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ECONOMIC DETERMINANTS OF OBESITY AND OVERWEIGHT IN TEN POST-COMMUNIST CEE COUNTRIES – SIMILAR TRENDS?

Abstract: *The paper brings to the fore the economic perspective of obesity and overweight in a selection of ten post-communist Central and Eastern European countries in the context of transition from command economy to market economy. Developing economies have been exposed to open markets, which led to the availability of a wider assortment of products for the population. Using spatial regression models, the paper shows the impact on obesity and overweight of relevant economic factors, such as price evolution, household income, food expenses, trade openness and social factors, such as education level and demographic evolution. The study provides a classification of the countries into risk categories from the perspective of obesity and overweight, and finds the explanatory factors for the dependent variables in the case of children, adolescents and adults.*

Keywords: *obesity, overweight, post-communist CEE countries, developing economies, spatial regression model.*

JEL Classification: **C33, F69, I15, P29**

1. Introduction

The European Union (EU) has largely overcome the issues of hunger, but new challenges related to nutrition are emerging, such as obesity and overweight. The latter have come to the fore in the last decade mainly due to their spread and impact, being on the list of EU Sustainable Development Goals (Agenda 2030),

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e.g., SDG 3 refers to good health and well-being for all at all ages. The study focuses on ten post-communist countries: Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. These countries shifted from command to market economies and from non-EU to EU member state status. Such transitions have created the conditions for all the markets to open, which led to the availability of a wider assortment of goods and services for the population. This openness, along with an increasing income per capita, has translated into a more diversified diet and higher expenses on food and beverages, and also into changes in the level of obesity and overweight. In this context, the purpose of the paper at hand is to depict the relevance of macroeconomic factors associated with changing economic conditions and trade openness on obesity and overweight.

Using spatial regression models, we look at the impact on obesity and overweight of eight independent variables, which were built based on the relevant literature review. The eight independent variables are: raised fasting blood glucose in adults (BGA), education attainment (EA), population (POP), price index for food and non-alcoholic beverages (DEF), real net disposable income per capita (NDIC), real expenditure on food and non-alcoholic drinks per capita (REFNA), share of expenditure on food and non-alcoholic drinks in total household consumption (SEFNAC), and share of imports of food and non-alcoholic drinks from intra- and extra-EU28 partners in total expenditure on food and non-alcoholic drinks (SIFNA). Based on descriptive statistics, of data from 2000 to 2016, the paper provides a classification of the ten countries into risk categories from the perspective of obesity and overweight: high risk country, average risk country and low risk country, in the case of adults, but it also provides a specific analysis of vulnerable groups like children and adolescents.

2. Literature review

The widely accepted cause of obesity is energy imbalance, i.e. the energy of consumed calories is higher than the energy expended. This implies excessive fat accumulation and, consequently, health menaces. However, the energy imbalance in itself is insufficient to explain such complex phenomena as overweight and obesity (Feinman et al., 2004). Extending the search for causes of overweight and obesity also means considering medical (e.g. hormonal imbalance and its effects on metabolism) and non-medical explanations (e.g. dietary composition), which are either alternative or complementary ones (Hall, 2017; Romieu et al., 2017). For the purpose of this article, the literature review is mainly concerned with the non-medical causes of overweight and obesity, more specifically those related to economic factors.

Unhindered trade, investment liberalisation, lower tariffs and market openness have all led to the advent of obesogenic environments (Mendez Lopez et al., 2017), with readily available convenient calorie-dense foods such as hyperpalatable and relatively inexpensive ultra-processed products (Ferretti et al., 2019).

The literature shows that the sedentary technological change is a reason for the long-run growth in obesity. By lowering the real price of food and the physical expenditure of calories per hour worked, sedentary technological change has induced two consequences: a lower cost of consuming calories and a higher cost of expending calories (Philipson et al., 2003). Consumption of high in sugar-sweetened beverages and energy-dense ultra-processed foods depends on their prices and the disposable income (Saman et al., 2018). Affordability as seen through the price and income lenses presents a large variability across countries, but there is a clear tendency of increase with the level of economic development (Ferretti et al., 2019). Liberalization brings freedom. A recent study conducted on the CEE countries reveals that economic freedom has positive impact on human development (Gezer, 2020). The influence of the disposable income on the consumption of less healthy food has been demonstrated in a study covering 78 countries over a time period of 16 years. More precisely, it was found that carbonated soft drink sales were significantly positively related to BMI (Body Mass Index), overweight and obesity, but only in the lower-middle income countries. Moreover, it was found that in poorer countries sales restrictions lead to a decrease in the consumption of soft drinks.

