Environmental Quality and Health Status in the Baltic States in Comparison with Slovak and Czech Republics

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Abstract

The paper deals with the impact of environmental quality on human health in the Baltic States. The quality of environment and health are the core indicators of quality of life and they are closely interrelated. The indicators system to assess environmental quality and health status wasdeveloped to assess the impact of environmental quality on health in the Baltic States based on regular consolidated statistical data provided by EUROSTAT. The paper presents the concept of assessment of environmental quality and health status dimensions in the quality of life measurements and provides analysis of dynamics of environmental and health indicators in Lithuania, Latvia and Estonia states. The integrated environmental quality and health indicators were developed and assessed in the Baltic States since EU accession in 2004. The relationship between the main environmental quality and health status indicators is assessed. Comparison of environmental quality and health status indicators in the Baltic States and in Czech Republic and Slovakia are provided as well. Based on the analysis performed policy recommendations are presented.

Keywords: *environmental quality, health status, integrated indicators, comparative assessment*

JEL Classification: I31, I38, O47

Introduction

There is a close relationship between health and environment. The health of population is affected by the healthiness of their physical environment. The impact of pollutants, hazardous substances on people's health is assumed to be sizeable. Environmental policies have a critical role to play in dealing with global health priorities and in improving people's lives. Many studies indicated that

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health status of population has significant impact on economic growth, which then stimulates health. Taking into account a scenario where both variables stimulate one another leads to significant policy implications. Therefore, policy-makers should look at health expenses as an investment rather than a cost, taking a balanced approach, and implementing a long-run viewpoint. Governments must take health seriously, if they want to sustain and improve economic and social outcomes (Bloom and Canning, 2008; Bhargava et al., 2001).

Environmental quality is a key dimension of people's well-being, as quality of life is strongly affected by a healthy physical environment (Kahn and Matsusaka, 2002; Holman and Coan, 2008).In the long-term, drastic changes in the environment may also impair human health through climate change, transformations in the carbon and water cycles and biodiversity loss (Prüss-Üstün and Corvalán, 2006; Balestra and Dottori, 2011). According to (Pearce and Warford, 1993), the immediate and most important consequences of environmental degradation are damage to human health through different forms of diseases. Many authors investigated how air quality may be associated to population's health. Some studies showed that air pollution may increase mortality and morbidity rate (Gangadharan and Valenzuela, 2001; Chay and Greenstone, 2003; Aunan and Pan, 2004; Jerrett et al., 2005). Jerrett et al. (2005) and investigated whether chronic exposure to particulate air pollution is significantly associated with mortality when the effects of other social, demographic, and lifestyle confounders are taken into account. Most studies showed statistically significant health effects of air pollution. On the other hand, authors assess the link between pollution and particular illness, such as cardiorespiratory disease (Aunan and Pan, 2004; Burnett and Krewski, 1994; Jerrett et al., 2005), asthma (Nauenberg and Basu, 1999) and congenital anomalies (Rankin et al., 2009).

Generally, it is assumed that health outcomes of a population improve when the economy grows and this improvement is facilitated by the rise in general standard of living (access to educational opportunities and health services). The Central and East Europe countries including the Baltic States have lower living standards because of lower income and GDP per capita (Clowes and Bilan, 2014) therefore it is expected that health quality indicators in these countries are lower than in old EU member states and lower than EU average. However, health mostly depends on the quality of physical environment, such as the amount of air pollution and the quality of drinking water (Hill, 2004; Drabo, 2010). At the same time, the quality of a country's physical environment is the result of certain growth factors in the economy (intensive use of land, forest, and air and water pollution). According to (Gangadharan and Valenzuela, 2001) it is possible even to assess health as a function of income, physical environment quality and other control variables (Drabo, 2010).

The main European policies aim to provide an environment in which the level of pollution does not give rise to harmful effects on human health and the environment, and vulnerable population groups are protected. Lithuania and other Baltic States have developed and implemented Sustainable Development Strategies and other policy documents aiming at the reduction of environmental pollution and increase in environmental quality and health performance. Therefore, it would be useful to compare results achieved by the Baltic States in improving environmental quality and enhancement of health performance since entering EU in 2004.

The aim of this paper is to develop a framework for assessment of environmental quality and health status indicators relevant to quality of life and to apply this framework for comparative assessment of these indicators and their interrelationship in the Baltic States since EU accession.

The main tasks to achieve this aim are as follows:

- To develop a framework for assessment of environmental quality and health status indicators based on consolidated statistical data for EU members states provided by EUROSTAT.
- To analyse and compare the trends of environmental quality and health status indicators in the Baltic States during 2004 – 2012 year period.
- To develop integrated indicators of environmental quality and health status in the Baltic States and compare trends of these indicators since EU accession.
- To investigate the relationship between environmental quality and health status indicators in the Baltic States.
- To analyse and compare the development of health and environmental quality indicators in the Baltic States and Czech Republic and Slovakia.
- To develop policy recommendations based on analysis provided.

Environmental Quality and Health Indicators

The objective approach in assessment of quality of life supposes to use the objective indicators that reflect different aspects of quality of life, measurable by using secondary data, which is available mainly from official governmental data collections. This approach is widely used in different studies, as it has major advantages. Quality of life research in Lithuania is not well developed yet. Recently, the interest on this topic has been growing. Most empirical studies in Lithuania paid most attention just to the objective component of quality of life. The quality of life according to Rakauskiene and Servetkiene (2011) can be measured by indicators covering the following 3 main dimensions: health, environment and demographics; the material conditions of life; education, culture, moral and ethical and spiritual values.

The environmental indicators of quality of life are included in the first dimension of quality of life covering health, environment and demographic conditions (Rakauskiene and Servetkiene, 2011). The ideal set of objective environmental indicators relevant to quality of life would inform about quality of a number of environmental media (soil, water, air), on people access to environmental services and amenities and environmentally responsible behavior as well (Mohit, 2013). The objective environmental indicators of quality of life presented in this paper are limited to only a subset of indicators reported by EUROSTAT databases.Though the concept of "environmental quality indicators" is very broad and encompasses a number of environmental media (*e.g.* soil, water, air) because of the lack of relevant data for some of these media and the evidence of sizeable effects of air pollutants on human health, the main attention in this paper is paid to air pollution indicators related to environmental quality (Burnett and Krewski, 1994; Nauenberg and Basu, 1999; Jerrett et al., 2005; Aunan and Pan, 2004; Day, 2007; Rankin et al., 2009).

The objective measure of air quality used in this paper takes into account PM10 and ground ozone concentrations only. Epidemiological studies conducted over the past twenty years have reported significant associations between short-term and long-term exposure to increased ambient PM concentrations and increased morbidity and premature mortality (Schwartz, 1994; Samet et al., 2000; Goldberg et al., 2001; Dockery, 2001; Arruti, Fernández-Olmo and Irabien, 2010).

The urban population exposure to ozone indicator shows the population-weighted concentration of ozone to which the urban population is potentially exposed. The principle metric for assessing the effects of ozone on human health is, according to the WHO recommendations, the daily maximum 8-hour mean. Ozone effects should be assessed over a full year.

