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# THE STATE OF HEALTH OF THE POPULATION AND ACCESSIBILITY TO PHYSICIANS

The aim of the research is to determine the relationship between the state of health of the population and the accessibility to physicians. The research deals with 15 European countries and bases on time series of variables describing life duration and number of physicians per 10,000 inhabitants.

## 1. INTRODUCTION

Determining the state of health of the population and its influencing factors is an extremely difficult exercise mainly because the state of health and many factors are not measurable as well they raise objections during observation. It seems possible to treat the measures of life duration as sufficient indexes of health state (Rosset 1979; Sen 1993; Worach-Kardas 1996), especially in international comparisons. This solution is accepted in the study intending to determine the meaning of the accessibility to physicians for the state of health of the population.

The life duration is characterized by males' and females' life expectancy at birth, and by infant mortality, the accessibility to physicians – by the number of physicians per 10,000 inhabitants.

The research was based on time series of the variables mentioned above from the years 1970–1992, describing 15 European countries for which data were accessible (Table 1). The political changes of the 90's made us decide about the treatment of the data from those countries which had changed their status. The Czech data till 1990 comprise the data of Slovakia and Czech, and the data for the Czech Republic exclusively from 1990. The data for Germany till 1989 came from the German Federal Republic, and from 1990 – from the whole Germany. It is worth mentioning that the framing of the demographic variables till 1989 was similar in both German countries, and the lack of data about the number of physicians in old and new lands from 1990 makes impossible separate examination of the two groups of lands. It was not possible to get the complete time series of all the data considered. In case of life expectancy at birth there were serious scarcities in the 70's, for the gauges

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published in those days were usually worked out on the basis of approximate coefficients of deaths from a few years. Disagreement of these measures, with the clear growing tendency, seemed to be acceptable. Single scarcities of the data about the number of physicians were supplemented by interpolation. The most complementation of all data concerns Spain and Portugal, thus the results relating to these countries have to be interpreted very carefully.

## 2. LIFE DURATION BETWEEN 1970–1992

In 1970 males' life expectancy higher than 70 occured only in four countries – Sweden, Denmark, Norway, and the Netherlands. In 1992 there were 12 such countries; Hungary, Poland and the Czech Republic were not among them. In 13 countries, i.e. in 12 where life expectancy exceeded 70 years in 1992, and in the Czech Republic, the tendency estimated on the basis of the complete time series was increasing, but diverse. In Poland stabilization took place, in Hungary the tendency was decreasing. As a result the arrangement of the countries has changed significantly, which can be proven by the Spearman coefficient of rank correlation from 1970 and 1992, which equals 0.741.

Table 1 contains the short description of males' life expectancy at birth  in the years 1970–1992. Even taking into account possible inaccuracies of estimation

Table 1
Life expectancy at birth, males, in 1970 and in 1992

| No | Country | 1970 | | 1992 | | (5:3)*100 |
|---|---|---|---|---|---|---|
| | | value | rank | value | rank | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | Austria | 66.2[a] | 10 | 72.7 | 9 | 109.8 |
| 2 | Belgium | 67.4[a] | 7 | 73.1 | 7 | 108.5 |
| 3 | Denmark | 70.7[a] | 3 | 72.6 | 10 | 102.7 |
| 4 | Finland | 65.8[a] | 12 | 72.6 | 10 | 110.3 |
| 5 | France | 68.1[a] | 6 | 73.2 | 6 | 107.5 |
| 6 | Germany | 67.1[a] | 8 | 73.0 | 8 | 108.8 |
| 7 | Hungary | 66.2 | 10 | 64.6 | 14 | 97.6 |
| 8 | The Netherlands | 70.7[a] | 3 | 74.3 | 2 | 105.1 |
| 9 | Norway | 71.2[a] | 2 | 74.2 | 3 | 104.2 |
| 10 | Poland | 66.6 | 9 | 66.7 | 13 | 100.1 |
| 11 | Portugal | 65.3[a] | 13 | 70.7 | 11 | 108.3 |
| 12 | Spain | 69.7 | 4 | 73.7 | 4 | 105.7 |
| 13 | Sweden | 72.0[a] | 1 | 75.4 | 1 | 104.7 |
| 14 | The Czech Republic | 66.1 | 11 | 68.5 | 12 | 103.6 |
| 15 | England and Wales | 68.6[a] | 5 | 73.5 | 5 | 107.1 |

[a] -- own calculation based on a few-years average.
    Source: For Hungary, Poland and the Czech Republic in the year 1970: Kędelski 1989; for the year 1992: Population (INED).

for the year 1970, it can be stated that the countries which in 1970 had the lowest or one of the lowest coefficients of life expectancy made particular progress. They were: Finland (10.3% growth) and Portugal (8.3% growth). Both of these countries moved up two places. The biggest failure was Hungary, where the coefficient decreased by 2.4% which meant moving in the ranking table to last place from position 10.