Other factors influencing overweight and obesity in middle-income countries include: food expenditure and the level of education (Thi et al., 2018). Thus, household expenditure was found to have a positive and significant impact on the likelihood of mothers to be overweight or obese (Abdulai, 2010). In addition, female education attainment has been found to have a negative impact on overweight and obesity rate – graduates of secondary and tertiary education are less likely to be overweight or obese on account of better health knowledge, healthier food consumption and engagement in physical exercise. Female education is also credited with a negative impact on the weight status of children (Abdulai, 2010). We notice that the prevalence of overweight among children has increased around the world and in Europe as well. A recent study demonstrates that past sugar consumption is sufficient to explain adult obesity in the past 30 years. The fact that past sugar consumption determines adult obesity is an additional reason to study obesity and overweight by age groups (Alexander Bentley et al., 2019). Exceptions were found among children in certain lower-income countries. It was shown that obesity and overweight have increased more dramatically in economically developed countries (Wang et al., 2006). Therefore, there is still a strong need to research this topic from a sustainable development standpoint.

Overweight and obesity prevalence increases as the income increases, the highest rates being reached in the upper-middle-class. In higher income countries, it has been argued that there is an inverse relationship between the socio-economic and educational levels, on one hand, and overweight and obesity prevalence, on the other hand. However, in medium- and low-income countries, the relationship is positive, i.e. the BMI increases with the level of socio-economic status (Roman et al., 2015; Rakic et al., 2011).

In the United States (US), it has been reported that fast-food (obesogenic food) consumption rises as income rises, with only small variations in adult fast-food consumption across income and wealth groups. Alternatively, the underlying factors for fast-food consumption are: lack of knowledge about the product ingredients for not reading labels, and the number of hours of work (Zagorsky et al., 2017). Despite the positive correlation between consumption and income, the percentage of a household's budget spent on less healthy food falls substantially as income increases. This is why policies aimed at diminishing the consumption of such goods will disproportionately impact lower income households (Hoffer et al., 2017). Weight gain prevalence among young adults has grown at a faster rate than that of older groups. At the same time, protective influence of factors, such as education and income, on an individual's BMI, has decreased over time. In other words, US prevalence of overweight and obesity is a phenomenon that has spread unequally onto all population groups (Cook et al., 2008). A generalised increase in glucose levels has also been noticed. Overall, higher caloric intake may be a direct factor of increase in BMI through the effect of real GDP per capita increase and labour force participation, which is further associated with low physical activity (Doytch et al., 2016).

The investigated literature led us to design the eight independent variables mentioned in the introduction, which are strongly correlated with obesity and overweight. Evidence shows that obesity is a global concern (WHO), affecting not only highly developed countries or rich nations but also developing countries, such as the ten selected for this study. European initiatives against obesity and overweight are very reactive. The existence of a large number of policies and initiatives is explained by the global need for a healthier population. In this respect, programs related to obesity and overweight focus to a larger extent on the younger population. This is why this study focuses on analysing the evolution of obesity and overweight not only among adults, but also among adolescents and children.

3. Methods

Values from ten countries were processed over the course of 17 years, using spatial regression models. For territorial analyses, the classical regression model is frequently inadequate due to the spatial autocorrelation among territorial units, case in which the hypothesis regarding the independence of model errors is not complied with. We find this method to be relevant for our study, because the spatial dimension is also consistent in the analysis of obesity and overweight expressed by health status of relevant economic factors alongside with social factors. In recent years, the spatial regression model has been used for models with panel data sets, which can consider the dependencies created by errors or by the temporal lag of the chronological series. Authors such as Kapoor (2007), Baltagi et al. (2007) or Lee and Yu (2010) developed and generalised models that contain both spatial dependencies and errors, besides the fixed or random effects, and proposed a series of tests in order to choose the adequate model for making predictions (for instance, Hausmann test). One of the best-known models of this kind, which is often used in empirical studies, is the one created by Baltagi and Li (2004), which was developed within a study regarding demand for cigarettes in 46 American states during the period 1963-1992.

As concerns spatial interactions that take place within territorial units, there are four main types that can be considered.

1. The first model includes the spatial lag of the dependent variable, which show to what extent the dependent variable from unit i depends on the dependent variable from the neighboring territorial units j (j different from i). This effect is calculated using a spatial weight matrix W. The spatial lag WY_t introduces within the regression model the structure of spatial dependencies from the observations of the endogenous variable. Such a model, named SAR, has the following form (Debarsy et al, 2009):

$$Y_t = \rho W Y_t + X_t\beta + U_t \quad (1)$$

where ρ represents the spatial autoregressive parameter, and U_t represents a vector measuring the errors.

