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Original article

RELATIONSHIP BETWEEN CARDIOVASCULAR RISK FACTORS AND SOCIO-ECONOMIC FACTORS: THE EXAMPLE OF SOUTH-EASTERN EUROPEAN COUNTRIES

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Abstract

Cardiovascular disease is recognized as a leading cause of mortality in developed societies and one of the most fatal conditions affecting the health of developing countries' populations. In addition to the generally expected risk factors such as family history, diabetes, obesity, smoking and hypertension, recent research shows that socio-economic status plays important part in the pathogenesis of cardiovascular disease. There are many evidence that adverse socio-economic conditions are associated with a higher risk of cardiovascular disease and premature mortality. Therefore, in the present article, we aim to review the relationship between the six dimensions of socio-economic factors at macro level (economy, education, transport, urbanization, health habits and health management) and the selected risk factors for cardiovascular diseases (obesity, diabetes and hypertension). The analysis was conducted on the example of the following countries of South Eastern Europe: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Greece, Macedonia, Montenegro, Romania, Serbia, Slovenia and Turkey.

Key words: cardiovascular disease, epidemiological transition, economic factors

1. Introduction and background

The World Health Organization defines Cardiovascular Diseases (CVDs) as a group of diseases of the heart and blood vessels that includes (i) coronary heart disease – the disease of the blood vessels supplying the heart muscle; (ii) cerebrovascular disease - the disease of the blood vessels supplying the brain; (iii) peripheral arterial disease – the disease of the blood vessels supplying the arms and legs; (iv) rheumatic heart disease – the damage of the heart muscle and heart valves from rheumatic fever caused by streptococcal bacteria; (v) congenital heart disease - malformations of the heart structure existing at birth; (vi) deep vein thrombosis and pulmonary embolism - blood clots in the leg veins, which can dislodge and move to the heart and lungs. (World Health Organization, 2018).

Coronary heart disease (CHD) is the single most significant cause of mortality in developed countries and one of the leading disease burdens in developing countries. At the beginning of the 20th century, cardiovascular disease was responsible for less than 10% (Gaziano T.A, 2005) of all deaths, globally observed, whereas today it is 31%. Namely, the World Health Organization estimates that in 2015, 17.7 million people died of cardiovascular disease, 7.4 million died from coronary heart disease and 6.7 million died of stroke out of the total number of cardiovascular disease deaths. Cardiovascular diseases occur due to elevated blood pressure, elevated blood glucose levels and excessive weight and obesity, which is harmful to heart health. According to the same resource, triggers for these diseases are tobacco consumption, unhealthy diet, physical inactivity and alcohol use. (WHO, 2018)

Most of the world's spending on the health sector refers to high income countries, while the prevalence of the disease is inversely proportional to the size of the funds that are invested. (Gottret P & Schieber G, 2006). From this relation it is easy to conclude that the low and middle income per capita countries are faced with difficulties providing the needed treatments for patients. This is especially noticeable in the case of cardiovascular diseases where a number of problems appear. Low and middle income countries often don't have sufficiently developed integrated primary health care programs for early detection and treatment of patients with risk factors compared to high income countries. Thus, for example, in low and middle income countries, CVD preventions and early detection programs are not sufficiently developed, causing the disease to be discovered late and patients die in their most productive years.

In addition, with diagnosed patients problems arise because they do not have access to effective and equitable health services that meet their needs. At the household level there is evidence that cardiovascular diseases and other diseases contribute to poverty due to unplanned spending on health and high out of pocket costs. At the macroeconomic level, cardiovascular diseases pose a severe burden on the economies of low and middle income countries. (WHO, 2018) Due to the above said, cardiovascular diseases are in the focus of interest of not only the health sector but of the economists too.

In the first part of this paper we have given an overview of the relationship between economic growth and health indicators while the second part refers to the concept of epidemiological transition that analyzes the changes in the dominant forms of disease and mortality that are burdened by the population, which occurs at different stages of economic development and development of health systems.

