The Burden of Smoking on the Financing of Healthcare

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BACKGROUND: Smoking seems to be one of the serious health problems of present-day society, even in developed countries. In addition, smoking and its consequences may have a significant impact on health expenditure. **AIM:** Objective of the study is to determine the impact of smoking on health expenditure in a sample of the OECD member countries. **DESIGN AND MEASUREMENTS (METHODS):** Analytical procedures examine data from 2011 to 2018. Six variables, including two dependent (Health expenditure in US Dollars per capita and Health expenditure (% of GDP)) and four independent variables focused on smoking and tobacco consumption. **SAMPLE:** The sample consisted of all the OECD countries. **RESULTS:** For the variable identifying healthcare funding in terms of GDP, a impact was evident in smokers over 15 years of age, as well as those in the age range from 15 to 24 years. In the case of health expenditure per capita, an impact appeared only in smokers over 15 years of age. A medium-to-substantial rate of relation was identified in the link between health expenditure per capita and both smokers aged over 15 and smokers aged between 15 and 24. The relations that were analysed were negative. **CONCLUSIONS:** The results of the present study show that smoking has a negative impact on health expenditure.

Keywords | Smoking Addiction – Smokers – Healthcare Expenditure – OECD

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1 INTRODUCTION

Healthcare is an integral part of everyday life, whether individual health or the health of the whole population is being discussed. The aim of each economy should be to improve the health status of the population and to extend the years of a productive and quality life free of disease and other health barriers. It is important to realize that the health of a population depends not only on the development of healthcare, but also on the involvement of the population and the strengthening of their control over the conditions that people may influence themselves. Many authors have agreed that health is a precondition for economic development and prosperity (European Commission, 2013), i.e. an important economic value, as the good health status of a population affects the economic growth of countries, including productivity, human capital, real income, and public spending (Bloom et al., 2004; Boachie, 2017; Sharma 2018). Consequently, poor health is associated with the reduction of human potential and depletion of public resources. With regard to smoking, many studies have dealt with the impact of smoking on health (Adda & Lechene, 2013; Carter et al., 2015; Lopez-Nicolas et al., 2018). Also, Darden et al. (2018) stated that smoking is detrimental to health and causes morbidity and mortality. Despite the fact that the prevalence of smoking has declined over time and across age cohorts (Di Novi & Marenzi, 2019), it seems to be one of the serious health problems of contemporary society, even in developed countries. Looking to the future, tobacco consumption in the Czech Republic will grow until 2028; the projected number of smokers in 2028 is 4-8% higher than in 2013 (Janda & Strobl, 2019). Smoking places tremendous financial and health burdens upon both society and individuals (Chung et al., 2007). The economic costs of tobacco use are substantial and include significant healthcare costs for treating the disease caused by tobacco use, as well as the lost human capital that results from the morbidity and mortality attributable to tobacco (WHO, 2019). Smoking and its consequences may have a significant impact on healthcare expenditure. The present study focuses on determining the impact of smoking on health expenditure in a sample of OECD countries.

