

Infant Mortality Gap in the Baltic Region – Latvia, Estonia, and Lithuania – in Relation to Macroeconomic Factors in 1996–2010

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Key Words: infant mortality; Baltic States; correlation; macroeconomics; socioeconomic factors.

Summary. *Background and Objective.* A constant gap has appeared in infant mortality among the 3 Baltic States – Latvia, Estonia, and Lithuania – since the restoration of independence in 1991. The aim of the study was to compare infant mortality rates in all the 3 Baltic countries and examine some of the macro- and socioeconomic factors associated with infant mortality.

Material and Methods. The data were obtained from international databases, such as World Health Organization and EUROSTAT, and the national statistical databases of the Baltic States. The time series data sets (1996–2010) were used in the regression and correlation analysis.

Results. In all the 3 Baltic States, a strong and significant correlation was found: Latvia ($r=-0.81$, $P<0.01$), Lithuania ($r=-0.93$, $P<0.01$), and Estonia ($r=-0.91$, $P<0.01$). There was also a correlation between infant mortality and healthcare expenditure in local currency per capita: Latvia ($r=-0.81$, $P<0.01$); Lithuania ($r=-0.90$, $P<0.01$) and Estonia ($r=-0.88$, $P<0.01$). In Latvia ($r=0.87$, $P<0.01$) and Estonia ($r=0.70$; $P<0.01$), a significant correlation between infant mortality and unemployment levels was observed from 1996 to 2008, whereas the statistical significance disappeared in the period from 1996 to 2010. In Lithuania, the relationship was not significant.

Conclusions. Higher infant mortality rates and a less stable decreasing tendency in Latvia are apparently explained by less successful adaptation to a new political and economic situation and limited skills in adjusting the healthcare system to the reality of life.

Introduction

Since the recovery of its independence, Latvia has demonstrated the highest infant mortality within 25 European Union (EU) countries. Moreover, the infant and child mortality rates in Latvia are significantly higher than in other Baltic States (1, 2). Studies conducted by the United Nations Children's Fund (UNICEF) and the World Health Organization (WHO) in some countries point to the relationship between child mortality rates and unemployment, gross domestic product (GDP), healthcare expenditure, fair distribution of revenue, and other factors (1, 3).

The high child mortality rates in Latvia are difficult to explain, since all the 3 Baltic States found themselves in very similar socioeconomic and political circumstances after the restoration of their independence at the beginning of the 1990s. Furthermore, in the years of the Soviet rule, Latvia in many cases had the best indicators in pediatric healthcare in the Baltic region (1, 3).

This study investigated the relationships between infant mortality and macroeconomic indicators in the 3 Baltic States in order to find the reasons for essential differences among them, with Latvia continuously having the highest infant mortality. For

example, in 2010, the infant mortality rate in Latvia was 5.7 per 1000 live births, whereas, in Lithuania, it was 4.3 per 1000 and even lower in Estonia, i.e., 3.3 per 1000 live births (Fig. 1) (2). Earlier, we conducted research on the relationship between child mortality and macroeconomic indicators for schoolchildren (4, 5). Our aim was to analyze infant mortality in the Baltic States in relation to the following macroeconomic factors: GDP per capita in terms of purchasing power standards and GDP at current prices, healthcare expenditure per capita in local currencies, total healthcare expenditure as a percentage of GDP, and unemployment rates. The key issue in our research was to find out whether such associations can be identified and what differences exist among the Baltic States regarding infant mortality in relation to socioeconomic factors.

Material and Methods

This ecological study was conducted using the data on infant mortality and macro- and socioeconomic indicators from the open access databases in all the 3 Baltic States from the Central Statistical Bureau of Latvia, Estonia, and Lithuania as well as other international databases, i.e., the WHO European Health for All database (HFA-DB) and the European Union statistical database (Eurostat) (2, 6–9).

The following socioeconomic factors were included in the data analyses: unemployment rate,

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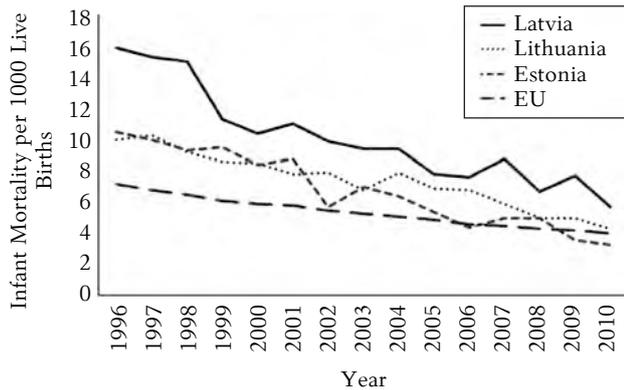


Fig. 1. Infant mortality per 1000 live births in the Baltic countries and the European Union average from 1996 to 2010 (2)

GDP per capita at current prices and in purchasing power standards (PPS), healthcare expenditure per capita in local currency, and total expenditure on healthcare as a percentage of GDP. The time series data sets (1996–2010), each year regarded as one observation, were used to study how infant mortality was associated with macro- and socioeconomic factors. The Pearson correlation coefficients were calculated for associations between the socioeconomic factors and the infant mortality data.