In the central part of the paper we will analyze the relationship between the six dimensions of socio-economic factors at macro level (economy, education, transport, urbanization, health habits and health management) and the selected risk factors for cardiovascular diseases (obesity, diabetes and hypertension in women and men) . The analysis was conducted on the example of the following countries of South Eastern Europe: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Greece, Macedonia, Montenegro, Romania, Serbia, Slovenia and Turkey. Due to the lack of data, Kosovo was not included in the analysis.

2. Economic development and health

Numerous studies carried out in recent years have shown that there is a mutual causal link between health and economic growth. In 1966, Barro already showed that there was a significant positive impact of the population's health status (measured by the expected life expectancy at birth) on economic growth. (Barro, 1966) Similar results have been obtained by authors who measured the population's health indicators through child mortality, adult mortality, or the expected lifetime at the age of five. In the regression analysis, Doppelhofer, Miller and Sala-Martin (2004) included more than twenty factors that could have an impact on economic growth and came to the conclusion that health is the most important component of human capital affecting economic development. Studies dealing with health and economic development issues can be divided into three major groups. (Pijalović, 2016). The first group consists of

studies based on historical data on economic growth and the effect of income. These studies deal with the question of how the advancement of health in a certain historical period influenced the growth of income. Thus, for example, Fogel concluded that health and nutrition improvements could account for more than 50% of the British annual growth rate per capita in the 200-year period from 1780 to 1979, which was about 1.15% (Fogel, 1994a, 1994b, 2002).

The second group of studies are the studies looking at the macroeconomic effects of investing in health, i.e. studying how this investment affects individuals' income. In addition to increasing the productivity of workers, investing in health also influences the economic development by increasing the number of working-age population members and by reducing direct and indirect treatment costs. (Pijalović, 2016)

The third group of papers are macro or cross-country studies that use data on various initiators of economic development. Thus, Jamison, Lau and Wang calculate the impact of health on technological progress in 2006, with the assumption that health impacts investment in education, education then contributes to increasing the number of investments and finally investments have impact on technological development.

In addition to the impact of health on economic growth, numerous studies have also dealt with the repercussions of economic development on health. Nevertheless, although numerous other studies that we haven't cited here indicate that there is a measurable, positive and significant bilateral relationship between economic development and health, it is evident that, despite economic development, there is an increase in some diseases such as cardiovascular diseases.

The reasons for this phenomenon can be sought in the elasticity of demand for calories. The elasticity of the demand for calories (i.e. the measure of the percentage of changes of demand for calories when income changes by 1%) tends to decline with income growth, with two different patterns of consumption appear: for people with higher and lower incomes. The results Zhou and Yu got showed that when the revenue increases by 10%, the elasticity of calorie income will be 0.012. (Zhou and Yu, 2014) When consumers reach the stage of wealth, additional revenue growth has no significant impact on the elasticity of demand for calories. Such shift in calorie elasticity can be explained by two factors: revenue is spent on food but also on other goods and the second part of the increased food costs is used to increase the variety of food without necessarily increasing the calorie expending. If the link between income and nutrition is really low, as some studies show, then

the development policies that emphasize the increase in income of the poor without paying attention to the way these extra resources are spent can't lead to health improvement and successful development in general, at least not so quickly. (Todaro, 2010). In addition, even if calorie income elasticity is greater than the, traditionally, very low estimates, it is important to highlight the difference between nutritional needs of adults and their children and the fact that increased income often allows families in developing countries to change consumption of nutrients such as potato and spinach, to "empty calories" such as candies and carbonated juices. Namely, such nutrition in developing countries can be perceived as "modern" or even as a symbol of success. Very important initiators here are urbanization, trade, direct investment and marketing. Namely, the openness of the market for trade and foreign investment leads to numerous economic benefits, but also leads to an increase in the risk of adopting an unhealthy lifestyle. Several non-financial transnational corporations engaged in the production of food, beverages, cigarettes and cars belonging to one of the world's top 100 companies are linked to the risks of chronic illnesses. (Yach et al., 2004).