2 THEORETICAL BACKGROUND

The financing of healthcare is one of the main elements of each economy, and its return may be multiplied in the form of a healthy and productive population. Health is a significant part of public budgets. This is demonstrated by the very rapidly increasing trend and the assumptions that by 2060 public health expenditure will have increased by one third (EC, 2013). While health expenditure was around 5.8% of GDP in 1990, it was 8.7% in 2015 and it is projected to rise to 12.6% of GDP by 2060 (OECD, 2015; 2016a). Looking at the year-on-year comparison of health expenditure in the OECD countries between 2010 and 2018, there is an increase of 29.6% (OECD, 2019a). Toader et al. (2017) confirmed that the health status of the population is primarily dependent on the financing of healthcare and consumption habits. Unhealthy consumption reduces health and longevity and this fact should be taken into account by individuals contemplating the consumption of addictive goods (Strulik, 2018). The decisions to start or quit smoking are different for each individual, but an important aspect to consider is information about the health risk of smoking (Lillard & Onder, 2019). As the evidence shows, the current smoking status among people differs according to gender, ethnicity, religion, and household income. Conto et al. (2019) revealed that men are more inclined to smoke than women are, and smoking decreases as education and household income increase. Muhyedin et al. (2019) also identified a significant difference between males and females, as well as concluding that smoking habits are influenced by religion. Keto et al. (2017) confirmed that smokers use primary healthcare more frequently per year than non-smokers. Additionally, Li et al. (2018) found similar results in their study. Keto et al. (2017) adds that this phenomenon not only predicts an elevated incidence of serious illnesses, but it also imposes an economic burden on the healthcare system. According to the WHO (2013, 2019), tobacco kills more than 8 million people a year around the world and it causes more than half a trillion dollars' worth of economic damage each year. More than 7 million of those deaths are a result of direct tobacco use, while around 1.2 million are a result of non-smokers being exposed to second-hand smoke. Smoking is responsible not only for deaths, but also for acute myocardial infarctions, strokes, cancer diagnoses, and millions of years of potential life lost. Therefore, Pinto et al. (2019) proposed that taxes on cigarettes should be increased in order to reduce morbidity and mortality. Smoking represents a heavy economic burden all over the world. The level of healthcare expenditure caused by diseases attributable to smoking was 5.7% of global health expenditure in 2012 (Goodchild et al., 2018). Ekpu and Brown (2015) state that the economic burden of smoking represents about 15% of the aggregate healthcare expenditure in high-income countries. On the other hand, the economic activities generated by the production and consumption of tobacco provide an economic stimulus, such as tax revenues, employment, or cost savings in pension payments from the premature deaths of smokers. The authors agree, in their conclusion, that while tobacco smoking may be economically beneficial, its direct costs to society far outweigh any benefits. As Alcaraz et al. (2016) argue, tobacco smoking accounts for a significant proportion of healthcare expenditure in Latin America, and the tax collected from cigarette sales is far from covering this. The results of their study show that the cost attributed to tobacco smoking ranged from 5.2% to 12.7% of healthcare expenditure, and tax collection from cigarette sales covers almost 35% of the healthcare expenditure attributed to tobacco smoking. There are several studies that deal with the relationship between healthcare expenditure and smoking (Harrison et al., 2003). Most authors agree that the total economic loss from smoking-related diseases highlights the significant loss to society, the health sector, and the country's economy (Bundhamcharoen et al., 2016). Hayashida et al. (2010) confirmed that smokers have a higher mortality rate, shorter life expectancy, and generally higher annual medical expenditure than non-smokers. The results of

other studies show that current smokers have higher health costs than former smokers (Barnett et al., 2015, Maciosek et al., 2015). Generally, it is believed that reducing the prevalence of smoking has a positive effect on increasing public resources as a result of the reduction in healthcare expenditure related to the treatment of poor health caused by smoking. Nevertheless, several authors argue that smokers have no significant impact on healthcare expenditure in the long run compared to non-smokers. This statement is based on the fact that the increased healthcare expenditure of smokers over their lifetime is balanced by their reduced life expectancy (Leu & Schaub, 1984). Consequently, smokers do not require any additional old-age healthcare expenditure compared to non-smokers. On the other hand, healthcare expenditure and the loss of economic output resulting from premature death should be taken into account (Owen et al., 2019). Kontsevaya and Kalinina (2011) analysed the costs of healthcare in Russia. They confirmed that smoking is associated with significant healthcare expenditure and highlighted investment in preventive programmes to reduce the prevalence of smoking. Izumi et al. (2001) also state that smokers consume excess medical care, and Max (2001) adds that this leads to increased healthcare expenditure over their lifetime. Lightwood and Glantz (2016) conducted a study that dealt with smoking behaviour and healthcare expenditure in the United States (1992-2009) and the results showed that the states with lower rates of smoking have substantially lower medical costs and those that have higher rates of smoking have higher medical costs. Higher health expenditure may be associated with ambulatory health services (Miller et al. 1999), but also with smoking-related hospitalizations (Tai et al., 2018). Thus, smoking still imposes a substantial economic burden in terms of total costs (Chen et al., 2019), and in their conclusions many authors have highlighted the need for a more stringent tobacco control strategy to reduce smoking (Polakowska et al., 2017; Xu et al., 2015; Yang et al., 2011). There is evidence of health-promoting interventions that target proximal behavioural risk factors, such as tobacco having important effects on health outcomes (Cylus et al. 2018). A reduction of smoking is also significant for changes in healthcare expenditure; it is expected that a decrease in smoking will be followed by a reduction in healthcare expenditure (Lightwood & Glantz, 2016). Barendregt et al. (1997) outlined the relation between smoking and healthcare costs and confirmed that smoking cessation leads to savings in healthcare costs, but only in the short term. Conversely, quitting smoking would lead to increased healthcare costs in the long term. According to the OECD (2016b), the trend in the OECD countries is a negative percentage change in smoking, as evidenced by an average decrease in smoking by 24.4% between 2000 and 2013; however, smoking is one of the biggest public health threats and the impact of smoking on healthcare expenditure needs to be addressed.