The correlation and regression analysis was employed to establish the interrelations between the pairs of factors. The horizontal axis (x-axis) of the regression equation was used for plotting the factorial feature (economic indicators), whereas the dependent variable (infant mortality) was plotted on the vertical axis (y-axis). When analyzing the correlations, it was taken into account that 2 variables were not necessarily related in a cause-and-effect relationship. The infant mortality rates were transformed by taking the natural logarithm for improving interpretability and making it easier to discern the association between 2 variables.

For all the statistical tests used in this work, a significance level of 0.05 was chosen and the results with a P value of <0.05 were evaluated as statistically significant. The SPSS software (version 19) was used for data processing.

Results

Infant Mortality Rates in the Baltic Countries (1996–2010)

A decreasing tendency was observed for infant mortality in all the Baltic countries. A more rapid decrease was observed in Estonia with an annual decrease by 0.92 times ($e^{-0.0813}$) per year or 8.5% ($P<0.001$), in Latvia by 0.94 times ($e^{-0.0643}$) or 6.2% ($P<0.001$), and in Lithuania by 0.95 times ($e^{-0.0563}$) or 5.5% ($P<0.001$) (Fig. 2).

GDP and Infant Mortality

In all the 3 Baltic States, there was a statistically significant correlation between GDP per capita and infant mortality per 1000 live births. A strong correlation was observed when calculating GDP at local currency and in purchasing power standards. Notably, in Latvia, the correlation was weaker when GDP per capita was calculated at current prices rather than in PPS.

GDP per Capita at Current Prices and Infant Mortality. The analysis of the relationship between infant mortality and GDP per capita at current prices (local currency) showed a strong and statistically significant correlation for all the 3 Baltic States: Latvia ($r=-0.81$, $P<0.01$), Lithuania ($r=-0.93$, $P<0.01$), and Estonia ($r=-0.91$, $P<0.01$). There were no statistically significant differences among the correlation coefficients comparing the countries, and a mean reduction in infant mortality according to the linear regression equation was similar. The analysis of the regression equation showed the following trend: a 1% increase in GDP per capita was associ-

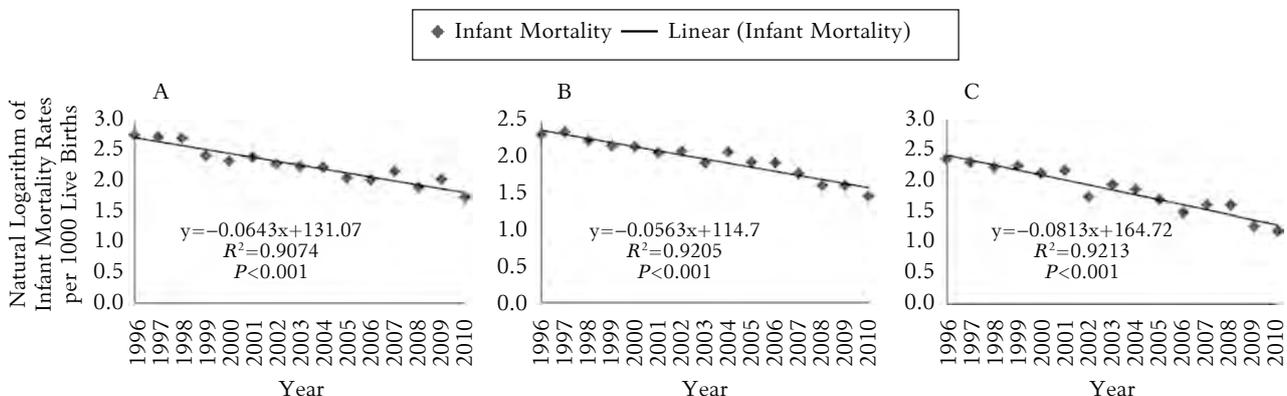


Fig. 2. Infant mortality rates per 1000 live births (1996–2010) Infant mortality rates (natural logarithm) in Latvia (A), Lithuania (B), and Estonia (C) by year. Mortality data for 1996–2010 were gathered from the open access database (2).

ated with a mean decrease by 0.01% in infant mortality in all the Baltic countries (Fig. 3).

GDP per Capita in Purchasing Power Standards and Infant Mortality per 1000 Live Births. In the Baltic States, there was a strong and statistically significant correlation between infant mortality and GDP per capita calculated in PPS. In Latvia, the correlation was slightly weaker in comparison with the other Baltic countries (Latvia, $r=-0.86$, $P<0.01$; Lithuania, $r=-0.91$, $P<0.01$; and Estonia, $r=-0.92$, $P<0.01$). The regression equation showed the following trend: a 1% increase in GDP (in PPS) was associated with a mean decrease by 3.2% in infant mortality in Latvia, 2.7% in Lithuania, and 2.9% in Estonia (Fig. 4).