Females' life expectancy at birth  (Table 2) was higher than 70 years in all countries in 1970, and the order of the countries was similar to the  one  for men. The Spearman coefficient for men and women in 1970 equalled 0.916 and in 1992, 0.873.

Table 2
Life expectancy at birth, females, in 1970 and in 1992

| No | Country | 1970 | | 1992 | | (5:3)*100 |
| --- | --- | --- | --- | --- | --- | --- |
| | | value | rank | value | rank | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | Austria | 73.5[a] | 11 | 79.2 | 8 | 107.8 |
| 2 | Belgium | 74.0[a] | 8 | 79.8 | 5 | 107.8 |
| 3 | Denmark | 75.9[a] | 4 | 77.9 | 11 | 102.6 |
| 4 | Finland | 73.9[a] | 9 | 79.4 | 6 | 107.4 |
| 5 | France | 75.6[a] | 5 | 81.4 | 1 | 107.7 |
| 6 | Germany | 73.6[a] | 10 | 79.3 | 7 | 107.7 |
| 7 | Hungary | 72.2 | 14 | 73.7 | 14 | 102.1 |
| 8 | The Netherlands | 76.6[a] | 3 | 80.3 | 4 | 104.8 |
| 9 | Norway | 77.2[a] | 1 | 80.3 | 4 | 104.0 |
| 10 | Poland | 73.3 | 12 | 75.6 | 13 | 103.1 |
| 11 | Portugal | 70.1[a] | 15 | 78.1 | 10 | 111.4 |
| 12 | Spain | 74.9 | 7 | 80.9 | 3 | 108.0 |
| 13 | Sweden | 76.7[a] | 2 | 81.2 | 2 | 105.9 |
| 14 | The Czech Republic | 73.0 | 13 | 76.1 | 12 | 104.2 |
| 15 | England and Wales | 75.0[a] | 6 | 79.1 | 9 | 105.5 |

a – own calculation based on a few-year average.
Source: see Table 1.

In all the countries the tendency estimated on the basis of complete time series was increasing, though diverse in its intensity, which is proven by the Spearman coefficient of rank correlation from 1970 and 1992 equal 0.744. In 1970 Portugal took last place, and thanks to growth to 11.4% in 1992 it moved to tenth place. Three countries with the lowest coefficients after Portugal in 1970, i.e. Hungary, the Czech Republic, and Poland took the last places in 1992.

Infants make a group under  special care in all societies. The actions under-taken in this field manifested in the decrease in mortality in this sub-population between 1970 and 1992. Infant  mortality (per 1000 live births) decreased more than twice in all countries. The difference between the countries in particular years also became smaller. In 1970 the lowest mortality was in Sweden (11%); and the highest coefficient of 58% was in Portugal.

Table 3

Infant mortality in 1970 and in 1992

| No | Country | 1970 | | 1992 | | (5:3)*100 |
|---|---|---|---|---|---|---|
| | | value | rank | value | rank | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | Austria | 25.9 | 12.0 | 7.5 | 9 | 29.0 |
| 2 | Belgium | 21.1 | 9 | 8.2 | 11 | 38.9 |
| 3 | Denmark | 13.5 | 5 | 6.5 | 6 | 48.1 |
| 4 | Finland | 13.2 | 4 | 5.1[a] | 1 | 38.6 |
| 5 | France | 15.1 | 6 | 6.7 | 8 | 44.4 |
| 6 | Germany | 23.6 | 11 | 6.2 | 4 | 25.4 |
| 7 | Hungary | 35.9 | 13 | 14.1 | 14 | 39.3 |
| 8 | The Netherlands | 12.7 | 2 | 6.3 | 5 | 49.6 |
| 9 | Norway | 12.7 | 2 | 5.8 | 3 | 45.7 |
| 10 | Poland | 36.7 | 14 | 17.3 | 15 | 47.1 |
| 11 | Portugal | 58.0 | 15 | 9.3 | 12 | 16.0 |
| 12 | Spain | 20.6 | 8 | 7.7[a] | 9 | 37.4 |
| 13 | Sweden | 11.0 | 1 | 5.3 | 2 | 48.2 |
| 14 | The Czech Republic | 22.1 | 10 | 10.9 | 13 | 49.3 |
| 15 | England and Wales | 18.2 | 7 | 6.6 | 7 | 36.3 |

[a] – interpolation.

Source: Population (INED), Roczniki demograficzne [Demographic Yearbooks] (1970; 1992). GUS, Warszawa.

