

© Razvodovsky Y.E., Zotov P.B., 2017

SUICIDE AND TUBERCULOSIS MORTALITY: A COMPARATIVE ANALYSIS OF TIME SERIES

Y.E. Razvodovsky¹, P.B. Zotov²

Grodno State Medical University,
Gorkogo str., 80, 230009, Grodno, Republik of Belarus (1)
Medical center "Medical City",
Barnaulskaya str., 32, 625041, Tyumen, Russian Federation (2)

Until recently tuberculosis mortality and the suicide rates in Russia were among the highest in the world. Tuberculosis and suicide belong to the medico-social problems and these epidemiological parameters are often considered indicators of psychosocial distress. There are theoretical premises and empirical evidence which suggest the positive relationship between suicide and tuberculosis mortality at individual and population levels. **Aim.** The aim of the present study was to find out a link between the epidemiological parameters of tuberculosis and the suicide rates in Russia. **Materials and Methods.** Trends in tuberculosis incidence/mortality and the suicide rates from 1980 to 2015 were analyzed using a time series analysis in order to assess bivariate relationship between the time series. **Results.** The results of analysis indicate the presence of a statistically significant association between tuberculosis mortality and suicide rates for men at lag zero ($r=0.71$; $SE=0.169$). The association between tuberculosis mortality and suicide rates for women was also positive, but statistically not significant ($r=0.26$; $SE=0.169$). **Conclusions.** The results of this study suggest positive aggregate-level relationship between tuberculosis mortality and suicide rates in men. This study indirectly supports the hypothesis that tuberculosis mortality can be considered an indicator of psychosocial distress.

Keywords: tuberculosis mortality, suicide, trends, Russia, 1980-2015.

Until recently, Russia has been among the countries with the highest level of tuberculosis mortality rates and suicide. Tuberculosis was one of the so-called social diseases, therefore the epidemiological parameters of tuberculosis are often used as an indicator of social well-being in the country. The role of socio-economic factors in the spread of tuberculosis is well illustrated by the number of bacterial dischargers per 100 000 of population in the countries with different levels of development and state of the economy: the USA and Canada – 7, Europe – 24, Latin America – 80, Asia – 110, Africa – 165. In one study it was shown that the risk factors for death from tuberculosis in the Urals, which is one of the most unfavorable regions

of Russia, are unemployment, low level of incomes, unfavorable living conditions, unbalanced diet. In the Kaluga region, the risk of morbidity and mortality of the population from tuberculosis increases with a decreasing able-bodied part of the population, an outflow of investments from the region, deterioration in living conditions, and a decrease in the level of employment of the population.

At first glance, the existence of a link between suicide and tuberculosis mortality seems doubtful since suicidal behavior is a psychosocial phenomenon, while tuberculosis is an infectious disease. However, there are at least several possible aspects of such link at the individual level. First, there are arguments in favor of the psychosomatic nature of tuber-

culosis [1]. Here, the common etio-pathogenetic factor of suicidal behavior and tuberculosis may be psychosocial distress accompanied by a decrease in the immunity, in general resistance of the organism which increases the risk of tuberculosis [1]. Besides, an important aspect of existence of relationship between the suicidal behavior and tuberculosis is a suicidal behavior of patients with tuberculosis. One of common mental disorders in patients with tuberculosis is depression, which increases the risk of suicide. In the literature, there are also reports of an increased risk of suicidal behavior against the background intake of antituberculous drugs. In general, the mortality rate of tuberculosis patients from external causes: injuries, alcohol poisoning, murders and suicides, is 4 times higher than in the common population.

