

The Effects of Changes in the Health System on the Health of the Population: A Natural Experiment in the Countries of the Former Soviet Union

Salma Haidar, Ph. D., MPH¹, Nailya Delellis, Ph. D., MPH² & Lindsay Soave, BS³

Abstract

This descriptive study views the collapse of the Soviet Union in 1991 as a unique natural experiment to study the effect of changes of healthcare system on health and healthcare outcomes in the 15 post-soviet countries. The study utilized secondary data obtained from the World Bank. Data collected included indicators of health and lifestyle (e.g., life expectancy, birth rate, infant mortality rate), healthcare (e.g., number of physicians, health expenditure, number of hospital beds), and socio-economic development (e.g., GDP, out-of-pocket expenditure). Countries were divided into "Private" or "Public" health systems based on their public health expenditure percentage. Although there was no major shifts in the patterns over time, regression analysis showed that countries with a private healthcare system tended to have higher infant mortality rate (standardized $b=0.158$, $p<0.01$) and lower total life expectancy (standardized $b=-0.096$, $p<0.01$). As healthcare systems continue to evolve, it is important to examine the effects of health system changes on health outcomes. Our results showed that no single system in the post-soviet countries presented superior outcomes on all health domains; rather, each system had individual strengths and weaknesses. However, more research is required to examine the effect of health systems on the population health.

Keywords: Healthcare, Health Indicators, Former Soviet Union, Natural experiment.

1.0 Introduction

Recent healthcare reform occurring in the United States (US) has led to an interest in the effect of a healthcare system on population health. Commonly, researchers compare the health indicators of the US with the outcome of other developed countries, such as the United Kingdom, other European countries or Canada (Squires, 2011; DPE Research Department, 2014) using the national system of the country as an indicator of health status of the population (2015 Global Reference List of 100 Core Health Indicators). However, actual effect of the healthcare system, being private or public on the health outcome of the population is often confounded by other factors, such as political systems, economics and historical development (BUŞOİ, 2010). With that said, while individuals may be responsible for their individual health to a certain degree, they are largely controlled by greater health determinants inherent to a specific health system structure (World Health Organization). Factors often tied to a country's specific structure, such as education and the gap between the rich and the poor have also been consistently linked to overall health (World Health Organization).

¹School of Health Sciences, Central Michigan University, Health Professions Building 2204, Mount Pleasant, MI 48859, haida1s@cmich.edu, Office (989)774-2623, Fax (989)774-2908

²School of Health Sciences, Central Michigan University, 208G Rowe Hall, Mount Pleasant, MI 48859, dele1no@cmich.edu, Office (989) 774-7674, Fax (989) 774-2888

³Blue Cross Blue Shield of Michigan, 28055 Rollcrest Rd., Farmington Hills, MI 48334, Soave.Lindsay@gmail.com, (248)701-4764

The Centers for Disease Control and Prevention (CDC) lists health services including access to quality health care as one of the health determinants, along with biological, behavioral, as well as social and physical environmental factors (CDC, n.d.). Similarly, health policies and access to health services are listed by the Healthy People 2020 initiative as health determinants, along with social factors, individual behaviors, and biologic and genetic factors (Healthy People 2020, n.d.). While healthcare system financing methods are often classified as out of pocket payment, general taxation, social health insurance, private health insurance, or community insurance, and are expected to have impact on population health, historically, changes in healthcare systems, such as introduction of governmental insurance, take place in one country at a time and cannot be directly compared for outcome evaluation. One of the rare possibilities to study such change, however, was presented by the collapse of Soviet Union (SU) on December 31, 1991 (Collapse of the Soviet Union - 1989-1991, n.d.).

The healthcare system of the SU that was formed in 1920 is known as "Semashko model" (Rowland & Telyukov, 1991) and can be clearly characterized as a national health system (Balabanova, Roberts, Richardson, Haerpger, & McKee, 2012). Rooted in planned economy, SU healthcare had six different levels of governing bodies with oversight of different areas of healthcare. For example, the Ministry of Health led research efforts while the Sanitary Epidemiology Service dealt with public health matters. Though logical, the system was not very efficient as it duplicated a number of services at various levels of government in an attempt to treat a patient at the lowest level possible. For example, each rayon (county analogy) was expected to have a small hospital with a number of units. Besides general departments, each hospital would have a pediatric unit, infectious disease unit (separate for adults and children), and sometimes independent TB, STD, and psychiatric hospitals. At the level of oblast center (analogy for regions within a US state), some hospitals would be at a higher level of expertise. Republic capitals would often add a research component to similar hospitals and were expected to treat more complicated cases. (Dubikaytis, Larivaara, Kuznetsova, & Hemminki, 2010; Balabanova, Roberts, Richardson, Haerpger, & McKee, 2012)

The collapse of the Soviet Union provided a unique opportunity of a natural experiment to determine how health indicators at the country level may be affected by the healthcare resources available for a population. Prior to the Soviet Union's dissolution in 1991, healthcare resources were rationed causing health indicators to be relatively equal across the union. Upon the collapse, the following countries were formed: Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine and Uzbekistan. No longer under the control of the Soviet Union, these countries had to develop individual healthcare systems that would become their own. Now, more than twenty years later, current health indicator results can be analyzed to view how expenditures affect population health. Thus, comparisons can be made related to economic status as well as other factors that can affect health indicators.