Healthcare Expenditure Per Capita in Local Currency and Infant Mortality

There also was a correlation between healthcare expenditure in local currency per capita and infant mortality in the Baltic States. The correlation coef-

ficients were as follows: $r=-0.81$ in Latvia ($P<0.01$), $r=-0.90$ in Lithuania ($P<0.01$), and $r=-0.88$ in Estonia ($P<0.01$). The linear regression equation showed that the growth of healthcare expenditure by 1% in local currency was associated with a mean decrease by 0.78% in infant mortality in Latvia, 0.08% in Lithuania, and 0.12% in Estonia (Fig. 5).

Total Expenditure on Healthcare as Percentage of GDP and Infant Mortality

The analysis of how infant mortality relates to total healthcare expenditure as a percentage of GDP showed a larger reduction in infant mortality according to the regression equation in comparison with the previously mentioned macroeconomic factors (Fig. 6).

A strong and statistically significant correlation was established for Latvia ($r=-0.82$, $P<0.01$). The regression equation showed that if the total health expenditure as a percentage of GDP increased by 1%, there would be an average reduction in infant

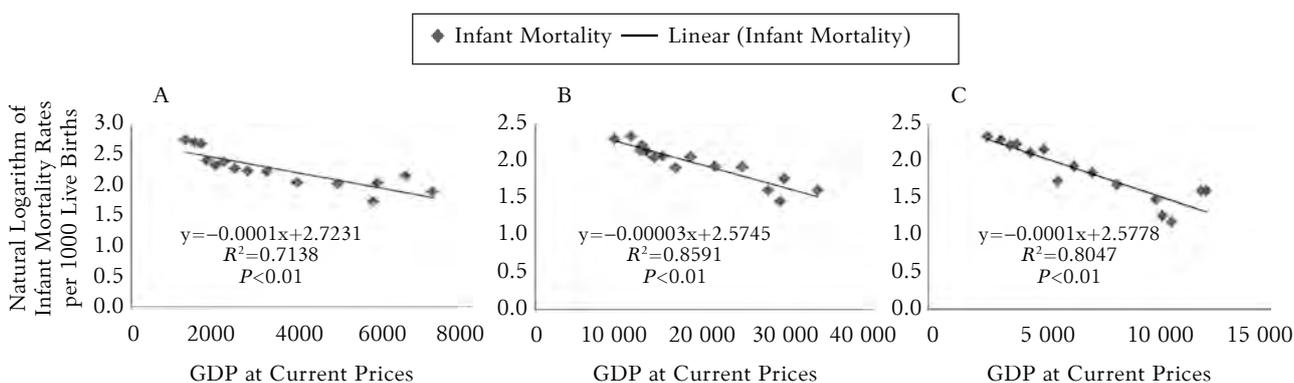


Fig. 3. Gross domestic product (GDP) per capita at current prices and infant mortality rates per 1000 live births (1996–2010). The regression analysis was used to analyze the data of Latvia (A), Lithuania (B), and Estonia (C) for 1996–2010 from the open access databases (2, 6–9). The horizontal axis (x-axis) of the regression equation was used for plotting the factorial feature (gross domestic product per capita at current prices), whereas the dependent variable (natural logarithm of infant mortality) was plotted on the vertical axis (y-axis).

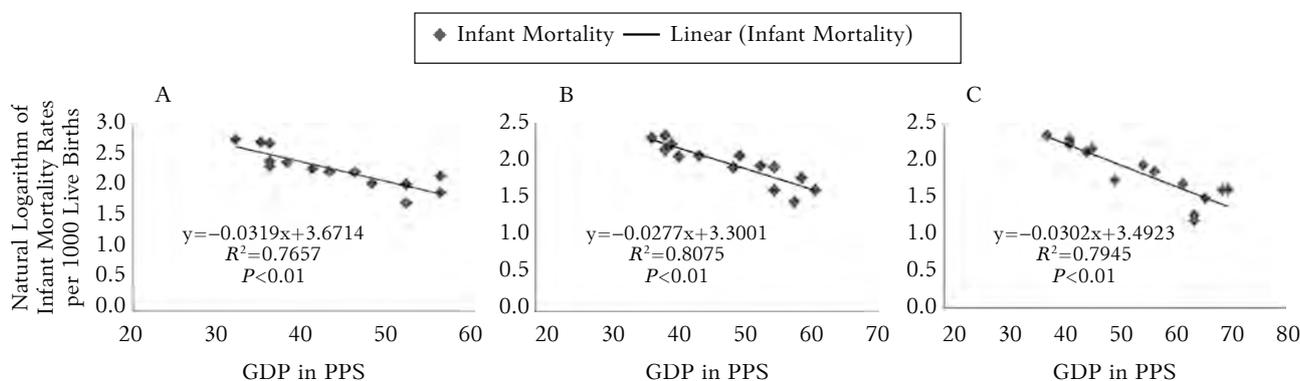


Fig. 4. Gross domestic product (GDP) per capita in purchasing power standards (PPS) and infant mortality rates per 1000 live births (1996–2010).