In a number of previous studies an attempt was made to identify the relationship between suicide and tuberculosis mortality at the population level. In one of them it was shown that between 1990 and 1995 in 15 countries of Eastern Europe the suicide rate was positively correlated with the death rate from tuberculosis ($r = 0.58$, $P < 0.05$), while in 17 of Western Europe countries there is no such correlation [2]. At the same time, the level of both types of mortality was significantly higher in countries of Eastern Europe. Based on these data a hypothesis was proposed according to which the level of tuberculosis mortality along with the level of suicide may be an indicator of the socio-economic crisis. In a later study a close relationship was shown between trends in suicide rates and tuberculosis mortality in the late 1980 s and early 1990 s in Belarus, which confirms the important role of psychosocial distress caused by the socio-economic crisis in the etiology of suicide and mortality from tuberculosis. It was also suggested that the level of suicide is a more sensitive indicator of psychosocial distress than the death rate from tuberculosis due to the latency of tuberculosis.

The purpose of this study was an attempt to identify the relationship between suicide and tuberculosis mortality at the population level in Russia. For this purpose, a comparative analysis of the dynamics of the level

of gender coefficients of suicides and of tuberculosis mortality in Russia was carried out between 1980 and 2015.

Materials and Methods

Sex-related mortality rates for suicides and deaths from tuberculosis for the period from 1980 to 2015 (according to Rosstat) were used in the study. The death rate from tuberculosis is one of the most informative and reliable indicators since it is least susceptible to distortions and reflects the epidemic situation with a higher extent of reliability [2].

To examine the relationship between the variables throughout the studied period a time series analysis was performed using the statistical package "Statistica 10. StatSoft." Bivariate correlations between the raw data from two time series can often be spurious due to common sources in the trends and due to autocorrelation [3]. One way to reduce the risk of obtaining a spurious relationship between two variables that have common trends is to remove these trends by means of a 'differentiation' procedure, as expressed in the formula: $\nabla x_t = x_t - x_{t-1}$

This means that the annual changes ' ∇ ' in variable 'X' are analyzed rather than raw data. The process whereby systematic variation within a time series is eliminated before the examination of potential causal relationships is referred to as 'prewhitening'. This is subsequently followed by inspection of the cross-correlation function in order to estimate the association between the two prewhitened time series. It was Box and Jenkins who first proposed this particular method for undertaking a time series analysis that is commonly referred to as ARIMA (autoregressive integrated moving average) modeling.

In this work, both methods were used to remove the trend. After the initial series were approximated to the stationary one, its model was selected. The model was considered matched if the residual component of the series was a process of "white noise" type. The next stage involves investigating the cross-correlation function between two "whitened" series.

Results and Discussion

During the studied period, the level of suicide among men and women significantly fluctuated (Fig. 1-2).

