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THE INFLUENCE OF THE STANDARD OF LIVING ON BREAST CANCER MORBIDITY AND MORTALITY IN EUROPE IN THE PERIOD BETWEEN 2017 AND 2019

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Abstract

This paper explores the hypothesis that there is a connection between the standard of living (expressed by the Human Development Index) and the standardised rates of breast cancer incidence and mortality in the female population of Europe. The examination whether the standard of living has an impact on breast cancer incidence and mortality is based on the use of bivariate correlation, as the simplest form of quantitative analysis of two variables which seeks to determine the empirical relationship between them. The second part of the analysis involves the determination of linear relationships using simple linear regression analysis models testing the average impact of the Human Development Index on the standardised breast cancer incidence and mortality rates. The analysis takes into account the importance of yet another socioeconomic factor – response to screening, which can have a major impact on breast cancer mortality..

Key words: breast cancer, index of social development, factors, incidence, mortality.

УТИЦАЈ ЖИВОТНОГ СТАНДАРДА НА МОРБИДИТЕТ И МОРТАЛИТЕТ ОД КАРЦИНОМА ДОЈКЕ У ЕВРОПИ У ПЕРИОДУ ИЗМЕЂУ 2017. И 2019. ГОДИНЕ

Апстракт

Овај рад анализира хипотезу о повезаности животног стандарда (преко индекса HDI) и стандардизованих стопа инциденције и морталитета од карцинома дојке у женској популацији Европе. Испитивање постојања утицаја животног

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стандарда на појаву морталитета и инциденције услед карцинома дојке заснива се на употреби биваријантних корелација, као најједноставнијих облика квантитативне анализе две варијабле у сврху одређивања емпиријског односа међу њима. Други део анализе односи се на утврђивање линеарних веза моделима просте линеарне регресионе анализе, који тестирају просечни утицај индекса друштвеног развоја на стандардизовану стопу морталитета и инциденције. Анализа разматра значај одазива на скрининг као додатни фактор, који може имати велики утицај на смртност од карцинома дојке, а који такође припада групи социоекономских фактора.

Кључне речи: карцином дојке, индекс друштвеног развоја, фактори, инциденција, морталитет.

INTRODUCTION

The rapid increase in chronic degenerative diseases is one of the major health challenges of global development in this century. Cancer is the leading cause of death worldwide, responsible for nearly 10 million deaths in 2020, or nearly one in six deaths globally (WHO, 2022). The most common types of cancer are breast cancer, lung cancer, colon cancer, rectal cancer, and prostate cancer. Breast cancer is listed as a cause of death that could be avoided if timely diagnosis and adequate treatment are provided (OECD & European Commission, 2022). The most common risk factors that have been the subject of scholarly research over a considerable period of time include the quality of healthcare and lifestyle (smoking, insufficient physical activity, poor diet, stress, alcoholism), as well as poor prevention (no access to screening, not responding to screening, insufficient information about health and specifically about diseases). Furthermore, public health and the global economy are inextricably linked. Due to this, different levels of investment in health care, approaches to optimal treatment, stages of the disease at the moment of diagnosis, and levels of healthcare organisation on the national level are reflected in the different mortality and morbidity rates across countries. According to the data provided by the American Cancer Society (ACS) and the International Agency for Research on Cancer (IARC) in 2020, breast cancer is the leading cause of neoplasms in the female population in almost all parts of the world (IARC, 2022). As far as the overall new cancer burden among women is concerned, the standardised incidence rates show that the countries of the world can be roughly divided into economically developed ones, with high incidence rates, and other countries, with significantly lower values. The trend of high incidence rates is explained by a better organisation of preventive examinations, and a better quality of diagnostics, but also by the effects of demographic aging, which leads to an increased number of women at risk of this disease (IARC, 2022)

It has been estimated that there were 684,996 deaths worldwide among women diagnosed with breast cancer in 2020. The clustering of the

countries of the world according to the number of prevalence cases and breast cancer mortality shows some regularity related to the level of economic development (IARC, 2022). The Cancer Atlas (Jemal et al., 2019) confirms the connection between the degree of socioeconomic inequality (shown through the HDI[1]) and different types of cancer (although a more detailed analysis at country level has not been done). The study indicates that increased HDI values are accompanied with a transformation of healthcare and clinical services, which leads to an increased prevalence. In countries marked by a high socioeconomic development, cancer is the leading cause of premature death, after cardiovascular diseases, because it is a disease "linked to socioeconomic transitions" (Jemal, et al., 2019, pp. 44). Breast, lung, colorectal, prostate and stomach cancer are predominant diseases in these countries. On the other hand, countries with low HDI values are going through social and economic changes, and it can be expected, according to the forecasts of the international organisations ACS and IARC, that cancer death rates in these countries will double by 2040 (ACS, 2019).