The regression analysis was used to analyze the data of Latvia (A), Lithuania (B), and Estonia (C) for 1996–2010 from the open access databases (2, 6–9). The horizontal axis (x-axis) of the regression equation was used for plotting the factorial feature (gross domestic product per capita in PPS), whereas the dependent variable (natural logarithm of infant mortality) was plotted on the vertical axis (y-axis).

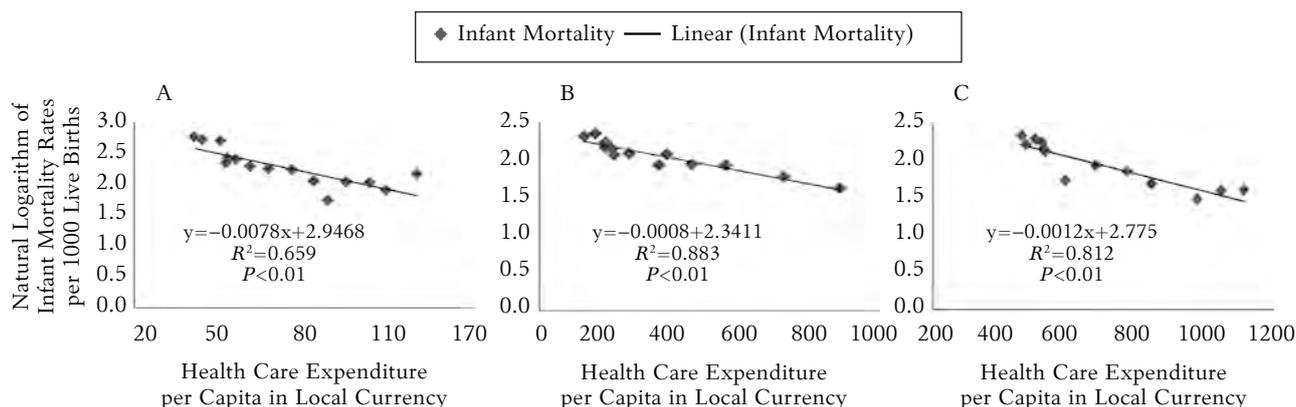


Fig. 5. Health care expenditure per capita in local currency and infant mortality rates per 1000 live births (1996–2010) The regression analysis was used to analyze the data of Latvia (A), Lithuania (B), and Estonia (C) for 1996–2010 from the open access databases (2, 6–9). The horizontal axis (x-axis) of the regression equation was used for plotting the factorial feature (healthcare expenditure per capita in local currency), whereas the dependent variable (natural logarithm of infant mortality) was plotted on the vertical axis (y-axis).

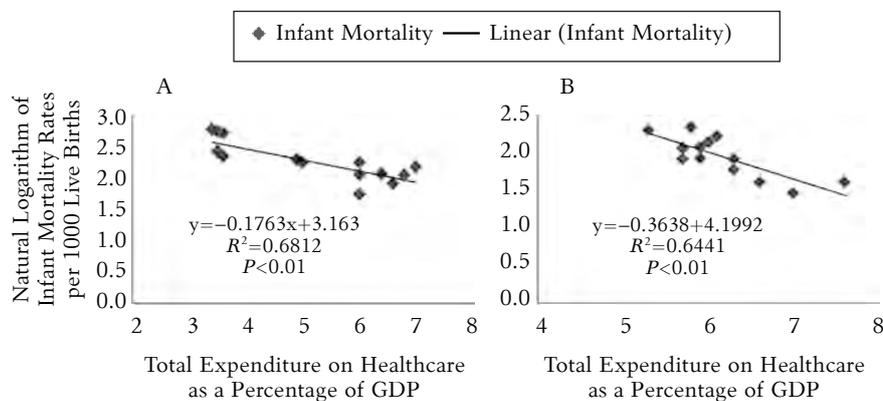


Fig. 6. Total expenditure on healthcare as a percentage of gross domestic product (GDP) and infant mortality rates per 1000 live births (1996–2010)

The regression analysis was used to analyze the data of Latvia (A) and Lithuania (B) for 1996–2010 from the open access databases (2, 6–9). The horizontal axis (x-axis) of the regression equation was used for plotting the factorial feature (total expenditure on healthcare as a percentage of GDP), whereas the dependent variable (natural logarithm of infant mortality) was plotted on the vertical axis (y-axis).

mortality by 16.2%.

In Lithuania, there also was a strong and statistically significant correlation between total healthcare expenditure as a share of GDP and infant mortality ($r = -0.77$, $P < 0.01$), but there would a more rapid average reduction in infant mortality by 30.5% if the total healthcare expenditure as a share of GDP grew by 1%. For Estonia, no statistically significant association between the 2 abovementioned values was established.