In 1992 the phenomenon's intensity was the lowest in Finland: 5.1%, and the highest in Poland: 17.3%. It means, that during over 20 years the relationship between the examined countries changed. The phenomenon's intensity in the country taking first place in 1970 was over 5 times higher than in the country in last place, and in 1992 it was only 3 times higher.

In all the countries the trends of the phenomenon were decreasing. The rate of the decrease was, though, diverse. In 1992 in three countries: Hungary, Poland, and the Czech Republic the number of deaths exceeded 10 per 1000 live births. In Poland and the Czech Republic they managed to decrease infant mortality by nearly 50% during the examined period, in other words the same rate as it was in Sweden or Norway, i.e. the leading countries in 1970. At the same time in Austria, Belgium, Germany, Portugal, and Spain, i.e. in the countries with a relatively high intensity of deaths in 1970, the success in the field of decreasing infant mortality was bigger. Diverse intensity of changes caused minor changes in the order of the countries. The Spearman coefficient of rank correlation from 1970 and 1992 worked out at 0.818.

Regarding the big number of data we have illustrated by diagrams the situation only in 6 countries also high as low value of variables (Fig. 1, 2, 3).
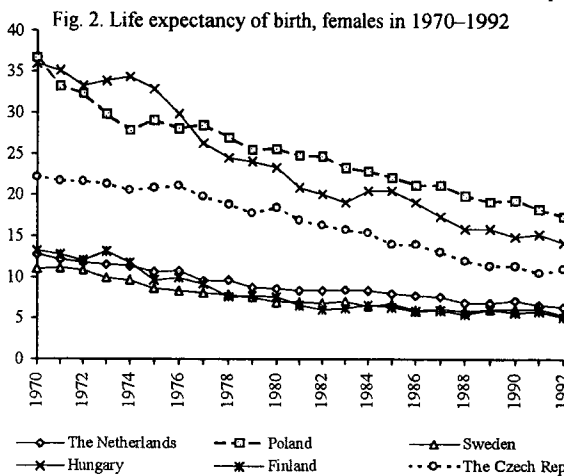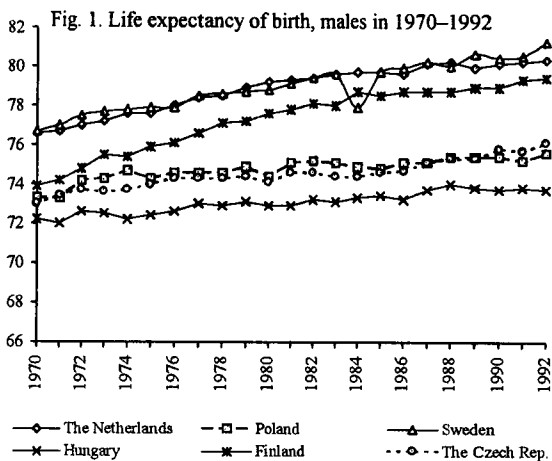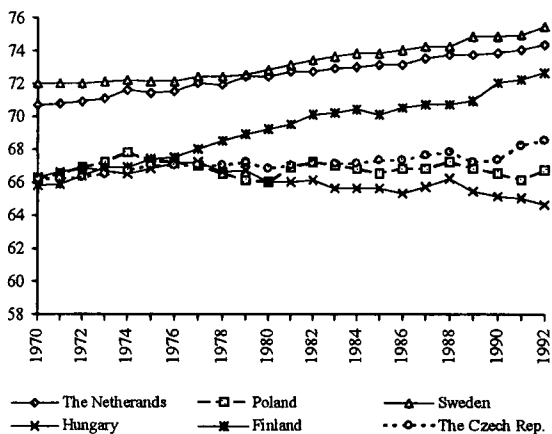
Fig. 1. Life expectancy of birth, males in 1970–1992



Fig. 2. Life expectancy of birth, females in 1970–1992



Fig. 3. Inflant mortality in 1970–1992

## 3. THE NUMBER OF PHYSICIANS PER 10,000 BETWEEN 1970 AND 1992

The degrees of accessibility to physicians in 1970 and 1992 are shown in Tables 4 and 5 and Figure 4. It is worth mentioning that different measures of the coefficient of physicians' number in 1970 and 1992 correspond with the same names of classes.

Table 4
Countries regarding to number of physicians in 1970

| Coefficient | Number of physicians per 10,000 inhabitants | Country |
|---|---|---|
| low | to 12 | Finland, Portugal |
| moderate | 12–14 | France, the Netherlands, Norway, Spain, Sweden, England and Wales |
| quite high | 14–16 | Belgium, Denmark, Poland |
| high | 16–18 | Austria, Germany |
| very high | 18 and more | Hungary, the Czech Republic |

Source: Roczniki statystyczne [Statistical Yearbooks ] (1971–1996). GUS, Warszawa.