1. Methods

In order to evaluate the effect of healthcare systems on population health, data from 1991 to 2013 were collected from a single source, the World Bank (WB) (Indicators, n.d.), to ensure information was standard among all nations. The study used infant mortality rate and total life expectancy as major indicators of population health (2015 Global Reference List of 100 Core Health Indicators; Wold, 2008) in a time series model to account for natural changes throughout the study period. In addition, the study reviewed following health indicators: Adolescent fertility rate, Crude birth rate, Crude death rate, Infant mortality rate, Total fertility rate, Hospital beds per 1,000 people, Incidence of tuberculosis, Life expectancy at birth, Male and female mortality rates, and Physicians per 1,000 people. A major predictor of interest was a binary variable for Country Healthcare System, which was identified as "Private" if Private Health expenditure percentage (% of total health expenditure; reported in 1995 by WB) exceeded 50%; otherwise a country was listed as having "Public" healthcare. According to this classification, four countries, Armenia, Azerbaijan, Georgia, and Tajikistan were labeled as "Private" health system countries, whereas the remaining 11 countries were considered "Public" Health system countries.

In addition to descriptive statistics, this study employed multivariate linear regression to evaluate the effect of public versus private healthcare system on major health indicators. To account for a possibility of "natural" changes in the outcome variables over time, the regression controlled for time. Automatic linear modeling function of SPSS was used to identify initial set of the predictors.

2. Results

The availability of data varied from year to year; while some indicators were reported every year (such as crude birth rate and crude death rate), others were available only sporadically. In order to ensure stability of the data, the study was based on a single source of World Bank data depository (definitions of the variables are provided in table 1)(Indicators, n.d.).

Table 1: Variables used definition, and years of data available.

Variable	World Bank definition	Years of data available
Adolescent fertility rate (births per 1,000 women ages 15-19)	Adolescent fertility rate is the number of births per 1,000 women ages 15-19.	1985-2012
Birth rate, crude (per 1,000 people)	Crude birth rate indicates the number of live births occurring during the year, per 1,000 populations estimated at midyear. Subtracting the crude death rate from the crude birth rate provides the rate of natural increase, which is equal to the rate of population change in the absence of migration.	1985-2012
Death rate, crude (per 1,000 people)	Crude death rate indicates the number of deaths occurring during the year, per 1,000 populations estimated at midyear. Subtracting the crude death rate from the crude birth rate provides the rate of natural increase, which is equal to the rate of population change in the absence of migration.	1985-2012
Fertility rate, total (births per woman)	Total fertility rate represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates.	1985-2012
Health expenditure, public (% of total health expenditure)	World Health Organization Global Health Expenditure database (see http://apps.who.int/nha/database for the most recent updates).	1995-2012
Hospital beds (per 1,000 people)	Hospital beds include inpatient beds available in public, private, general, and specialized hospitals and rehabilitation centers. In most cases beds for both acute and chronic care are included.	1985-1997 Sporadic data available between 1998-2012
Incidence of tuberculosis (per 100,000 people)	Incidence of tuberculosis is the estimated number of new pulmonary, smear positive, and extra-pulmonary tuberculosis cases. Incidence includes patients with HIV.	1991-2012
Life expectancy at birth, female (years)	Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.	1985-2012
Life expectancy at birth, male (years)	Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.	1985-2012
Life expectancy at birth, total (years)	Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.	1985-2012
Mortality rate, infant (per 1,000 live births)	Infant mortality rate is the number of infants dying before reaching one year of age, per 1,000 live births in a given year.	1985-2012 (Missing data 1985-1987 for Georgia)
Physicians (per 1,000 people)	World Health Organization's Global Health Workforce Statistics, OECD, supplemented by country data.	1985-1997 Sporadic data available between 1998-2012

Source: World Bank (Indicators, n.d.)

These variables were plotted on line graphs to examine the changes over time. Figures 1- 10 show these changes. These graphs did not show any major shift in pattern over time and there was no major difference between "private" countries (solid lines) and "public" countries (dotted lines).

Figure 1: Changes of Adolescent fertility rate between 1985- 2012 in the 15 post- SU countries.