3. Epidemiological transition

Over the past decades, most of the cardiovascular diseases have occurred in industrialized countries or higher income countries. However, developing countries now experience a much greater burden of cardiovascular diseases than the developed countries so they will bear the greatest burden of cardiovascular disease in the future. It is estimated that more than 75% of all deaths from cardiovascular disease in 2015 occurred in low- and middle-income countries. (WHO, 2018) However, the mortality rate of cardiovascular disease varies dramatically among developing countries. Trends are not consistent even among countries within the same geographic region. In general, there are three forms: the first in which we note growth and decline, where rates of mortality rose, fell and then fell considerably; the growing pattern, where rates are constantly increasing, pointing to the current epidemic; and the even pattern, where mortality rates remained relatively low and stable. The pattern of growth and decline is the most significant in high-income Anglo-Celtic, Nordic and Northwestern Continental Europe as well as in the United States and Australia. In these countries mortality rates reached the peak in the 60s or early 70s and have since fallen sharply, about 50 percent on average. The growing pattern is the most significant in the Eastern European and former Soviet countries, where rates of mortality have continued to grow at an alarming pace

and where the highest rates of mortality are currently being observed. By contrast, mortality rates in Japan and several European Mediterranean countries remained relatively low, following a consistent picture (Fuster V. and Kelly B.B, 2010). Reasons for different rates of incidence, prevalence and mortality can be sought at different levels of risk factors, the existence of others, cardiovascular diseases associated with death, the availability of resources to combat cardiovascular disease and the emergence of epidemiological transition in which each country or region is located. (Gaziano A. T and all, 2010).

Epidemiological Transition, the concept first proposed by Abdel Omran in the 1970s (Omran, 1971), refers to changes in dominant forms of illness and mortality that burden the population which occurs when the economy and health system are developed. As countries progress from agrarian to industrial to post-industrial countries, there is a number of ecological, social and structural changes that occur, some of which lead to an increase in longevity, while others lead to exposure to risk factors for chronic diseases.

With increased development, there comes an increased level of risk factors, as well as improved public health and increased accessibility to more efficient health systems for a higher percentage of the population. The balance of these factors can lead to different levels of coronary heart disease incidence and various levels of prevalence and mortality from cardiovascular disease. Secondly, certain additional pressures in some regions, such as war or contagious diseases, may limit the aging of the population and consequently the death rate from cardiovascular disease has not increased as in other regions. Third, different regions may have a genetic predisposition to risk factors of coronary heart disease, as is the case with possible metabolic syndrome in South Asia. In underdeveloped countries in the early phases of epidemiological transition, infectious diseases are dominant, but as the economy, development status and health systems of these countries improve, the population moves to a later stage of epidemiological transition and chronic non-communicable diseases become the major causes of death and disease.

According to Omran (Omran, 1971), all societies experience three phases in the process of modernization: "age of pestilence and famine", during which mortality is high and fluctuating, with an average lifespan of up to 30 years; "age of receding pandemics", life span is significantly increasing, from less than 30 to over 50 years "age of degenerative and man-made diseases", during which the rate of mortality decreases, while the disappearance of contagious diseases increases the visibility of degenerative diseases.

During the first phase, Pestilence and Famine, cardiovascular disease, which accounts for less than 10% of deaths, takes the form of rheumatic heart disease and cardiomyopathies due to infection and malnutrition. Per capita income and life expectancy increase during the phase of receding pandemics as the emergence of public health systems, cleaner water supplies, and improved nutrition combine to drive down deaths from infectious disease and malnutrition. Rheumatic valve disease, hypertension, coronary heart disease and stroke are the predominant forms of CVD. CHD is often seen at an equivalent or lower prevalence rate compared to stroke. During the stage of Degenerative and Man-made Diseases, CHD and stroke are predominant and between 35% and 65% of all deaths can be traced to CVD. Typically, the rate of CHD deaths exceeds that of stroke by a ratio of 2: 1 to 3: 1. In the Stage of Delayed Degenerative Diseases, which didn't exist in the original Orman model, it was introduced later, CVD and cancer remain the major causes of morbidity and mortality, with CVD accounting for 30-40% of all deaths. (Gaziano et al., 2010).