Unemployment Rate and Infant Mortality

The Baltic States have a high unemployment rate reaching 10%–15% at the beginning of the millennium and declining to 5%–6% in the period of the “economic boom.” As a result of the economic crisis, in 2010, the unemployment in Latvia soared to 18.7%, becoming the highest unemployment figure in the Baltic States, with 17.8% and

16.9% being in Lithuania and Estonia, respectively (Table 1). However, according to the WHO database “Health for all,” these indicators are not reliable, since unemployment levels might be higher in the respective countries because of nonrecorded unemployment; moreover, some of those who are officially unemployed work for the gray economy sector (2). The outlined changes in the employment situation were also observed in the study results regarding infant mortality and unemployment, revealing significant changes of the correlation coefficient in relation to unemployment and infant mortality, i.e., the correlation remained, but it was no longer statistically significant. For this reason, the data were further analyzed over 2 separate time periods, i.e., 1996–2008, when unemployment was gradually declining, and 1996–2010, covering also a steep rise in unemployment due to the economic crisis.

Table 1. Unemployment in Baltic Countries and European Union Average from 1996 to 2010 (2, 6)*

| Year | Latvia | Lithuania | Estonia | EU |
|------|--------|-----------|---------|------|
| 1996 | 20.7 | 6.2 | 9.9 | 10.8 |
| 1997 | 15.1 | 6.7 | 9.6 | 10.5 |
| 1998 | 14.1 | 13.2 | 9.8 | 10.1 |
| 1999 | 14.3 | 14.6 | 12.2 | 9.9 |
| 2000 | 14.4 | 16.4 | 13.6 | 9.1 |
| 2001 | 13.1 | 17.4 | 12.6 | 8.6 |
| 2002 | 12.0 | 13.8 | 10.3 | 9.0 |
| 2003 | 10.6 | 12.4 | 10 | 9.3 |
| 2004 | 10.4 | 11.4 | 9.7 | 9.3 |
| 2005 | 9.0 | 8.3 | 7.9 | 9.0 |
| 2006 | 6.8 | 5.6 | 5.9 | 8.2 |
| 2007 | 6.0 | 4.3 | 4.7 | 7.6 |
| 2008 | 7.5 | 5.8 | 5.5 | 7.3 |
| 2009 | 16.9 | 13.7 | 13.8 | 9.3 |
| 2010 | 18.7 | 17.8 | 16.9 | 9.8 |

Values are percentage.

*Data for Estonia and Lithuania from the HFA database; data for Latvia from the Central Statistical Bureau of Latvia.

The analysis of the relationship between infant mortality and unemployment across the Baltic countries revealed different tendencies. In Lithuania, even though child mortality was found to be

related to unemployment levels, the relationship was statistically insignificant. In Latvia and Estonia, on the other hand, before the economic crisis, the 2 indicators were very closely associated; however, when the data sets from the years of the economic crisis and the last few years with high unemployment rates were added to those before the crisis and analyzed together, there was no longer a statistically significant relationship (Table 2).

In Latvia ($r=0.87$, $P<0.01$) and in Estonia ($r=0.70$, $P<0.01$), a statistically significant correlation between infant mortality and unemployment levels was observed from 1996 to 2008, whereas the statistical significance disappeared in the period from 1996 to 2010. The linear regression equation showed that the growth of unemployment by 1% in Latvia was associated with a mean increase in the infant mortality rate per 1000 live births by 6% in 1996–2008, whereas in Estonia, with a mean increase by 8.6% (Fig. 7).

Table 2 shows the associations between macroeconomic factors and infant mortality in the Baltic States from 1996 to 2010.

Table 2. Relationships Between Economic Factors and Infant Mortality in Baltic States, 1996–2010

| Relationship Between Infant Mortality and Factor | Latvia | | Estonia | | Lithuania | |
|--|----------|--|----------|---|-----------|---|
| | <i>r</i> | Average Decrease in Infant Mortality Rate, % | <i>r</i> | Decrease or Increase in Mortality per 1000 Live Births, % | <i>r</i> | Decrease or Increase in Mortality per 1000 Live Births, % |
| Share of the unemployed 1996–2010 | NS | NS | NS | NS | NS | NS |
| 1996–2008 | 0.87* | 6.0 | 0.70* | 8.6 | NS | NS |
| Healthcare expenditure per capita in local currency | -0.81* | 0.78 | -0.88* | 0.12 | -0.90* | 0.08 |
| GDP per capita in PPS | -0.86* | 3.2 | -0.92* | 2.9 | -0.91* | 2.7 |
| Total expenditure on healthcare as percentage of GDP | -0.82* | 16.2 | NS | NS | -0.77* | 30.5 |
| GDP per capita at current prices | -0.81* | 0.01 | -0.91* | 0.01 | -0.93* | 0.0001 |

NS, not significant; * $P<0.01$.