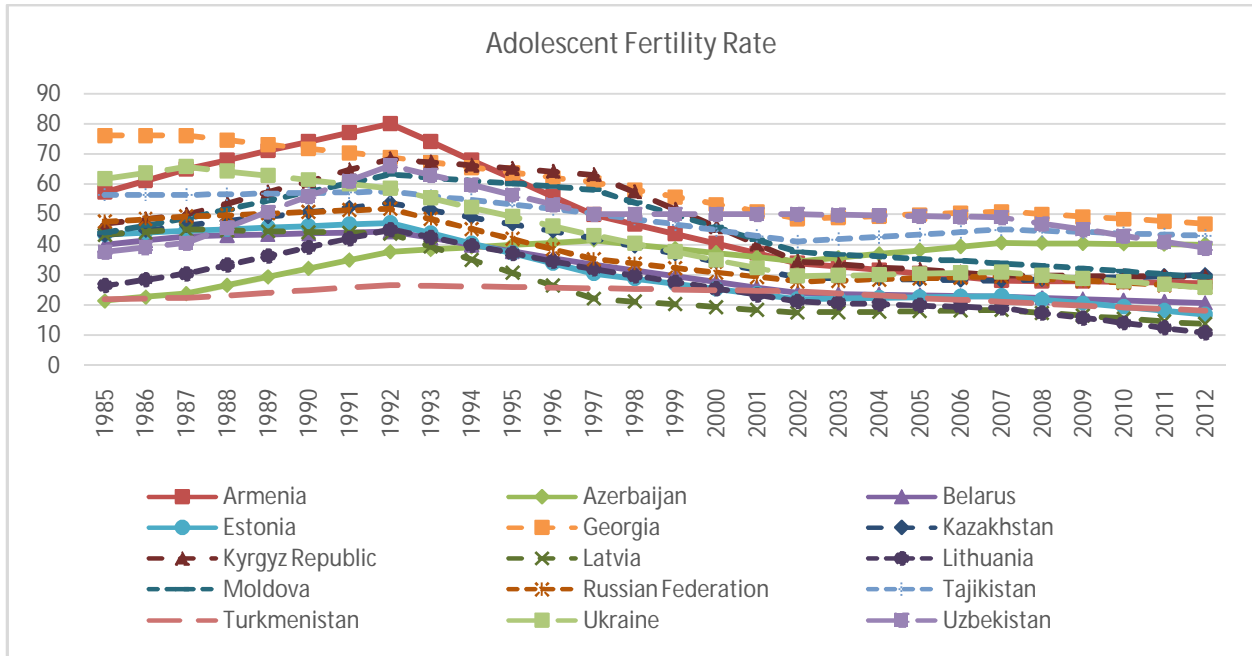


Figure 2: Changes of Birth rate, crude (per 1,000 people) between 1985- 2012 in the 15 post- SU countries.

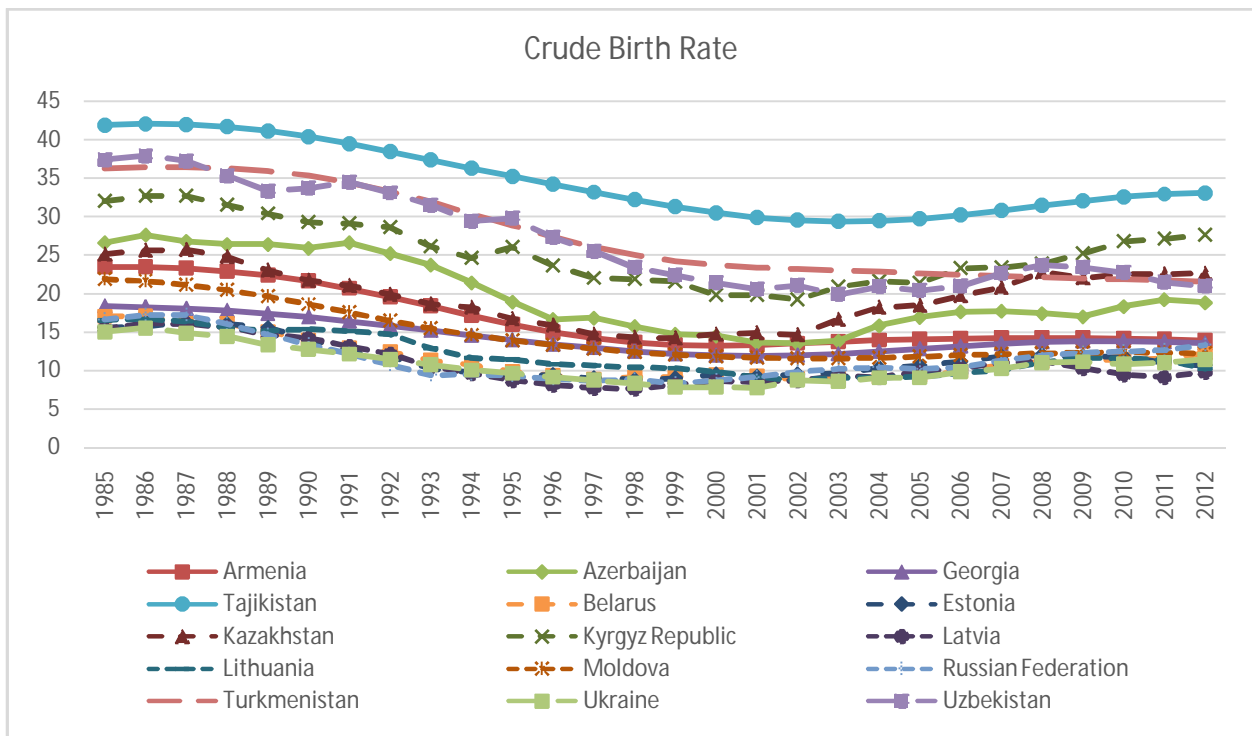


Figure 3: Changes of Death rate, crude (per 1,000 people) between 1985- 2012 in the 15 post- SU countries.