Table 5
Countries regarding to number of physicians in 1992

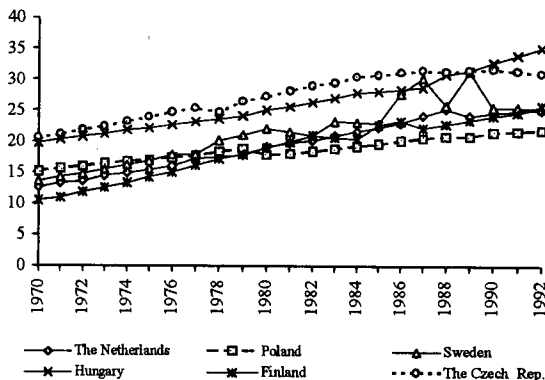| Coefficient | Number of physicians per 10,000 inhabitants | Country |
|---|---|---|
| low | to 22 | Poland, England and Wales |
| moderate | 22–26 | Finland, the Netherlands, Sweden |
| quite high | 26–32 | Denmark, France, Portugal |
| high | 30–34 | Austria, Germany, Norway, the Czech Republic |
| very high | 34 and more | Belgium, Hungary, Spain |

Source: see Table 4.



Fig. 4. Number of phusicians in 1970–1992 (per 10,000 inhabitants)

The data from these tables help us realize that the accessibility to physicians in particular countries was changing differently in time, which proves the Spearman coefficient of rank correlation from 1970 and 1992, amounting to 0.378.

In every country the coefficient of the physicians' number had a growing tendency, and it was the tendency much more intensive than that of males' and females' life expectancy.

In nine countries the growth of the measure was double or higher. The highest increases occurred in Portugal (245% of growth), Spain (197% of growth), and Finland (147% of growth). These countries in 1970 had low values of coefficient of the physicians' number (subsequently: 15th, 10th, and 14th place). The lowest growths occurred in England and Wales (by 33%), Poland (by 44%), and the Czech Republic (by 51%). England and Wales had a low value of the coefficient (13th place), Poland – quite high (6th place), the Czech Republic the highest (1st place). For the examined populations of the countries there was no relationship between the coefficient's value and its dynamics.

Table 6
Number of physicians in 1970 and in 1992 (per 10,000 inhabitants)

| No | Country | 1970 | | 1992 | | (5:3)*100 |
|----|---------|------|------|------|------|-----------|
| | | value | rank | value | rank | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | Austria | 16.5 | 3 | 30.6 | 7 | 185.5 |
| 2 | Belgium | 15.4 | 5 | 34.9 | 2 | 226.6 |
| 3 | Denmark | 14.4 | 7 | 27.9[a] | 9 | 193.8 |
| 4 | Finland | 10.4 | 14 | 25.7 | 10 | 247.1 |
| 5 | France | 13.2 | 11 | 27.5[a] | 11 | 208.3 |
| 6 | Germany | 16.0 | 4 | 31.9 | 5 | 199.4 |
| 7 | Hungary | 19.7 | 2 | 39.7 | 3 | 201.5 |
| 8 | The Netherlands | 12.5 | 12 | 25.0[a] | 13 | 200.0 |
| 9 | Norway | 13.8 | 8 | 32.7 | 4 | 237.0 |
| 10 | Poland[b] | 15.1 | 6 | 21.8 | 14 | 144.4 |
| 11 | Portugal | 8.4[a] | 15 | 29.0 | 8 | 345.2 |
| 12 | Spain | 13.4 | 10 | 39.8[a] | 1 | 297.0 |
| 13 | Sweden | 13.6 | 9 | 25.3 | 12 | 186.0 |
| 14 | The Czech Republic | 20.5 | 1 | 30.9 | 6 | 150.7 |
| 15 | England and Wales | 12.2 | 13 | 16.2 | 15 | 132.8 |

[a] – own estimation based on trends,  [b] – only civil service.
Source: Roczniki statystyczne [Statistical Yearbooks] (1970–1996). GUS, Warszawa.

## 4. THE RELATIONSHIPS BETWEEN LIFE DURATION AND ACCESSIBILITY TO PHYSICIANS IN EACH COUNTRY SEPARATELY

In this part of the study we would like to answer the question whether the changes in time of coefficients of life duration are accompanied by subsequent

changes of coefficients of the number of physicians in each of the examined countries. The results of the research are not interpreted in terms of cause-effect, but we treat them as signals making us consider whether such relationships exist. Regression analysis is the tool of the examination. We are going to check the significance of function's parameter's estimate and of coefficient of determination $R^2$, for which we will introduce an additional conventional scale ($R^2$ has been expressed in percents): 90 and more – very strong, 89–80 – strong, 79–70 – quite strong, 69–60 – moderate, 59–50 – weak, 50 and less – very weak.