4. Variables and model specification

In order to decrease the burden of illnesses related to cardiovascular diseases, risk factors such as hypertension, obesity, diabetes and physical inactivity for CVD are often studied in developed countries. Moreover, more and more studies have documented social determinants such as economic situation, cultural changes, health behavior and lifestyle in high income countries. However, previous studies rarely focused on low and middle income countries. On the other hand, the growing pattern of cardiovascular diseases is most significant in Eastern and former Soviet countries, where mortality rates have continued to grow at an alarming pace and where the current highest mortality rates are recorded. Therefore, we have decided to include the countries of South East European our analysis: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Greece, Macedonia, Montenegro, Romania, Serbia, Slovenia and Turkey. Due to the lack of data, Kosovo is not included in the analysis.

Starting from the concept of economic transition, as outlined in the previous part of the paper, this paper analyzes socio-economic factors on macro-level including six dimensions: economic, education, transportation, urbanization, health behavior and health governance and analyzes the correlation of these factors and risk factors for cardiovascular diseases.

Table 1 shows overview of dependent and independent variables that we have used.

Table 1. Overview of dependent and independent variables

Indicator	Unit	Description	Source
Dependent variables			
Obesity	% of population	Percentage of defined population (aged 18 years and over) with a body mass index (BMI) of 30 kg/m2 or higher.	World Health Organization (WHO) - Global Health Observatory (GHO)
Raised fasting blood glucose	mmol/l	Percent of defined population with fasting glucose ≥126 mg/dl (7.0 mmol/l) or history of diagnosis with diabetes or use of insulin or oral hypoglycaemic drugs.	World Health Organization (WHO) - Global Health Observatory (GHO)
Mean systolic blood pressure	mm Hg	Mean systolic blood pressure, for men and women	World Health Organization (WHO) - Global Health Observatory (GHO)
Independent variables			
GDP per capita	USD/capita	GDP per capita is GDP divided by midyear population.	The World Bank
School enrollment, tertiary	% gross	Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown.	The World Bank (WB) & UNESCO Institute for Statistics.
Infrastructure investment	%GDP	Total inland infrastructure investment	OECD Statistics
Urban population	% of total population	Urban population refers to people living in urban areas as defined by national statistical offices. It is calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects.	The World Bank
Current Health Expenditure	USD/capita	Current Health Expenditure (CHE) per Capita in US$	World Health Organization (WHO) - Global Health Observatory (GHO)

Source: the authors' table

As *dependent variables* we used obesity, systolic blood pressure for males and for females, and fasting blood glucose. Dependent variable obesity refers toWHO assessment age-standardized prevalence of obesity defined as BMI = 30 kg/m2 for people of 18 years of age and more, showed in percentages. The variable Raised fasting blood glucose shows a percentage of defined population with fasting glucose ≥126 mg/dl (7.0 mmol/l) or a history of diagnosis with diabetes or use of insulin or oral hypoglycaemic drugs. Independent variable means systolic blood pressure is gender-specific and is shown in mm Hg.

Having in mind the number of countries analyzed for each dimension, we used one *independent variable*. For economic dimension we used GDP per capita shown in dollars, for education we used the variable School enrollment,

tertiary in percentages, for transportation we used variable Infrastructure investment which represents the total inland transport infrastructure investment per GDP. For urbanization we used the percentage of urban population, for health behavior we used alcohol consumption in liters per capita among people> = 15 years within a calendar year and as the variable for health governance we used the current health expenditure per capita in US dollars. Sources of data are official statistics of international organizations (World Health Organization and World Bank) and the latest available data were collected, which in this case is data from 2014.