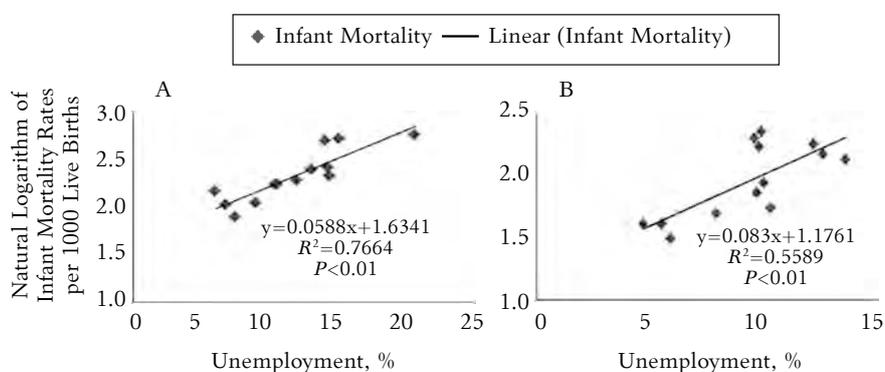


Fig. 7. Unemployment and infant mortality rates per 1000 live births (1996–2008)

The regression analysis was used to analyze the data of Latvia (A) and Estonia (B) for 1996–2008 from the open access databases (2, 6–9). The horizontal axis (x-axis) of the regression equation was used for plotting the factorial feature (percentage of unemployment), whereas the dependent variable (natural logarithm of infant mortality) was plotted on the vertical axis (y-axis).

Discussion

Infant mortality in Latvia is still significantly higher and does not have a stable but rather an irregular tendency to decrease in comparison with the other Baltic countries and the EU average. In 2010, the infant mortality rate in Latvia was 5.7, whereas in Lithuania it was 4.3 and in Estonia 3.3 per 1000 live births, i.e., the level was 1.8 times lower on the average than in Latvia. The mean EU infant mortality rate (4.1 per 1000 live births) in 2010 was 1.4 times lower than in Latvia, similar in Lithuania, and significantly higher than in Estonia. Infant mortality in Latvia decreased in 2010 in comparison with 2009. However, in 2009, the infant mortality rate in Latvia was 1.8 times higher than the EU average (7.7 per 1000 in Latvia compared with 4.2 per 1000 live births in the EU). The differences between infant mortality rates in Latvia and in the EU were less substantial comparing with other Baltic countries, where a decrease in infant mortality was more stable. In Estonia, there was a reduction in the infant mortality rate from 5.0 per 1000 live births in 2008 to 3.3 in 2010 and 2.5 in 2011. In Lithuania, infant mortality remained relatively stable over the past several years, at just above 4 per 1000 live births. Yet in Latvia, the infant mortality rate grew again in 2011, reaching 6.6, while the EU average was 4 per 1000 live births (2, 9).

Infant mortality has a multivariate cause-and-effect relationship with countrywide and regional economic, political, and environmental processes, educational levels, and many other circumstances; thus, they all must be taken into account when analyzing differences among countries (4).

Looking back, all the 3 Baltic States started implementing economic and healthcare reforms in similar socioeconomic conditions after restoring independence in 1991. Since 1991, infant mortality has decreased in all the 3 countries, but in Latvia, the infant mortality rates have always been higher than in the other 2 Baltic States. However, before the restoration of independence in 1991, Latvia mostly had comparatively lower infant mortality than Estonia and Lithuania (4, 5). Of concern is the fact that even after joining the EU in 2004, infant mortality is still higher, and many other national welfare indicators are worse in Latvia than in the 2 neighboring countries, Lithuania and Estonia, whereas the socioeconomic situation is still similar.

A change in the socioeconomic situation and healthcare systems may lead to a change in infant mortality rates; therefore, it is necessary to analyze any differences among the Baltic countries. At the beginning of independence, the 3 Baltic States started refurbishing their healthcare systems from an equal starting point, the Semashko model, which was highly specialized and focused on in-hospital

care. Primary healthcare in its classical form hardly existed (10). At the primary care level, children are attended by family doctors, in some cases pediatricians, who have the “gatekeeping” function in referring children to the secondary and tertiary level healthcare (11).

Unfortunately, during the 20 years since the restoration of independence, the reformation of the healthcare system in Latvia still has not been completed to the extent that it has been in Lithuania and Estonia.

Consequently, in Latvia, “free healthcare” for children frequently remains a misleading concept because the actual monthly costs for healthcare services covered by 79% of parents often reach LVL 20 to 40 per child (17% of the minimal monthly salary in the country) (12).

The UNICEF report “Decade of Transition” released in 2001 showed that in 1990–1999, Latvia had the highest recorded infant mortality in the Baltic States and the highest maternal mortality, 3 times that of Lithuania and Estonia (9 and 14, respectively) and even Romania (1).