The main goal of the paper is to test the hypothesis on the connection between the standard of living (shown by the HDI) and breast cancer incidence and mortality rates in the female population of Europe. Focusing on European countries, which are demographically, socially, culturally, historically and ethnically much closer to each other, with a prevailingly high level of social development (measured by the HDI), could yield more precise information about the degree to which breast cancer incidence and mortality trends are linked with the level of the standard of living. The purpose of the analysis is to test whether the level of social development can still be considered (and to what extent) a determinant in breast cancer incidence and mortality in Europe. Can we say that there is a certain level of social development above which the standard of living becomes irrelevant? The importance of responsiveness to screening, which also belongs to the group of socioeconomic factors, will be taken into consideration as an additional factor that can have a major impact on breast cancer mortality. One of the reasons for focusing this research on European countries is the greater reliability and availability of data, as well as a greater degree of equality between women and men, especially in terms of access to healthcare and prevention.

METHODOLOGY

This research involves an analysis of the data on the standardised breast cancer incidence and mortality rates, based on the database maintained by the Statistical Office of the European Union (EUROSTAT), and the Human Development Index (HDI), calculated by the Office of the

[1] HDI stands for the Human Development Index.

Human Development Report, of the United Nations Development Program (UNDP). The analysis presented in this paper addresses the average values of the indicators for the 2017–2019 period. Out of fifty-one European countries, thirty-two, for which all the necessary data was available, are included in the analysis. The countries that have been left out are mostly those of Central and Eastern Europe.

The Human Development Index (HDI) is used as an indicator of the level of the standard of living, as an assessment of the country's progress through three main dimensions of social development: healthcare, education, and the economic state of the nation. The summary health indicator is the value of life expectancy at birth. Education is measured by the (average and total) years of schooling for those aged 25 and older, whereas economic power is calculated based on the gross national income per capita (adjusted to the purchasing power parity). According to the HDI values, countries are classified into three categories as highly developed (very high index =>0.800, high 0.700–0.799), developing (medium 0.550–0.699), and underdeveloped (low <= 0.549). According to the HDI, which is either very high or high in Europe, all European countries belong to the category of developed countries of the world.

The examination of whether breast cancer incidence and mortality are related to the standard of living is based on the use of bivariate correlation, as the simplest form of the quantitative analysis of two variables for the purposes of determining the empirical relationship between them, and testing simple hypotheses about the relationship. This type of analysis was used to test the hypothesis that breast cancer incidence and mortality rates depended on the population's standard of living. The Pearson correlation coefficient was used in the analysis, assuming the normality of distribution.

The second step in establishing linear relationships was the application of simple linear regression analysis models, which test the average impact of the Human Development Index on the standardised mortality rate and the standardised incidence rate. The analysis was performed using the least squares deviation method (LSD) on logarithmic data with a significance level (α) of 5%. Data analysis and visualisation were done in the RStudio programme, in the R programming language.

RESULTS

The scatter diagram shows that there is no statistically significant relationship between the variations in the incidence rate and the standard of living index (Diagram 1.a). The Pearson correlation coefficient did not confirmed the hypothesis that the Human Development Index is associated with the standardised incidence rate. The values indicate a very weak positive monotonic relationship between these variables ($R=0.31$, $p>0.05$). The scatter diagram between the Human Development Index and the standardised mortality rate (Diagram 1.b) also indicates a weak, but

negative correlation (R=-0.26, p>0.10). The inverse nature of the correlation means that the decreasing mortality rate corresponds to an increased standard of living in this trend. The scatter diagrams show a large dispersion of data around a straight line, which means that their interdependence is weak and virtually non-existent. In either case, the Pearson coefficients showed there is no statistically significant monotonic relationship between the variables at the 5% significance level.