The life duration will be a dependent variable, and the number of physicians per 10,000 inhabitants – an independent variable. Simultaneous relationships in time ($x_t$, $y_t$) will be examined, and because it can be expected that the possible influence of physicians' accessibility is proceeding with time lag, regression functions with the lag from 1 to 5 years ($y_t$, $x_{t-p}$) of physicians' number coefficient will be estimated.

Table 7 contains the best gained estimation of regression function of males' life expectancy. In the case of men linear significant relationships ($\alpha=0.05$) appeared in 14 countries. In most of the countries the relationships can be considered very strong (nine countries), or strong (three countries). In six countries the simultaneous relationships occurred to be the strongest, in the remaining countries – the relationships examined with the lag of 1–4 years.

An important aspect of relationships' investigations is the direction of the influences. According to intuition, the relationships considered should be positive. This is so in 13 countries. In Hungary there is a significant negative relationship and in Poland an insignificant negative relationship. As we know from point 3, in these countries, as in the remaining ones, there appeared a growing tendency of physicians' number coefficient. So, the growth of physicians' employment in these two countries was accompanied by the decrease of males' life expectancy.

As to females' life expectancy the relationships occurred to be stronger than with men (Table. 8). In all the countries they are significant relationships, including nine very strong, five strong, and one quite strong. Another important difference in comparison to the picture of the men's group is that contemporarily all the relationships are positive. So different types of life expectancy performance towards physicians' number are observed in the case of men and women.

Infant mortality stays in very strong (nine countries), or strong (six countries) relationships with the physicians' number coefficient. All the relationships are negative, according to the expectations (see Table 9).

Allowing the cause-effect interpretation here it can be stated that increase in physicians' employment gives the biggest result in infant mortality decrease.

Table 7
Regression models of life expectancy at birth ($e_{om}$) regarding to coefficient of physicians (p), males

| Country | Number of years of time lag | Model | | $R^2 * 100$ | $s$ Standard error |
|---|---|---|---|---|---|
| Austria | 3 | a | $e_{om} = 56.70 + 0.56p$ | 95.5 | 0.41 |
| | | b | 0.653   0.011 | | |
| | | c | 86.73   20.18 | | |
| Belgium | 0 | a | $e_{om} = 63.00 + 0.29p$ | 97.2 | 0.31 |
| | | b | 0.272   0.011 | | |
| | | c | 231.28   26.94 | | |
| Denmark | 2 | a | $e_{om} = 68.99 + 0.11p$ | 87.1 | 0.19 |
| | | b | 0.223   0.010 | | |
| | | c | 308.92   11.33 | | |
| Finland | 0 | a | $e_{om} = 61.34 + 0.42p$ | 97.5 | 0.33 |
| | | b | 0.282   0.015 | | |
| | | c | 217.19   28.63 | | |
| France | 4 | a | $e_{om} = 64.85 + 0.32p$ | 98.8 | 0.16 |
| | | b | 0.171   0.009 | | |
| | | c | 379.90   36.83 | | |
| Germany | 2 | a | $e_{om} = 61.53 + 0.38p$ | 94.2 | 0.43 |
| | | b | 0.512   0.021 | | |
| | | c | 19.90   17.22 | | |
| Hungary | 2 | a | $e_{om} = 69.09 - 0.13p$ | 68.3 | 0.36 |
| | | b | 0.531   0.021 | | |
| | | c | 130.21   - 6.40 | | |
| The Netherlands | 0 | a | $e_{om} = 67.52 + 0.26p$ | 97.6 | 0.18 |
| | | b | 0.175   0.009 | | |
| | | c | 385.22   28.96 | | |
| Norway | 1 | a | $e_{om} = 69.04 + 0.17p$ | 95.2 | 0.18 |
| | | b | 0.179   0.008 | | |
| | | c | 386.59   19.94 | | |
| Poland | 3 | a | $e_{om} = 68.95 - 0.12p$ | 25.8 | 0.36 |
| | | b | 0.829   0.045 | | |
| | | c | 83.19   - 2.57 | | |
| Portugal | 0 | a | $e_{om} = 61.39 + 0.34p$ | 95.5 | 0.53 |
| | | b | 0.324   0.016 | | |
| | | c | 189.30   21.14 | | |
| Spain | 0 | a | $e_{om} = 67.98 + 0.16p$ | 89.0 | 0.51 |
| | | b | 0.330   0.012 | | |
| | | c | 206.30   13.05 | | |
| Sweden | 3 | a | $e_{om} = 69.22 + 0.20p$ | 94.3 | 0.26 |
| | | b | 0.251   0.012 | | |
| | | c | 275.55   17.25 | | |
| The Czech Republic | 0 | a | $e_{om} = 64.03 + 0.11p$ | 62.0 | 0.35 |
| | | b | 0.531   0.019 | | |
| | | c | 120.53   5.85 | | |
| England and Wales | 4 | a | $e_{om} = 56.22 + 1.02p$ | 85.88 | 0.53 |
| | | b | 1.500   0.101 | | |
| | | c | 37.49   10.17 | | |