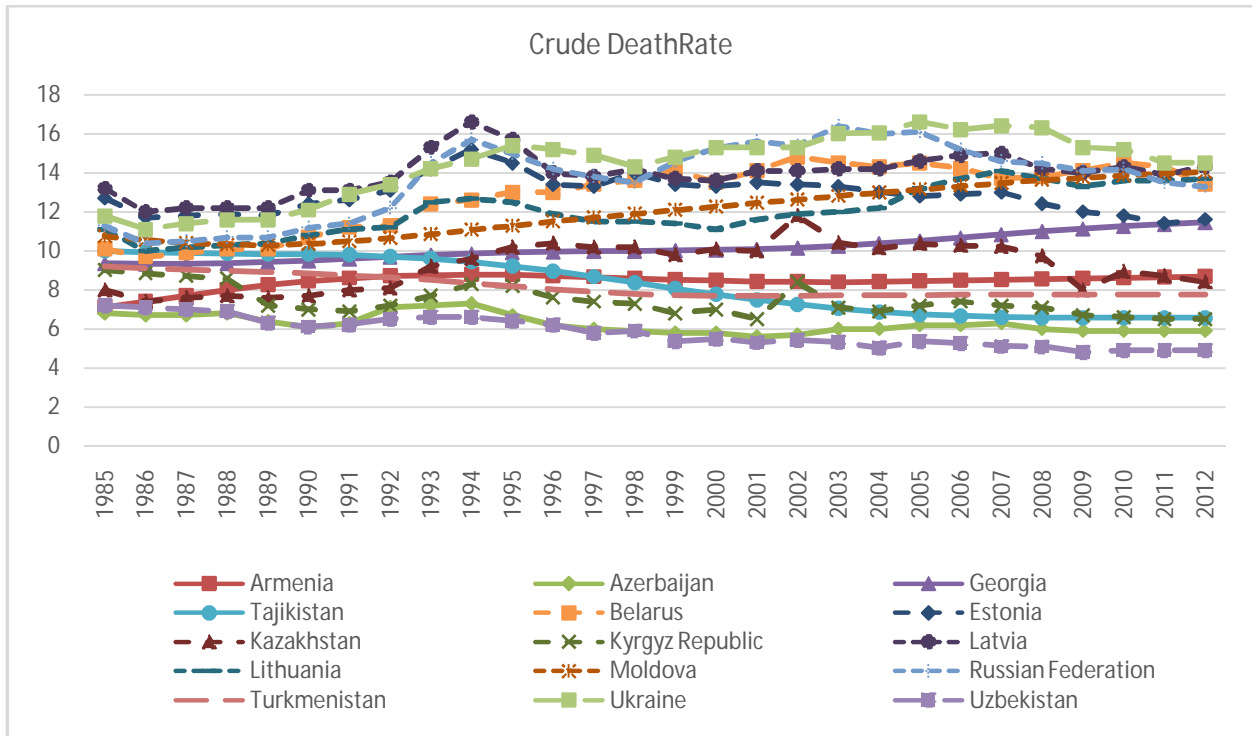


Figure 4: Changes of Fertility rate, total (births per woman) between 1985- 2012 in the 15 post- SU countries.

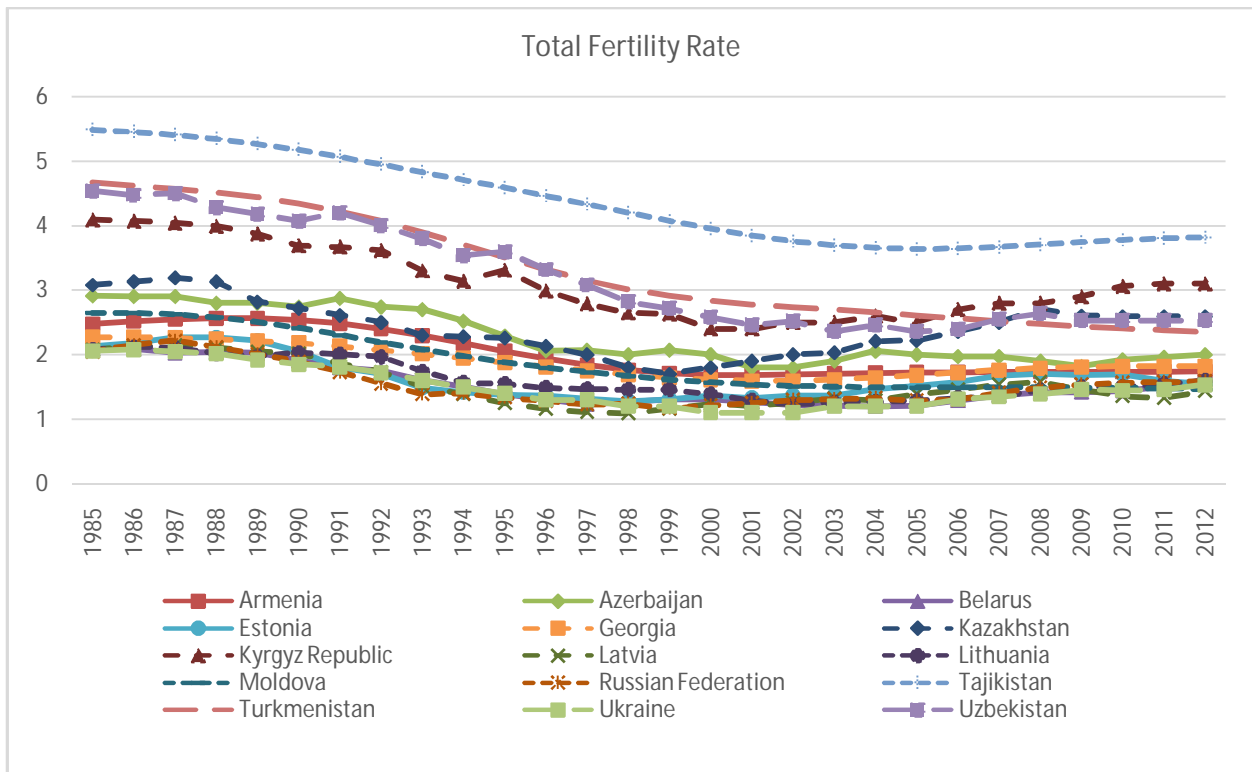


Figure 7: Changes of Incidence of tuberculosis (per 100,000 people) between 1985- 2012 in the 15 post- SU countries.

