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Public health management: life expectancy and air pollution

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Abstract. *Part of the National Strategy of Sustainable Development from Romania, life expectancy and air pollution indicators have an important role in establishing long term public health management strategies. International scientific literature within the field underlines the strong connection between air pollution and life expectancy. This research study focuses on the impact of greenhouse gas emissions, particulate matter air pollutants, ozone air pollutants on the length of life at 65 years old and life expectancy at birth of the population from Romania. The methods used for research are correlation and linear regression. Our results will be a starting point for further development of public health policies in developing countries, which mostly focus on socio-economic aspects, neglecting the negative impact of air pollution.*

Keywords: Public health management, life expectancy, air pollution, socio-economic development, developing countries.

Introduction

Many researchers consider that air pollution has an important influence on life expectancy at birth and length of life at 65 years old. The current study has the main purpose to explain the role of air pollution (greenhouse gas emissions, particulate matter air pollutants, ozone air pollutants) on the length of life at 65 years and life expectancy at birth, for the population of Romania. Effective public health management must be based on a better understanding of the local air pollution problems, in order to provide solutions to reduce its impact on health.

Correlation and simple linear regression method are used to validate/invalidate the proposed hypotheses of the current study. The linear correlation is largely used, because it synthesizes the importance of the relationship between two variables. The linear regression explains a dependent variable by one or more independent quantitative variables. If there is only one independent variable, we make use of the simple regression. The regression is used for explanation and prediction.

Hypothesis no 1. There is a statistically significant correlation between chronic exposure to greenhouse gas emissions, particulate matter air pollutants, ozone air pollutants and the length of life at 65 years old.

Hypothesis no 2. There is a statistically significant correlation between chronic exposure to greenhouse gas emissions, particulate matter air pollutants, ozone air pollutants and the life expectancy at birth.

Hypothesis no 3. There is a significant level of influence of the greenhouse gas emissions on life expectancy at 65 years old.

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Literature review

World Health Organization (WHO) underlines the effects of air pollution, which "harms human health, particularly in those already vulnerable, because of their age or existing health problems", focusing on the fact that the outdoor pollution leads to "more than 3 million premature death each year", due to: vehicles, power plants, waste burning, landfill emissions, livestock production, while the indoor pollution leads to "more than 4,3 million estimated premature deaths each year, due to: dirty cookstoves, unprocessed coal, kerosene and diesel fuels" (WHO, 2017).

One of the main causes for air pollution is represented by the rapid urbanization. On the other hand, the population living in rural areas encounters different health behaviors than the urban population, to the same marker of exposure. (Keijzer et al., 2016)

The most significant air pollutants causing increased mortality rate are particulate matter air pollutants: $PM_{2,5}$ of 2,5 μm aerodynamic diameter and PM_{10} of 10 μm aerodynamic diameter. (Anderson et al., 2012) Dziunabek et al. (2017) analyzed the high correlation between long-term inhalation exposure to the mixture of PM_{10}, BaP, Cd, Pb and, the length of life of the people from Silesia province in Poland.

Fotourehchi (2016) analyzed the effects of PM10 and CO2 air pollutants on infant mortality and life expectancy at birth, in 60 developing countries, between 1990-2010.

The current research focuses on the analysis of the effects of air pollutants on life expectancy at 65 years old and at birth, making use of the following variables:

- Greenhouse gas emissions (GHE);
- Particulate matter air pollutants (PM);
- Ozone air pollutants (O_3);
- Life expectancy at 65 years old (LE65);
- Life expectancy at birth (LEB);

Research Methodology

The research methodology analysis is based on data gathered from The National Institute of Statistics' website. It is a time series data, providing information about the chosen variables, during the period 2005-2015 and, where available, 2000-2015.

