Assessment of risk factors of serious diseases in OECD countries

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Abstract

Despite a remarkable progress in health status and life expectancy in OECD countries over the past decades, there remain large inequalities across countries and also across population groups within each country. These inequalities in health status are linked to many factors, including differences in exposure to risk factors to health and in access to health care. The online OECD Health Database 2016 offers the most comprehensive source of comparable statistics on health and health systems across OECD countries. It is an essential tool to carry out comparative analyses and draw conclusion from international comparisons of health care results. The aim of this article is to use the mentioned database and apply appropriate multidimensional statistical methods to assess the risk factors in relation to mortality caused by selected serious diseases, and quantify the impact of factors such as gender, age, income inequality, costs of treatment and selected characteristics of health systems in OECD countries.

Keywords: *comparisons, factor analysis, multidimensional comparative analysis, risk factors, serious diseases*
JEL Classification: C38, I15

1 Introduction

The mission of the Organization for Economic Co-operation and Development (OECD) is to promote policies that will improve the economic and social well-being of people around the world. Today this organization focuses on helping governments around the world to re-establish healthy public finances as a basis for future sustainable economic growth.

According to *Health at a Glance 2015* (2015) people in OECD countries are living longer than ever before, with life expectancy now exceeding 80 years on average, thanks to improvements in living conditions and educational attainments, but also to progress in health care. But these improvements have come at a cost. Health spending now accounts for about 9% of GDP on average in OECD countries, and exceeds 10% in many countries. Higher health spending is not a problem if the benefits exceed the costs, but there is an evidence of inequities and inefficiencies in health systems which need to be addressed.

Nearly all OECD countries have achieved universal (or almost universal) health coverage for a core set of health services and goods. Still, inequalities in access to care exist across

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different socio-demographic groups, including sex, age, geographic area and socio-economic status, for financial and non-financial reasons.

By using selected multidimensional statistical methods on a selected set of indicators of health status, focusing particularly on serious diseases and risk factors of health, health expenditures and health systems financing in OECD countries we attempt to identify and quantify what causes the differences in people´s health in OECD countries.

2 Data and methods

The OECD health database *OECD Health Statistics 2016* (OECD, online) offers the most comprehensive source of comparable statistics of health and health systems across OECD countries. This online database was released on June 30 and all datasets have been updated on October 12. The list of variables in OECD health statistics is very broad. The problem is missing data for some OECD countries which it is possible partly supplement from the database of World Health Organization (WHO, online).

As the basis of a multivariate statistical analysis the following indicators from the database *OECD Health Statistics 2016* have been selected*:*

*X*1 – Current expenditure on health, % of gross domestic product

*X*2 – Current expenditure on health, per capita, US$ purchasing power parities

*X*3 – Public expenditure on health, % of current expenditure on health

*X*4 – Public expenditure on health, per capita, US$ purchasing power parities

*X*5 – Life expectancy at birth, total population

*X*6 – Life expectancy at 65 years old, female population

*X*7 – Life expectancy at 65 years old, male population

*X*8 – Alcohol consumption, liters per population aged 15+

*X*9 – Poverty rate, 2014 or late

*X*10 – Gini coefficient

*X*11 – Neoplasms mortality

*X*12 – Malignant neoplasms of trachea, bronchus, lung mortality

*X*13 – Malignant neoplasms of colon mortality

*X*14 – Leukemia mortality

*X*15 – Malignant neoplasms of bladder mortality

*X*16 – Ischemic heart disease mortality, 2013 (or nearest year)

*X*17 – Cerebrovascular disease mortality, 2013 (or nearest year)

According to the above mentioned goals of analysis of these variables we have used the factor analysis (FA), multidimensional comparative analysis (MCA) and graphical methods.

The goal of factor analysis (Hair et al., 2007) is to characterize the *p* variables in terms of a small number of common factors. An important result of the factor analysis model is the relationship between the variances of the original variables and the variances of the derived factors. An important concept in factor analysis is the rotation of factors. In practice, the objective of all methods of rotation is to simplify the rows and columns of the factor matrix to facilitate interpretation. The Varimax criterion centres on simplifying the columns of the factor matrix.

The correlation between the original variables and the factors is shown by the factor loadings. They are the key for understanding the nature of a particular factor. Squared factor loadings indicate what percentage of the variance in an original variable is explained by a factor.