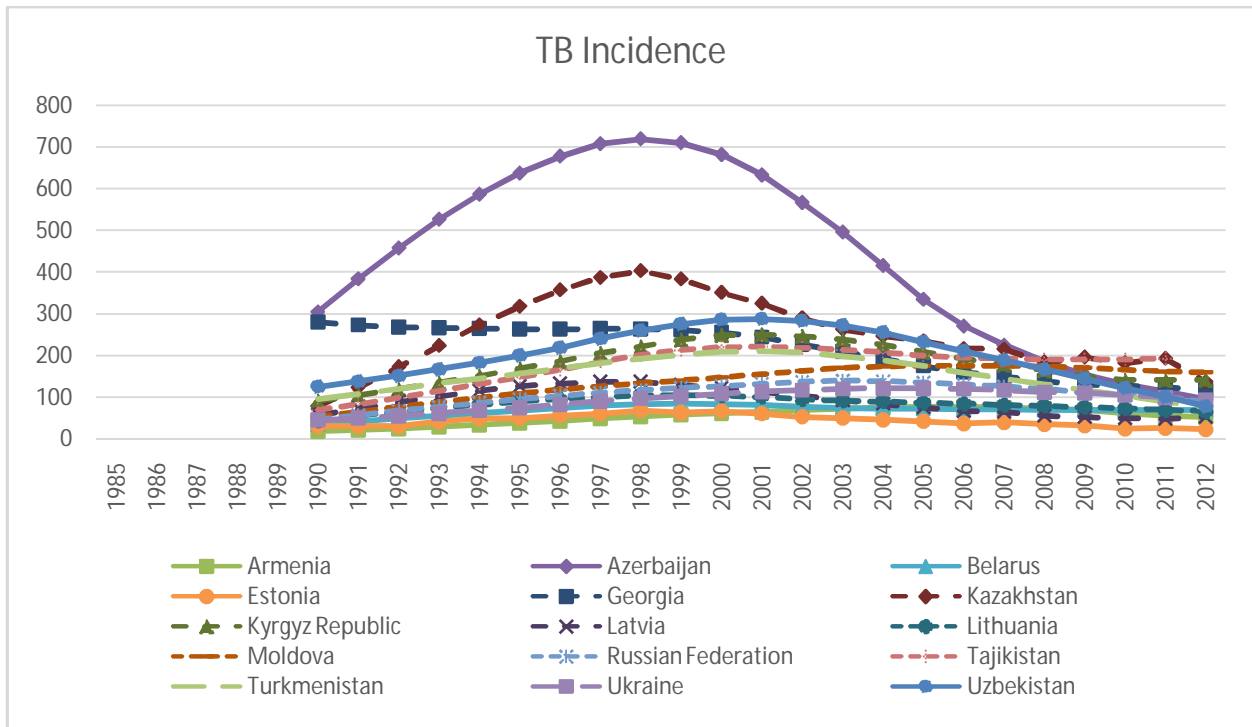


Figure 8: Changes of Life expectancy at birth, total (years) between 1985- 2012 in the 15 post- SU countries.

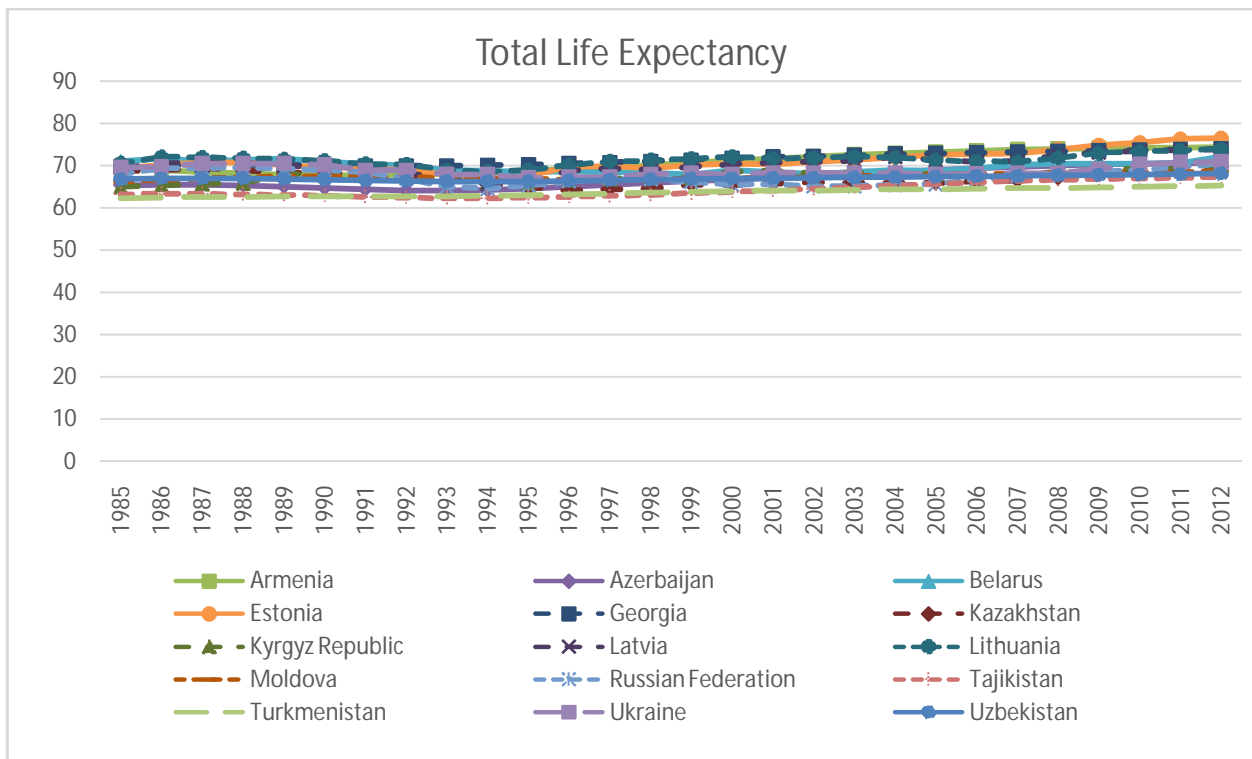


Figure 9: Changes of Mortality rate, infant (per 1,000 live births) between 1985- 2012 in the 15 post- SU countries.