2. The second model measures the effect of interactions taking place between the error terms. This effect is also calculated using a spatial weight matrix W and has the form Wμt; it represents the spatial lag of errors. The model with spatial lag of errors illustrates the fact that territorial units may behave similarly due to some unobserved feature.

Such a model, named SEM, has the following form (Debarsy et al, 2009):

$$Y_t = X_t\beta + U_t,\ U_t = \lambda W U_t + \varepsilon_t \quad (2)$$

where λ represents the intensity of spatial correlation between residuals, and Ut is the vector that measures standard errors.

3. The model containing both effects (the spatial lag of the dependent variable and of errors), named SAC, has the following form (Elhorst, J.P., 2017):

$$Y_t = \rho W Y_t + X_t\beta + u_t,\ u_t = \lambda W u_t + \varepsilon_t \quad (3)$$

The parameters ρ and λ measure the intensity of these spatial dependencies.

However, one last model should be mentioned. It includes the spatial lag WY_t and the spatial lag WX_t. The spatial lag WX_t introduces within the regression model the structure of spatial dependencies from the observations of the exogenous variables. It is named SDM and has the following form (Elhorst, J.P., 2017):

$$Y_t = \rho W Y_t + X_t\beta + W X_t + \varepsilon_t \quad (4)$$

For panel data, the model that includes fixed and random effects has the following form (Elhorst, J.P., 2017):

$$Y_t = \rho W Y_t + X_t\beta + \mu + u_t,\ u_t = \lambda u_t + \varepsilon_t \quad (5)$$

μ: the vector for fixed or random effects.

For the purposes of this study we have used Geoda (software dedicated to spatial econometrics) and STATA specific packages. This represents an ideal environment for analysis due to the existing instruments infrastructure for panel data analysis. Therefore, the efficiency and consistency of econometrics estimates are enhanced. The observations were distributed onto the ten countries and onto multiple successive periods of time. The available packages provide comprehensive and important instruments to estimate econometric models by integrating both spatial components from among the observations and those occurred among errors (Salima, 2018). Moreover, fixed and random effect models are implemented. Using Geoda, the spatial weight matrix is created, and then introduced into STATA to create spatial models.

In order to integrate within the model, the spatial correlation between the observations recorded in each country, we created a queen spatial weight matrix. In general, all countries have a certain spatial relationship and the intensity of the correlation among countries is related to the distance intervals (Zhao and Zhong, 2021). The time range chosen for the analysis is 17 years, from 2000 till 2016. We considered this interval to be representative for reflecting the evolution of obesity and overweight in all ten selected countries experiencing minimum ten years of transition. Another reason for choosing this interval is data availability. Data have not been updated since they were last reported by WHO in 2017. For BGA, data were available up until 2014. For this reason, the values for the years 2015 and 2016 were estimated, considering that the existing values were very similar for the analysed period.

The research aims to present the main factors affecting obesity rate among children (5–9 years old) (ORC), adolescents (10–19 years old) (ORT), and adults (ORA), overweight rate among children (5–9 years old) (OWC), adolescents (10–19 years old) (OWT), and adults (OWA), for a selection of ten post-communist CEE EU countries: Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. The dependent variables are obesity rate and overweight rate expressed by body mass index (BMI). BMI is defined as the weight expressed in kilos divided by the square of the height expressed in meters. According to Eurostat data, people aged 18 years or over are considered obese if their BMI is equal or greater than 30. The category overweight (BMI equal or greater than 25) combines the two categories pre-obese and obese. The eight independent variables that were initially considered, as they appear in the literature described above, were calculated based on data from Eurostat: EA - education attainment, expressed in percentage of the population aged 16–64, with at least secondary education, DEF - price index (implicit deflator) for food and non-alcoholic beverages, 2000=100, euro, was recalculated from the existing data using as base year 2010 into new data using as base year 2000, POP -population, expressed in million inhabitants, NDIC - net disposable income, in million euros, in current prices, divided by the population, deflated using DEF, and expressed in thousand euros, REFNA - real expenditure on food and non-alcoholic drinks per capita, expressed in thousand Euro was calculated using the nominal expenditure per inhabitant in euro on food and non-alcoholic beverages, deflated using DEF, SEFNAC - share of expenditure on food and non-alcoholic drinks in total household consumption, was calculated using real expenditure on food and non-alcoholic beverage in euro by dividing it to the final consumption expenditure of households, in current prices, in euro, which was deflated using DEF, expressed in percentage, and SIFNA - share of imports of food and non-alcoholic drinks from intra-and extra-EU28 partners in total expenditure on food and non-alcoholic drinks, expressed in percentage, was calculated by dividing the imports of food and non-alcoholic beverages, in euro, in constant prices (from current values deflated using DEF) to the real expenditure on food and non-alcoholic beverages, expressed in euro. The value of imports was taken from the trade with intra-and extra-EU28 partners.