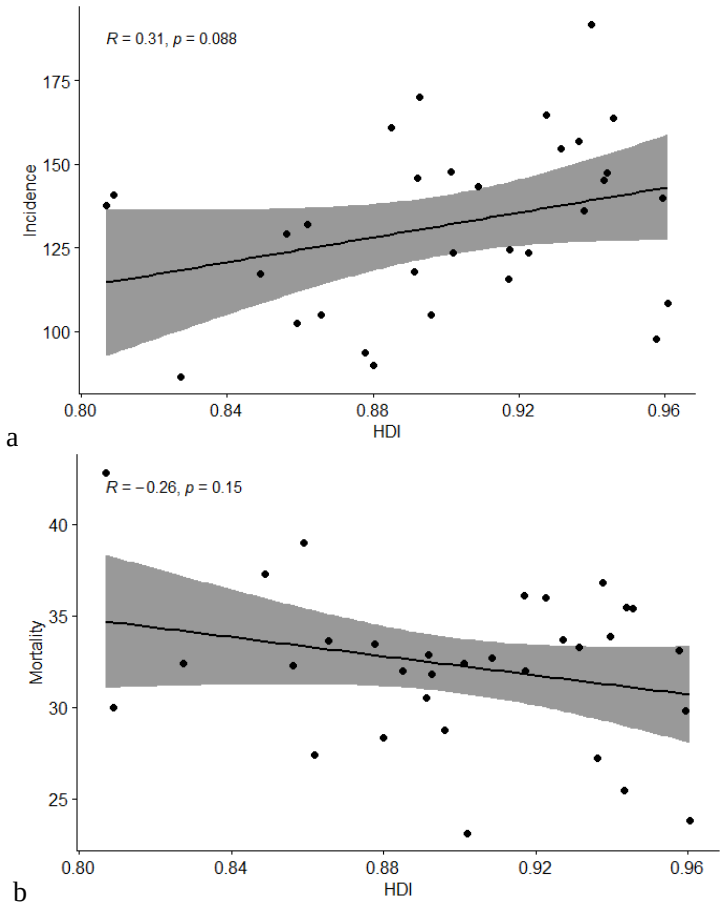


Figure 1. *Correlation diagrams, Human Development Index and standardised breast cancer incidence rates (a) and Human Development Index and standardised breast cancer mortality rates (b) among women, European countries, 2017–2019*

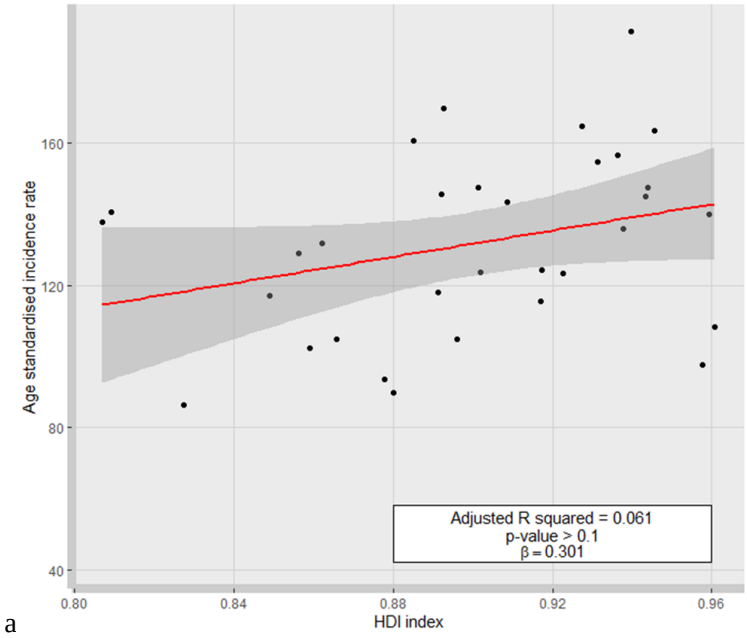
Note. The value of the Pearson correlation (R) ranges from -1 to +1. The value of the coefficient determines the strength of the correlation and the sign determines the direction of the correlation.

Source: Prepared by the author.