Since 1996, Lithuania and Estonia made rapid progress in decreasing infant mortality, whereas in Latvia, a positive shift was observed only in 1999 when mortality significantly decreased. In Lithuania and Estonia, the impact of socioeconomic changes on infant mortality was substantially milder, possibly a consequence of differences in healthcare financing (5, 13).

In the period between 1992 and 1999, the healthcare budget of Latvia grew by a mere 0.7%, whereas in Lithuania and Estonia, it grew by 1.7% and 2.4%, respectively, and almost half of the population could not afford quality medication and/or qualified health services in Latvia (1, 14, 15). For a relatively long period of time, Latvia did not have a social safety net for protecting its population against financial constraints stemming from aggressive market economy. Thus, at the end of the 1990s, 10% of Latvian children under the age of 5 lived in the conditions of extreme poverty, whereas 52.5% were among the very poor, while the respective percentages in Lithuania were only 4.8% and 34.7% and considerably lower in other countries of the same region (1). In Lithuania and Estonia, most of the healthcare services were free of charge or fully covered by insurance and only 10% of the population, when seeing a doctor, had to pay out-of-pocket, but in Latvia, 80% of patients had to cover a co-payment or the full cost of treatment. Only 5% of the people in Latvia made use of preventive screening, whereas in Lithuania and Estonia the percentage was twice as big. Even though then 98% of healthcare was public in Lithuania and one-third was private in Estonia, in both cases healthcare costs were covered by the

state (16–18). The unfavorable situation was further aggravated by high unemployment levels.

This leads to the conclusion that in the context of the Baltic region, the unsatisfactory indicators of child (including infant) mortality, morbidity, and welfare in Latvia in the first decade of independence were related to the low growth of health budget, limited healthcare accessibility, and a relatively high poverty level in the population. However, the main cause of the statistical differences between Latvia and the other 2 Baltic States is that the healthcare reforms in Lithuania and Estonia were much more considerate and population-friendly (11, 13).

The differences among the health policies in the 3 Baltic States also had to be identified during the second decade since the restoration of independence. The present study focused on the period between 1996 and 2010; therefore, it is important to assess the changes that took place in this particular period and the factors that might have had an impact on healthcare and, thus, infant mortality.

Although there was a considerable growth of the healthcare budget, in terms of purchasing power, it remained lower than in Estonia and did not reach the general population (11, 19–23).

A comparison of the economic indicators leads to the conclusion that at the beginning of the analyzed period, Latvia had the lowest purchasing power expressed in purchasing power standards. Among the 3 Baltic States, during the analyzed period, Estonia had the highest purchasing power standard level, followed by Lithuania. Regarding the unemployment levels, at the beginning of the analyzed period, unemployment was the lowest in Lithuania, followed by Estonia. Lithuania experienced a steep growth in unemployment in 1998–2001, followed by a steady reduction in later years. In Estonia, an increase in unemployment can be observed from 1999, followed by a stable decrease beginning in 2001. In Latvia, unemployment peaked in 1998–1999; since 2000, a stable decreasing tendency can be observed. Right before the onset of the economic crisis, the unemployment was still the highest, 7.5%, in Latvia, 5.8% in Lithuania, and the lowest, 5.5%, in Estonia. The second spell of high unemployment hit Latvia in 2008, reaching 20%, i.e., the highest unemployment rate among the Baltic States until the end of the period studied, 2010 (2, 6).

The analysis of the data studied and its comparison with literature leads to the conclusion that in Latvia, like in other countries, a sustained decline in child mortality cannot be achieved without developing and abiding by the principles of commensurability in the distribution of state income (4, 11, 13, 24).

The analysis of the results of our research on the relationship between macro- and socioeconomic in-

dicators and infant mortality shows that GDP and total public health expenditure per se are not crucial regarding mortality indicators and healthcare. Income distribution – quantified by the Gini coefficient – might have a more important role. In Latvia, the Gini coefficient has continuously been one of the highest among the EU candidate states, with an average of 37.3% (9). We confirmed a significant correlation between child mortality and the Gini coefficient, including this finding in our presentation during the 1st Baltic Pediatric Congress in Vilnius in 2012.

A larger disparity of income between population quintiles is often associated with higher mortality, even in cases of significantly higher healthcare budgets. This can be observed in the United States, Scandinavia, and the Baltic States (13). GDP per capita does not reflect healthcare equally among all the population strata. The wider the income gap between the population quintiles of different social strata, the less representative GDP per capita of healthcare accessibility to each particular individual is. Healthcare budget per capita is a more credible but not unequivocal indicator (13, 22–24).

Yet, in light of what has been said, an increase in the healthcare budget would still be imperative in Latvia, since the soaring inflation figures of the past years have made both the previous as well as the current budget incompatible with the average purchasing power in the EU (11).