CO_2 emissions are the main problem of climate change. Especially, large problems are related with transport pollution in EU. The emissions from the transport sector have been constantly growing together with the increase of living standards. The use of more efficient cars can provide for GHG emission reduction in transport sector (EEA, 2010; Ahmad and Yamano, 2011). Therefore indicator – carbon dioxide emissions per km from new passenger cars in EU, gCO_2/km was selected to address the problem of transport pollution.

Access to clean water is fundamental to human well-being. Managing water to meet that need is a major – and growing – challenge in many parts of the world. Many people are suffering from inadequate quantity and quality of water. Despite significant progress in EU member states in reducing water pollution, from fixed sources such as industrial and municipal wastewater treatment plants, diffuse pollution from agriculture and urban run-offs remains a challenge and

improvements in freshwater quality are not always easy to discern. The biochemical oxygen demand in rivers is the main indicator showing the water quality in rivers. Organic matter, measured as Biochemical Oxygen Demand (BOD) and total ammonium, are key indicators of the oxygen content of water bodies. Concentrations of these parameters normally increase as a result of organic pollution caused by discharges from waste water treatment plants, industrial effluents and agricultural run-off. Severe organic pollution may lead to rapid de-oxygenation of river water, a high concentration of ammonia and the disappearance of fish and aquatic invertebrates. The most important sources of organic waste load are: household wastewater; industries such as paper industries or food processing industries; and silage effluents and manure from agriculture.

A serious problem in EU is waste generation. In EU every year about 3 billion tonnes of waste is generated and some 90 million tonnes of it hazardous. This amounts to about 6 tonnes of solid waste per capita according to Eurostat statistics. It is clear that treating and disposing of all this material – without harming the environment – becomes a major concern. The main indicator of environmental quality in this areas municipal waste, generated per capita indicating the waste accumulation rate and the problem in EU member states.The EU's *Sixth Environment Action Programme* identifies waste prevention and management as one of four top priorities. Its primary objective is to decouple waste generation from economic activity, so that EU growth will no longer lead to more and more rubbish, and there are signs that this is beginning to happen.

Increase in all 5 selected environmental quality indicators (PM10 and ground ozone concentrations, CO_2 emissions, Bioxemical oxygen demand in rivers, municipal waste generated per capita) represents negative trends in terms of environmental quality and is supposed to have a negative impact on human health and quality of life.

According to the World Health Organization (WHO) the health status depends on 4 factors (WHO Europe, 2010): health care system performance (20%), environmental impact (20%); inherited or genetic impacts (10%); and life styles or determinants of health such as prevalence of obesity, alcohol and tobacco consumption etc. (50%). As Baltic States are very close countries in terms of economic development, living standards and culture the health status indicators are supposed to be similar in the Baltic States.

There are several important health status indicators developed by the WHO and reported at EUROSTAT databases and other international organizations data bases (OECD, 2012).The most important indicators representing health status are: average life expectancy at birth, healthy life years at birth and at age 65, standardized death rate and various death rates and morbidity rates (due to chronic

disease, due to cancer, due to tuberculosis, due to ischemic heart disease etc.). In addition, there several subjective health status indicators developed by EUROSTAT which represent self-perceived health status of population.

As there are many indicators of health status and some of them are overlapping, the 5 main indicators have been selected based on their relevance in investigating environmental quality impact: average life expectancy at birth, healthy life years at age 65, self-perceived good health and chronic morbidity and standardized death rate per 1 000 000 inhabitants. These indicators are being collected by EUROSTAT database in relation with various thematic areas (sustainable development indicators, quality of life indicators, Principal European Policy Indicators etc.) and developed to monitor implementation of policy targets.

The average life expectancy at birth is the main indicator of the health of the population (European Observatory on Health Care Systems, 2000).Life expectancyat birth is a statistical average of the number of years a human is expected to live. Mathematically, life expectancy is the expected (in the statistical sense) number of years of life remaining at birth. There are great variations in life expectancy between different parts of the world, mostly caused by differences in public health, medical care, and environmental quality.

The indicator Healthy Life Years (HLY) at age 65 measures the number of years that a person at age 65 is still expected to live in a healthy condition. HLY is a health expectancy indicator which combines information on mortality and morbidity. The data required are the age-specific prevalence (proportions) of the population in healthy and unhealthy conditions and age-specific mortality information. A healthy condition is defined by the absence of limitations in functioning/disability. The indicator is calculated separately for males and females. The indicator is also called disability-free life expectancy (DFLE).

The European Statistics of Income and Living Condition (EU-SILC) survey contains a small module on health, composed of 3 variables on health status and 4 variables on unmet needs for health care. The variables on health status represent the so called Minimum European Health Module (MEHM), and measures 3 different concepts of health: self-perceived health; chronic morbidity (people having a long-standing illness or health problem) and activity limitation – disability (self-perceived long-standing limitations in usual activities due to health problems). All indicators are expressed as percentages within (or share of) the population and breakdowns are given by: sex, age, labour status, educational attainment level, and income quintile group.

Data on causes of death (COD) provide information on mortality patterns and form a major element of public health information. COD data refer to the underlying cause which – according to the World Health Organisation – is “the disease

or injury which initiated the train of morbid events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury". The crude death rate or standardized death rate describes mortality in relation to the total population. Expressed in deaths per 100 000 inhabitants, it is calculated as the number of deaths recorded in the population for a given period divided by population in the same period and then multiplied by 100 000.

In Table 1 the environmental quality and healthstatus indicators are presented.

T a b l e 1

The Environmental Quality and Health Indicators Relevant to Quality of Life

Dimensions	**Indicators**				
Environmental quality	Urban population exposure to air pollution by particulate matter, micrograms per cubic metre	Urban population exposure to air pollution by ozone, micrograms per cubic metre day	Biochemical oxygen demand in rivers, mg/l	Average carbon dioxide emissions per km from new passenger car, gCO_2/km	Waste generated by household, tones
Health quality indicators	Average life expectancy at birth, years	Healthy life years at age 65, males, years	Self-perceived good health, %	People having a long-standing illness or health problem, %	Standardized death rate per 100 000 inhabitants

Source: Created by authors.

As one can see from the information provided in Table 1, the environmental quality indicators represents the situation in terms of negative indicators. The increase in environmental quality indicators given in Table 1 shows the negative trend in environmental quality. In terms of health status, indicators the 3 of them represent positive health status (average life expectancy at birth, healthy life years at age 65, and self-perceived good health) and the desirable trend is the increase in these health status indicators, though two of them represent negative health status (people having long-standing illness or health problems and standardized death rates). The increase of these indicators shows negative trends.

In the next section of this paper OLS regression is applied to analyse the relationship between health status and environmental indicators.

The Regression Analysis between Environmental Quality and Health Indicators

The impact of all selected environmental indicators (PM10, ground ozone concentrations, CO_2 emissions, biochemical oxygen demand (BOD) and municipal waste generated per capita) on average life expectancy at birth, healthy life years at age 65, self-perceived good health and chronic morbidity and standardized

death rate per 100 000 inhabitants in the Baltic States was assessed by applying ordinary least squares (OLS) regression. As regards the choice of regressors, they mainly measure pollution of the environment in different approaches. Obviously, higher level of pollution might induce a decrease in life expectancy and other indicators reflecting the state of health within a population. Furthermore, municipal waste indicator captures the level of economic development as higher income induces higher amounts of waste generated. Country dummies and a quadratic time trend are introduced to account for heterogeneity among the countries under analysis. Therefore, the model becomes an instance of fixed effects model.