3 METHODOLOGY

The primary objective of the study is to determine the impact of smoking on health expenditure in a sample of OECD countries. The objective will be met by analytical procedures that examine data from 2011 to 2018. Six variables enter the processing; two dependent variables are represented: H_EXP_US$ – Health expenditure in US Dollars per capita and H_EXP_% – Health expenditure (% of GDP), and four independent variables are represented: Smors_D%15 – Daily smokers in % of population 15+, Smors_D%15–24 – Daily smokers in % of population 15–24, Cig_D – Number of cigarettes per day per capita, G_Tab – Grams yearly per capita. From the point of view of the correct methodological approach, the following research question and two main hypotheses were formulated:

RQ: Is there any impact of smoking on health expenditure?

H1: It is assumed that there is a significant impact of selected smoking-related characteristics on health expenditure as a percentage of GDP in the OECD countries.

H2: It is assumed that there is a significant impact of selected smoking-related characteristics on health expenditure in US Dollars per capita in the OECD countries.

The data that was analysed (variables) was collected from the OECD databases (OECD, 2019b). H_EXP_US$ – Health expenditure in US Dollars per capita represents the total health expenditure of all healthcare providers in all fund schemes expressed in US dollars. H_EXP_% – Health expenditure (% of GDP) represents the total health expenditure of all healthcare providers in all fund schemes expressed as a percentage of gross domestic product (GDP). The independent variables include Smors_D%15 – Daily smokers in % of population 15+, which expresses the ratio of smokers over the age of 15 to the total population of a given state; Smors_D%15–24 – Daily smokers in % of population 15–24, which expresses the ratio of smokers over 15 and under 24 years (inclusive) to the total population of a given state; Cig_D – the number of cigarettes per day per capita, expressing the average number of cigarettes consumed per person per day, without age specification; G_Tab – Grams yearly per capita, which expresses the average tobacco consumption in grams per person older than 15 years (inclusive). The above data was collected from 2011 to 2018 for all OECD countries (36).

A method of regression analysis, multiple linear regression (OLS), was used for statistical processing. On the basis of the Gauss-Markov theorem, the primary focus was on the homogeneity (constancy) of variability of residues (homoscedasticity) and multicollinearity, which are the two most significant characteristics influencing the BLUE (best linear unbiased estimator) estimate. Heteroscedasticity was tested by using the Breusch-Pagan test (Breusch & Pagan, 1979) and multicollinearity by using VIF (Variance Inflation Factors) statistics (Fox & Monette, 1992). Outliers were tested by using the Bonferroni test (Cook & Weisberg, 1982). A correlation analysis was also displayed. Multivariate normality was tested with the help of Henze-Zirkler's multivariate normality test (Henze & Zirkler, 1990). On the basis of this output, the Spearman coefficient ρ was chosen as an

alternative to the parametric Pearson r. The analytical processes were realized by using the programming language R v 3.6.1 (Action of the Toes).