Table 2: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Obesity	12	22.23333	3.339116	17.1	30.8
Blood glucose	12	9.291667	1.42603	7.8	13.2
Blood pressure- male	12	132.525	5.260163	120.6	137.4
Blood pressure- female	12	124.6167	4.162131	117.1	129.4
GDP per capita	12	12149.41	7998.188	4578.7	27400.8
Infrastructure	10	1.2558	.5842773	.26	2.074
School enrollment	9	63.50711	15.82448	38.329	87.019
Urban	12	57.83583	15.62622	22.37	77.68
Alcohol	12	7.296667	3.797471	1.13	12.14
Health expenditure	12	875.3434	630.7549	314.8626	2052.64

Source: the authors' table

Table 2 shows descriptive statistics for dependent and independent variables. The prevalence of Obesity ranges from 17.1% to 30.8% with the mean value of 22.23%. Among the analyzed countries, Cyprus has the lowest percentage of population with diabetes with 7.8% and Turkey has the highest one with 13.2%. The results show slightly higher values (both minimal and maximal) of mean systolic blood pressure for men than for women. The lowest mean systolic blood pressure (117.1 mm Hg) was recorded among female population in Greece while the highest mean systolic blood pressure (137.4 mm Hg) was observed for males in Slovenia.

In order to examine the correlation between each dependent variables and the independent variables mentioned above, we used Linear regression models and we estimated four models: Model 1 - Link between variable Obesity and Independent Variables; Model 2: Connection between variable Blood

Glucose and Independent Variables, Model 3: Relationship between Variable Blood Pressure Variables and Independent Variables and Model 4 Connection of variable Blood Pressure (Female) and Independent Variables. After analyzing the normality of the distribution, the logarithmic transformation of GDP and Health expenditure per capita was performed, and because of the problem with multicolinearity, the variable Alcohol was excluded from the model, after which the problem was solved (VIF = 3.16). Table 3 gives an overview of the beta coefficients and standard errors for each of the estimated models.

Table 3: Linear regression model

	Model	Model 2	Model 3	Model 4
	b/se	b/se	b/se	b/se
GDP_log	0.124	-1.765	2.096	0.124
	(0.57)	(1.24)	(1.29)	(0.57)
School enroll.	0.169**	-0.065	0.203**	0.169**
	(0.02)	(0.04)	(0.03)	(0.02)
Infrastructure	5.146**	-4.166	6.770	5.146**
	(0.53)	(1.54)	(2.23)	(0.53)
Urban	-0.059	0.059**	-0.026	-0.031
	(0.00)	(0.00)	(0.00)	(0.00)
Healthexp_log	2.139	-1.658	3.902	2.139
	(0.84)	(1.74)	(1.28)	(0.84)
_cons	94.717**	57.634	70.359	94.717**
	(9.83)	(21.22)	(24.02)	(9.83)

* p<0.05, ** p<0.01, *** p<0.001

Although we have analyzed three risk factors for cardiovascular diseases (Obesity, Diabetes, Blood Pressure for Women and Men), our analysis has not shown that there is a link between these factors and GDP. Similar results came from Li-yuan Sun and others who in 2015 analyzed the correlation of these risk factors and GDP with the example of the Low-Middle Income State (Li-yuan Sun at al, 2015). Although our research has not shown that there is a significant relationship between these values, before making the final conclusion it is necessary to do a panel analysis by using data from several years and to include more states in the analysis.

Percentage of School enrollment tertiary in our analysis proved to be significant in Models 1, 3 and 4 while in Model 2 there is no significance. Unlike

our model, Li-yuan Sun and others did not find a significant link between this variable and the observed risk factors. It is important to note that, contrary to our expectations and assumptions of the theory, there is a positive relationship here that indicates that a higher rate of enrollment is associated with a greater risk of cardiovascular disease.

There is a positive and significant link between investing in infrastructure and obesity and blood pressure for women. This connection can be explained by the fact that in countries that invest more in the infrastructure, people use cars, they move less, which results in an increased risk of cardiovascular diseases.

The percentage of urban population associated with fasting blood glucose is expected to be positive, suggesting that greater percentage of urban population increases the percentage of diabetes population. Other authors have shown that there is a significant relationship between the percentage of the population and the cardiovascular risk factors (obesity, diabetes, and high blood pressure). (Li-yuan Sun at al, 2015).

No significant correlation between cardiovascular risk factors and the healthcare variable was found. Other research also shows that there is either no or very weak correlation between the health expenditure variable and risk factors for cardiovascular diseases. (Li-yuan Sun at al, 2015).