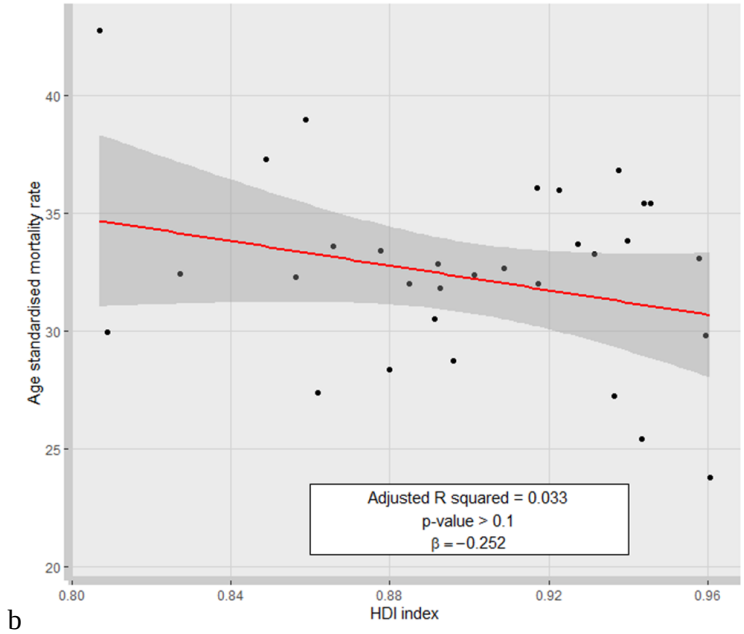
It was of particular importance for the analysis to determine the degree of impact of the standard of living, as a predictor variable, on the level of variation in the breast cancer incidence and mortality rates, i.e. to analyse the degree to which the standard of living explained variation in the incidence and mortality variables. Answers were provided by examining the presence and significance of linear correlation using simple linear regression analysis models. The simple linear regression models were derived from logarithmic data for all three variables. From the first linear regression model (Diagram 2.a), wherein the dependent variable is breast cancer incidence and the independent variable is the HDI, we learn through the least squares method that only 6%[2] of the variation in incidence can be predicted and explained by the standard of living. The standard of living does not have a statistically significant positive impact on incidence, as demonstrated by determining the statistical significance of the standardised beta coefficient (β=0.301, $p>0.1$). In the second model (Diagram 2.b), wherein the dependent variable is breast cancer mortality and the independent variable is the HDI, it can be observed that only 3% of the variation in mortality is explained by the standard of living, while the rest is explained by the influence of other factors. This means that there are other more important variables, apart from the standard of living, that influence the trend of breast cancer incidence and mortality. Although the value of the standardised beta coefficient is negative (β=-0.252, $p>0.1$), indicating a negative impact of the standard of living on breast cancer mortality, the p-value of the test is greater than 0.1, which indicates the absence of statistical significance between the variables.

The results of the correlation and linear regression analyses do not allow for the conclusion that there is a correlation without statistical significance between the standard of living and the number of new cases and deaths from breast cancer. It can be concluded that there is a very weak correlation between the standard of living and breast cancer incidence, which move in the same direction, and the variation in different directions of the standard of living and breast cancer mortality. Finally, the regression analysis suggests that the number of new cases and deaths cannot be explained by the level of the standard of living in a particular country. The comparative data for European countries (Table 1) used in the analysis suggests significant deviations that clarify the results of the statistical method indicating the correlation between these variables. For example, in the countries of Central and Eastern Europe, most of which have the lowest living standards in Europe, there are countries that are not marked by low incidence rates and high mortality rates. For example, the Republic of Serbia has the lowest values of the standard of living among the se-

[2]Through adjusted R-squared



a



b

Figure 2. Simple linear regression models of the Human Development Index and standardised breast cancer incidence rates (a), standardised breast cancer mortality rates (b) among women in selected European countries, 2019–2020

Source: Prepared by the authors

lected countries, while it average incidence rates are in the same range as in Western European countries for the given time period. On the other hand, unlike the Republic of Serbia, Slovenia has a high standardised mortality rate, while it is among the top 15 European countries in terms of the standard of living. The example of Lithuania shows that both the values of the standard of living and the standardised mortality rates can be low – in this particular case, even below those of Switzerland, which is second in Europe in terms of the standard of living.

Table 1. *A comparative overview of the average HDI values, standardised incidence and mortality rates for selected European countries, 2017–2019*

