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Factor Analysis Reflecting the Impact of Labor Migration on the Spread of Socially Dangerous Diseases in Russia*

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Abstract. The goal of the paper is to assess the possible impact of international labor immigration on the prevalence of the following diseases which are dangerous to others: HIV, active tuberculosis, syphilis, drug addiction, enterobiosis, pediculosis, acute and chronic viral hepatitis B and C in Russia's regions. We analyze the works on the impact of migration on the health of the population of the host territory. The main research methods that we use include econometric and correlation analysis. We construct panel models for each of the diseases. The models test various socio-economic indicators (including education level, cash income, housing improvement and the incidence of alcoholism), as well as climatic, geographical and demographic indicators. In order to calculate the indicators characterizing the level

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of labor immigration in the regions we use Rosstat data on the legal employment of foreign citizens in the regions of the Russian Federation and on the number of foreign citizens who arrived in Russia. The study has shown that of all the diseases considered, immigration can only have an impact on the spread of drug addiction. This issue needs further study. As far as infectious diseases are concerned, labor immigration does not affect the level of morbidity detected in the regions. As a rule, these diseases are associated with poor sanitary and socio-economic conditions (tuberculosis, syphilis and enterobiosis); on the other hand, there are big problems concerning their detection, and the real level of morbidity in the country is unknown (HIV and viral hepatitis). We also reveal a significant statistical correlation between the groups of diseases: 1) drug addiction, HIV, active tuberculosis, acute viral hepatitis and 2) alcoholism, syphilis, chronic viral hepatitis.

Key words: labor immigration, socially dangerous diseases, well-being of the territory, regions of Russia.

Introduction

International migration raises many socio-economic issues, including the impact of migration on the health of the host society and migrants themselves. Health issues faced by migrants are often similar to those faced by the rest of the population, although in some cases they may be specific. However, the link between migration and the importation of contagious diseases, as well as the impact of the presence of migrants on their spread (including "socially dangerous" diseases), has not been fully studies yet. Health and migration are generally considered independently by the researchers. The research into the correlation between these population processes started not so long ago.

Some foreign researchers have found that migrants who moved less than two years ago were healthier at the time of their arrival (except when they were diagnosed with contagious diseases) than local residents of the host country. This phenomenon, which is been called "the Healthy Migrant Effect", can be explained by the self-selection of healthier people who decide to move from their homeland to another country. This effect was confirmed by studies in the US [1], Canada [2], Australia [3], and several countries in Western Europe [4]. Some time after migrating, the health of migrants and indigenous people in the host country is usually compared [5] and sometimes it does not happen. For example, the overall mortality rates of immigrants from Latin America are lower than that of indigenous people of the United States despite their less favorable socio-economic conditions [6]. A similar result was obtained in studies of citizens of Morocco in France [7] and the Turkish population in Germany [8]. One reason is that old and diseased migrants often return to their homeland, so the average life expectancy of those who remain is increased. In any case, this is exactly what happens in the US [9].

O.A. Kislitsyna, after analyzing data from the European Social Survey and the Russian Monitoring of Economic Situation and Health, identified statistically significant differences in self-reported health of migrants and indigenous people in 14 out of 29 countries, including Russia. She notes that most countries lack statistics to compare the health of migrants and indigenous people. This is particularly the case of Russia [10].

With regard to the possible role of migration in the importation of contagious diseases into the host community, the WHO regional office for Europe (WHO/Europe) insist that "there is no systematic link between these phenomena. Contagious diseases are mainly related to poverty. Europe has a many-years' experience in fighting against infectious diseases such as tuberculosis (TB), HIV/AIDS, hepatitis, measles and rubella, and has managed to largely relieve the burden of these diseases in the course of economic development through improving housing conditions, providing safe water and proper sanitation, efficient operation of healthcare systems and ensuring access to vaccines and antibiotics. However, these diseases have not yet been eliminated and still exist in the European region, regardless of migration. ... The risk of importing rare infectious agents into Europe ... is extremely low. Experience shows that when it takes place, the disease vectors are ordinary passengers, tourists or health workers, rather than migrants or refugees"[1].

At the same time, the Infectious Disease Epidemiology Annual Report published in 2017 at Robert Koch Institute, points to the negative consequences of a mass influx of migrants for the health of the German population. The report lists diseases whose prevalence has increased including: cholera, hepatitis, AIDS, leprosy, malaria, syphilis, and tuberculosis[2].

Most European studies analyzing the spread of HIV-associated tuberculosis confirm that the level of HIV-associated tuberculosis among migrants is higher than among the local population [11].

A number of European researchers writing about the diagnosis and treatment of infectious diseases mark the underreporting of cases. A lesser degree of underreporting of infectious diseases in reports among migrants is noted compared to the underreporting of illnesses among the local population. We see the reason that the share of unreported cases of tuberculosis is less among migrants than that of the local population is in the strengthened communicable disease surveillance over migrants [12, 13]. Nightingale et al. assumed that a lower degree of underreporting of hepatitis B and C among migrants compared to local residents is associated with mandatory screening of arriving migrants [14].

Better definition of diseases among migrants compared to the local population may also have an impact on morbidity rates in Russia. N.Ya. Shcherbak and I.M. Ulyukin analyze the experience of authorized organizations in Saint Petersburg in terms of medical examination of foreign citizens and stateless people in 2010–2013 and note that the incidence of HIV, tuberculosis and syphilis among foreign citizens is 1.5 times higher than that of local residents [15]. According to data of the Central Research Institute of Tuberculosis, among every 100,000 examined Russians and every 100,000 thousand foreign citizens in Russia, tuberculosis is detected 2.65 times less often among the former, HIV – 2.93 times more often than among the latter [16]. And this is despite the fact that all foreign citizens are subject to mandatory medical examination for tuberculosis and HIV, unlike citizens of the Russian Federation.