Although the literature review has revealed, additional economic determinants of obesity and overweight, such as calorie intake or urbanisation, they have not been included in the study due to data unavailability. The data for ORA - obesity rate among adults, ORC - obesity rate among children, ORT - obesity rate among adolescents, OWA - overweight rate among adults, OWC - overweight rate among children, OWT - overweight rate among adolescents, and BGA - raised fasting blood glucose in adults, expressed in mmol/L or on medication, were taken from the official statistics of World Health Organization.

In the first stage, data stationarity was checked using the Levin-Lin-Chu test. With a p-value lower than 0.05, we accepted the null hypothesis, which means the panel is stationary both for dependent and independent variables. In order for the ORA, ORT, ORC, OWA, OWT and OWC series to be stationary, a log transformation was performed on the dependent variables. Following spatial dependency tests, the null hypothesis was rejected. Spatial errors are not independent, which means a spatial model is required.

As concerns the spatial dependency, using the xsmle package in Stata, we tried to estimate the adequate model. Initially starting from the SDM model, we checked if it can be reduced to SAR or SEM. The tests showed that the model can be transformed both into SAR and into SEM, because results indicate the fact that for both tests applied we can reject the null hypothesis to guarantee 95% the results. The next step consisted in the estimation of a model with autoregressive errors (SAC). The choice between SDM and SAC was made based on the loglikelihood criteria, AIC and BIC.

4. Results

The paper highlighted the impact on obesity and overweight of some relevant economic factors (BGA, DEF, EA, NDIC, POP, REFNA, SEFNAC and SIFNA) and also classify the ten emerging countries into three risk categories from the perspective of obesity and overweight in the case of children, adolescents and adults (ORA, ORC, ORT, OWA, OWC, OWT).

Using the spatial regression model, we correlate each one from the eight independent variables with the six-dependent variable, considered to justify the directions of the effects on obesity and overweight.

As stated before, raised fasting blood glucose in adults (BGA) is an indicator of the health status. The vertical analysis of the matrix highlights that BGA is positively correlated with all obesity and overweight rates. The correlation between BGA and the six dependent variables shows that increasing blood glucose is one of the main factors of increasing rates of obesity and overweight.

In addition, it can be noticed that education attainment (EA) is positively correlated with ORA, ORC, ORT and OWT. This could be explained by the fact that more educated people will have more static occupations, which are conducive to obesity and overweight for all age groups.

From a demographic point of view, the number of inhabitants, as expressed by population level (POP), is positively correlated with obesity and overweight, more precisely with ORA, ORC, OWA and OWT. The transition process in the majority of post-communist countries led to a decrease in the number of inhabitants, mainly because of labour-related migration phenomena. The exceptions among the ten analysed countries are: the Czech Republic, Slovakia and Slovenia, in which the population has grown. Evidence from countries with growing number of inhabitants reveals that, when the population increases, such countries are struggling to produce larger quantities of food by using production technologies meant to obtain highly processed food or to import it. Such food is a source of high rates of obesity and overweight. In the case of post-communist countries, this theory is not tested, because population drops for migration reasons, and in these ten countries this phenomenon seems to be uncorrelated with matters related to obesity and overweight. Therefore, post-communist countries are not faced with the challenge of finding alternatives to produce more (and not better) food, but the real challenge is to overcome relative poverty in the region. Poverty could explain a stronger propensity towards cheap low-quality sugar-dense food, with chemical additives, which could be the source of higher rates of obesity.

Another transition-related aspect is the degree of market openness, which is analysed in this paper via the share of imports of food and non-alcoholic drinks from intra-and extra-EU28 partners in total expenditure on food and non-alcoholic drinks (SIFNA). Surprisingly, SIFNA was not found to be a determinant of obesity in the analysed countries. During the communist regime, all these countries were, to a certain extent, deprived of a wider assortment of food and non-alcoholic drinks from would-be trade partners other than the communist countries. In some post-communist CEE countries, the experience with communism had great impact on their consumption behaviour related to food consumption. Population has faced a restrictive consumption both in quantity and food diversity. Because of this restrictive environment there were some reactions in the attitude regarding food consumption. Deprivation can be a stimulus for enhancing consumer behaviour. This sequel created the propitious psychological environment for the population to avidly consume newly-introduced food products. This changing behaviour left its mark on food consumption patterns, as consumers more frequently prefer goods such as: carbonated soft drinks, fast food and sugar-dense products. Despite all these, our analysis has not identified any correlation between trade openness and obesity or overweight, contradicting the existing literature.