[a] – model,  [b] – standard error,  [c] – Student's $t$.
Source: own calculation.

Table 8

Regression models of life expextancy at birth ($e_{of}$) regarding to coefficient of physicians (p), females

| Country | Number of years of tme lag | Model | | $R^2 * 100$ | $s$ Standard error |
|---|---|---|---|---|---|
| Austria | 1 | a | $e_{of} = 65.65 + 0.47p$ | 94.2 | 0.42 |
|  |  | b | 0.617   0.026 |  |  |
|  |  | c | 106.40   17.97 |  |  |
| Belgium | 0 | a | $e_{of} = 69.35 + 0.31p$ | 96.9 | 0.36 |
|  |  | b | 0.322   0.013 |  |  |
|  |  | c | 215.85   24.26 |  |  |
| Denmark | 2 | a | $e_{of} = 74.78 + 0.11p$ | 84.8 | 0.21 |
|  |  | b | 0.246   0.011 |  |  |
|  |  | c | 304.51   10.3 |  |  |
| Finland | 0 | a | $e_{of} = 70.80 + 0.35p$ | 97.2 | 0.29 |
|  |  | b | 0.248   0.013 |  |  |
|  |  | c | 285.39   27.02 |  |  |
| France | 2 | a | $e_{of} = 71.82 + 0.35p$ | 97.5 | 0.26 |
|  |  | b | 0.263   0.013 |  |  |
|  |  | c | 273.35   27.32 |  |  |
| Germany | 0 | a | $e_{of} = 67.80 + 0.38p$ | 92.6 | 0.52 |
|  |  | b | 0.559   0.023 |  |  |
|  |  | c | 121.19   16.16 |  |  |
| Hungary | 5 | a | $e_{of} = 69.86 + 0.14p$ | 86.9 | 0.17 |
|  |  | b | 0.333   0.014 |  |  |
|  |  | c | 209.54   10.29 |  |  |
| The Netherlands | 0 | a | $e_{of} = 73.39 + 0.28p$ | 95.0 | 0.28 |
|  |  | b | 0.280   0.014 |  |  |
|  |  | c | 262.06   19.96 |  |  |
| Norway | 4 | a | $e_{of} = 74.91 + 0.22p$ | 93.3 | 0.19 |
|  |  | b | 0.282   0.014 |  |  |
|  |  | c | 265.39   15.38 |  |  |
| Poland | 3 | a | $e_{of} = 71.27 + 0.20p$ | 79.0 | 0.18 |
|  |  | b | 0.448   0.025 |  |  |
|  |  | c | 159.04   8.22 |  |  |
| Portugal | 0 | a | $e_{of} = 68.03 + 0.36p$ | 93.3 | 0.70 |
|  |  | b | 0.425   0.021 |  |  |
|  |  | c | 159.93   17.10 |  |  |
| Spain | 0 | a | $e_{of} = 72.73 + 0.21p$ | 96.7 | 0.36 |
|  |  | b | 0.232   0.008 |  |  |
|  |  | c | 313.46   24.82 |  |  |
| Sweden | 3 | a | $e_{of} = 77.22 + 0.19p$ | 83.7 | 0.45 |
|  |  | b | 0.427   0.020 |  |  |
|  |  | c | 176.1   9.62 |  |  |
| The Czech Republic | 5 | a | $e_{of} = 70.74 + 0.15p$ | 81.8 | 0.36 |
|  |  | b | 0.480   0.018 |  |  |
|  |  | c | 147.46   8.49 |  |  |
| England and Wales | 2 | a | $e_{of} = 63.97 + 0.89p$ | 85.6 | 0.46 |
|  |  | b | 1.250   0.083 |  |  |
|  |  | c | 51.16   10.63 |  |  |

[a] – model,   [b] – standard error,   [c] – Student's $t$

Source: own calculation.