The factor scores in the results of a factor analysis procedure display the values of the rotated factor scores for each of *n* cases, in our analysis in each of 34 OECD countries. The factor score show where each country belongs to with respect to the extracted factors.

Multidimensional comparative analysis deals with the methods and techniques of comparing multi-feature objects, in our case OECD countries. The objective to establish a linear ordering among a set of objects in a multidimensional space of features, from the point of view of certain characteristics which cannot be measured in a direct way (the standard of living, public health situation ...). Application of these methods to compare health and health care in selected countries can be found for example in Pacáková et al., (2016), Pacáková et al., (2013) or Pacáková and Papoušková (2016).

At the beginning of the analysis, the type of each variable should be defined. It is necessary to identify whether the *great* values of a variable positively influence the analysed processes (such variables are called stimulants) or whether their *small* values are favourable (these are called destimulants).

$$b_{ij} = \frac{x_{ij}}{x_{\max,j}} \cdot 100 \tag{1}$$

$$b_{ij} = \frac{x_{\min,j}}{x_{ij}} \cdot 100. \tag{2}$$

The initial variables employed in composing an aggregate measure are, usually, measured in different units. The aim to normalize them is to bring them to comparability. Normalisation is performed according to formula (1) for stimulants and to formula (2) for destimulants

(Stankovičová and Vojtková, 2007). The synthetic indicator for each country has been calculated as the average of the b_{ij}, $i = 1,\ldots, n$.

3 Results and discussion

- *Results of Factor analysis*

The purpose of the analysis is to obtain a small number of factors which account for most of the variability in 17 variables. In this case, 4 factors have been extracted, since 4 factors had eigenvalues greater than 1.0. Together they account for 78.991% of the variability in the original data.

Variable	Factor 1	Factor 2	Factor 3	Factor 4
*X*1	0.2539	0.1133	0.8779	-0.0448
*X*2	0.2726	0.0066	0.9260	0.1457
*X*3	0.2089	0.1939	-0.0288	0.7818
*X*4	0.3583	0.0032	0.7812	0.3433
*X*5	0.9097	-0.0417	0.2190	0.2316
*X*6	0.9016	-0.0708	0.1658	0.1104
*X*7	0.8508	-0.2249	0.2677	0.0598
*X*8	-0.1359	0.3003	0.2620	0.2219
*X*9	0.0802	-0.1742	-0.2042	-0.8990
*X*10	-0.1204	-0.3453	-0.1147	-0.8522
*X*11	-0.2612	0.8641	-0.0616	0.2957
*X*12	-0.1182	0.7716	0.0996	0.1547
*X*13	-0.2444	0.7495	-0.2006	0.3561
*X*14	-0.1392	0.6858	0.1673	0.0099
*X*15	0.0695	0.8633	-0.1784	0.1536
*X*16	-0.8095	0.2687	-0.1424	0.1621
*X*17	-0.5808	0.3016	-0.3667	-0.0095

Table1. Factor Loading Matrix After Varimax Rotation.

Factor loadings (Table 1) present the correlation between the original variables and the factors after Varimax rotation and they are the key for understanding the nature of a particular factor. Rotation is performed in order to simplify the explanation of the factors. Substantive

interpretation of the four extracted factors is based on the significant higher loadings in Table 1. Factor 1 (*F*1), which explains 34.448% variability of the total variability in the data, has 3 significant loadings with positive signs with variables *X*5-*X*7, which are the variables of life expectancy. Factor 1 has also significant loadings with negative signs with variables *X*16 and *X*17, which are indicators of cardiovascular diseases mortality. According to *Health at a Glance 2015* all the above mentioned variables are the main indicators of health status, so *F*1 can be identified as *a Health status factor* in OECD countries. The high values of this factor mean high level of health status. Strong significant positive correlation with variables *X*11 – *X*15 is the reason that we have interpreted *Factor* 2 (*F*2) as a *Cancer mortality factor*. This factor explains 28.503% of the variability in the data. The higher the value of *F*2, the higher is the mortality from cancer. *Factor* 3 (*F*3) explains 8.695% of the variability in the data and correlates strongly with variables *X*1, *X*2 and *X*4, so we can interpret it as a *Health expenditures factor* in OECD countries. The higher are the values of *F*3 are, the higher are the health expenditures in OECD countries are, and vice versa. The Factor 4 (*F*4) explains 7.345% of the whole data variability and its significant positive correlation with variable *X*3 and significant negative correlation with variables *X*9, *X*10 is the reason that we have interpreted it as an *Economic and social situation factor*. The higher the values of *F*4 are, the better the economic and social situation of relevant OECD countries is.