Life expectancy at 65 years old registered an ascendant trend between the years 2000 (79 years old) and 2015 (81 years old). Women at 65 years old register a higher life expectancy, between 80 years old (year 2000) and 82 years old (year 2015). On the other hand, men at 65 years old register a lower life expectancy than women at the same age, from 78 years old in 2000 and 79 years old. On average, life expectancy at 65 years old registered the highest pick between the years 2012-2015 (81 years old). (Figure 1)

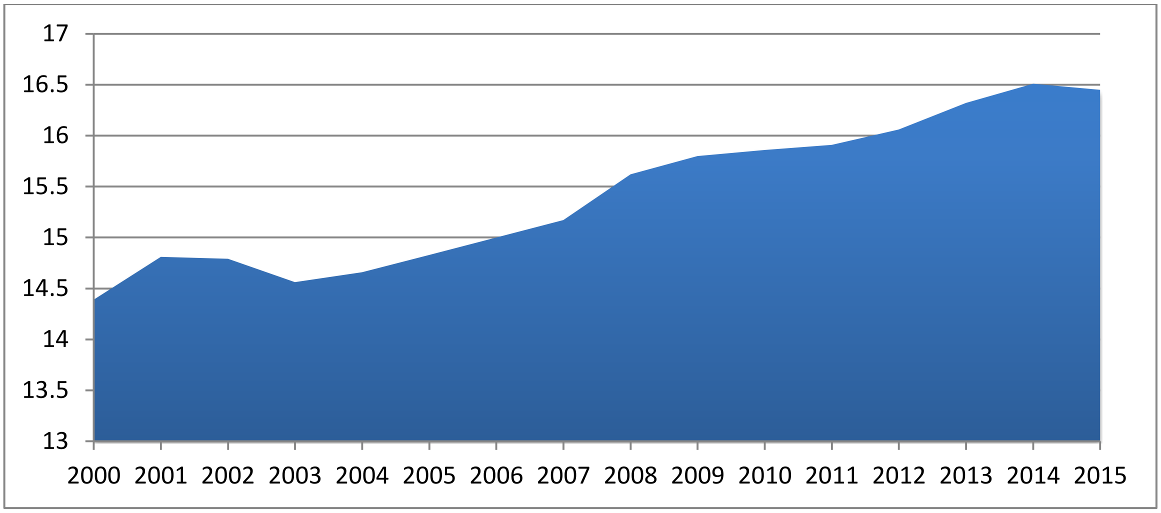

Figure 1. **Life expectancy at 65 years old of the population from Romania (2000-2015)**

Source: www.insse.ro, accessed 1st of February 2017

At birth, life expectancy increased considerably from 70 years old in 2000 to 75 years old in 2015. Life expectancy at birth for female was 78 years old, while life expectancy at birth for male was 71 years old (2015), rising from 74 years old for new born female and 67 years old for new born male (2000) (Figure 2).