Results of the OLS regression indicate that differences in average life expectancy present among the countries analysed can be explained in terms of country-specific factors as captured by country dummies and time trend as captured by the quadratic time trend (Table 1). After removing regressors featuring extremely high p-values, just PM10 and ground ozone concentration remain in the model. However, they have no significant impact on average life expectancy. Therefore, other environmental quality indicators – such as CO_2 emissions, BOD and municipal waste per capita – show no relationships with average life expectancy at birth as evidenced by rather high p-values. As both of the terms of the time trend are significant at the level of significance of 10%, it is obvious that the average life expectancy followed a U-shape trend after accounting for country effects. Considering Lithuanian life expectancy as a yardstick, one can note that Latvia shows no significant difference, whereas life expectancy is significantly higher in Estonia.

T a b l e 2

Regression Model Describing the Relationship between the Average Life Expectancy and PM10 and Ground Ozone Concentrations in the Baltic States

	Coefficients	**Standard Error**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**
Intercept	71.75766	1.034572956	69.35969	2.68E-22	69.5749	73.94041
EST	1.838478	0.320434248	5.737459	2.42E-05	1.162421	2.514536
LV	–0.00617	0.274751586	–0.02245	0.982347	–0.58584	0.573506
T	–0.35577	0.194932261	–1.82508	0.085612	–0.76704	0.055505
t2	0.088541	0.020933162	4.229719	0.000564	0.044376	0.132707
PM10	–0.04718	0.036022353	–1.30972	0.407716	–0.12318	0.028821
Ozone	4.97E-05	8.63872E-05	0.575831	0.572274	–0.00013	0.000232

Source: Create by authors.

As extremely high p-values were obtained for relationships among other health status indicators (healthy life years at age 65, self-perceived good health and chronic morbidity and standardized death rate per 100 000 inhabitants) and environmental indicators, one can conclude that no significant relationships

can be established in this sense. Given it is not possible to define the relationships between health status and environmental quality indicators in the Baltic States by the means of OLS regression, the trends in environmental quality and health status indicators are analysed and compared among the Baltic States by the means of an integrated environmental quality and health status indicators in the sequel of the paper.

Dynamics of Environmental Quality Indicators in the Baltic States

The analysis of the main environmental quality indicators in the Baltic States and their comparison with EU-27 average would allow defining the most problematic environmental issues in the Baltic States that might negatively affect health status of population. In Table 3 the dynamics of environmental quality indicators in the Baltic States and EU-27 average is presented.

T a b l e 3

Dynamics of Environmental Quality Indicators in the Baltic States and EU-27 Average

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Urban population exposure to PM10, mg/m^3								
EU average (27 countries)	27	28	30	28	26	26	26	27
Estonia	18	21	23	19	11	13	14	13
Latvia	23	24	23	24	24	20	24	23
Lithuania	23	23	20	21	19	23	27	23
Urban population exposure to air pollution by ozone, mg/m^3								
EU average (27 countries)	3 491	3 677	4 478	3 611	3 580	3 648	3 368	3 706
Estonia	1 299	1 321	4 331	2 308	1 381	1 668	2 467	2 402
Latvia	1 030	1 308	1 758	:	1 354	1 260	1 213	1 806
Lithuania	2 909	5 048	4 621	1 891	3 653	2 110	1 416	3 057
Dynamic of biochemical oxygen demand in rivers, mg/l								
EU-27	2.55	2.19	3.76	4.41	3.82	–	3.22	
Estonia	2.19	2.50	2.30	2.17	2.00	–	1.50	
Latvia	1.98	1.68	1.44	1.52	1.48	–	1.33	
Lithuania	2.90	2.80	2.90	2.50	2.70	–	2.80	
Carbon dioxide emissions per km from new passenger cars, gCO_2/km								
EU average (27 countries)	160	159.0	159.0	158.7	153.6	145.7	140.3	135.7
Estonia	179	183.7	182.7	181.6	177.4	170.3	162	156.9
Latvia	192.4	187.2	183.1	183.5	180.6	176.9	162	154.4
Lithuania	187.5	186.3	163.4	176.5	170.1	166.0	150.9	144.4
Municipal waste per capita, kg								
EU average (27 countries)	513	515	521	522	519	509	505	500
Estonia	449	436	399	449	391	337	303	298
Latvia	311	311	412	378	332	334	304	350
Lithuania	367	377	391	401	408	361	381	442

Source: EUROSTAT.

As one can see from the information provided in Table 3 in Lithuania the urban population exposure to air pollution by particulate matter was stable during 2004 – 2011 period. Comparing with EU-27 average one can notice that in Lithuania urban population expose to air pollution was lower during all investigate period however it was higher thanWHO Air Quality Guidelines for PM10 which are set at 20 $\mu g/m^3$ as an annual mean. In Estonia urban population exposure to air pollution by particulate matter was lower than in Lithuania and Latvia during all investigated period.

In the period 2004 – 2011, 14 – 65% of the urban population in EU-27 was exposed to ambient ozone concentrations exceeding the EU target value set for the protection of human health (120 microgram O_3/m^3 daily maximum 8-hourly average, not to be exceeded more than 25 times a calendar year, averaged over three years and to be achieved where possible by 2010). The 65% of the urban population exposed to ambient ozone concentrations over the EU target value was recorded in 2003, which was the record year.In Lithuania urban population exposure to air pollution by ozone was lower than EU-27 during all investigated period however it is also significantly higher than EU target value. Estonia again distinguishes from other Baltic States with low urban population exposure to ozone concentrations during investigated period.

As it can be seen from the information provided in Table 3 the BOD was lower in Estonia and other Baltic States than EU-27 average during all investigated period. The decrease of BOD can be observed in Estonia, Latvia and at EU-27 level though in Lithuania some increase since 2008 can be noticed. The decrease in BOD is mainly due to improved sewage treatment resulting from the implementation of the Urban Wastewater Treatment Directive and national legislations. In recent years, however, the downward trends in BOD across Europe have generally levelled. This suggests that either further improvement in wastewater treatment is required or that other sources of organic pollution, for example from agriculture, require greater attention, or both.In Lithuania BOD was almost stable during 2004 – 2010.

Regarding carbon dioxide emissions per km from new passenger cars Baltic States have positive trends of this indicator development however the recent carbon dioxide emissions per km from new passenger cars indicator is still lower at EU-27 level.

As one can see from the information provided in Table 3 the municipal waste generated by capita was the lowest in Estonia. Comparing with EU-average all Baltic States have lower municipal waste generated per capita. Though the significant reduction has been noticed in 2008 however the new trends of increase are followed after economic crisis in Latvia and Lithuania.

One can notice that as regards to quality of environment comparing with EU-27 average the Baltic States are performing better in almost all environmental quality indicators except carbon dioxide emissions per km from new passenger cars. Estonia is the best performing country according all environmental quality indicators among Baltic States except carbon dioxide emissions per km from new passenger cars.

Dynamics of Health Status Indicators in the Baltic States

The analysis of the main health status indicators in the Baltic States and their comparison with EU-27 average would allow to define the most problematic health status issues in the Baltic States. In Table 4 the dynamics of health status indicators in the Baltic States and EU-27 average is presented.