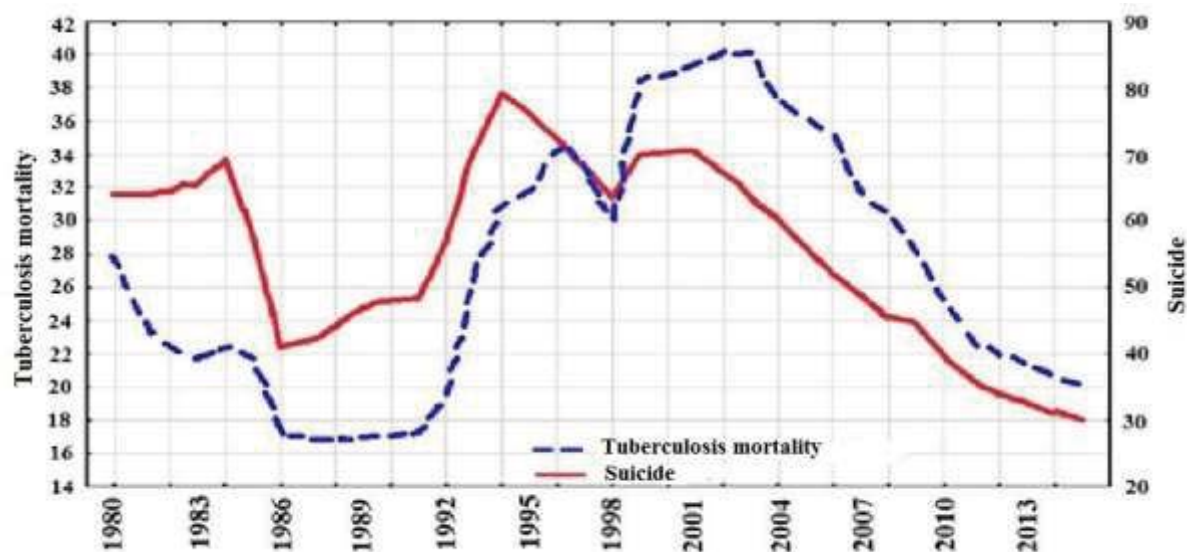


Fig. 1. Dynamics of death rates from suicide and tuberculosis among men

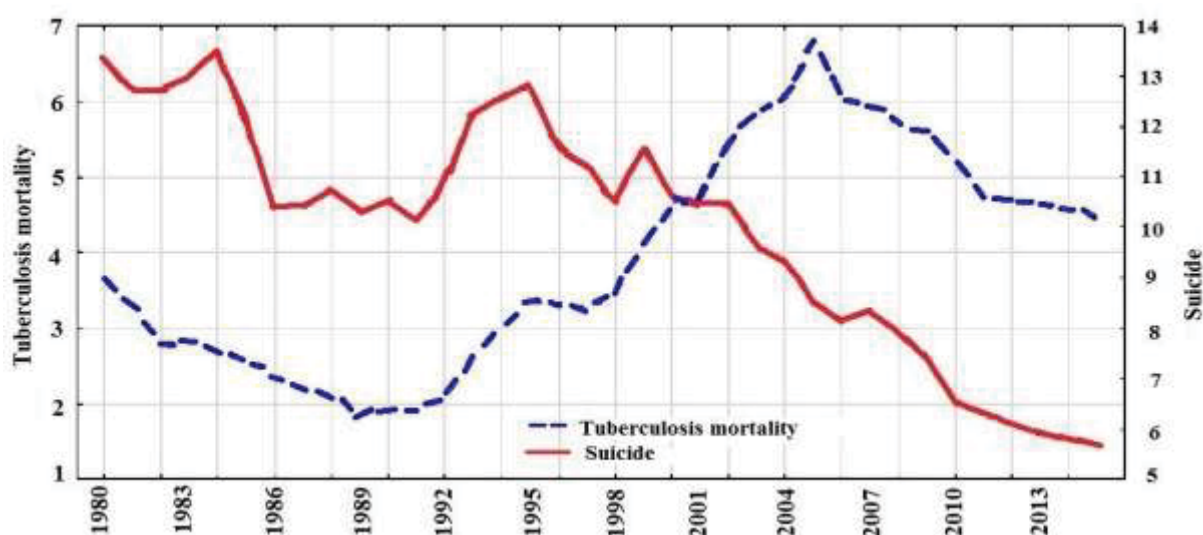


Fig. 2. Dynamics of death rates from suicide and tuberculosis among women

The level of suicides among men significantly declined between 1984 and 1986, sharply increased between 1991 and 1994, again declined from 1994 to 1998, then again increased between 1998 and 2002, after which began to decline. The dynamics of this parameter among women largely repeated the pattern of suicides among men, with the exception of some differences. In particular, the level of suicides among women grew up to 1995, after which it began to decline, demonstrating an insignificant surge in 1999 against this background.

The death rate from tuberculosis among men, as well as the level of suicides, declined significantly between 1984 and 1986, then increased sharply between 1991 and 1996, declined between 1996 and 1998, again grew during the period from 1998 to 2003, and then began to decline. The dynamics of the death rate from tuberculosis among women demonstrated a slightly different pattern. This parameter declined until 1991, then sharply increased in the period from 1991 to 2005, after which began to decline again.