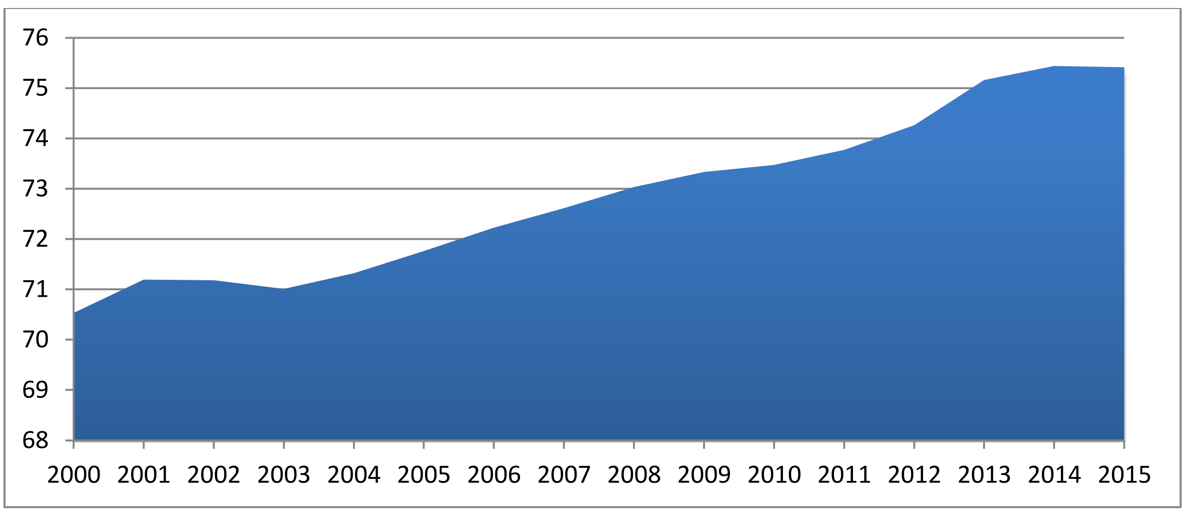

Figure 2. **Life expectancy at birth of the population from Romania (2000-2015)**

Source: www.insse.ro, accessed 1st of February 2017

During the last years, the greenhouse gas emissions registered an important descendent trend between the years 2008-2011, decreasing from 116.165,41 thousand tones (2008) to 98.054,21 thousand tones (2011) (Figure 3).

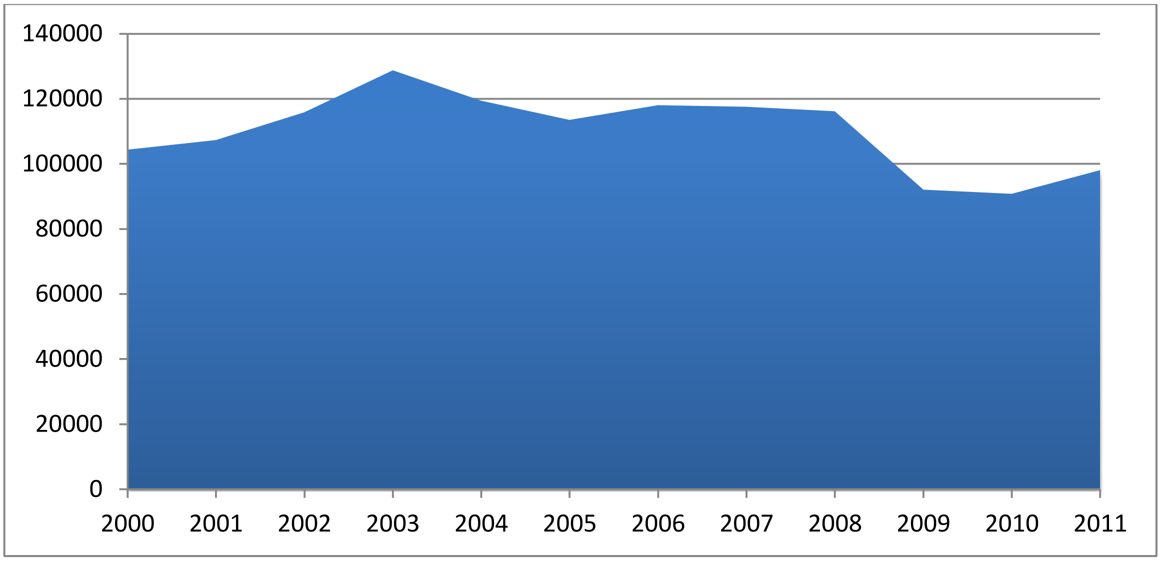

Figure 3. **Greenhouse gas emissions in Romania (2000-2011)**

Source: www.insse.ro, accessed 1st of February 2017

Particulate matter emissions (PM) mainly come from transport activity. In Romania, PM emissions decreased between 2005 (4,289 kilotons) and 2014 (3,497 kilotons). (Figure 4)