T a b l e 4

Dynamics of Health Status Indicators in the Baltic States and EU-27 Average

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Average life expectancy at birth, years									
EU-27	77.8	77.9	78.3	78.5	78.7	79.0	79.3	79.6	79.6
Estonia	71.9	72.4	72.5	72.6	73.7	74.6	75.3	75.8	76.0
Latvia	70.6	70.2	70.1	70.4	71.6	72.3	72.5	73.4	73.6
Lithuania	71.5	70.7	70.5	70.2	71.1	72.4	72.6	73.1	73.4
Healthy life years at age 65, males									
EU-27	:	8.6	8.8	8.8	8.3	8.4	8.7	8.8	8.8
Estonia	4.6	3.4	4	3.5	4	5.6	5.3	5.6	5.4
Latvia	:	5	4.6	5.2	4.9	4.8	4.9	4.8	5.3
Lithuania	:	5.2	5.9	5.3	5.8	6.1	6.3	6.2	5.6
Self-perceived good health, %									
EU-27	:	21.7	21.4	21.5	22.0	22.4	22.7	22.3	23.5
Estonia	6.4	7.0	7.5	7.3	7.3	6.5	8.1	7.8	8.9
Latvia	:	2.6	3.3	3.4	4.7	4.1	4.7	4.1	4.1
Lithuania	:	7.0	6.3	6.7	6.6	7.2	7.0	6.6	7.1
People having a long-standing illness or health problem, %									
EU-27	:	30.7	31.0	30.6	31.0	31.3	31.4	31.8	31.5
Estonia	41.3	38.5	38.6	40.2	38.1	40.1	42.6	44.7	43.7
Latvia	:	36.3	35.2	33.8	33.6	33.0	34.3	35.7	35.2
Lithuania	:	30.3	33.5	31.7	29.1	28.5	26.9	29.0	29.6
Standardized death rate per 100 000 inhabitants									
EU-27	1,269.8	1,205.7	1,196.3	1,138.0	1,120.9	1,103.3	1,079.8	1,056.3	
Estonia	1,766.1	1,700.8	1,661.6	1,623.9	1,584.8	1,493.4	1,415.1	1,361.0	
Latvia	1,883.9	1,852.3	1,877.5	1,864.0	1,845.7	1,707.2	1,627.8	1,622.3	
Lithuania	1,679.2	1,662.2	1,737.2	1,741.3	1,737.5	1,655.3	1,567.8	1,558.3	

Source: EUROSTAT.

As one can see from Table 4 average life expectancy is the highest in Estonia. Average life expectancy in Latvia and Lithuania is very similar but significantly lower (6 years) than EU-27 average and lower (more than 2 years) than in Estonia.

There is a large difference between HLY among males and females especially in the Baltic States, i.e. females have about 5 years higher HLY therefore HLY at 65 for males was selected for comparative assessment of health status as more relevant indicator in assessment of health quality and indicating the most problematic issues. As one can see from the information provided in Table 4 HLY at 65 for males in the Baltic States are lower than EU-27 average. The lowest HLY indicator is in Latvia.

According adult's self-reported health status Baltic States are inn very bad position comparing with EU-27 average. Just 4.1% of population in Latvia reports that they are healthy. In Estonia and Lithuania these indicators are higher however in Latvia negative trends of these indicators can be noticed.

According indicator of people having a long-standing illness or health problem one can notice that again in Latvia and Estonia situation is worse than EU-27. Just Lithuania has reported a slightly better situation and the share of people having a long-standing illness or health problems was slightly lower than in EU-27 in 2012. Since 2008 the negative trends can be noticed in the development of this indicator in the Baltic States.

Standardized death rate per 100 000 inhabitants indicator in the Baltic States is significantly higher than EU average. Especially high standardized death rate per 100 000 inhabitants indicator is in Latvia. Estonia distinguishes from Baltic States with the lowest death rate. The trends of this indicator are positive in the Baltic States since 2008.

According all health status indicators Baltic States are performing worse than EU-27 average except the share of people having a long-standing illness or health problem as Lithuania has less people having a long-standing illness or health problem than EU-average during investigated period. Comparing health status indicators between Baltic States one can notice that Estonia distinguishes with the best health status indicators between Baltic States except the share of people having a long-standing illness or health problem.

Though Estonia is the best performing country in almost all environmental quality and health performance indicators amongst the Baltic States, there are some exemptions and Lithuania is performing better in some environmental quality (municipal waste generated per capita) and health indicators (the share of people having a long-standing illness or health problem) in the following section of paper integrated environmental quality and health status indicators are developed for comparative assessment of environmental quality and health status and their interrelations in the Baltic States.

Integrated Index of Environmental Quality and Health Status

Integrated assessment indicators are being developed to monitor the success of strategies implementation and to assess policies and measures seeking to reflect the main targets set in strategies or policy documents as well as for the comparison of countries in achievement of certain aims. Various multi-criteria methods can be applied in developing integrated indicators (Streimikiene et al., 2011; Kaplikski and Tupenaite, 2011; Zvirblis and Buracas, 2012; Streimikiene and Balezentiene, 2012; Streimikiene, 2013).As the increase of environmental quality and the health status of the population are the main aims of sustainable development, environmental and health care policies in the Baltic States the integrated indicators can be applied for the comparative assessment of the Baltic States in terms of environmental quality and health performance.Therefore, seeking to compare countries in terms of environmental quality and health status indicators the integrated indices were developed for Lithuania, Latvia and Estonia for the comparisons. All indicators are equally important for development of integrated environmental and health quality indicators therefore the equal weights were applied in computing integrated assessment indicators.

Each integrated index (environmental quality or health status) consists of 5 indicators and are developed by applying formula:

$$I_n = \sum_{i=1}^{n} w_i \cdot Q_{in} \qquad \text{where} \qquad \sum_{i=1}^{n} w_i = 1 \tag{1}$$

where

I_n – integrated index of environmental quality or health status at time moment *n*;

Q_{in} – the index of environmental or health indicator at time moment *n*;

w_i – the weight of *i*-indicator (in this case they are equal and make 0.2 for each of 5 indicators).

The index Q_{in} of *i*-environmental or health indicator is obtained by the following formula if the increase of indicators is desirable trend:

$$Q_{in} = q_{ni} / q_{oi} \tag{2}$$

where

Q_{in} – index of *i*-environmental or health indicator at time moment *n*;

q_{ni} – the value of *i*-environmental or health status indicator at time moment for specific country;

q_{oi} – the value of *i*-environmental or health status indicator at time moment *n* for EU-27 average.

If the increase of indicators is undesirable trend the inverted indicators should be calculated as in the case of environmental quality and health status indicators:

$$Q_{in} = 1 / (q_{ni} / q_{oi}) \quad (3)$$

The dynamics of integrated indices of environmental quality in the Baltic States is presented in Table 5. The environmental quality indices were calculated by applying data in Table 3 and formula 3. As the increase of indices is desirable trend and the higher index represents the higher environmental quality and better health status the environmental quality indicators were assessed as inverted because EUROSTAT data for environmental quality is presented in form of negative indicators (urban population exposure to pollution, bioxemical oxygen demand, municipal waste per capita etc.).