Table 9

Regression models of infant mortality (IMR)regarding to coefficient of physicians (p)

| Country | Number of years of time lag | Model | | $R^2 * 100$ | $s$ Standard error |
|---|---|---|---|---|---|
| Austria | 5 | a | IMR = 41.46 − 1.31p | 86.0 | 0.99 |
|  |  | b | 2.977   0.132 |  |  |
|  |  | c | 13.93 − 9.91 |  |  |
| Belgium | 1 | a | IMR = 26.69 − 0.58p | 93.0 | 0.99 |
|  |  | b | 0.902   0.036 |  |  |
|  |  | c | 29.58 − 16.31 |  |  |
| Denmark | 0 | a | IMR = 18.24 − 0.41p | 85.3 | 0.76 |
|  |  | b | 0.844   0.037 |  |  |
|  |  | c | 21.62 − 11.02 |  |  |
| Finland | 0 | a | IMR = 18.41 − 0.56p | 92.5 | 0.77 |
|  |  | b | 0.661   0.034 |  |  |
|  |  | c | 27.86 − 16.14 |  |  |
| France | 0 | a | IMR = 20.71 − 0.52p | 95.2 | 0.57 |
|  |  | b | 0.531   0.025 |  |  |
|  |  | c | 39.04 − 20.46 |  |  |
| Germany | 0 | a | IMR = 41.49 − 1.20p | 87.7 | 2.18 |
|  |  | b | 2.336   0.098 |  |  |
|  |  | c | 17.77 − 12.23 |  |  |
| Hungary | 5 | a | IMR = 60.67 − 1.65p | 87.8 | 1.89 |
|  |  | b | 3.751   0.154 |  |  |
|  |  | c | 16.17 − 10.73 |  |  |
| The Netherlands | 0 | a | IMR = 17.60 − 0.44p | 95.2 | 0.43 |
|  |  | b | 0.431   0.022 |  |  |
|  |  | c | 40.86 − 20.42 |  |  |
| Norway | 3 | a | IMR = 16.41 − 0.39p | 80.0 | 0.72 |
|  |  | b | 0.932   0.046 |  |  |
|  |  | c | 17.62 − 8.42 |  |  |
| Poland | 1 | a | IMR = 67.90 − 2.35p | 95.8 | 0.95 |
|  |  | b | 2.034   0.110 |  |  |
|  |  | c | 33.38 − 21.43 |  |  |
| Portugal | 1 | a | IMR = 56.12 − 1.71p | 93.1 | 3.27 |
|  |  | b | 2.055   0.105 |  |  |
|  |  | c | 27.30 − 16.38 |  |  |
| Spain | 0 | a | IMR = 26.44 − 0.52p | 93.4 | 1.28 |
|  |  | b | 0.823   0.030 |  |  |
|  |  | c | 32.14 − 17.27 |  |  |
| Sweden | 0 | a | IMR = 14.46 − 0.32p | 81.9 | 0.78 |
|  |  | b | 0.724   0.033 |  |  |
|  |  | c | 19.98 − 9.74 |  |  |
| The Czech Republic | 5 | a | IMR = 40.36 − 0.95p | 98.3 | 0.47 |
|  |  | b | 0.832   0.031 |  |  |
|  |  | c | 48.51 − 30.28 |  |  |
| England and Wales | 5 | a | IMR = 40.68 − 2.03p | 92.8 | 0.73 |
|  |  | b | 2.098   0.142 |  |  |
|  |  | c | 19.39 − 14.33 |  |  |

[a] – model,  [b] – standard error,  [c] – Student's *t*.

Source: own calculation.

## 5. CROSS-SECTIONAL ANALYSIS OF THE RELATIONSHIPS

In this part of the study we try to answer the following questions:
– is the same life duration in all the countries related to the same number of physicians? In other words, whether there exists the same "standard" of physicians' number per 10,000 inhabitants in relation to life duration in all the countries?
– in the countries with high physicians' number coefficient is there also long life duration, and vice versa?

To answer these questions the cross-sectional analysis in 1970 and 1992 was made by means of confronting the demographic data with the data of physicians' number coefficient in each of the years separately and by combining the demographic data from 1992 with the coefficient of physicians from 1970.