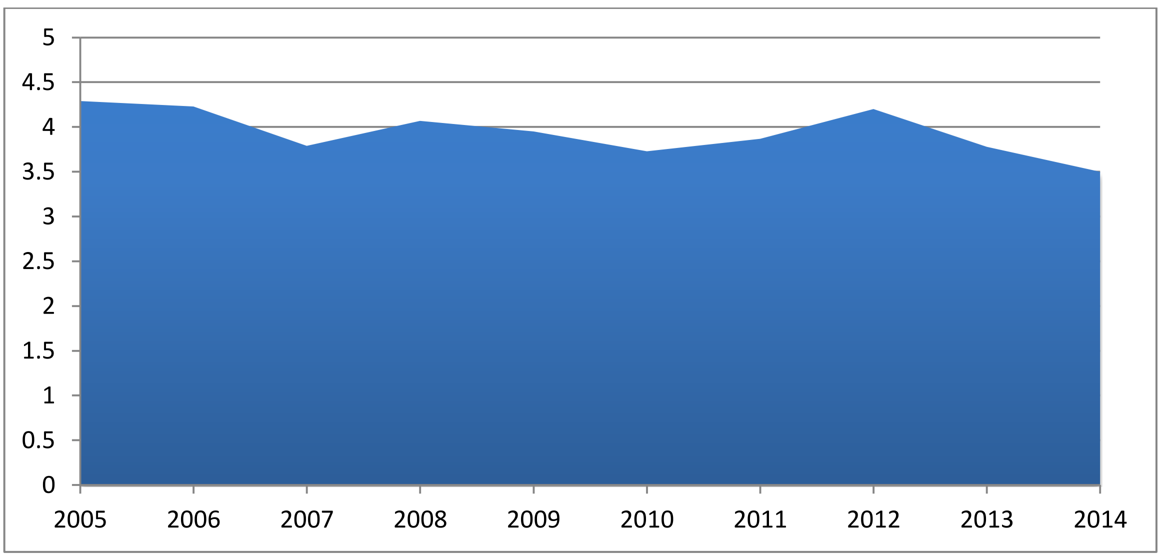

Figure 4. **Particulate matter air pollutants in Romania (2005-2014)**

Source: www.insse.ro, accessed 1st of February 2017

Ozone emissions also decreased during the years 2005 (109,363 kilotons) and 2014 (104,030 kilotons). (Figure 5)

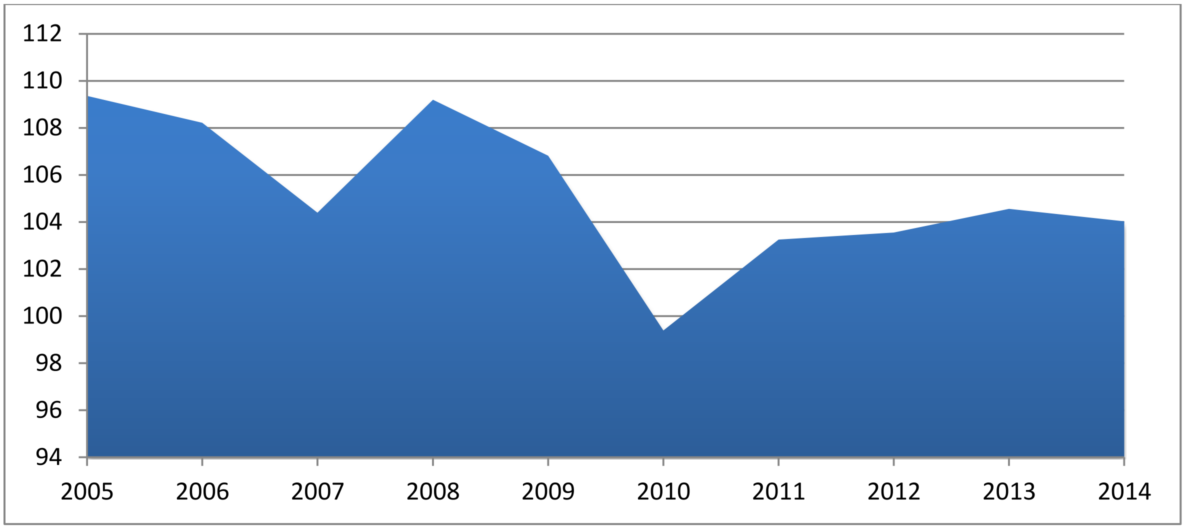

Figure 5. **Ozone air pollutants in Romania (2005-2014)**

Source: www.insse.ro, accessed 1st of February 2017

Hypothesis no 1. There is a statistically significant correlation between chronic exposure to greenhouse gas emissions, particulate matter air pollutants, ozone air pollutants and the length of life at 65 years old.