	Country	HDI Index				Standardised rate								Region
						Incidence				Mortality				
		2017	2018	2019	Average	2017	2018	2019	Average	2017	2018	2019	Average	
1	Norway	0,959	0,962	0,961	0,961	108,1	108,8	107,9	108,3	22,9	25,4	23,1	23,8	Northern Europe
2	Switzerland	0,957	0,959	0,962	0,959	140,7	139,8	139,3	139,9	29,7	30,2	29,5	29,8	Western Europe
3	Iceland	0,954	0,959	0,96	0,958	96,8	97,9	98,2	97,7	38,1	31,4	29,7	33,1	Western Europe
4	Germany	0,944	0,945	0,948	0,946	164,4	163,7	163,1	163,7	35,0	35,6	35,7	35,4	Western Europe
5	Denmark	0,944	0,942	0,946	0,944	148,4	147,6	146,4	147,5	34,4	35,0	36,9	35,4	Northern Europe
6	Sweden	0,941	0,942	0,947	0,943	146,1	146,1	143,1	145,1	24,6	25,5	26,2	25,4	Northern Europe
7	Netherlands	0,937	0,939	0,943	0,940	190,6	192,4	192,1	191,7	33,2	33,7	34,7	33,8	Western Europe
8	Ireland	0,934	0,937	0,942	0,938	135,1	136,3	136,5	135,9	33,9	39,2	37,3	36,8	Northern Europe
9	Finland	0,934	0,936	0,939	0,936	157,7	156,5	155,9	156,7	26,7	26,5	28,5	27,2	Northern Europe
10	United Kingdom	0,93	0,929	0,935	0,931	153,5	155,3	155,3	154,7	/	33,2	33,4	33,3	Western Europe
11	Belgium	0,913	0,933	0,936	0,927	163,5	164,7	165,9	164,7	31,7	34,7	34,7	33,7	Western Europe
12	Luxembourg	0,919	0,922	0,927	0,923	124,1	123,3	123,0	123,5	34,2	33,9	39,8	36,0	Western Europe
13	Slovenia	0,913	0,917	0,921	0,917	115,0	115,7	116,4	115,7	33,9	38,4	35,9	36,1	Central and Eastern Europe
14	Austria	0,916	0,917	0,919	0,917	124,3	124,4	124,6	124,4	32,1	32,3	31,6	32,0	Western Europe
15	Malta	0,901	0,91	0,915	0,909	143,2	143,4	143,6	143,4	31,5	38,6	27,8	32,7	Southern Europe
16	Spain	0,897	0,901	0,908	0,902	121,7	124,0	125,2	123,6	22,4	23,4	23,5	23,1	Southern Europe
17	France	0,898	0,901	0,905	0,901	146,7	147,7	148,7	147,7	31,6	32,6	33,0	32,4	Western Europe
18	Czechia	0,897	0,894	0,897	0,896	103,9	105,3	105,5	104,9	29,7	28,1	28,5	28,8	Central and Eastern Europe
19	Cyprus	0,887	0,892	0,897	0,892	144,8	145,6	146,8	145,7	32,7	32,5	33,4	32,9	Southern Europe
20	Italy	0,888	0,893	0,897	0,893	168,1	170,6	171,4	170,0	31,3	32,2	32,0	31,8	Southern Europe
21	Estonia	0,887	0,891	0,896	0,891	118,0	118,0	117,7	117,9	28,7	31,2	31,6	30,5	Central and Eastern Europe
22	Greece	0,88	0,886	0,889	0,885	157,0	161,6	164,2	160,9	32,2	31,8	32,0	32,0	Southern Europe
23	Lithuania	0,876	0,88	0,884	0,880	89,6	89,5	90,2	89,8	30,0	28,3	26,8	28,4	Central and Eastern Europe
24	Poland	0,875	0,877	0,881	0,878	93,3	93,4	93,5	93,4	33,7	33,6	33,1	33,4	Central and Eastern Europe
25	Latvia	0,86	0,866	0,871	0,866	104,4	104,9	105,6	105,0	33,7	33,2	33,9	33,6	Central and Eastern Europe
26	Portugal	0,859	0,86	0,867	0,862	130,8	132,0	133,1	132,0	28,0	26,8	27,3	27,4	Southern Europe
27	Slovakia	0,856	0,859	0,862	0,859	101,2	102,3	103,2	102,3	37,2	39,4	40,3	39,0	Central and Eastern Europe
28	Croatia	0,852	0,856	0,861	0,856	129,5	128,9	129,0	129,1	30,2	31,9	34,9	32,3	Central and Eastern Europe
29	Hungary	0,845	0,849	0,853	0,849	116,6	117,9	116,8	117,1	37,7	36,9	37,3	37,3	Central and Eastern Europe
30	Romania	0,823	0,827	0,832	0,827	86,1	86,3	87,0	86,4	31,5	32,7	33,1	32,4	Central and Eastern Europe
31	Bulgaria	0,808	0,809	0,81	0,809	139,7	141,2	141,4	140,8	31,3	29,2	29,3	30,0	Central and Eastern Europe
32	Serbia	0,802	0,808	0,811	0,807	135,9	137,8	139,5	137,7	41,7	42,3	44,4	42,8	Central and Eastern Europe