Graphical display of OECD countries in a two-dimensional coordinate system with axes of the two selected factors allows us to assess quickly the level of the both factors in each OECD country, and also allows us to compare the situation in all OECD countries by these factors and to assess the causal relationship of the two selected factors.

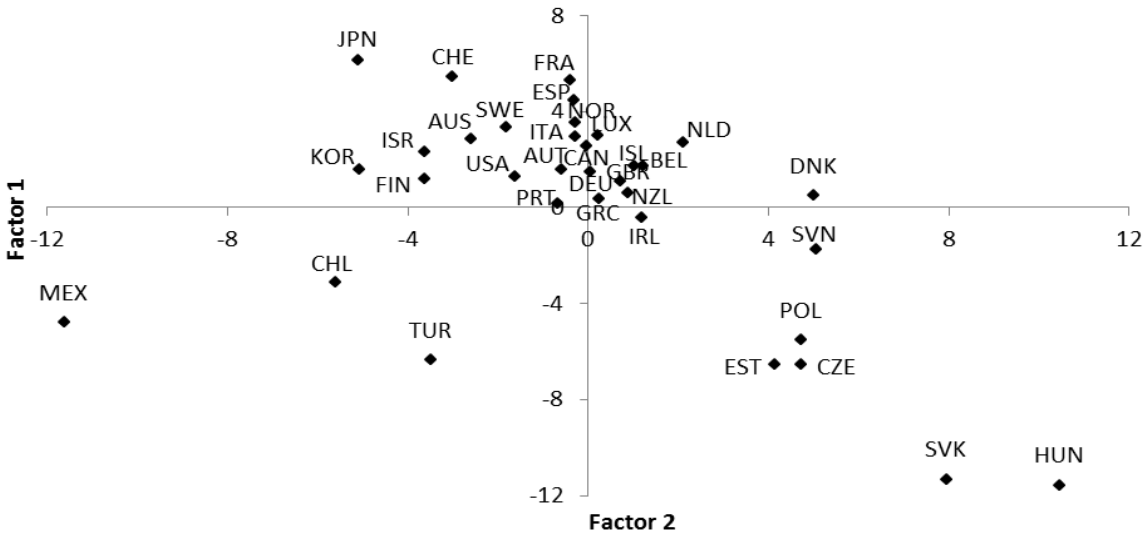

Fig. 1. Location of OECD countries in the coordinate system of factors *F*1 and *F*2.

Figure 1 presents the causal relationship of factors *F*1 and *F*2. Spearmans' rank correlation between this pair of factors is -0.4124, which means moderately strong indirect dependency. Ireland and the former socialist countries, namely Slovenia, Poland, Estonia, the Czech Republic, the Slovak Republic and Hungary, represent a group of countries with high cancer mortality and low level of health status. Besides the low mortality in Mexico, Chile and Turkey we can observe low level of health status too. Dependence of life expectancy and level of health care is confirmed also in articles by Jindrová and Slavíček (2012) and Kubanová and Linda (2014).