In order to verify the Hypothesis no 1, we make use of the correlation function between the following variables: greenhouse gas emission (GHE), particulate matter air pollutants (PM), ozone air pollutants (O_3), life expectancy at 65 years old (LE65). (Table 1)

Table 1. *Correlations between chronic exposure to greenhouse gas emissions, particulate matter air pollutants, ozone air pollutants and the length of life at 65 years old*

		GHE	PM	O_3	LE65
GHE	Pearson Correlation	1	,570	,651	-,657*
	Sig. (2-tailed)		,182	,113	,020
	N	12	7	7	12
PM	Pearson Correlation	,570	1	,635*	-,666*
	Sig. (2-tailed)	,182		,049	,035
	N	7	10	10	10
O_3	Pearson Correlation	,651	,635*	1	-,560
	Sig. (2-tailed)	,113	,049		,092
	N	7	10	10	10
LE65	Pearson Correlation	-,657*	-,666*	-,560	1
	Sig. (2-tailed)	,020	,035	,092	
	N	12	10	10	16

*. Correlation is significant at the 0.05 level (2-tailed).

Source: Authors' own research with SPSS Software 20.0 for Windows.

The results from the Table 1 show that there is a statistically significant negative correlation between Life expectancy at 65 years old and greenhouse gas emissions (Pearson coefficient = -0,657, p= 0,020< 0,05), and also between Life expectancy at 65 years old and particulate matter air pollutants (Pearson coefficient = - 0,666, p= 0,035< 0,05).

Hypothesis no 1 is partially verified. There is a statistically significant correlation between chronic exposure to greenhouse gas emissions, particulate matter air pollutants and the length of life at 65 years old.

Hypothesis no 2. There is a statistically significant correlation between chronic exposure to greenhouse gas emissions, particulate matter air pollutants, ozone air pollutants and the life expectancy at birth.

For verifying the Hypothesis no 2, we use the correlation function between the following variables: greenhouse gas emission (GHE), particulate matter air pollutants (PM), ozone air pollutants (O_3) and life expectancy at birth (LEB).

Pearson correlation coefficient indicates the extent to which two measured variables within the same group of observations are connected. If the correlation coefficient is close to 1 or -1, we can state that the two variables are linked and they can explain themselves mutually. If the Pearson coefficient is close to 0, there is a weak correlation. If the Pearson coefficient is close to +1, the two variables vary in the same way, while if the correlation coefficient is close to -1, the two variables vary in an opposite way one from another.

The results underline a statistically significant negative correlation between Life expectancy at birth and Particulate matter air pollutants (Pearson coefficient= -0,674, p= 0,033< 0,05) (Table 2)

Table 2. *Correlations between chronic exposure to greenhouse gas emissions, particulate matter air pollutants, ozone air pollutants and the life expectancy at birth*

		GHE	PM	O_3	LEB
GHE	Pearson Correlation	1	,570	,651	-,567
	Sig. (2-tailed)		,182	,113	,054
	N	12	7	7	12
PM	Pearson Correlation	,570	1	,635*	-,674*
	Sig. (2-tailed)	,182		,049	,033
	N	7	10	10	10
O_3	Pearson Correlation	,651	,635*	1	-,521
	Sig. (2-tailed)	,113	,049		,123
	N	7	10	10	10
LEB	Pearson Correlation	-,567	-,674*	-,521	1
	Sig. (2-tailed)	,054	,033	,123	
	N	12	10	10	16
*. Correlation is significant at the 0.05 level (2-tailed).					

Source: Authors' own research with SPSS Software 20.0 for Windows.

Hypothesis no 2 is partially verified. There is a statistically significant correlation between chronic exposure to particulate matter air pollutants and the life expectancy at birth.

Hypothesis no 3. There is a significant level of influence of the greenhouse gas emissions on life expectancy at 65 years old.