T a b l e 5

The Dynamics of Integrated Indices of Quality of Environment in the Baltic States

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Environmental quality indicators								
Urban population exposure to PM10, index								
Estonia	1.49	1.33	1.30	1.47	2.38	2.00	1.87	2.08
Latvia	1.18	1.16	1.30	1.16	1.09	1.30	1.09	1.18
Lithuania	1.18	1.22	1.49	1.33	1.37	1.14	0.96	1.18
Urban population exposure to air pollution by ozone index								
Estonia	2.70	2.78	0.83	1.56	2.56	2.17	2.62	1.54
Latvia	3.33	2.85	2.56	2.04	2.63	2.83	2.78	2.04
Lithuania	1.20	0.73	0.97	1.92	0.98	1.72	2.38	1.22
Biochemical oxygen demand in rivers index								
Estonia	1.16	0.88	1.64	2.04	1.92	–	2.17	–
Latvia	1.28	1.32	2.63	2.94	2.56	–	2.44	–
Lithuania	0.88	0.78	1.27	1.75	1.41	–	1.16	–
Carbon dioxide emissions per km from new passengers car index								
Estonia	0.89	0.87	0.87	0.88	0.87	0.85	0.86	0.87
Latvia	0.83	0.85	0.87	0.86	0.85	0.83	0.86	0.88
Lithuania	0.85	0.85	0.97	0.90	0.90	0.88	0.93	0.94
Municipal waste per capita index								
Estonia	1.13	1.18	1.30	1.16	1.33	1.51	1.67	1.67
Latvia	1.63	1.63	1.26	1.39	1.56	1.52	1.67	1.43
Lithuania	1.22	1.37	1.33	1.12	1.27	1.41	1.33	1.14
Environmental quality index								
Estonia	7.37	7.04	5.94	7.11	9.06	–	9.19	–
Latvia	8.25	7.81	8.62	8.36	8.69	–	8.84	–
Lithuania	5.33	4.95	6.03	7.02	5.93	–	6.76	–

Source: Created by authors.

As one can see from the information provided in Table 5 the highest integrated index of environmental quality was obtained for Estonia. Lithuania has the lowest integrated environmental qualityindex however the trends of these indices

development since 2004 were very diverse. As regards the quality of environment the best situation in 2010 was in Estonia mainly because low urban population exposure by PM10, ozone and low biochemical oxygen demand in rivers indicators.

The dynamics of integrated indices of health status in the Baltic States is presented in Table 6. The indices were calculated by applying data in Tables 4 and formulas presented above. The positive health status indicators such as average life expectancy at birth, self-perceived good health and healthy life years at birth in percentage of the total life expectancy for males are calculated by applying formula (2). As the increase of some indices is desirable trend and the higher index represents the better health performance some health status indicators were assessed as inverted (people having long-term standing illness or health problems, standardized death rate) and calculated by applying formula 3 as these indicators developed by EUROSTAT are presented in negative form of health performance.

T a b l e 6

The Dynamics of Integrated Indices of Health Status in the Baltic States

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Health performance indicators									
Average life expectancy at birth, years									
Estonia	0.92	0.930	0.93	0.92	0.94	0.94	0.95	0.95	0.96
Latvia	0.911	0.900	0.90	0.90	0.91	0.92	0.91	0.92	0.93
Lithuania	0.92	0.910	0.90	0.89	0.90	0.92	0.92	0.92	0.90
Healthy life years at age 65, males									
Estonia		0.40	0.46	0.40	0.48	0.67	0.61	0.64	0.61
Latvia		0.58	0.52	0.59	0.59	0.57	0.56	0.55	0.60
Lithuania		0.61	0.67	0.6	0.70	0.72	0.72	0.71	0.64
Self-perceived good health, %									
Estonia		0.32	0.35	0.33	0.33	0.29	0.36	0.35	0.38
Latvia		0.12	0.15	0.16	0.21	0.18	0.21	0.18	0.17
Lithuania		0.32	0.29	0.31	0.30	0.32	0.31	0.30	0.30
People having a long-standing illness or health problem, %									
Estonia		0.8-	0.80	0.76	0.81	0.78	0.74	0.71	0.72
Latvia		0.85	0.88	0.90	0.95	0.95	0.91	0.89	0.89
Lithuania		1.01	0.93	0.96	1.08	1.10	1.16	1.10	1.05
Standardized death rate per 1 000 000 inhabitants									
Estonia		0.72	0.71	0.72	0.70	0.71	0.74	0.76	0.78
Latvia		0.68	0.65	0.64	0.61	0.61	0.65	0.66	0.65
Lithuania		0.76	0.72	0.69	0.65	0.65	0.67	0.69	0.65
Health performance index									
Estonia		3.17	3.25	3.13	3.26	3.39	3.40	3.41	3.45
Latvia		3.13	3.10	3.19	3.27	3.23	3.24	3.22	3.24
Lithuania		3.61	3.51	3.45	3.63	3.71	3.78	3.72	3.54

Source: Created by authors.

As one can see from the information provided in Table 6 the best performing countries according health status indicators are Lithuania and Estonia. In 2012 the countries have very similar health performance indicator. Though Estonia distinguishes as the best performing country in environmental quality indicators, some health status indicators in Lithuania are better (people having a long-standing illness or health problem) and according health status indicator in 2012 countries achieved similar results.

One can notice that according to all environmental quality indicators the Baltic States are performing better than EU-27 except carbon dioxide emissions per km from new passenger cars. Estonia is the best performing country according all environmental quality indicators among Baltic States except carbon dioxide emissions per km from new passenger cars.

Though according to almost all environmental quality indicators the Baltic States are performing better than EU – average, in terms of health quality situation is different and the Baltic States have worse indicators comparing with EU-27 average except the share of people having a long-standing illness or health problem. Lithuania had less people having a long-standing illness or health problem than EU-average during investigated period.

This is related with the fact that other health status determinants such as performance of health protection system, healthy life styles etc. overweight the negative impact of environmental quality indicators impact on human health in most developed EU member states.

Comparative Analysis of Health Quality and Environmental Quality Indicators Development in the Baltic States and Czech Republic and Slovakia

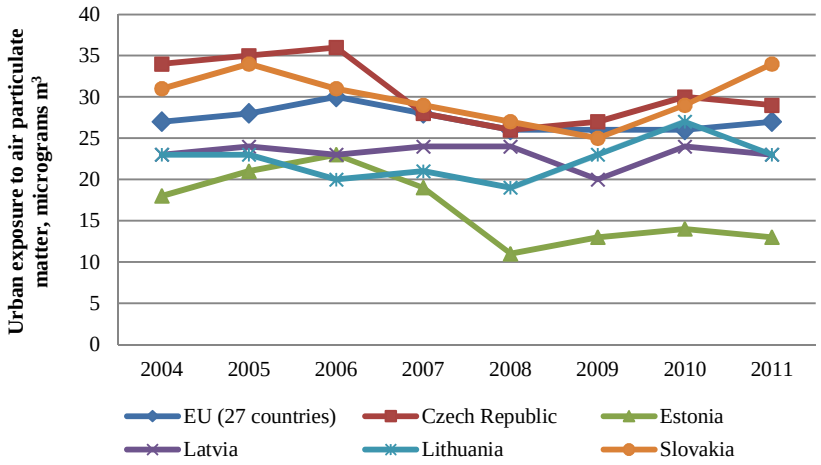
Comparative analysis of environmental quality and health indicators in the Baltic States indicated that the best performing country according environmental quality indicators is also the country having the best health status indicators. However it is useful to analyse the main environmental quality and health indicators in other new EU member states and compare with results achieved in comparative assessment of the Baltic States.