4 RESULTS

The next section of the study is devoted to analytical processing leading to the fulfilment of the assumptions and objectives stated in the previous section. This section is divided into the basic output of descriptive statistics and three separate parts. The first part is devoted to the processes leading to the verification of the first main hypothesis; the second part includes the processes related to the second hypothesis, and the last part represents the correlation analysis.

Table 1 shows the basic descriptive statistics used to complete the research idea and identify the variables that were examined.

The first rows of *Table 1* show the amount of data that entered the processing, as well as the amount of missing data. As may be deduced, many observations are missing. Therefore, data from earlier years was also used. It was eight years ago that the occurrence of missing values was very frequent. In this case, specific characteristics such as stationarity or autocorrelation are not a threat that could affect the overall output of the model. When assessing the central tendencies of the variables being analysed, it is appropriate to focus on the rate itself on the one hand, and on the other hand, on the difference between the mean and median, where excessive deviations indicate a non-compliance with the normal distribution. The standard deviation identifies the rate of fluctuation from the average. Skewness and kurtosis are identifiers that assess deviations from the normal distribution, and exceeding the interval from -1 to 1 indicates discrepancy. Quartiles indicate a rate of 25% of the lowest and 75% of the highest values.

4.1 Impact of smoking on health expenditure as a percentage of GDP

On the basis of the Gauss-Mark theorem, it is necessary to verify the conditions of multicollinearity and heteroscedasticity. The VIF outputs are less than five for all independent variables (Smors_D%15 – 3.7048; Smors_D%15-24 – 3.100; G_Tab – 1.5050; Cig_D – 1.9199). Therefore, the rate of multicollinearity is acceptable. Homoscedasticity was verified by using the Breusch-Pagan test, which has a p-value of 0.01428 for a BP statistic of 12.453 and four degrees of freedom. This value is less than 0.05. Thus, there are significant deviations in the homogeneity of variability of residues, i.e. there is heteroscedasticity. The HC3 estimator was used to derive the significance of the impact. The Bonferroni outlier test does not show significant outliers. *Table 2* (below) shows the outputs of the regression model of this part of the analysis.

The most important information in Table 2 is the p-value, shown in the last column. As may be seen, this value is less than 0.05 for Smors_D%15 and Smors_D%15-24. At the α level of 0.1, the Cig_D variable may also be considered as an indicator that has a significant impact on health expenditure. It may not be considered that G_Tab has a sig-

Descriptive	H_EXP_%	H_EXP_US$	Smors_D%15	Smors_D%15-24	G_Tab	Cig_D
N	288	288	144	129	143	117
missing N	0	0	144	159	145	171
Mean	8.7720	3559.9826	17.1431	15.0535	1324.4091	13.0957
Median	8.9330	3483.5000	17.0500	14.8000	1120.1000	13.2000
Std. Deviation	2.3167	1740.2646	4.2979	5.8911	583.7598	2.3247
Skewness	0.7678	0.9711	0.1173	0.3292	1.3983	-0.1723
Kurtosis	1.8980	1.7971	-0.4315	0.2756	2.0613	0.6305
Q1	7.0228	2123.7500	13.8500	11.5000	905.0000	11.5000
Q3	10.3190	4697.0000	19.9750	18.5000	1625.0000	14.7000

Table 1 | Descriptive statistics of variables

OLS model HC3	Estimate	Std.Error	t value	Pr(>|t|)
(Intercept)	13.9937	2.1686	6.4529	2.13×10^{-8}
Smors_D%15	-0.7988	0.1717	-4.6513	1.86×10^{-5}
Smors_D%15–24	0.1762	0.0692	2.5468	1.35×10^{-2}
G_Tab	0.0005	0.0005	1.0282	3.08×10^{-1}
Cig_D	0.4659	0.2663	1.7494	8.53×10^{-2}