In order to analyze the Hypothesis no 3, linear regression function was used to underline the level of influence that the independent variable (greenhouse gas emissions) has on the dependent variable (life expectancy at 65 years old).

The regression model has some minimal requirements:

- The linearity of the measured phenomenon. The linearity is important, because the concept of correlation is based on a linear relationship. The linearity of a bivariate relation is verified by the exam of residues.
- The constant variance of the error (homoscedasticity). Homoscedasticity is verified by the exam of residues or by a simple statistics test.
- The independence of the error terms. Besides the graphic of residues, it can also be validated by the Durbin-Watson test.
- The normal distribution of the error term.

R square has a value of 0,657, thus Life expectancy at 65 years old can be influenced by the exposure to greenhouse gas emissions, in a percentage of 65,7%. (Table 3)

Table 3. *Regression analysis (greenhouse gas emissions, life expectancy at 65 years old)*

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,657[a]	,432	,375	,42957
a. Predictors: (Constant), Pollution				

Source: Authors' own research with SPSS Software 20.0 for Windows

According to ANOVA analysis, the model is significant (Sig=0,02< 0,05). (Table 4)

Table 4. *ANOVA analysis (greenhouse gas emissions, life expectancy at 65 years old)*

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1,403	1	1,403	7,602	,020[b]
	Residual	1,845	10	,185		
	Total	3,248	11			
a. Dependent Variable: Life_expectancy						
b. Predictors: (Constant), Pollution						

Source: Authors' own research with SPSS Software 20.0 for Windows

The exposure to the greenhouse gas emissions has a significant negative effect on the life expectancy at 65 years old (t = -2,757, Sig.< 0,05). (Table 5)

Table 5. *Coefficients' analysis (greenhouse gas emissions, life expectancy at 65 years old)*

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	18,467	1,221		15,119	,000
	Pollution	-3,042E-005	,000	-,657	-2,757	,020
a. Dependent Variable: Life_expectancy						

Source: Authors' own research with SPSS Software 20.0 for Windows

The hypothesis no 3 is verified. There is a significant level of influence of the greenhouse gas emissions on life expectancy at 65 years old.

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Results and discussion

The current study underlines the effects of the air pollution on life expectancy in Romania. However, in some cities of Romania, $PM_{2,5}$ air pollutants exceed the WHO 2005 guidelines limits of 10 μg/m^3 annual mean and 25 μg/m^3 24-hour mean, reaching values between 16-35 μg/m^3 for the year 2013, mostly in the south of the country. The WHO 2005 guidelines for PM_{10} are 20 μg/m^3 annual mean and 50 μg/m^3 24-hour mean. On the other hand, the 2005 Air Quality Guideline of Ozone (O_3) is 100 μg/m^3 24-hour mean. (WHO, 2016)

Bucharest, the capital of Romania, with 1,8 million inhabitants registered a mean of $PM_{2,5}$ = 23 during the year 2013, while the mean of PM_{10} = 31 during the year 2013 (http://maps.who.int/airpollution/).

One of the most polluted city in Romania, with particulate matter air pollutants is Rovinari, with a mean of $PM_{2,5}$ = 29 during the year 2013, while the mean of PM_{10} = 39 during the year 2013, followed by Constanta, with a mean of $PM_{2,5}$ = 27 during the year 2013, while the mean of PM_{10} = 37 during the year 2013 (http://maps.who.int/airpollution/ , 2016).

According to a study made by WHO (2012), Romania is on the fifth position in the classification of the European Union's countries regarding the death attributable to ambient air pollution, with 14 497 deaths (14 400 cases of death), after Poland (26 589 cases), Germany (26 160 cases), Italy (21 057 cases), United Kingdom of Great Britain and Northern Ireland (16 355 cases). (Figure 6)