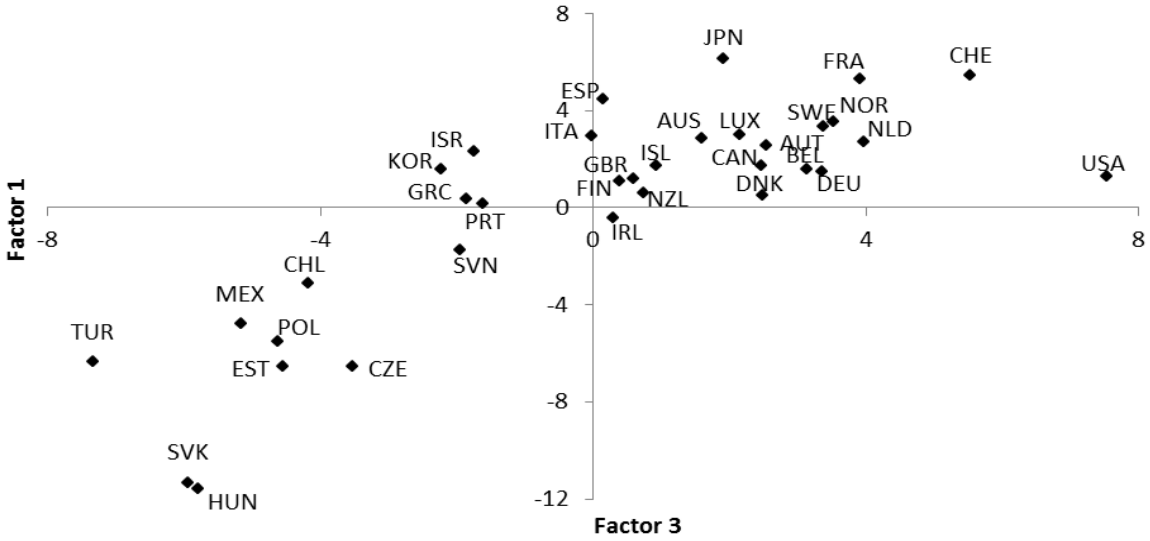

Fig. 2. Location of OECD countries in the coordinate system of factors *F*1 and *F*3

The value 0.7470 of Spearman rank correlation coefficient between factors *F*1 and *F*3 is shown in Figure 2. It is obvious that health expenditures in OECD countries considerably affect health status. In the lower left quadrant, which represents the lowest health expenditures and also the lowest health status, again the countries such as Turkey, the Slovak Republic, Hungary, Mexico, Chile, Poland, Estonia, the Czech Republic and Slovenia can be found.

It is evident that the high level of health expenditures in OECD countries does not automatically imply high level of health status (see the USA). The important thing is, of course, the efficient use of this health expenditure, but the assessment of effectiveness is not an objective of this article. According to Figure 2, we can conclude the effective use of health expenditure in Japan and Spain.

Factor 4 referring to the economic and social situation explains only 7.345% variability of the whole dataset and high values of this factor are the consequence of a high proportion of public expenditure on health from the current expenditure or the consequence of a low

poverty rate. Spearman rank correlation coefficient between factors *F*1 and *F*4 is only 0.1759, but between factors *F*2 and *F*4 is higher, it equals 0.6037. The relationship of factors *F*2 and *F*4 is presented in Fig. 3.

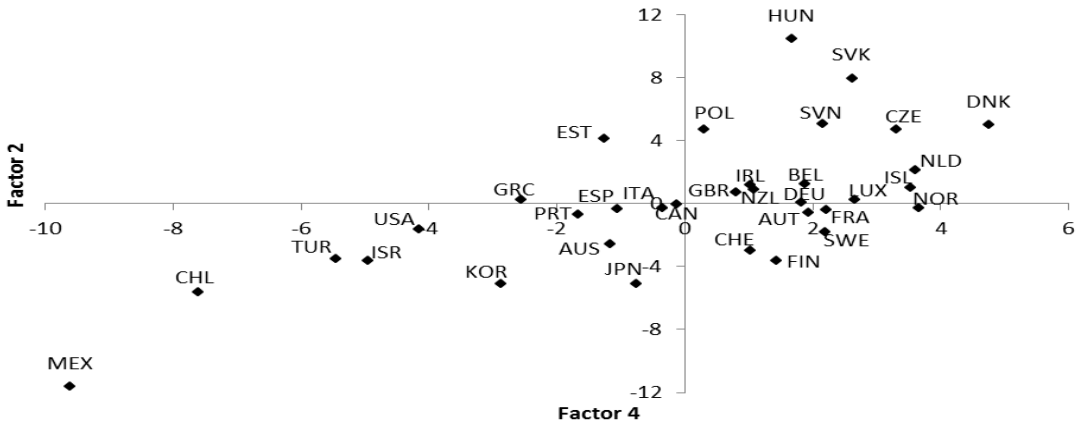

Fig. 3. Location of OECD countries in the coordinate system of the factors *F*2 and *F*4.

The fact that the economic and social situation of the inhabitants in OECD countries is an important factor of health status confirmed also the results of a self-reported health assessment in selected OECD countries (Fig. 4). A significant relationship between health and poverty and social deprivation is also presented in article by Šoltés and Šoltésová (2016).