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5. CONCLUSION

The World Health Organization's statement that out of the total number of deaths, 31% or 17.7 million people died of cardiovascular disease points to the global significance of studying this modern age monster. That is why it is no surprise that, apart from numerous papers in the field of medicine, cardiovascular diseases are becoming a major area of interest for economists. There are numerous papers and studies that show that there is a mutually strong causal link between different health and economic development indicators, which stem from the assumption that economic growth leads to a decrease in the number of people affected and vice versa, that better health status of the population leads to a faster economic growth. However, this connection is not unambiguous. Namely, in spite of the recorded economic growth, there is a rise in some diseases among which cardiovascular diseases are the most significant. The World Bank warns that cardiovascular illnesses at the macroeconomic level represent a difficult burden on the economic development of less developed countries.

As countries pass through different phases of development, a number of economic, ecological, social and structural changes occur, some of which lead to an increase in longevity and others lead to exposure to risk factors for chronic diseases. At the same time, there are two forces: one which leads to an increase in the level of risk factors, and the other, that acts in the direction of improving public health and increasing access to more efficient health systems. The balance of these factors leads to different levels of prevalence and mortality from cardiovascular diseases, so that in developing countries we have three forms: (i) the first in which we note growth and decline, where rates of mortality rose, fell and then fell considerably; (ii) a growing pattern, where rates are constantly increasing, pointing to a current epidemic; and (iii) a flat pattern where mortality rates remained relatively low and stable.

As the growing pattern is related to the Eastern European and former Soviet states, this work is focused on the countries of South-Eastern Europe. In this paper, we assessed four models of four risk factors for cardiovascular diseases, dependent variables being: Obesity, Blood glucose, and Systolic blood pressure values for women and men. As independent variables, we took country-level macroeconomic indicators that included the following variables: GDP per capita, infrastructure investments, urban population share, enrollment rate at tertiary level of education, and health expenditure per capita. The results of regression analysis have shown that the risks of cardiovascular diseases are multidimensional concepts that cannot be directly measured by one set of indicators. Risks of cardiovascular diseases are related to indicators of education, infrastructure investment and urbanization, whereas the link between different risk variables of cardiovascular diseases and GDP and healthcare expenditure has not been demonstrated in our paper.

Although a small sample size can cause low reliability and low static power, since this paper is focused on South-Eastern European countries, we believe that this can serve as a solid basis and guidance for future research that should include panel analysis with the involvement of a larger number of countries.

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RELACIJA IZMEĐU KARDIOVASKULARNIH FAKTORA RIZIKA I SOCIO-EKONOMSKIH FAKTORA: PRIMJER ZEMALJA JUGOISTOČNE EVROPE

Sažetak

Kardiovaskularne bolesti prepoznate su kao vodeći uzrok smrtnosti u razvijenim društvima i imaju status jednog od najfatalnijih oboljenja kada je riječ o zdravlju stanovnika zemalja u razvoju. Osim generalno očekivanih faktora rizika, kao što su porodična historija, dijabetes, gojaznost, pušenje i hipertenzija, novija istraživanja pokazuju da socio-ekonomski status pojedinca igra značajnu ulogu u patogenezi kardiovaskularnih bolesti. Postoje brojni dokazi koji ukazuju na vezu između nepovoljnih socio-ekonomskih uslova i visokog rizika od kardiovaskularnih oboljenja odnosno preuranjene smrtnosti. Stoga, u ovom radu, nastojimo ispitati vezu između šest dimenzija socio-ekonomskih faktora na makro nivou (ekonomija, obrazovanje, transport, urbanizacija, zdravstvene navike i upravljanje zdravstvom) i odabranih faktora rizika za kardiovaskularne bolesti (gojaznost, dijabetes i hipertenzija). Analiza je sprovedena na uzorku sljedećih zemalja Jugoistočne Evrope: Albanija, Bosna i Hercegovina, Bugarska, Hrvatska, Kipar, Grčka, Makedonija, Crna Gora, Rumunija, Srbija, Slovenija i Turska.

Ključne riječi: kardiovaskularna oboljenja, epidemiološka tranzicija, ekonomski faktori