The majority of post-communist countries went through the transition process to achieve economic growth mainly through increased consumption. The price index (implicit deflator) for food and non-alcoholic beverages (DEF) is positively correlated with ORA, ORT, and OWT. The relatively low incomes in the analysed countries could be an argument for decreasing purchasing power: as the price index for food and non-alcoholic beverages increases, individuals tend to consume lower quality food. In terms of healthy diet, the population will substitute more expensive food with relatively cheaper products.

Real net disposable income per capita (NDIC) negatively correlated with ORA shows that lower levels of income could explain higher rates of obesity and overweight for all the age categories of population. This characteristic is specific to formerly communist countries that are still experiencing low levels of income, where increase in food consumption is mainly quantitative, and not qualitative. We would assume that a higher education attainment would lead to a higher income; however, we have identified an inverse relationship between NDIC and ORA. Therefore, the complexity of the obesity phenomenon could provide us with the explanation for such correlations. In other words, it is the lifestyle that could explain the cause of obesity to a higher extent and not just the economic factors alone.

The two consumption components analysed, REFNA and SEFNAC, reveal different relationships with obesity and overweight. Thus, real expenditure on food and non-alcoholic drinks per capita (REFNA) is negatively correlated with OWA and positively with ORT and OWC, while the share of expenditure on food and non-alcoholic drink in total household consumption (SEFNAC) is positively correlated with OWA and OWT, as expected. The difference between absolute and relative measure of expenditure can be justified as follows: when the absolute expenditure on food increases, this may show a qualitative improvement in food consumption; however, when the share of expenditure on food tends to increase, this is not a sign of a wealthier population, but a sign of higher allocations of money on food to the detriment of other categories of goods and services addressing superior needs.

When interpreting these independent variables, the spatial effects should be considered. Following spatial dependency tests, the null hypothesis was rejected. Spatial errors are not independent, which means a spatial model was required. The dependent variables are: ORA - obesity rate among adults, ORC - obesity rate among children, ORT - obesity rate among adolescents, OWA - overweight rate among adults, OWC - overweight rate among children, OWT - overweight rate among adolescents.

ORA (obesity rate among adults). Based on the results, the SDM model with fixed effects is deemed the most adequate. The coefficients for this model are shown in Table 1:

Table 1: ORA model

	Main	Wx	P-value
BGA	1,22226	-.0551226	.000
EA	.0373314	-.0084636	.050
DEF	.0303244	-.004002	.022
POP	.0064371	-.0010566	.005
NDIC	-.0018443	.0005342	.023
Spatial Parameters			
Rho	.1374082		.000

Source: authors' development

Our results indicate that only NDIC variable is negatively correlated with ORA, all the other variables being positively correlated with the dependent variable. Also, the spatial weight matrix attached to each independent variable affects both negatively and positively the spatiality effect onto the dependent variable, ORA. Thus, if there is an increase in BGA, EA, DEF, POP in the neighboring countries, ORA decreases in country i (due to negative spatial correlations Wx). For NDIC, an increase in a neighboring country will lead to an increase in country i. The spatial rho coefficient, associated to the spatial lag of the variable, is positive and significant for the model. This positive value indicates that what is happening in one country has a significant effect on the activity in neighboring countries. Thus, an increase in the ORA value in one country could determine an increase in the ORA value in a neighboring country. In fact, the SDM model shows that ORA depends both on the values of ORA from the other countries (through the rho coefficient), and on the values of BGA, EA, DEF, POP, NDIC of its neighbours (through the Wx matrix). We observed that changes in the values of independent variables from a country have a direct effect on the ORA values from that country, and an indirect effect on the ORA values from the other countries. The indirect effect is added to the direct one, which leads to an increase of the total effect. The tests performed in this regard confirm the existence of all these effects, the direct one being positive and the indirect one being negative. The total effect is a reduced one, and it is higher only for the BGA variable.

ORC (obesity rate among children). After developing the three spatial regression models using panel data, the SAC model was validated, meaning the one containing both effects of spatial dependency. The resulting coefficients and their validation were performed based on Table 2.