Czech Republic and Slovakia have entered EU in the same year with the Baltic States (2004) however these countries were not integrated in Former Soviet Union as Baltic States and may have better health status and/or environmental quality indicators.

In Figures 1 – 5 the dynamics of the main environmental quality indicators in the Baltic States and Czech Republic and Slovakia is provided.

F i g u r e 1

Dynamics of Urban Population Exposure to PM10, Micrograms per m^3 in the Baltic States and Czech Republic and Slovakia

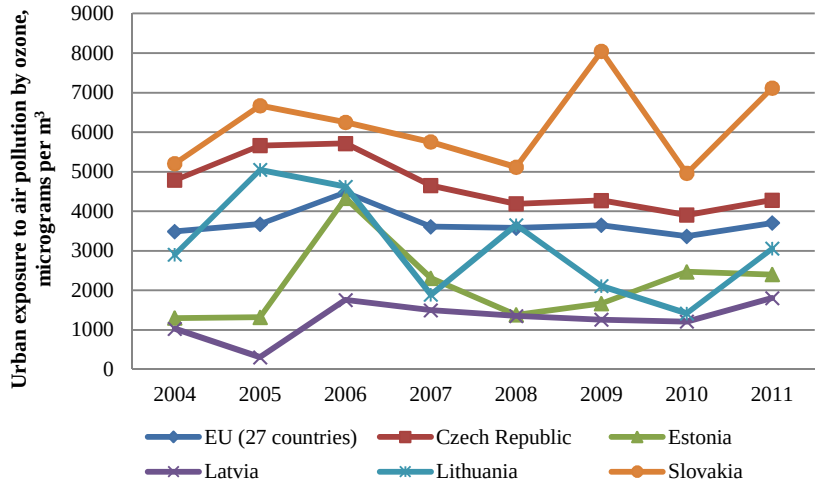


Source: EUROSTAT.

As one can see from the information provided in Figure 1 the main air quality indicator – urban exposure to particulate matter in Slovakia and Czech Republic was higher than in the Baltic States during all investigated period. The worst situation with air quality during investigated time frame was in Czech Republic.

F i g u r e 2

Dynamics of Urban Population Exposure to Air Pollution by Ozone in the Baltic States, Czech Republic and Slovakia, Micrograms per m^3

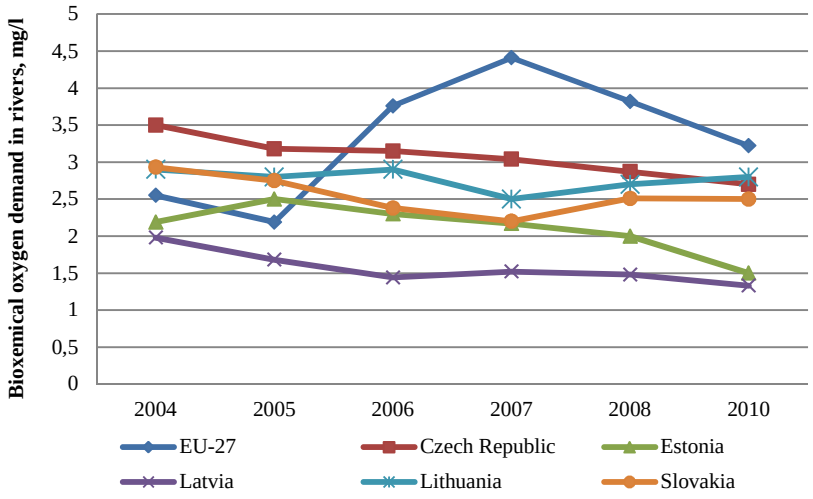


Source: EUROSTAT.

As one can see from Figure 2 urban pollution exposure to particulates matter in Slovakia and Czech Republic was higher than in all the Baltic States and EU-27 average during all investigated period.

Figure 3

Dynamics of Biochemical Oxygen Demand in Rivers in the Baltic States and Czech Republic and Slovakia, mg/l



Source: EUROSTAT.

As one can see from information presented in from Figure 3 during investigated period bioxemical oxygen demand in rivers was the highest in Czech Republic following by Lithuania and Slovakia.

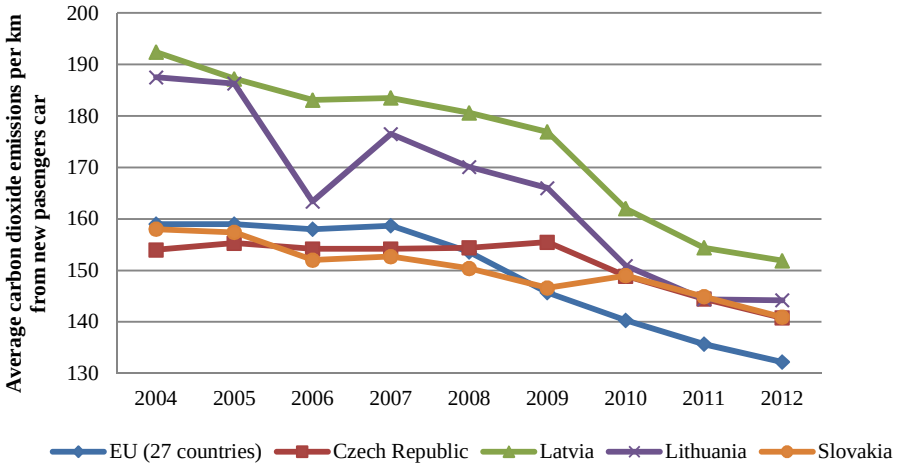
As one can see from Figure 4 the highest carbon dioxide emissions per km from new passenger cars was in Latvia following by Lithuania. The lowest carbon dioxide emissions from new passenger's cars were in Slovakia and Czech Republic during all investigated period.

As one can see from Figure 5 the municipal was generated per capita during investigated period the lowest was Czech Republic and Slovakia however in 2010 and 2011 the municipal waste generated per capita in Estonia declined significantly and became the lowest among the analysed countries. In Latvia the municipal waste generated per capita was the highest one.

The comparative analysis of environmental quality indicators in the Baltic States and Czech Republic and Slovakia indicated that according air and water quality indicators the Baltic States were performing better during investigated period however according other environmental quality indicators related to municipal generated per capita and carbon emissions from new passengers cars Czech Republic and Slovakia were performing better than Baltic States.