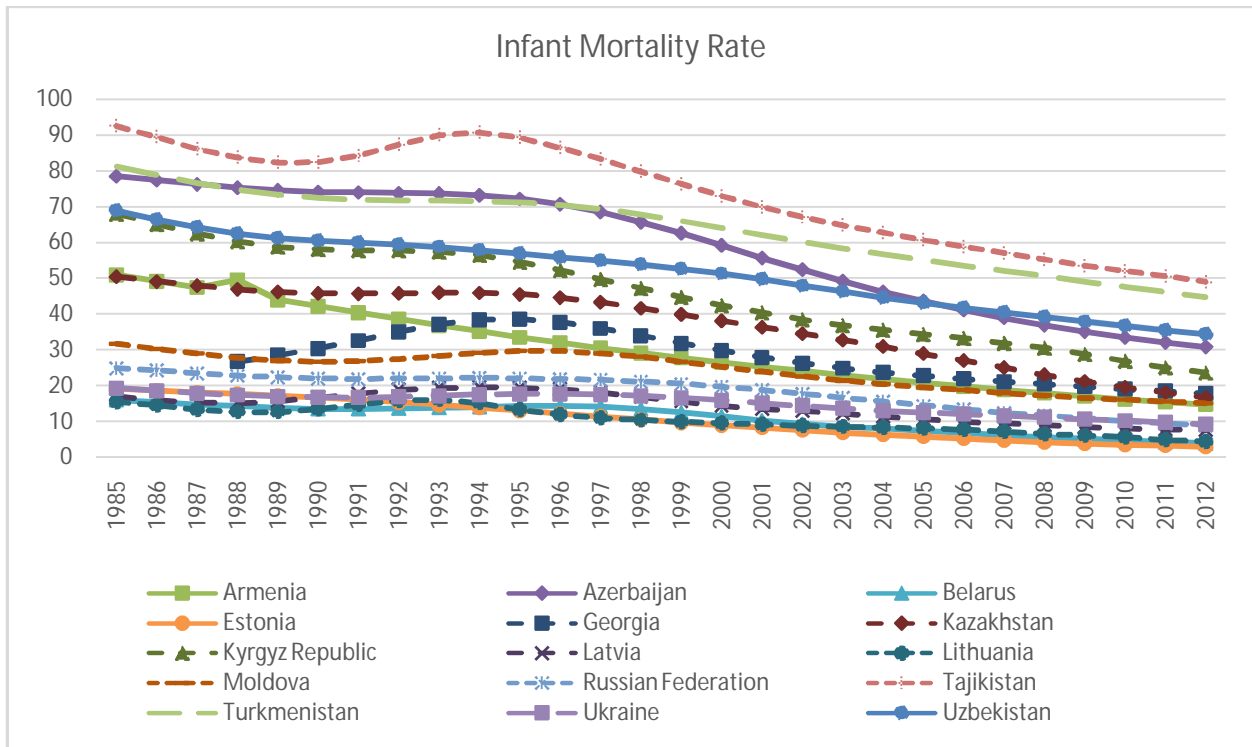
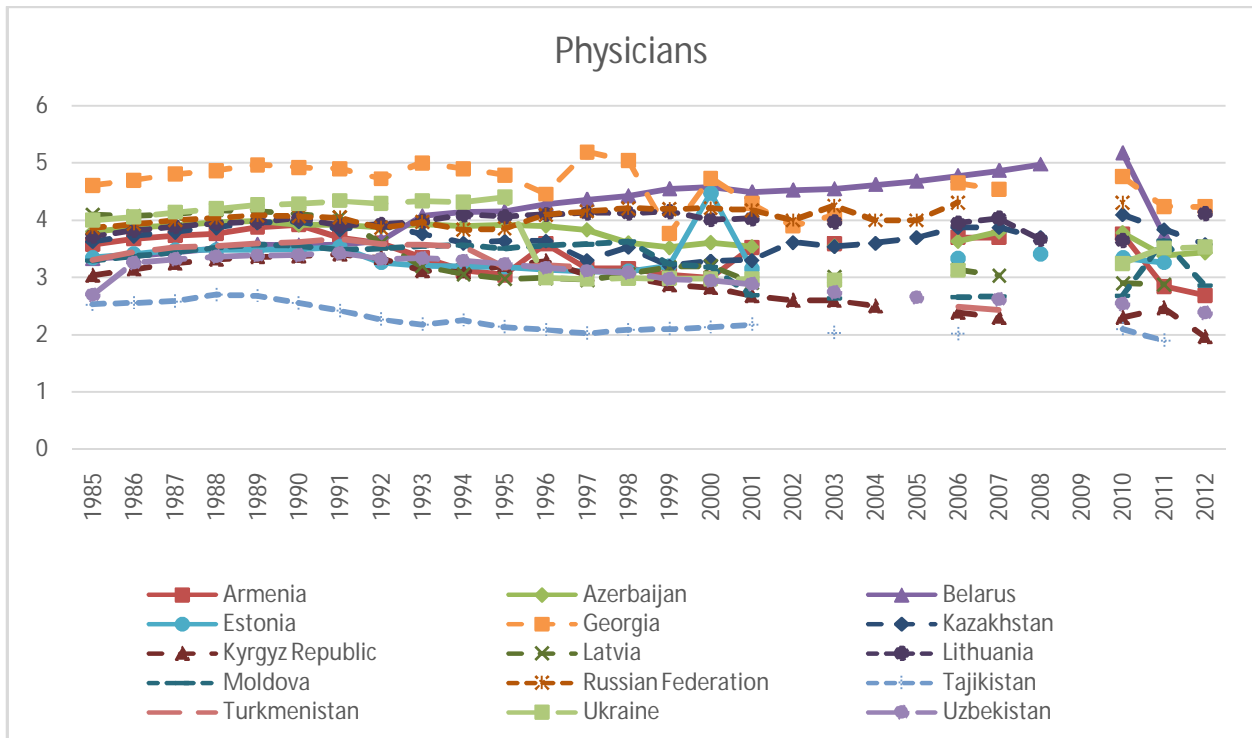