Source: UNDP Human Development Index,
standardised incidence and mortality rates EUROSTAT

Prevention Examinations

The available literature often highlights the importance of preventive examinations and the mortality rates from various forms of cancer. Research has shown that women of a lower socioeconomic status attend

screening programmes less frequently, and that they often ignore symptoms, and are therefore more likely to be diagnosed with the disease at an advanced stage (Ceronja, 2010). Education, as one of the direct determinants of socioeconomic status, is as an important factor behind differences in medical examination attendance. Among the countries of the European Union, in Bulgaria, Cyprus, Greece, Poland and Lithuania, there is a pronounced difference between women with a higher level of education, who undergo X-ray examinations of the breasts more frequently, and those with a lower level of education (Eurostat, 2022b). The fact that the population is insufficiently informed is the result of the poor functioning of the national screening programme and the healthcare system in general, which should be an important source of information. The geographical distance from health services is a type of economic inequality, which also affects screening attendance. In Romania and Bulgaria, there is a significant difference between women who live in cities and those who live in rural areas, and the number of the former who attend preventive examinations is 15% higher than the number of their counterparts from the latter group (Eurostat, 2022b).

The percentage of the population covered by national screening programmes is the greatest in Northern European countries, which means that its effect on breast cancer incidence and mortality rates is also greater. Covering of 75% or more of the target population of women is an indicator of the successful implementation of the screening programme. According to the latest available data for the 2017–2020 period (Eurostat, 2022a), the Netherlands, Denmark, Ireland, Finland, Norway, Slovenia, Malta and Great Britain reported a coverage of more than 70%. Less than half of the target population was covered by screening programmes in countries that had joined the European Union last, and generally in those countries of Europe that had lower values of the HDI (Serbia, Bulgaria, Latvia, Hungary, Slovakia). Unresponsiveness to screening programmes is usually interpreted as the effect of an insufficient involvement of local communities, and of low investment in prevention, namely in the activities aimed at improving women's health. Usually, unresponsiveness is seen as a consequence of the poor functioning of the healthcare system. One of the conclusions of the World Health Organisation (WHO) is that national mammographic breast screening programmes are not an optimal solution for countries with limited economic resources, because the healthcare systems of many European countries cannot ensure the testing of a large number of healthy women, and cannot establish quick and accurate diagnosis, and provide therapy quickly enough for positive cases of breast cancer. For these countries, the WHO recommends the so-called early diagnosis programme, which is based on the rapid identification of cancer in patients who already have the symptoms of the disease. This idea arose after a study conducted in Ukraine, which demonstrated that

the disease was diagnosed at an advanced stage in one out of four breast cancer cases in this country (WHO, 2021).

Preventive measures include keeping statistics, i.e. keeping registries of cancer patients. This analysis includes countries with a very high and high standard of living, and it is surprising that some of them do not have a cancer registry with national coverage. It is assumed that a small part of the breast cancer incidence and mortality that was below the expected level in our analysis could be explained by partial registration.

In this analysis, the Republic of Serbia stands out for the unusually high standardised mortality rates. Although there is a registry at the national level, it is right to say that the high rates have to do with relatively poor cancer surveillance and insufficiently effective programmes for the early detection of breast cancer. Between 2017 and 2021, only 8.4% of the women in Serbia responded to the national annual breast cancer screening (Eurostat 2022a).

The study titled *Global Availability of Cancer Registry Data* investigates whether there is a correlation between the gross national income and the existence of a population-based cancer registry (Siddiqui & Zafar, 2018). The analysis found that the gross national income is directly related to the existence of a registry, through the values of the average health expenditure per capita. Countries with different standards of living spend a similar percentage of their gross domestic product on healthcare, but have a different average rate of healthcare spending per capita. High-income countries spend about 3,224 US dollars per capita on healthcare, while spending on healthcare in low-income countries amounts to only 39 US dollars per capita. The research shows that the countries with the lowest income do not have nationwide registries, which is the reason it is impossible to assess the cancer-related situation, and which makes it difficult for the governments of those countries to direct resources to fight cancer (Siddiqui & Zafar, 2018).