Table 2: ORC and ORT models

	ORC		ORT	
	Main	P-value	Main	P-value
BGA	2.348176	.000	3.352941	.000
EA	.0576603	.082	.0691208	.065
POP	.0412284	.000		
DEF			.0832409	.035
REFNA			.2075195	.000
Spatial Parameters				
Lambda	-.274855	.000	-.1941473	.003
Rho	.1334327	.003	.1145477	.001

Source: authors' development

Our results indicate that all independent variables are positively correlated with ORC. The BGA variable has the highest effect on the ORC value. Both the spatial rho coefficient and the lambda coefficient are significant, the former being positive and the latter one being negative. Thus, we may assert that what happens with ORC in one country has a significant impact on the value of ORC in the neighboring countries, and that the dependence is positive, which lead to an increase in the value. Also, the model errors have a negative influence on the ORC value.

ORT (obesity rate among adolescents). After developing the three spatial regression models using panel data, the SAC model was validated. The resulting coefficients and their validation were performed based on Table 2. Our results indicate that all independent variables are positively correlated with ORT. The BGA variable has the highest effect on the ORT value. Both the spatial rho coefficient and the lambda coefficient are significant, the former being positive and the latter one being negative. Thus, we may assert that what happens with ORC in one country has a significant impact on the value of ORT in the neighboring countries, and that the dependence is positive, which lead to an increase in the value. Also, the model errors have a negative influence on the ORT value.

OWA (overweight rate among adults). The choice between SDM and SAC was made based on the loglikelihood criteria, AIC and BIC. Based on the results, the SDM model with fixed effects is deemed the most adequate. Our results indicate that only REFNA variable is negatively correlated with OWA, all the other variables being positively correlated with the dependent variable. Also, the spatial weight matrix attached to each independent variable affects both negatively and positively the spatiality effect onto the dependent variable, OWA. Thus, if there is an increase in BGA and POP in a neighbouring country, OWA decreases in country i (due to negative spatial correlations Wx). Similarly, an increase in REFNA and SEFNAC in a neighbouring country will lead to an increase in country I (positive spatial correlation Wx). The spatial rho coefficient, associated to the spatial lag of the variable, is positive and significant for the model. This positive value indicates that what is happening in one country has a significant effect on the activity in neighbouring countries. Thus, an increase in the OWA value in one country could determine an increase in the OWA value in a neighboring country. In fact, the SDM model shows that OWA depends both on the values of OWA from the other countries (through the rho coefficient), and on the values of BGA, POP, REFNA and SEFNAC of its neighbours (through the Wx matrix).

OWC (overweight rate among children). Initially starting from the SDM model, we checked if it can be reduced to SAR or SEM. The tests showed that the model cannot be transformed into SAR, but it can be transformed into SEM, because results indicate the fact that for the first test applied we cannot reject the null hypothesis to guarantee 95% the results. The next step consisted in the estimation of a model with autoregressive errors (SAC). The choice between SDM and SAC was made based on the loglikelihood criteria, AIC and BIC. Based on the results, the SAC model with fixed effects is deemed the most adequate. Our results indicate that OWC is positively influenced by BGA and REFNA. As concerns spatial coefficients, only rho is statistically significant. It has a positive value, which indicated that an increase in the OWC value in one country generates an increase in the value of the OWC value in some other neighbouring country. Also, the spatial coefficient measuring the interactions between errors is not statistically significant.

OWT (overweight rate among adolescents). After developing the three spatial regression models using panel data, the SAC model was validated. Our results indicate that all independent variables are positively correlated with ORT. The BGA variable has the highest effect on the OWT value. Both the spatial rho coefficient and the lambda coefficient are significant, the former being positive and the latter one being negative. Thus, we may assert that what happens with OWT in one country has a significant impact on the value of OWT in the neighboring countries, and that the dependence is positive, which lead to an increase in the value. Also, the model errors have a negative influence on the OWT value.

We also perform a risk analysis for all ten countries by age category (i.e. adults, adolescents and children). To this purpose, we calculated the average for all six dependent variables (ORA, ORC, ORT, OWA, OWC, OWT) and reached the conclusion that all means are representative after calculating the standard deviation. In addition, we calculated the rate of increase between 2000 and 2016 to identify the magnitude of leaps in time. Based on the two criteria (average and rate of increase), we have classified the ten countries into three risk categories: low risk (when both average and rate of increase are below the median values), average risk (when the average is lower than the median value and the rate of increase is above the median value and the vice-versa) and high risk (when both average and rate of increase are above the median values). Figures 1–6 show how each country is classified using quadrants.