Table 2 | Regression model – OLS HC3 (y = H_EXP_%)

OLS model	Estimate	Std.Error	t value	Pr(>|t|)
(Intercept)	8861.8228	1383.9007	6.4040	2.58×10^{-8}
Smors_D%15	-491.4469	85.0567	-5.7780	2.88×10^{-7}
Smors_D%15–24	22.6550	49.3351	0.4590	6.48×10^{-1}
G_Tab	0.4179	0.3915	1.0670	2.90×10^{-1}
Cig_D	240.6734	128.4714	1.8730	6.59×10^{-2}

Table 3 | Regression model – OLS (y = H_EXP_US$)

hz mvn test	Smors_D%15		Smors_D%15–24		G_Tab		Cig_D	
	hz	p value	hz	p value	hz	p value	hz	p value
H_EXP_%	1.7508	0.0005	1.7324	0.0005	5.5804	0.0000	3.0858	0.0000
H_EXP_US$	2.3651	0.0000	2.0071	0.0000	4.9452	0.0000	1.9032	0.0002

Table 4 | Multivariate normality test

relationship ρ		Smors_D%15	Smors_D%15–24	G_Tab	Cig_D
H_EXP_%	ρ	-0.267	-0.213	x	x
	p value	0.001	0.016	0.130	0.845
	N	144	129	143	117
H_EXP_US$	ρ	-0.471	-0.494	-0.262	x
	p value	0.000	0.000	0.002	0.678
	N	144	129	143	117

Table 5 | Relationship analysis – Spearman ρ

nificant impact on health expenditure. Consequently, the hypothesis H1 (It is assumed that there is a significant impact of selected smoking-related characteristics on health expenditure as a percentage of GDP in the OECD countries) may be confirmed. For the F-statistic of 15.93, the model obtained a value of Multiple R-squared: 0.5151 and Adjusted R-squared: 0.4828. These values are acceptable.

4.2 Impact of smoking on health expenditure in US Dollars per capita

In the previous section, multicollinearity was verified and its measured rate was considered acceptable. Homoscedasticity was verified by using the Breusch-Pagan test, which has a p-value of 0.015 for a BP statistic of 6.7454 and four degrees of freedom. This value is higher than 0.05, and thus the assumption of homoscedasticity is met. The Bonferroni outlier shows significant outliers. The Bonferroni outlier test shows the presence of one outlier (p-value = 0.13234), but this outlier appears to be acceptable. *Table 3* shows the outputs of the regression model of this part of the analysis.

The most important information in *Table 3* is the p-value, shown in the last column. As is evident, this value is less than 0.05 only for Smors_D%15. At the α level of 0.1, the Cig_D variable may also be considered as an indicator that has a significant impact on health expenditure. It may not be considered that G_Tab and Smors_D%15–24 have a significant impact on health expenditure. Thus, the hypothesis H2 (It is assumed that there is a significant impact of selected smoking-related characteristics on health expenditure in US Dollars per capita in the OECD countries) may be confirmed. For the F-statistic of 20.55, the model obtained a value of Multiple R-squared: 0.5781 and Adjusted R-squared: 0.55. These values are acceptable.

4.3 Relation between health expenditure and smoking

The next part points to the relations between the individual variables representing health expenditure and selected variables related to smoking. One of the basic conditions for the application of the parametric test (Pearson's r) is the approximate normality of the data being analysed. *Table 4* shows the outputs of Henze-Zirkler's multivariate normality test.

On the basis of the fact that the p-value is not higher than 0.05 in any case, the condition of normality was not met. *Table 5* shows the output of a non-parametric Spearman test of relation.

