in resources in terms of numbers of physicians and beds, has below average lengths of in-patient stay and above average utilisation rates. The general impression, therefore, is that of a system operating very close to, or at times under, its supply capacity which has some difficulty in meeting all of its demands. Long waiting lists are therefore an unsurprising characteristic. As such, Tony Blair's observations and concerns are indeed warranted, with the caveat that as an NHS country, the UK can generally be grouped with other NHS countries in the EU. However, increased spending should be expected if the UK is to attain EU levels when high spending, high resourced SI health care systems of the EU are included in the analysis.

6. DISCUSSION

Perhaps the first observation emerging from this study is that cluster analysis can be a useful statistical method that produces groupings based on similar characteristics and is particularly useful in generating hypotheses. The findings of the analyses indicate that:

1. Health expenditure in SI countries of the EU is higher than that of NHS countries.
2. There appears to be no strong association between the method of health care delivery and health outcomes.
3. There is greater variation in infant mortality than life expectancy across countries of the EU.
4. NHS countries generally have lower levels of resources in terms of number of in-patient beds and physicians than SI countries.
5. Average length of in-patient stay and in-patient admission rates are generally lower in NHS countries than those of SI countries.

When considering the strengths and weaknesses of hierarchical cluster analysis it was found that the approach used to create clusters was rather sensitive to the method of standardisation and the method of clustering. In comparing the results obtained with z scores and those obtained with a mean of one, for example, it was found that by visual examination of the scatter plots produced for the first four data groups, a mean of one produced the most consistent and 'defensible' solutions. This is thought to be due to the point that standardising on z scores tends to cause a loss of proportionality in the data [11]. By standardising on a mean of one, this feature of the data would appear to be better preserved whilst the requirement to avoid scaling bias is eliminated. In terms of the method of clustering, although some fairly minor differences were observed in testing clusters formed with single linkage and average within group linkage methods, the latter was adopted due to its inclusivity in terms of generating tighter clusters and the greater validity given to it in the literature.

It is also the case that the results of the clustering are conditioned on the chosen variables. If key variables are omitted then clearly the groupings produced will be somewhat limited. In this paper nine variables have been used in an attempt to present a compact and generic solution. However, with full implementation of EMU and a common currency throughout the EU, which will make comparative studies of this nature simpler, and the continuing development of the quality and range of available data [9] it will be possible to expand the chosen variables and anticipate an increase in their cross-national comparability, consistency and therefore validity.

The choice of variables in the framework adopted is naturally, therefore, open to discussion, particularly in relation to health outcomes which may be attributable to other factors such as lifestyle, socio-economic status and diet rather than the health care system of an EU citizen. Greece is of particular interest in this respect as it spends the least of all EU countries on health care but life expectancy for Greek males is the second highest level in the EU, although it also has the highest rate of infant mortality in the EU. Other variables would also be of interest in terms of the methodology, for example in patterns of primary care and access times to secondary care would provide good proxies for speed of access and patient satisfaction. The data utilised in this study, however, are aimed at reflecting the general ethos of health economics in measuring health outputs for a given level of expenditure with available resources, in this case at a macro rather than micro level.

One cannot ignore, either, that a degree of cross-border health care is available within the EU. Greek citizens, for example, with sufficient financial resources or private insurance may make use of health care systems in other countries within the EU, particularly for specialist treatments [12]. This form of cross-border trade and augmentation in health care is becoming perhaps an increasing feature within the EU as evidence suggests that this is occurring between other countries. Starmans and Leidl [13], for example, have examined in detail the movement of patients between the Netherlands, Belgium and Germany, although this only amounted to 2% of cases and many patients were living in the host country because of employment reasons. Lewalle and Lona [14] have shown that 90% of movements of this nature occur between Belgium, France, Italy and Germany. This may also apply to small countries like Luxembourg, as its citizens may also use, in particular, the French health care system, which may also partially account for Luxembourg's low level of spending as a percentage of GDP at fourth from bottom of the EU countries, although its strength in GDP terms may mean that share of GDP at the policy level of health care expenditure can be smaller than poorer countries to achieve the same impact in providing health services.

When examining the case of the UK NHS the analyses have shown that the UK achieves average or better levels in comparison with other NHS countries for health expenditure and health outcomes, but is below the EU mean for expenditure if SI countries are included. However, the UK is generally under-resourced in comparison with most other EU health care systems with numbers of physicians and numbers of beds well below the EU mean for all sub-categories. The UK also has lower lengths of stay and higher utilisation rates than the EU means for these variables, which confirms the general view of the UK NHS being over-stretched, especially when demand shocks to the system occur.

The reliability of the data set used in this study is also worthy of further verification in terms of consistency, the case of the Netherlands and in-patient length of stay being an illustrative example.

7. CONCLUSIONS

This paper has reported on the utilisation of hierarchical cluster analysis as a means of placing the health care systems of the EU into different groups using economic, health outcome, resource and utilisation variables. A composite solution, using all variables, has provided an overall assessment of the systems in terms of their clustering.

The limitation of this study in terms of the use of cluster analysis is that, whilst being easy to interpret and therefore attractive to policy makers, useful in terms of statistically classifying countries and generating hypotheses, hierarchical cluster analysis needs to be treated with some caution as the results vary according to the chosen data and the methods used to standardise them. By adopting a progressive method in this study, however, it has been possible to gain a reasonable degree of confidence in the methods, due to the use of scatter plots in conjunction with hierarchical cluster analysis for the initial pairs of variables. This allows the normal subjectivity of determining groups from scatter plots to be minimised.

The cluster solutions produced within the chosen framework have made it possible to place countries into discrete clusters, with two, three and four groups being formed dependent on the rescaled distances shown in the dendrograms. Homogeneity of typology is often but not always evident in the clustering produced, although with the exception of health outcomes, the clusters generated generally have an association with typology. NHS models, the most commonly used and increasing mode of organisation and delivery in the EU, are clearly better at containing expenditure than SI models, largely because of their centrally organised nature which offers opportunities for economies of scale and greater control through both supply-side and demand-side mechanisms. In terms of health outcomes there is no clear division in terms of typology, although the data indicate a north-south divide in infant mortality, with Mediterranean countries performing worse than countries of the north, particularly those of Scandinavia. Resources are generally more abundant in SI countries compared with countries with NHS modes of organisation, and in-patient admission rate and average length of stay are also generally higher in SI countries.

The composite solution is of particular interest. It clearly shows a strong association, taking into account all the chosen variables in the analysis, between grouping and the method of health care organisation. For policy makers, this strongly suggests that if greater convergence and integration are to be achievable goals in the EU [15], a degree of standardisation in terms of how health care is organised and delivered, is required. NHS models, according to this study, tend to produce similar health care characteristics, and likewise SI models.

The findings for the UK suggest Tony Blair is justified in calling for greater spending for the UK NHS, although the distinction between public expenditure allocations at the policy level (in other words share of GDP) needs to be considered in relation to a country's GDP income and its population size. Richer countries in GDP terms can afford to allocate less as a share of GDP to achieve the same level of per capita spending than poorer ones. However, in the case of the UK NHS its resourcing levels in terms of numbers of physicians and beds are well below EU levels and increased expenditure should help to increase these to a more comfortable situation with regards to its supply capacity. In this scenario, the UK NHS should be better equipped to deal with increased demand in times of crisis and in reducing its waiting lists which, although not examined in this study, are also a cause for concern. The methods illustrated in this study are likely to be of interest to other areas of health-related research.

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