For both obesity and overweight, the high-risk countries for adults are Bulgaria and Hungary, while the low-risk countries are Estonia, Latvia and Slovenia. All the other countries fall within the average-risk category (Figures 1 and 2). For the most vulnerable age group, children, Baltic countries present a low risk, while Hungary, Poland and Slovenia present a higher risk. Countries such as: Romania, Slovakia and the Czech Republic remain, as for the previous age categories, average-risk countries (Figures 5 and 6).

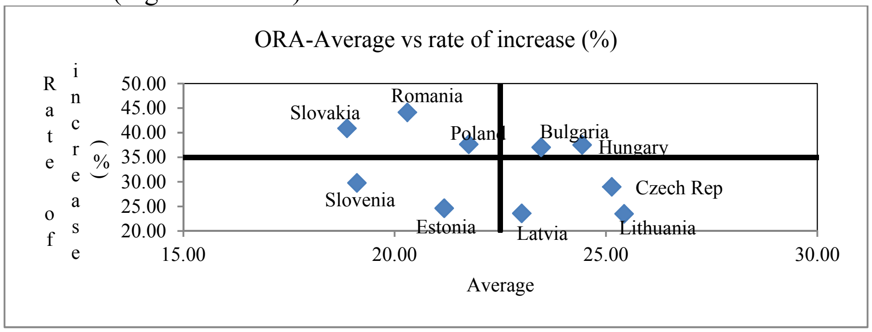

Figure 1. Country classification according to ORA (*source: own representation based on the analyzed data*)

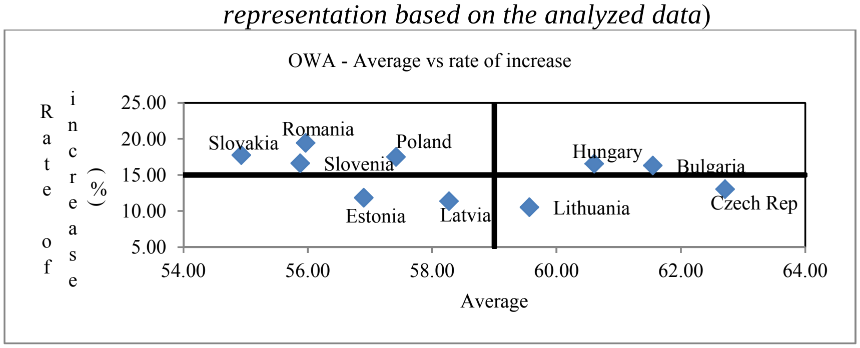

Figure 2. Country classification according to OWA (*source: own representation based on the analyzed data*)

For adolescents, the low-risk countries are Slovenia and Baltic countries, while high-risk countries are Bulgaria and Hungary (Figures 3 and 4).

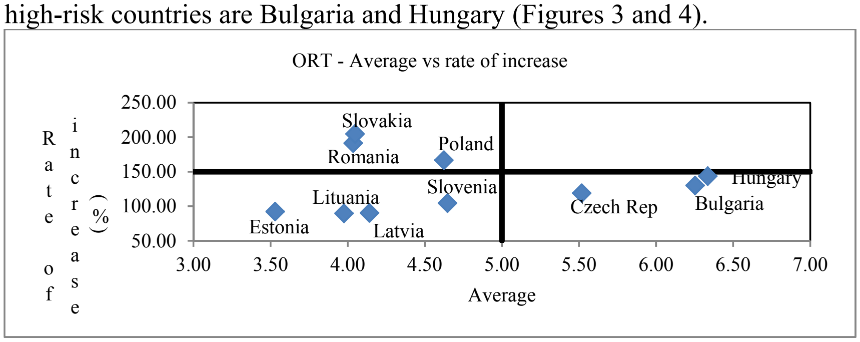

Figure 3. Country classification according to ORT (*source: own representation based on the analyzed data*)

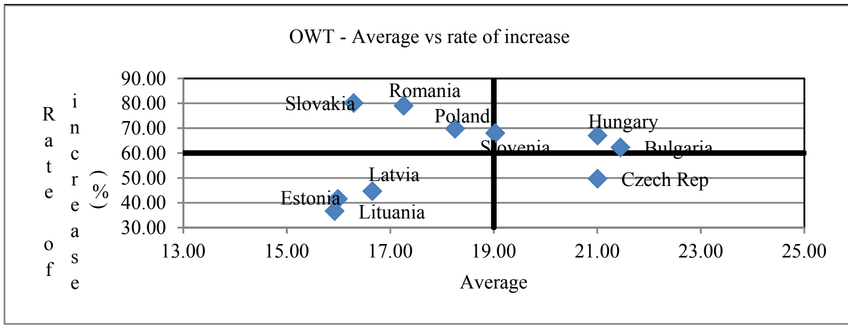

Figure 4. Country classification according to OWT (*source: own representation based on the analyzed data*)