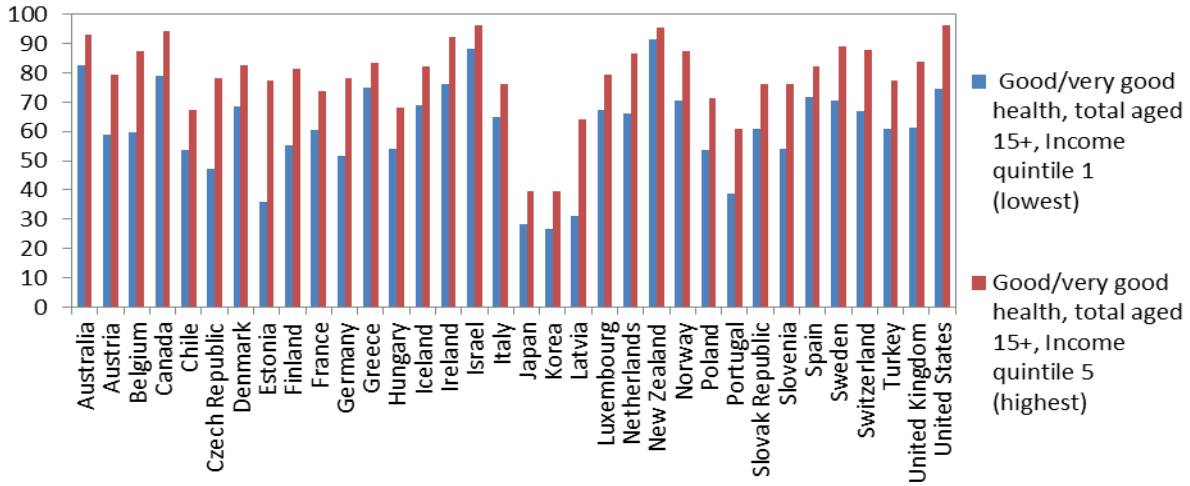

Fig. 4. Perceived health status by socio-economic situation

- *Results of multidimensional comparative analysis*

Table 2 contains the result of linear ordering of OECD countries by variables *X*1-*X*17, where variables *X*1-*X*7 are considered as stimulants and *X*8-*X*17 as destimulants with standardized

values by formulas (1) and (2). Hungary, Estonia, the Slovak Republic and Poland represent the countries with the worst situation in health status and its associated indicators.

Average	Country	Rank	Average	Country	Rank	Average	Country	Rank
65.6773	CHE	1	59.6782	AUT	13	53.3999	PRT	25
65.3741	JPN	2	59.6179	BEL	14	51.7387	TUR	26
64.6189	NOR	3	59.4758	DEU	15	51.1672	SVN	27
64.6164	FRA	4	58.4798	CAN	16	50.9784	GRC	28
63.3194	NLD	5	57.6897	KOR	17	50.5093	CZE	29
62.5676	SWE	6	56.9214	AUS	18	49.9149	CHL	30
61.3194	MEX	7	56.4980	ESP	19	46.7496	POL	31
61.1696	DNK	8	55.5291	ISR	20	45.9812	SVK	32
61.0327	USA	9	55.5039	GBR	21	44.8860	EST	33
60.7910	ISL	10	54.9689	ITA	22	42.8309	HUN	34
60.4493	FIN	11	54.5284	NZL	23			
60.4416	LUX	12	53.8069	IRL	24			