Figure 10: Changes of Physicians (per 1,000 people) between 1985- 2012 in the 15 post- SU countries.



Paired difference test was then applied to test the differences between 1991 and 2011 for some health indicators using “private” and “public” systems separately (Table 2). Adolescent fertility rate decreased by about 20/1000 women aged 15-19 in the “private” systems compared to a decrease of about 25/1000 in the “public” systems from 1991 to 2011. Crude birth rate decreased by about 6/1000 in the “private” systems compared to about 4/1000 in the “public” systems from 1991 to 2011. Crude death rate decreased by less than .5/1000 in “private” systems compared to an increase of less than 1/1000 in the “public” systems from 1991 to 2011. Hospital beds decreased by over 5 per 1000 people in the “private” systems compared to a decrease of about 6 per 1000 people in the “public” systems from 1991 to 2011. Incidence of tuberculosis decreased by 69/100,000 in “private” systems compared to an increase of 22.5/100,000 in the “public” systems from 1991 to 2011. Infant mortality decreased by nearly 27/1000 live births in “private” systems compared to a decrease of only 16.6/1000 live births in the “public” systems between 1991 and 2011. Total fertility decreased by 0.8 births per woman in “private” systems compared to a decrease of only 0.6 per woman in the “public” systems from 1991 to 2011. Total life expectancy at birth increased by more than 5 years in “private” systems compared to a decrease of only 2 years in the “public” systems from 1991 to 2011.

Table 2 summarized the results and showed significant results based on 0.05 level of significance. It is clear that there is no specific pattern between “private” and “public countries. When there is a change in pattern in one of the health indicator, the change happened in both systems in the same direction (increase or decrease), except for crude death rate and incidence of TB in which cases the changes were not always significant.

Table 2: Paired difference test between 2011 and 1991 for selected health indicators.

System	Health Indicator	Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Private									
	Adolescent fertility	-20.282	22.884	11.442	-56.695	16.132	-1.773	3	.174
	Crude birth rate	-5.819	2.130	1.065	-9.207	-2.430	-5.465	3	.012
	Crude death rate	-.448	2.061	1.031	-3.728	2.831	-.435	3	.693
	Hospital beds	-5.600	.955	.478	-7.120	-4.081	-11.727	3	.001
	Incidence of TB	-69.000	172.567	86.283	-343.592	205.592	-.800	3	.482
	Infant mortality	-28.675	11.941	5.970	-47.675	-9.675	-4.803	3	.017
	Total fertility	-.806	.394	.197	-1.434	-.178	-4.087	3	.026
	Total life expectancy	5.269	1.302	.651	3.197	7.342	8.093	3	.004
Public									
	Adolescent fertility	-25.812	7.762	2.340	-31.026	-20.598	-11.030	10	.000
	Crude birth rate	-3.869	4.853	1.463	-7.130	-.609	-2.644	10	.025
	Crude death rate	.946	1.747	.527	-.227	2.120	1.797	10	.103
	Hospital beds	-6.109	2.025	.765	-7.982	-4.236	-7.980	6	.000
	Incidence of TB	22.545	41.227	12.430	-5.151	50.242	1.814	10	.100
	Infant mortality	-16.609	9.051	2.729	-22.689	-10.529	-6.086	10	.000
	Total life expectancy	2.289	1.932	.582	.991	3.586	3.930	10	.003

The regression model for infant mortality rate was statistically significant in explaining the variation in the infant mortality rate ($F_{(4, 412)} = 449, p < 0.01$) and demonstrated a good fit (adjusted $R^2 = 0.812$). After exclusion of non-significant predictors, remaining variables are presented in Table 3. Overall, there was a statistically significant decrease in infant mortality for each year of the study period (standardized $b = -0.094, p < 0.01$), however, countries with a “private” healthcare system tended to have higher infant mortality rate (standardized $b = 0.158, p < 0.01$). In addition, higher fertility rates were positively associated with infant mortality.

Table 3: Regression coefficients for infant mortality rate

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	537.530	131.045		4.102	.000
HealthSystem Health System	8.115	1.203	.158	6.747	.000
Year	-.262	.065	-.094	-4.028	.000
Crudedearthrateper1000people Crude death rate (per 1,000 people)	-1.637	.218	-.221	-7.494	.000
Totalfertilityratebirthsperwoman Total fertility rate (births per woman)	15.216	.693	.651	21.956	.000

The regression model was also statistically significant in explaining the variation in the Total life expectancy ($F_{(5, 414)} = 6.72$, $p < 0.01$) and demonstrated a moderate fit (adjusted $R^2 = 0.44$). After exclusion of non-significant predictors, remaining variables are presented in Table 4. Overall, there was a statistically significant increase in total life expectancy for each year of the study period (standardized $b = 0.0148$, $p < 0.01$), however, countries with "private" healthcare system tended to have lower total life expectancy (standardized $b = -0.096$, $p < 0.01$).