The average gender gradient of the suicide rate for the entire period under review was 7.4, with the minimum of 4.4 in 2015 and maximum of 10.4 in 1996. The average gender gradient of the death rate from tuberculosis over the entire period under review was 5.6 with the minimum of 3.9 in 1986 and maximum of 6.7

in 2001. The graphical data presented in Fig. 3 indicate that the dynamics of the gender gradient of suicide rates and the level of tuberculosis mortality were quite similar. Both gender gradients declined substantially in the mid-1980 s, rose sharply in the 1990 s, and then began to decline.

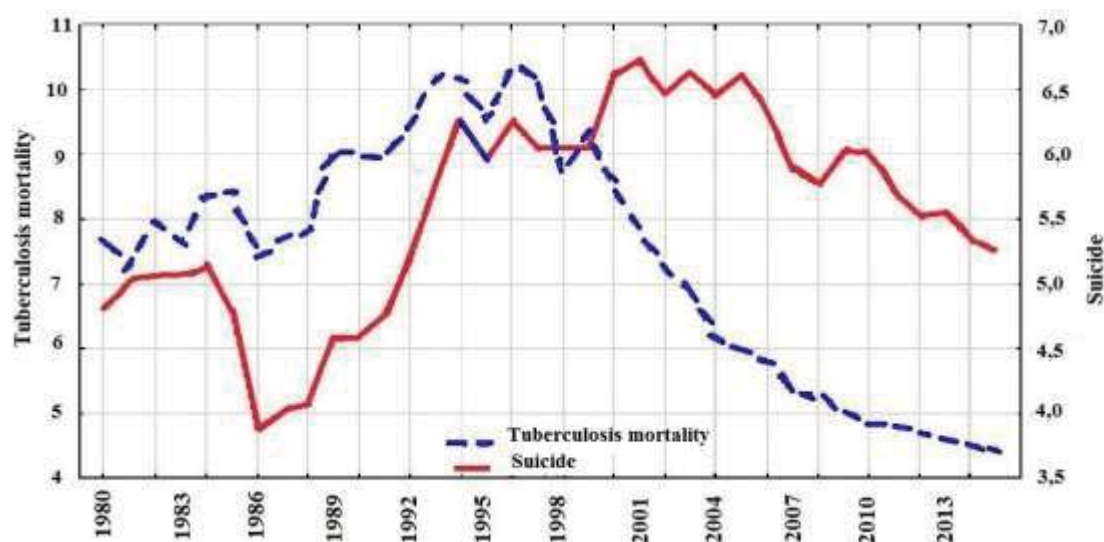


Fig. 3. Dynamics of death rates from suicide and tuberculosis in the population

A comparative analysis of the dynamics of suicide rates and the tuberculosis mortality rate testifies to the similarity of the trends in mortality among men and the significant differences in the trends of mortality among women. In particular, the dynamics of suicide rates and the death rate from tuberculosis among women showed an opposite trend in the period from 1997 to 2005.

The results of the Spearman correlation analysis revealed a positive statistically significant relationship between the suicide rate and the tuberculosis death rate among men ($r=0.56$, $p<0.001$), while the correlation between the level of these parameters in women is negative ($r = - 0.50$; $p<0.002$).

Visual analysis of graphical data (Fig. 1-2) indicates that the time series under study are not stationary, since they have a pronounced trend. Trying to remove the trend by the method of least squares did not allow us to bring the time series to a stationary view. Therefore, the next step was removal of the nonstationary component by the differentiation method. After removing the deterministic component, the relationship between the time

series was evaluated. Cross-correlation analysis of the converted time series showed that between the dynamics of the suicide rate and the tuberculosis mortality among men there was a statistically significant relationship at the zero lag ($r=0.71$; $SE=0.169$). The relationship between the level of these parameters in women was also positive, although it was not statistically significant ($r=0.26$; $SE=0.169$).

The existence of a positive link between suicide trends and tuberculosis mortality among men is consistent with the previous studies and indirectly supports the hypothesis that tuberculosis mortality is an indicator of psychosocial distress. However, the obtained data allow to consider this conclusion to be valid only for male mortality.