When interpreting *Table 5*, it is appropriate, in the first step, to focus on the p-value that is higher than 0.05 in three re-

lationships. Thus, there is no significant relation. Analysis of the relationships also points to a low-to-medium rate of relation in the case of the link between H_EXP_% and both Smors_D%15 and Smors_D%15–24. For the link between H_EXP_US$ and the G_Tab variable, there is also a low-to-medium rate of relation. A medium-to-substantial rate of relation may be identified in the link between H_EXP_US$ and both Smors_D%15 and Smors_D%15-24. In all of the above-mentioned relationships, there is a negative rate of the ρ coefficient and the negative relation is confirmed.

5 CONCLUSION AND DISCUSSION

As mentioned in the introduction, smoking is the cause of many diseases and much mortality (Darden et al., 2018) and a negative impact on health expenditure may be expected. Strulik (2018) also stated that the consumption of addictive goods generally affects consumer health. As a consequence of this, it may be predicted that the increased consumption of addictive goods leads to an increased burden on the financing of healthcare. On the other hand, there are some controversies over the economic effect of smoking when one looks at the economic consequences of smoking in a wider perspective. These controversies deal with the life expectancy of smokers (lower than non-smokers), tax revenues, employment, or cost savings in pension payments from the premature death of smokers (Leu & Schaub, 1984, Ekpu & Brown, 2015). However, the main focus of this study was only on the expenditure side. The primary objective of the study is to determine the impact of smoking on health expenditure in a sample of OECD countries. The objective was met by three steps of analytical procedures that examine data from 2011 to 2018. In the first step, the impact of selected smoking-related indicators on health expenditure as a percentage of GDP was deduced. In the second step, the impact of selected smoking-related indicators on health expenditure in US Dollars per capita was analysed. In the third step, an analysis of the relationships between smoking-related indicators and health expenditure was realized. For the first two steps above, two main hypotheses were formulated (H1: It is assumed that there is a significant impact of selected smoking-related characteristics on health expenditure as a percentage of GDP in the OECD countries; H2: It is assumed that there is a significant impact of selected smoking-related characteristics on health expenditure in US Dollars per capita in the OECD countries) and the third step identified the picture of the relations. Both hypotheses were confirmed. For the variable identifying healthcare funding in terms of GDP, a causal relation was evident in smokers over 15 years of age, as well as for the age range from 15 to 24 years. In the case of health expenditure per capita, a causal relation appeared only in smokers over 15 years of age. Analysis of the relationships points to a low-to-medium rate of relation in the case of the link between health expenditure as a percentage of GDP and both smokers aged over 15 and smokers aged between 15 and 24. For the link between health expenditure per capita and grams yearly per capita, there was also a low-to-medium rate of relation. A medium-to-substantial rate of relation was identified in the link between health expenditure per capita and both smokers aged over 15 and smokers aged between 15 and 24. As predicted, the relations that were analysed were negative. These findings confirm the statements of many authors (Izumi et al., 2001; Max, 2001; Hayashida et al., 2010; Kontsevaya & Kalinina, 2011). Keto et al. (2017) and Li et al. (2018) also point to an increased frequency of primary healthcare use among smokers in comparison to non-smokers, leading to increased health expenditure. By analogy, being a smoker is a stronger predictor of healthcare consumption. Lightwood and Glantz (2016) highlighted the fact that states with higher rates of smoking have higher health expenditure than states where smoking is less frequent. The negative consequences of smoking are therefore evident in terms of health expenditure.

From an applied point of view, negative relations may be interpreted as meaning that if the proportion of smokers or another statistically significant indicator decreases, health expenditure will decrease. At this point, the need for prevention leading to a reduction in the number of smokers in the population should be highlighted. The tools currently in use appear to be ineffective in many countries. The impact and relations confirmed in this study may be considered secondary. It may be assumed that smoking-related diseases, not smoking itself, are the cause of an increase in health expenditure, and this is a limitation of the research. Future research will focus on determining the primary consequences of smoking (COPD) for health expenditure. It is also planned to work with a longer time series as well as to enrich the relations with mediating variables e.g. the funding system. An assessment of the effectiveness of the preventive tools related to a reduction of smoking in individual countries is also considered necessary in future research.

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