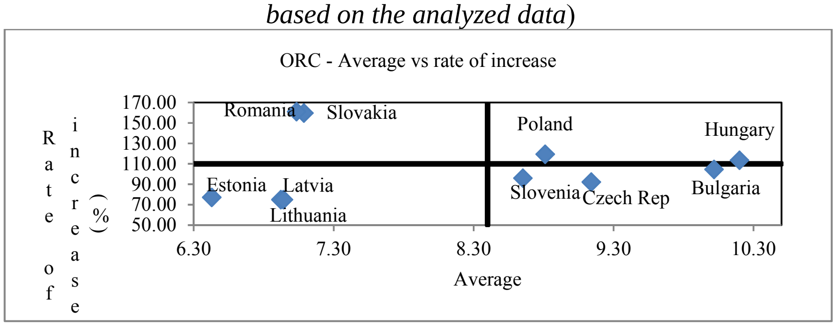

Figure 5. Country classification according to ORC (*source: own representation based on the analyzed data*)

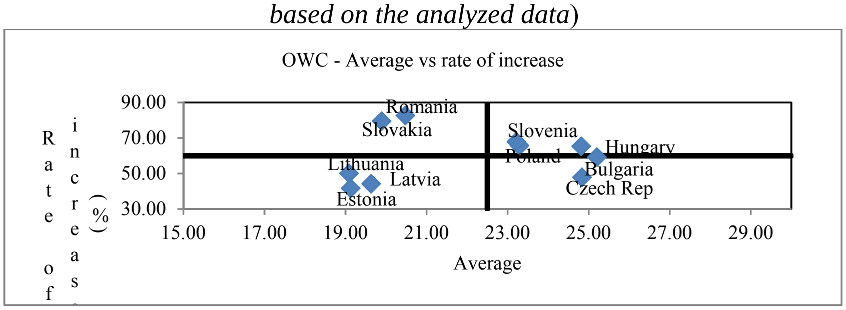

Figure 6. Country classification according to OWC (*source: own representation based on the analyzed data*)

5. Conclusions

The post-communist CEE countries analysed follow the global trend of increasing obesity and overweight. However, they faced relative poverty, goods and services relative deprivation, a poor assortment of food, associated with increasing consumption, higher imports of food and beverage, and high levels of migration. All these show that increasing blood glucose is one of the main factors of increasing rates of obesity and overweight. More educated people will have more static occupations, which are conducive to obesity and overweight for all age groups, because of lack of physical activity. Post-communist countries are strongly affected by migration so do not face with the challenge of finding alternatives to produce more food for population, but the real challenge is to overcome relative poverty in the region, so this could explain a stronger propensity for low-quality sugar-dense food, with chemical additives, which could be the source of higher rates of obesity. The market openness has no direct correlation with health issues like obesity and overweight, although it was influencing the level of price for food in all these years of transition. The relatively low incomes in the analysed countries could be an argument for decreasing purchasing power: as the price index for food and non-alcoholic beverages increases, individuals tend to consume lower quality food. In terms of healthy diet, the population will substitute more expensive food with relatively cheaper products. Also, the difference between the absolute and percentage change of expenditure in food shows a higher allocation of money on food to the detriment of other categories of goods and services addressing superior needs.

A useful output that may have policy implications, is the classification of the ten countries into three obesity and overweight risk categories: low risk (the Baltic countries and Slovenia), average risk (the Czech Republic, Poland, Romania and Slovakia), and high risk (Bulgaria and Hungary). Therefore, obesity-and overweight-control strategies targeting adults and adolescents should be adopted in countries like Bulgaria and Hungary, while policies for controlling the two negative phenomena among children should be put in place in Hungary, Poland and Slovenia. Data analysis reveals that the best performers in terms of managing obesity and overweight are the Baltic countries.

The main research limitation of the study is data unavailability for longer time ranges. In addition, calorie consumption by age category represents another research limitation, as calorie consumption is one of the main determinants of obesity. Future research can focus on investigating factors like: specific regional food consumption patterns, culture, level of physical activity, geographic factors, already existing policies and strategies in the field. The study can be replicated for other groups of countries that are similar from an economic standpoint or that are part of the same geographic area.

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