However, it is important that it be simultaneously ensured that healthcare allocations reach each particular individual and are used for their practical healthcare needs. The comparisons made in the study in the economic aspect lead to the conclusion that although the socioeconomic backgrounds in the 3 Baltic States after the restoration of independence were relatively similar, one of the crucial factors responsible for the constantly highest child mortality rates in Latvia is the difference in the principles of healthcare financing (with greater reliance on out-of-pocket payments in Latvia). In 2006, 77% of households were unable to cover their out-of-pocket health payments (3–5, 11, 25, 26).

Our latest study confirms that public healthcare expenditure per capita comparable with that of Latvia allowed Estonian and later Lithuanian pediatricians to succeed in maintaining a stable decrease in infant mortality since the restoration of independence. Why did they succeed while Latvia failed?

An interesting observation is that in Latvia, the correlation with infant mortality is weaker if GDP per capita is calculated at current prices rather than in purchasing power standards. This can be explained by the ability to cover healthcare services, which if calculated in PPS, turn out to be more expensive in Latvia. In the last several years, GDP has

substantially decreased in Latvia due to the crisis in comparison with Estonia and Lithuania, but overall the consequences of the decreased health budget on healthcare fully materialized later on, so that not all the study results were affected in the time period studied (1996–2010). It is of special note that pregnant women and newborns are much better provided with healthcare and social support in comparison with other social groups.

During the processing and analysis of the statistical data in all the 3 Baltic States, we ascertained that there also was a very strong and statistically significant correlation between healthcare expenditure per capita in local currencies and infant mortality. Therefore, the differences in the high child mortality rates in Latvia cannot be explained by this indicator because the differences in purchasing power are not so notable.

In fact, the only relevant macroeconomic indicator, the correlation of which with infant mortality substantially differed among the Baltic States, is unemployment. Our studies showed a close association between unemployment and infant mortality in Latvia and Estonia, whereas the statistical methods applied failed to prove it for Lithuania, regardless of the emphasis put on the indisputable effect of unemployment on mortality by international research centers (1, 4, 19). Therefore, the explanation most likely lies in the presence of some artifact in Lithuanian unemployment accounting methodology or the existence of a very strong social security net. The third hypothesis regarding the lack of the correlation with unemployment indicators is fictitious unemployment and prevalence of the gray sector economy (envelope salaries) or other unregistered income. A paradoxical observation was made at the end of the period analyzed: the correlation between unemployment and infant mortality, a relationship considered axiomatic internationally, weakened considerably or even disappeared in Latvia and Estonia. A hypothetical explanation may be one of the 3 unemployment compensation mechanisms described previously; an important role may be assigned to the tens of thousands of emigrants from the Baltic countries, now guest workers, who send their earnings home to support their families.

The data analysis showed the following trend: the growth of total healthcare expenditure as a percentage of GDP by 1% would result in a substantial reduction in infant mortality by 16.2% in Latvia and by 30.5% in Lithuania. This implies that with an equal increase in the healthcare budget as a percentage of GDP, it is possible to achieve a more effective reduction (by 50%) in infant mortality in Lithu-

ania than in Latvia, which suggests a comparatively weaker healthcare system and social safety net.

Therefore, Latvian authorities should take serious measures to improve the accessibility of healthcare, which may be of crucial importance in case of a pessimistic scenario, i.e., prolonged unemployment, low income levels, and stagnation of emigration rates in connection to the second wave of the crisis in the EU. It is immediately necessary to create a mandatory health insurance system according to the Estonian model, acquire the experience of Estonia and Lithuania in preventing infant mortality, and involve scientists from the Scandinavian countries who already have experience in doing similar research and applying the obtained results to real life situations.

Even within the current healthcare budget, there are a number of steps that can be taken in order to decrease infant mortality by reducing the prevalence of sudden infant death syndrome and promoting early diagnostics during pregnancy through nationwide campaigns. Another step would be to carry out a detailed comparative analysis of every difference by the death cause in Estonia and Latvia, similarly to several studies conducted by Danish colleagues starting in the 1990s when there were substantial differences in perinatal mortality between Denmark and Sweden. Lithuania has also been involved in such studies (27).

Conclusions

In all the 3 Baltic States, there is a strong and significant correlation between infant mortality and GDP per capita, as well as healthcare expenditure per capita. The strength of the correlation did not substantially change with the onset of the economic crisis in 2007. A strong and significant correlation between infant mortality and total healthcare expenditure as a percentage of GDP exists in 2 countries, Latvia and Lithuania, whereas no such correlation was observed in Estonia. A very strong correlation between infant mortality and unemployment was established in 2 countries, Latvia and Estonia, during 1996–2008, which weakened considerably with the onset of the economic crisis. In Lithuania, no correlation was observed between infant mortality and unemployment. The high infant mortality rates in Latvia cannot be reasonably explained by the insubstantial differences in macroeconomic indicators among the Baltic States but apparently by the features of healthcare financing, which limit access to healthcare services in Latvia.

Statement of conflict of interest

The authors state no conflict of interest.

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