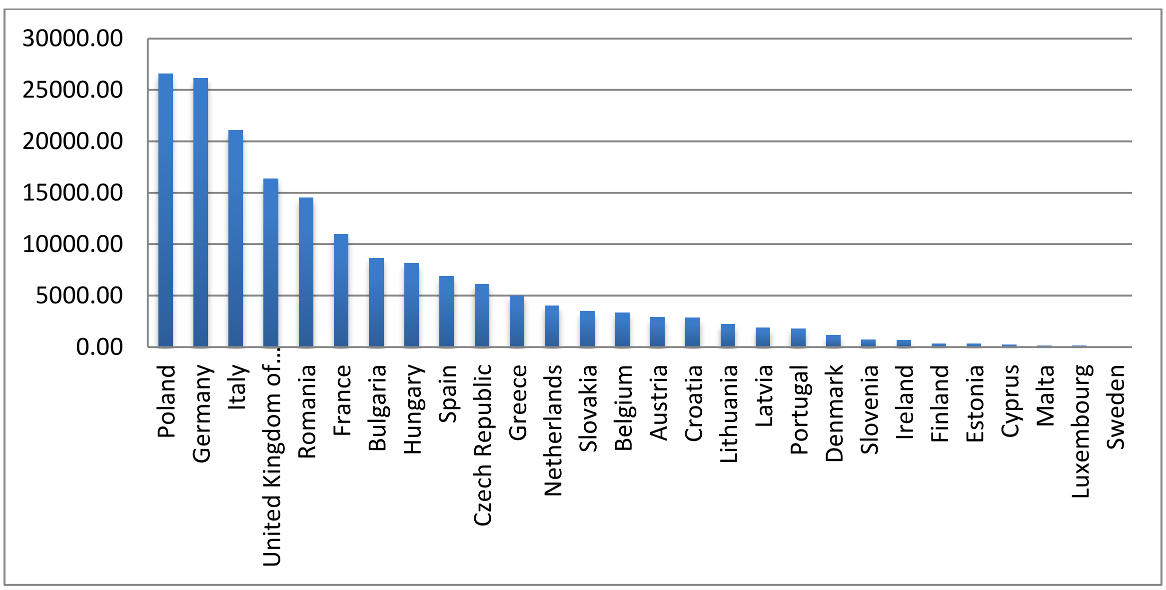

Figure 6. **Death attributable to ambient air pollution at the level of EU28 countries (2012)**

Source: http://apps.who.int/gho/data/node.main.ENVHEALTHJOINTAAPHAP?lang=en.

Conclusions

The main results of the study strengthen the international research studies' findings and underline the importance of measures taken to diminish the air pollution of a country.

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The main findings of the current research paper are: There is a statistically significant correlation between chronic exposure to greenhouse gas emissions, particulate matter air pollutants and the length of life at 65 years old; There is a statistically significant correlation between chronic exposure to particulate matter air pollutants and the life expectancy at birth; There is a significant level of influence of the greenhouse gas emissions on life expectancy at 65 years old.

On the other hand, big industries (e.g. mobile telecommunications industry, which "has an important place within an economy" (Meghisan, 2015)) have an important influence in air pollution changes of a country, together with the retail industry, which "had a real success nowadays perceived mainly by the fortune that the founders of the hypermarkets managed to gain", (Stancu and Meghisan, 2012), emphasized mainly by the "sophisticated theories of consumer behavior" recently developed by scientists. Eventhough the main goal of these industries is represented by the "efficiency of using their own capital of the company" (Circiumaru et al., 2010), the length of life of consumers and of labour force is vital, mainly because "during financial crisis of 2008-2009, the country's labour force suffered major changes and currently the country is trying to improve its macroeconomic situation" (Marcu et al., 2015), also influenced by the disequilibrium on stock markets during the same period of economic crisis (Acatrinei et al., 2013; Marcu and Meghisan, 2011, Miron et al., 2009, Dima and Vasilache, 2013).

The authors subscribe to the goals of the World Health Assembly (26th of May 2015), which adopted a series of resolutions to be adopted by the member states (WHO, 2015) in order to increase the air quality and health:

- Development of partnerships, dialogues and cooperation in accordance to the WHO guidelines;
- Rise awareness about the impact on air pollution on health towards large public and stakeholders;
- Facilitate research within the field;
- Collect and interpret the data related to health risk assessment;
- Take action to minimize air pollution.

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