DISCUSSION AND CONCLUSION

Access to education and employment, which influence health insurance and income levels, are identified as positive consequences, while the modern lifestyle (stress, smoking, physical inactivity, alcoholism) is highlighted as the negative consequence of the modernisation of society. Significant differences in breast cancer mortality rates among European countries are a consequence of improved patient survival rates thanks to an early diagnosis and better organisation of health services in the western parts of the continent. It is also possible to observe differences in survival rates among countries with similar medical standards, and these may be associated with the structure and funding of the healthcare system. Differences in treatment may also have an impact, as some countries

favour chemotherapy over surgery or *vice versa*. In some countries, access to specialist medical care is complicated, which may be a reason for establishing the diagnosis at an advanced stage.

The hypothesis that an increased HDI leads to increased breast cancer incidence and decreased mortality is well-aligned with the data at the global level. European countries have high values of HDI, regardless of the differences in the population's standard of living, and the aforementioned hypothesis is not plausible in this case. It seems that, upon reaching a certain level of social development, the importance of socioeconomic determinants in cancer mortality changes. According to the data, the variations in the relationship between breast cancer incidence and mortality are the smallest in the countries of Northern and Western Europe. On the other hand, the greatest variations are observed in the regions of Central and Eastern Europe. In countries that were under socialist rule for a great part of the 20th century, the values are the highest – especially the mortality rates, and the reasons for this are late diagnosis and the treatment of diseases in the terminal stage. The organisation of preventive examinations and the response to these are the major challenges for that group of countries, because it seems that a small share of women either respond to national screening programmes aimed at an early detection of breast cancer or they decide to initiate examinations independently, due to insufficient trust in the health system and poor awareness of the need to takes care of their own health. Research has shown that the attendance of screening programmes is lower among women of a lower socioeconomic status, and that national policy-makers should focus on special actions targeting those vulnerable categories in order to reduce socioeconomic inequalities in health outcomes.

The main limitations of this research that could challenge the reliability of our conclusions are related to the quality of the available data, especially in some countries, and the potential shortcomings of HDI as an indicator of the standard of living. According to critics, the HDI measures the average achievements of countries in some aspects, and can only provide a broad framework for some of the key issues of social development. Social development is assessed using indicators that are more common in developed economies, whereas the factors of poverty, and gender or ethnic inequality are not taken into account (Jahan, 2002). Just like no single indicator can cover all of the diverse aspects of countries' development, the HDI cannot fully capture the complexity of the indicators of progress and the quality of life. Therefore, its significance in relation to breast cancer mortality is not easy to explain.

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УТИЦАЈ ЖИВОТНОГ СТАНДАРДА НА МОРБИДИТЕТ И МОРТАЛИТЕТ ОД КАРЦИНОМА ДОЈКЕ У ЕВРОПИ У ПЕРИОДУ ИЗМЕЂУ 2017. И 2019. ГОДИНЕ

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Резиме

Карцином дојке је 2020. године забележен као најчешћи карцином код женске популације у готово свим деловима света. Када је реч о оптерећењу женске популације новооболелима од карцинома дојке, стандардизоване стопе инциденције показују да се земље света грубо могу поделити на економски развијене са високим стопама инциденције и земље са знатно нижим вредностима. Тренд високих стопа инциденције преписује се бољој организацији превентивних прегледа, квалитетнијој дијагностици и ефектима демографског старења који доводе до повећања броја жена у ризику од ове болести. Груписање земаља света према степену морталитета и случајевима преваленције показује одређене законитости које зависе од економског развоја. Најразвијеније земље имају опадајуће вредности стопа морталитета, док остале земље стагнирају или чак бележе раст ових вредности.

Према претходној анализи, закључили смо да између животног стандарда и стандардизоване стопе инциденције постоји слаба позитивна монотона корелација без статистичке значајности. Компаративна анализа земаља Европе потврђује да земље са највишим животним стандардом не морају по правилу имати највише вредности стандардизованих стопа инциденције од карцинома дојке. Анализа животног стандарда и стандардизованих стопа морталитета у земљама Европе потврђује негативну монотону корелацију, такође без статистичке значајности. У овим земљама, високог и веома високог нивоа животног стандарда, не постоји међусобна линеарна узрочност са стопама смртности. Утврђено је да индекс друштвеног развоја као социоекономска детерминанта здравља не представља нужан, већ доприносећи услов за стабилизацију и смањивање стопе морталитета и високих стопа инциденције.