It is obvious that the psychosocial distress caused by the socio-economic crisis and a sharp drop in the living standard of the population was an important determinant of growing suicide rates and tuberculosis mortality in the early 1990s. This is especially true for men, as they are more susceptible to the negative impact of socio-economic shocks. Given this fact, it can be assumed that the

psychosocial distress associated with the 1998 banking crisis caused another spike in suicide rates and tuberculosis mortality in subsequent years [4]. Some contrast to the previous events was a lack of suicide and death rates from tuberculosis in response to the 2008 economic crisis. Apparently, this crisis, unlike previous ones, did not produce such a significant negative impact on the living standard of the population. Presumptive reasons for reducing the mortality rate from tuberculosis in the coming years are: stabilization of the socio-economic situation and improvement of the living standards of the population, improvement of health financing, and improvement of the quality of tuberculosis care for the population [5,6].

In most countries of the world there is a significant gender gradient of the tuberculosis mortality rate, which varies considerably. On average, the death rate from tuberculosis among men is twice that of women. The causes of the gender gradient of the mortality rate from tuberculosis remain not fully understood. For the purpose of their explanation, a number of hypotheses have been proposed, the most famous of which are behavioral and biological ones. From the point of view of the behavioral hypothesis, men are more subject to the risk of infection, because they have more social contacts. Besides, among men, behavior that carries a high risk for health, such as smoking and alcohol abuse, is more common. One study showed that smoking accounts for 33% of gender differences in the prevalence of tuberculosis. The biological hypothesis explains the gradient of the death rate from tuberculosis by genetically programmed immunity characteristics, which provide different resistance to infection. Important factors in the gender gradient are women's greater access to medical care, as well as their higher compliance to treatment.

The dynamics of the gender gradient of the tuberculosis mortality rate in Russia demonstrated a pattern that correlates with the level of psychosocial distress: this indicator grew during the period of high level of distress (the first half of the 1990s), and then began to decline against the background decrease in socio-economic tensions. Given the

available data in favor of the psychosomatic etiology of tuberculosis, and the fact that men are more sensitive to the negative effects of psychosocial distress, it can be assumed that psychosocial distress is one of the factors of the high gender gradient of the level of tuberculosis mortality in Russia.

Since the phenomena we are studying are relatively independent of each other, we are talking about coinciding trends, formed under the influence of some general unaccounted factors. One of these potential factors is alcohol. The specific weight of the alcohol factor in the structure of suicides in Russia varies from 45 to 59% according to different estimates [7-11]. With regard to the contribution of alcohol to the death rate from tuberculosis, in a recent study using Russian data, the alcoholic fraction in the structure of this type of mortality was estimated at 35.4% for men and 32.0% for women [9]. The influence of the alcohol factor on suicide rates and mortality from tuberculosis was clearly manifested during the period of the anti-alcohol campaign of 1985-1988, which is the most famous experiment in the field of alcohol policy [12]. A sharp reduction in the availability of alcohol during this period was accompanied by a significant reduction in the level of suicide, as well as the tuberculosis death rate.

It should be also noted that reduction in the quality of the data of the post-Soviet period was a limitation to this study. A number of researchers indicate that due to the social significance of certain types of mortality from external causes, including suicide, certain manipulations with mortality statistics take place. The problem of data quality concerns the epidemic parameters of tuberculosis [4]. The reliability of data of the mortality rate from tuberculosis depends on the quality of diagnosis of the causes of death of tuberculosis patients from tuberculosis and concomitant diseases. Some researchers note that when filling out medical certificates of death, many errors are allowed, which distort the official statistics [2]. The quality of tuberculosis care to the population has a significant influence on the tuberculosis mortality rate. Such factors as inadequate financing of anti-tuberculosis measures, reduction of popula-

tion control surveys, destruction of the vertical management of the TB service and its isolation from the general treatment network were one of the reasons for the sharp increase in the tuberculosis death rate in the first half of the 1990s. [2,13,14].