Table 2. The results of multidimensional comparative analysis

- *Sex as a risk factor for serious diseases*

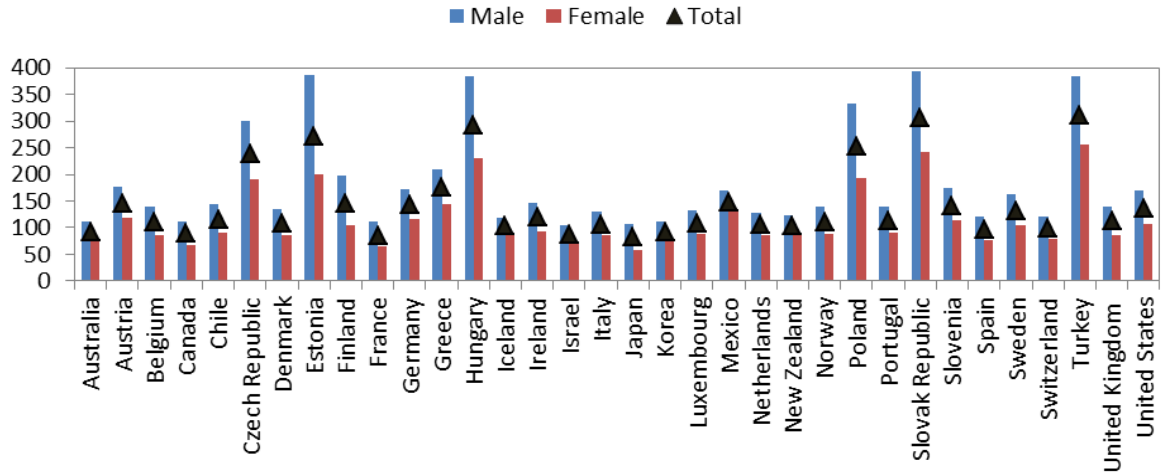

Fig. 5. Age-standardized mortality rate by cardiovascular diseases by sex (2013 or nearest year, per 100 000 population).

Cardiovascular and cancer diseases remain in the main causes of mortality in most OECD countries. Mortality from cardiovascular diseases, accounting 32.3% of all deaths in OECD countries in 2013, varies considerably across countries for both sex (Fig. 5).

Very high level of mortality from cardiovascular diseases with comparison of other countries is in the Slovak Republic, Hungary, Estonia, Poland, the Czech Republic and Turkey. The Slovak Republic and Hungary report a cerebrovascular mortality more than three times higher than that on Switzerland, Canada and France (WHO, 2017).

Cancer is the second leading cause of mortality in OECD countries, accounting for 25% of all death in 2013, up from 15% in 1960. In 2013, the average rate of mortality attributable to cancer across OECD countries was just over 200 per 100 000 population (Fig. 6).

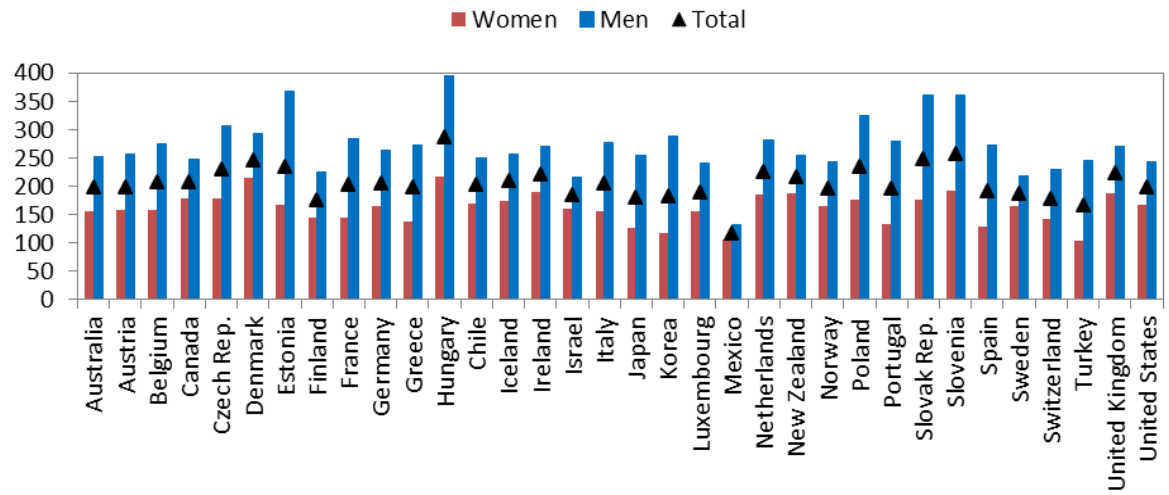

Fig. 6. Age-standardized mortality rate by cancer diseases by sex (2013 or nearest year, per 100 000 population).

Mortality due to cancer was the lowest in Mexico, Turkey, Finland, Switzerland and Japan. On the other hand, Hungary, Slovenia, the Slovak Republic and Denmark bear the highest cancer mortality burden, with the rates exceeding 240 per 100 000 population (OECD, 2015). In several countries, the death rate from cancer is as twice for men as for women (Fig. 6).

Conclusions

The results of analyses in the article confirmed the significant impact of the health expenditures on health status and cancer mortality in OECD countries. The graphic comparison of mortality from cardiovascular disease and cancer makes it evident that gender is a significant factor in mortality from these leading causes of death. The multivariate comparison of OECD countries and several other results in the article unfortunately confirm the poor state of health of the former socialist countries.

Acknowledgements

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