Table 4: Regression coefficients for life expectancy

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	20.885	9.988		2.091	.037
	HealthSystem Health System	-.619	.124	-.096	-5.005	.000
	Year	.030	.005	.084	6.091	.000
	Crudebirthrateper1000people Crude birth rate (per 1,000 people)	-.180	.034	-.521	-5.338	.000
	Crudedearthrateper1000people Crude death rate (per 1,000 people)	-.152	.023	-.161	-6.547	.000
	Totalfertilityratebirthsperwoman Total fertility rate (births per woman)	1.638	.275	.554	5.962	.000
	Femalemortalityrateadultper1000femaleadults Female mortality rate, adult (per 1,000 female adults)	-.040	.002	-.386	-16.241	.000
	Malemortalityrateadultper1000maleadults Male mortality rate, adult (per 1,000 male adults)	-.012	.001	-.293	-10.081	.000
	Infantmortalityrateper1000livebirths Infant mortality rate (per 1,000 live births)	-.104	.004	-.816	-25.555	.000

3. Discussion

Our results show that there was not a vast change over time in the health indicators studied. Moreover, there was not a large difference between "private" and "public" countries, indicating that the health system of the country is not a very good measure of the health status of that country. However, the regression model showed that countries with "private" healthcare systems tended to have a significantly higher infant mortality rate and lower total life expectancy. This finding might suggest that countries of the former Soviet Union that have a "public" health system tend to have better health systems than those that adapted a "private" health system.

One of the major disadvantages for this study is the use of secondary data. Data were selected from a single source of the World Bank to ensure standardization among nations. While this is a quick and inexpensive way to collect data for all fifteen countries of the former Soviet Union, the use of secondary data has some disadvantages. The quality of the data is not always optimal. It is difficult to determine if there are incorrect values in the dataset and there is also the issue of missing values (Hulley & Cummings, 1988). Moreover, the use of the World Bank data also comes with disadvantages. While the World Bank always strives to improve the quality of data, their data come from member countries and the quality of that data depend on the statistical system available for each country (Data Overview, 2015).

4. Conclusion

Health expenditure in the case of the former Soviet-Union showed no major effect on overall population health. This study showed that no single system in the post-soviet countries presented superior outcomes on all health domains; rather, each system had individual strengths and weaknesses. Although the relationship between health system and health indicator was not apparent, it seems that “private” health systems had higher infant mortality rates and lower total life expectancy. Understanding the correlations between these basic health indicators has provided an excellent foundation for further research in this area. In order to continue this discussion related to structural effects of healthcare on the population health, research will be continued dissecting the data based on the type of health system, as well as financing of healthcare.

References

- (n.d.). 2015 Global Reference List of 100 Core Health Indicators. World Health Organization. Retrieved from www.who.int/healthinfo/indicators/2015/en
- Balabanova, D., Roberts, B., Richardson, E., Haerpger, C., & McKee, M. (2012, April). Health Care Reform in the Former Soviet Union: Beyond the Transition. *Health Services Research*, 47(2), 840-864.
- BUŞOİ, C. (2010). Health Systems and the Influence of Political Ideologies. *Management in Health*, 14(2), 4-6.
- CDC. (n.d.). Social Determinants of Health. Retrieved from Centers for Disease Control and Prevention: <http://www.cdc.gov/socialdeterminants/Definitions.html>
- Collapse of the Soviet Union - 1989-1991. (n.d.). Retrieved from GlobalSecurity.org: <http://www.globalsecurity.org/military/world/russia/soviet-collapse.htm>
- Data Overview. (2015). Retrieved from The World Bank: <http://data.worldbank.org/about/data-overview>
- DPE Research Department. (2014). The U.S. Health Care System: An International Perspective. Department for Professional Employees Research Department.
- Dubikaytis, T., Larivaara, M., Kuznetsova, O., & Hemminki, E. (2010). Inequalities in health and health service utilisation among reproductive age women in St. Petersburg, Russia: a cross-sectional study. *St. Petersburg, Russia*. Retrieved from <http://www.biomedcentral.com/1472-6963/10/307>
- Healthy People 2020. (n.d.). Determinants of Health. Retrieved from Healthy People 2020: <https://www.healthypeople.gov/2020/about/foundation-health-measures/Determinants-of-Health#policymaking>
- Hulley, S. B., & Cummings, S. R. (1988). *Designing Clinical Research*. Baltimore: Williams & Wilkins.
- Indicators. (n.d.). Retrieved from World Bank: <http://data.worldbank.org/indicator>
- Rowland, D., & Telyukov, A. V. (1991). Soviet Health Care from Two Perspectives. *Health Affairs*, 10(3), 71-86.
- Squires, D. (2011). The U.S. Health System in Perspective: A Comparison of Twelve Industrialized Nations. The Commonwealth Fund pub. 1532 Vol. 16.
- Wold, C. (2008). Health Indicators A Review of Reports Currently in Use. The State of the USA.
- World Health Organization. (n.d.). The Determinants of Health. Retrieved from Health Impact Assessment (HIA): <http://www.who.int/hia/evidence/doh/en/>