Conclusions

1. The results of this study indicate the existence at the population level of the relationship between the level of suicide and the level of tuberculosis mortality among men.

2. A hypothesis is confirmed that the tuberculosis death rate among men can be

considered as an indicator of psychosocial distress caused by socio-economic factors.

3. Psycho-social distress is one of the factors that influence the high gender gradient of mortality from tuberculosis in Russia.

4. Taking into account independence of the studied phenomena from each other, it can be argued that intake of alcohol makes a significant contribution to increase in the mortality rates from both tuberculosis and suicide; that, in turn, increases the gender gradient, because use of alcohol is one of the socially acceptable ways of removal of the actual stress in men.

Authors have no conflict of interest to declare.

References

1. Kandrychyn SV. Historical and sociocultural aspects of epidemiology of tuberculosis. *Pskovskij regionologicheskij zhurnal*. 2017;1:46-58. (In Russ).

2. Box GEP, Jenkins GM. *Time Series Analysis: forecasting and control*. London: Holden-Day Inc.; 1976.

3. Razvodovsky YEA. Alcohol consumption and suicide rates in Russia. *Suicidology Online*. 2011;2:67-74.

4. Brojtigam V, Kristman P, Rad M. *Psychosomatic medicine*. Moscow: GeOTAR Medicina; 1999. (In Russ).

5. Shilova MV. A glance at the epidemic situation with tuberculosis in the Russian Federation (in modern socio-economic conditions). *Rossijskij jelektronnyj zhurnal luchevoj diagnostiki*. 2014;4(1):34-42. (In Russ).

6. Peltzer K, Louw J. Prevalence of suicidal behavior & associated factors among tuberculosis patients in public primary care in South Africa. *Indian J Med Res*. 2013; 138(2):194-200.

7. Merinov AV. *The role and place of the phenomenon of autoaggression in families of patients with alcohol dependence*. Saint Petersburg: Ekspertnye resheniya; 2017. (In Russ).

8. Merinov AV. To the issue of diagnosis of suicidal behavior in alcohol dependent pa-

tients. *Suicidology*. 2012;3(2):21-3. (In Russ).

9. Shitov EA, Merinov AV, Shustov DI, et al. The clinical and sociological characteristics of patients with alcohol dependence with a concomitant borderline personality disorder. *Rossijskij mediko-biologicheskij vestnik imeni akademika I.P. Pavlova*. 2015; 23(4):87-90. (In Russ).

10. Merinov AV. A suicide, experimental psychological and Drug characteristic spouses of married men suffering from alcohol dependence, with a second open family system. *Suicidology*. 2014;5(4):43-51. (In Russ).

11. Somkina OJu, Merinov AV. Modern ideas about female alcoholism (review). *Nauka molodykh (Eruditio Juvenium)*. 2014;4:128-35. (In Russ).

12. Nechaeva OB. Tuberculosis in the Russian Federation: morbidity and mortality. *Jepidemiologija i gigiena*. 2013;4:7-11. (In Russ).

13. Podgaeva VA, Golubev DN, Chernjaev IA, et al. Influence of socio-economic factors on the death rate of tuberculosis in the Urals. *Siberian Medical Journal*. 2011;26(2):151-8. (In Russ).

14. Razvodovsky YE. Alcohol and suicides in Russia, Ukraine and Belarus: a comparative analysis of trends. *Suicidology*. 2016;7(1):3-10. (In Russ).

Razvodovsky Y.E. – M.D., Ph.D., Senior Researcher of the Scientific Laboratory of Grodno State Medical University, Grodno, Republik of Belarus. SPIN 3373 3879, ORCID ID 0000-0001-7185-380X, Researcher ID T-8445-2017.
E-mail: razvodovsky@tut.by

Zotov P.B. – M.D., Grand Ph.D., Professor of Multidisciplinary Clinical Medical Center “Medical City”, Tyumen, Russian Federation. SPIN 5702-4899, ORCID ID 0000-0002-1826-486X.