Figure 4

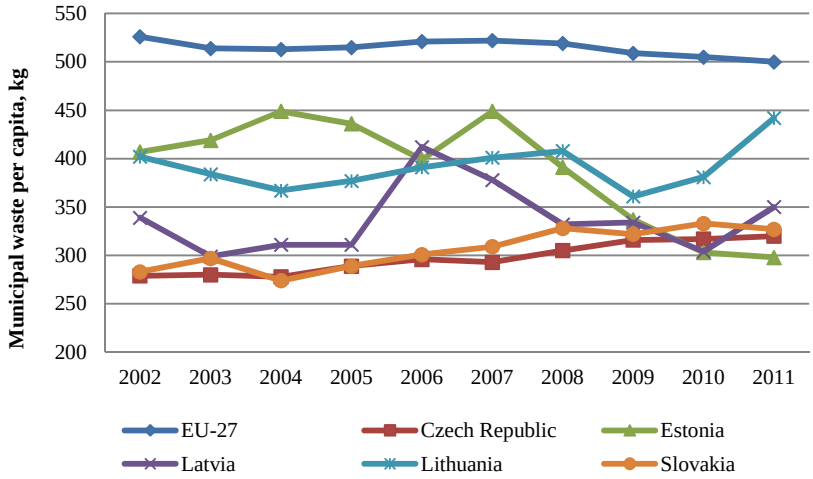
Carbon Dioxide Emissions per km from New Passenger Cars in the Baltic States and Czech Republic and Slovakia, gCO_2/km



Source: EUROSTAT.

Figure 5

Dynamics of Municipal Waste Generated per capita in the Baltic States and Czech Republic and Slovakia

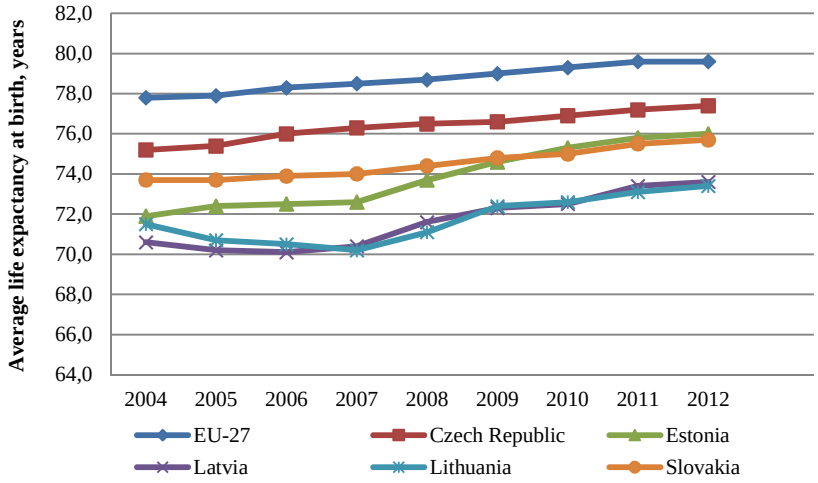


Source: EUROSTAT.

In Figure 6 – 9 the dynamics of health status indicators were compared in the Baltic States and Czech Republic and Slovakia.

Figure 6

Dynamics of Average life Expectancy at Birth in the Baltic States and Czech Republic and Slovakia

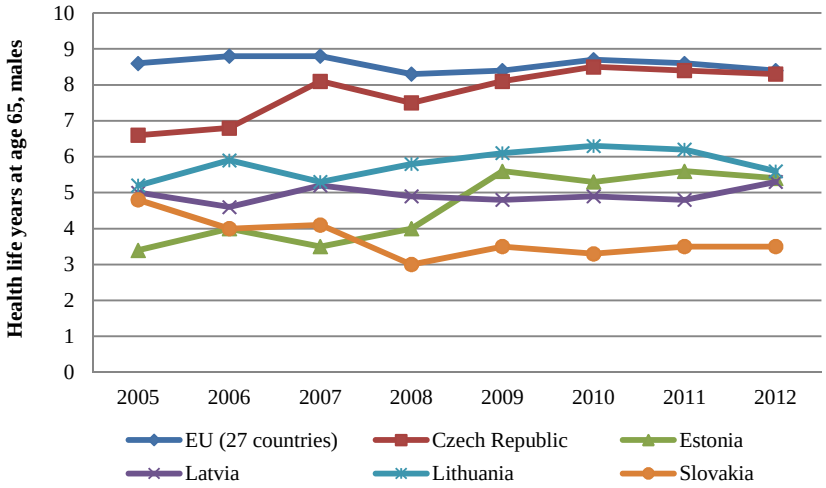


Source: EUROSTAT.

As one can see from Figure 6 the highest average life expectancy was in Czech Republic and Slovakia during all investigated period though in 2009 Estonia reached the average life expectancy of Slovakia.

Figure 7

Dynamics of Health Life Years at 65 for Males in the Baltic States and Czech Republic and Slovakia

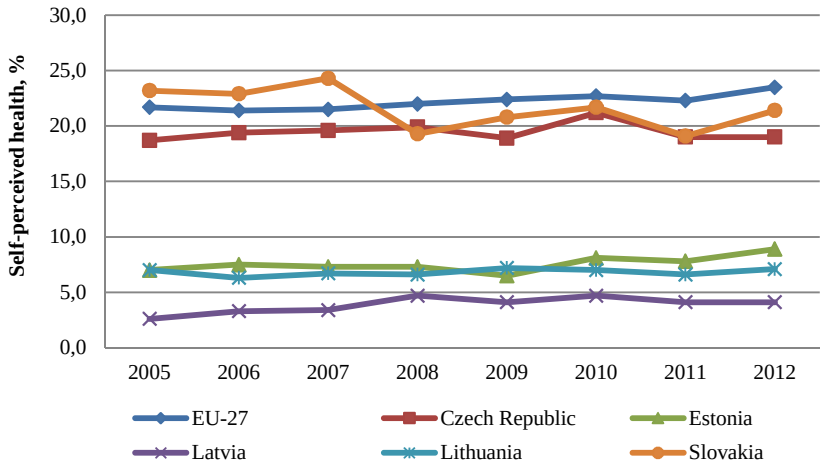


Source: EUROSTAT.

As one can see from the information provided in Figure 7 the highest health life year for males at 65 was in Czech Republic following by Lithuania however the lowest indicator of health life years at 65 was in Slovakia. One can notice that according all other compared indicators situation was very similar between Czech Republic and Slovakia.

Figure 8

Dynamics of Self-perceived Good Health in the Baltic States and Czech Republic and Slovakia



Source: EUROSTAT.

As one can see from Figure 8 self-perceived good health indicators were significantly higher in Slovakia and Czech Republic than in the Baltic States during all investigated period.

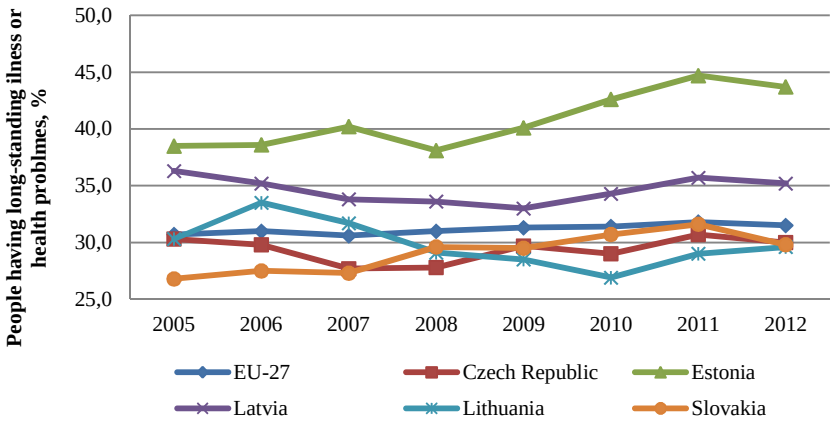
As one can see from Figure 9 the Estonia and Latvia distinguishes with high illness indicators and Czech Republic and Slovakia have the lowest illness indicators together with Lithuania.