Table 10
Cross-sectional regression models regarding to coefficient of physicians

| Model | $R^2 * 100$ |
|---|---|
| $e_{om(70)} = 69.80 - 0.12\ p(70)$ | 2.76 |
| $e_{om(92)} = 69.24 - 0.04\ p(92)$ | 1.17 |
| $e_{om(92)} = 69.83 - 0.12\ p(70)$ | 2.76 |
| $e_{of(70)} = 75.17 - 0.06\ p(70)$ | 0.86 |
| $e_{of(92)} = 80.11 - 0.04\ p(92)$ | 1.62 |
| $e_{of(92)} = 76.23 - 0.06\ p(70)$ | 4.45 |
| $IMR(70) = 26.39 - 0.26\ p(70)$ | 0.41 |
| $IMR(92) = 6.76 - 0.05 p(92)$ | 0.76 |
| $IMR(92) = 1.00 + 0.50\ p(70)$ | 20.47 |

Source: own calculation

The results of the research indicate that there are no these type relationships. The attempts to find some non-linear relationships also failed. Thus the answer for the above question is negative. To illustrate the situation we notify that in 1970 in the countries where males' life expectancy exceeded 70 years, the physicians' number coefficient figured out at 12.5–14.4, and in 1992 in the countries which achieved 72 years and more, it amounted to 16.2–39.8. In the countries where males' life expectancy was lower than 70 years, physicians' number coefficient worked out at 8.4–20.5 in 1970, and 21.8–39.7 in 1992. In case of women, in 1970 life expectancy of 75 years and more was achieved with physicians' number coefficient equal 12.2–13.8, and lower than 70 years with the coefficients equal 8.4–20.5. In 1992 the highest females' life expectancy, over 78 years, was present in countries with the coefficient of 16.2–39.8, and life expectancy lower than 70 years in the countries with coefficient of 21.8–39.7.

Infant mortality in 1970 had the lowest intensity of 11.0–15.1% with the physicians' number coefficient 10.4–14.4, and the highest over 35% with the coefficient 8.4–19.7. In 1992 the lowest mortality 5.1–6.0% was noticed in the countries with the coefficient 25.3–32.7, and the mortality exceeding 100% with the coefficient 21.8–39.7. So the number of physicians per 10,000 inhabitants does not explain the changes of life duration, if we take to consideration international data.

In search for the answer to this question, state expenditures on public health were checked. The evidence is hardly accessible, and its level depends on the health care organization changing in time. Thus the data was limited to the last few years, i.e. 1989–1992 (Table 11).

Table 11
Expenditures on public health care from state budget

| Country | Per capita expenditures (dollars) |
|---|---|
| Austria | 1070[d] |
| Belgium | 130[d] |
| Denmark | 110[c] |
| Finland | 830[b] |
| France | 1440[c] |
| Germany | 1010[c] |
| Hungary | 130[d] |
| The Netherlands | 1550[d] |
| Norway | 1160[d] |
| Poland | 108[d] |
| Portugal | 200[d] |
| Spain | 300[c] |
| Sweden | 98[c] |
| The Czech Republic | 363[a] |
| England and Wales | 950[b] |

[a] – 1989, [b] – 990, [c] – 1991, [d] – 1992.
Source: Roczniki statystyczne [Statistical Yearbooks]
(1990–1996). GUS, Warszawa.

The expenditure is very differentiated, from $98 in Sweden to $1550 in the Netherlands. We are not capable of assessing the credibility of the evidence or the health care organization's influence on the expenditures level in individual countries. Thus we will limit to figuring out the averages in the distinguished classes of life duration to evaluate their importance to the duration of life.

The information included in Table 12 indicates distinctly, that on average the higher the expenditure for public health, the longer the duration of life.

The result encourages further investigation of this relationship, based on reliable and comparable data.

Table 12
Duration of life and expenditures on public health care from state budget

| Duration of life in 1992 | Per capita expenditures on public health care (dollars) |
|---|---|
| Life expectancy at birth, males | |
| to 72 | 200 |
| 72 and over | 785 |
| Life expectancy at birth, females | |
| to 78 | 177 |
| 78 and over | 794 |
| Infant mortality rate | |
| to 10% | 794 |
| 10% and over | 177 |

Source: own calculation.

## 6. CONCLUSIONS

Assuming that the state of health of the population can be described by males' and females' life expectancy, and by infant mortality, the research carried allows us to state that in the highly-developed, free-market countries there exists a strong, positive relationship between the state of health of the population and the number of physicians per 10,000 inhabitants. In middle-eastern European countries this relationship is positive for females' life expectancy, negative for infant mortality, and, in Hungary and Poland – negative (insignificant) for males' life expectancy.

The cross-sectional analysis proved that there is no common "standard" of physicians' number adequate to the duration of life. Every country has its own specific way of how their medical service is organized and works. This means that the same life duration is achieved in different countries with a different number of physicians.

The available data showed that they are state expenditures for public health service rather than the number of physicians, that influence the duration of life (Indulski 1994). In most countries with a high life duration these expenditures are high, whereas in countries with a relatively low life duration they are also relatively lower.

The results of the research suggest that it is not the number of physicians, but the organization and quality of the medical service supported by financial aid that has a great deal of significance for the population's life duration.

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