As one can see from Figure 10 Lithuania and Latvia have the highest standardized death rates following by Slovakia during investigated period. Czech Republic distinguishes with the lowest standardized death rate per 100 000 inhabitants during all analysed countries.

Comparative analysis of health status indicators in the Baltic States and Czech Republic and Slovakia indicated that Czech Republic had the best health status indicators among all investigated countries. Slovakia was also among the best performing countries in terms of health status indicators except health life years at 65 for males.

Figure 9

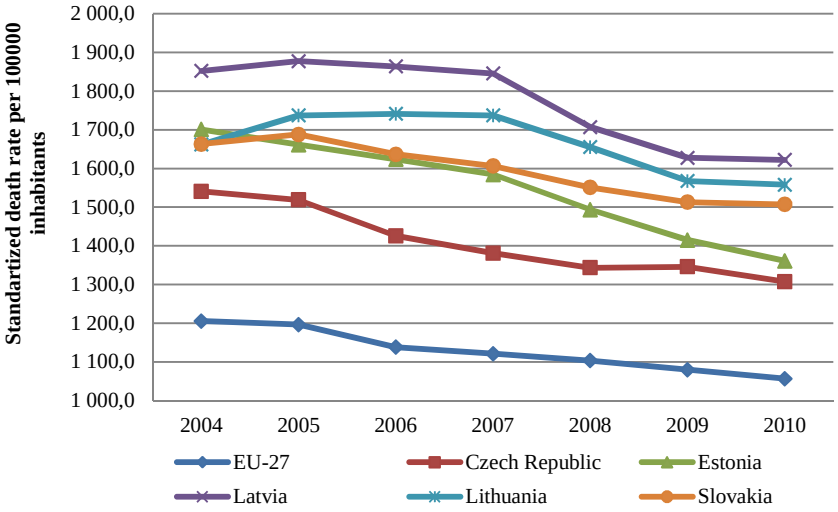
Dynamics of People Having a Long-standing Illness or Health Problems in the Baltic States and Czech Republic and Slovakia, %



Source: EUROSTAT.

Figure 10

Dynamics of Standardized Death Rate per 100 000 inhabitants



Source: EUROSTAT.

Though according some important environmental quality indicators having impact on human health such as urban population exposure to particulate matter and by ozone and bioxemical oxygen demand in rivers Czech Republic and Slovakia were performing worse than Baltic States almost all health status indicators were better in Czech Republic and Slovakia comparing with the Baltic States.

According some environmental quality indicators related to transport pollution and municipal waste generated per capita Czech Republic and Slovakia were performing better than Baltic States however more investigations are necessary seeking to define the relationship between environmental quality and human health as other important issues having impact on human health need to be taken in to account: health care system performanceand life styles or determinants of health such as prevalence of obesity, alcohol and tobacco consumption etc.

Conclusions

The set of indicators presented in this paper summarises information about major dimensions of environmental quality and health performance. The quality of environment and health status are the core indicators of quality of life and they are tightly interrelated. The indicators system to assess environmental quality and health status was developed to assess the impact of environmental quality on health in the Baltic States based on regular consolidated statistical data provided by EUROSTAT.

The environmental quality indicators encompass a number of environmental media (*e.g.* soil, water, air, waste). However, due to the lack of relevant data for some of these media and the evidence of sizeable effects of air pollutants on human health, the main attention has been paid to air pollution indicators related to environmental quality. The objective measure of air quality used in this paper takes into account PM10 and ground ozone concentrations only. The Carbon dioxide emissions per km from new passenger cars were selected to address increasing pollution in transport sector.The bioxemical oxygen demand in rivers was selected as water quality indicator and municipal waste per capita indicator was selected to assess environmental quality in terms of generated waste.

As there are many indicators of health status and some of them are overlapping, the 5 main health status indicators were selected based on their relevance in investigating environmental quality impact: average life expectancy at birth, healthy life years at age 65 for males, self-perceived good health and chronic morbidity and standardized death rate per 100 000 inhabitants. These indicators are being collected by EUROSTAT database in relation with various thematic areas (sustainable development indicators, quality of life indicators, Principal European Policy Indicators etc.) aiming to monitor implementation of policy targets.

The impact of all selected environmental indicators (PM10, ground ozone concentrations, CO_2 emissions, Bioxemical oxygen demand (BOD) and municipal waste generated per capita) on average life expectancy at birth, healthy life years at age 65 of males, self-perceived good health and chronic morbidity and

standardized death rate per 100 000 inhabitants in the Baltic States was assessed by applying ordinary least squares (OLS) regressions. Results of OLS regression indicated that just PM10 and ground ozone concentration have impact on reduction of average life expectancy. For other environmental quality indicators, such as CO_2 emissions, BOD and municipal waste per capita, it is not possible to define such relationship with average life expectancy at birth, because of very low p-value and very low significance of obtained results.

As it was not possible to define the relationship between health status and environmental quality indicators in the Baltic States by applying OLS regression the integrated environmental quality and health status indicators were developed for comparative assessment of countries.

Integrated environmental quality and health status indicators were calculated for the Baltic States based on statistical data provided by EUROSTAT. The indicators were normalized by EU-average and summed up. The equal weights were applied for all indicators comprising the integrated index.

The highest integrated index of environmental quality was obtained for Estonia mainly because of low urban population exposure by PM10, ozone and low biochemical oxygen demand in rivers indicators. Estonia is also the best performing country according to health quality indicators among the Baltic States except carbon dioxide emissions per km from new passenger cars. According to all environmental quality indicators the Baltic States are performing better than EU-27 except carbon dioxide emissions per km from new passenger cars.

According to all health status indicators the Baltic States were performing worse than EU-27 average except the share of people having a long-standing illness or health problem as Lithuania had less people having a long-standing illness or health problem than EU-average during investigated period. This is related with the fact that other health status determinants such as performance of health protection system, healthy life styles etc. overweight the negative impact of environmental quality indicators have significant impact on human health in most developed EU member states.

Though according to some important environmental quality indicators having impact on human health such as urban population exposure to particulate matter and by ozone and bioxemical oxygen demand in rivers Czech Republic and Slovakia were performing worse than the Baltic States, almost all health status indicators were better in Czech Republic and Slovakia therefore more investigations are necessary seeking to define the relationship between environmental quality and human health as other important issues having impact on human health need to be taken in to account: health care system performance and life styles or determinants of health such as prevalence of obesity, alcohol and tobacco consumption etc.

The health status have impact on economic productivity and growth, therefore governments need to look at health expenses as an investment rather than a cost. Policy-makers should introduce environmental policies which will guarantee that individuals' health needs are satisfied. Governments must take health seriously if they want sustain and improve upon economic and social outcomes in the country.Investments to improve health care system performance and life styles are also necessary to enhance heath status of population.

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