B.B. Prokhorov believes that the main factor affecting people's health is the socio-economic situation status of individual population groups [17]. It is obvious that this can affect the level of migrant morbidity. E.E. Rashkevich,

[1] WHO regional office for Europe. Migration and Health: key issues. Available at: http://www.euro.who.int/ru/health-topics/health-determinants/migration-and-health/migrant-health-in-the-european-region/migration-and-health-key-issues (accessed: 15.03.2018).

[2] Infektionsepidemiologisches Jahrbuch meldepflichtiger Krankheiten für 2016 Robert Koch-Institut, Berlin, 2017. Available at: http://www.rki.de/DE/Content/Infekt/Jahrbuch/Jahrbuch_2016.pdf?__blob=publicationFile (accessed: 15.03.2018).

Yu.V. Frolova and et al. note a rate of latent (3 times) and active tuberculosis (10 times) among children from okmgrant families in the Smolensk Oblast in 2014–2015. Migrant children are more often in contact with tuberculosis patients (6 times more often than children permanently residing in the Smolensk Oblast) and 25% less likely to have BCG-vectored vaccination [18]. The study of N.S. Maltseva et al. [19] indicates a fairly high level of hepatitis infection among foreign citizens who arrived in Khabarovsk on a work visa. At the same time, 17% of surveyed migrants possess antibodies to hepatitis E not endemic in Khabarovsk Krai. N.D. Alsalikh, D. A. Sychev et al. [20, 21] come to a conclusion that a significant share of labor migrants arriving in Russia are already infected with hepatitis C, which suggests a high probability of importation of this infection. P.V. Istomin, V.V. Mefodiev and V.G. Bychkov [22] conclude that migration significantly effects the spread of HIV. S.A. Solonin et al. speak of a significant level of hepatitis E infection among citizens coming from China to the territory of the Russian Federation [23]. N.L. Struin and A.S. Shubina [24] analyzed studies (mainly foreign) on the incidence of social infections among migrants in various countries; the analysis also confirms that the incidence of syphilis, HIV and other sexually transmitted diseases among migrants is higher than among local residents.

Thus, the majority of researchers engaged in studying the impact of foreign citizens on the epidemiological situation in the host territory agree that migration, including labor, can make a significant contribution to the spread of socially dangerous diseases, contrary to the statements of WHO/Europe. However, WHO/Europe materials state that, among other factors, "migrants' risk of catch or come down with tuberculosis depends on the incidence of tuberculosis in their country of origin", as well as on "the living and working conditions in the host country, including access to healthcare and social security". "The risk of contamination is higher in closed, poorly ventilated spaces". It is also noted that active tuberculosis "develops only among part of the infected (the risk ranges from 10% during life for the population as a whole to 10% during a year for HIV-positive people) and within a few months or years after infection", and that in migrants' most countries of origin the HIV rate is low, while "there is increasing evidence that some migrants become infected with HIV after migrating"[3].

Thus, at present, the impact of international migration on the spread of socially dangerous diseases remains debatable.

The present paper aims to use probability models to assess the possible impact of international labor immigration on the spread of a number of socially dangerous diseases in the Russian regions. To achieve this, we set the following objectives: to perform an econometric analysis of the spread of drug addiction and all those infectious diseases from the *List of socially dangerous diseases*,[4] which during 2010–2016 occurred in all Russian regions and for which there is enough statistics for modeling. Drug addiction is not included in the List, yet it can cause the spread of diseases from the List, and its spread could theoretically be influenced by international migration. Data from Rosstat, Unified Interdepartmental Statistical Information System (EMISS) and Ministry of Health of the Russian Federation are used.

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[3] WHO regional office for Europe. Migration and Health: key issues. Available at: http://www.euro.who.int/ru/health-topics/health-determinants/migration-and-health/migrant-health-in-the-european-region/migration-and-health-key-issues (accessed: 15.03.2018).

[4] Approved by the Resolution of the Government of the Russian Federation no. 715, dated 01.12.2004. Available at: http://base.garant.ru/12137881/ (accessed: 15.03.2018).

Description of statistical data and research methodology

The EMISS database[5] contains statistics of the Ministry of Health in the regional context (since 2005, on the number of registered patients with infections diagnosed for the first time, per 100,000 people) for the following socially dangerous diseases: 1) HIV; 2) active tuberculosis[6]; 3) syphilis; 4) drug addiction. EMISS provides statistics on the spread of other infections only since 2009 or 2010 and only on the number of cases in the regions[7]. We selected the following diseases for the purposes of our study: 5) enterobiasis[8]; 6) pediculosis; 7) chronic viral hepatitis (diagnosed for the first time, the virus is not specified, hepatitis B and C can become chronic); 8) acute viral hepatitis B; 9) acute viral hepatitis C.

Table 1 lists the regions with the highest and lowest incidence of each of the socially dangerous diseases under review. In brackets – years of observation and number of cases per 100,000 people. The absolute maximum for the country during the observation period is highlighted in bold.

Overall, statistics show that the incidence of tuberculosis, syphilis and acute viral hepatitis B and C is clearly declining. Statistics on other diseases (enterobiasis, chronic viral hepatitis and pediculosis) over the period under review do not show significant improvement. In terms of drug addiction the situation varies greatly by region, HIV is demonstrating an upward trend. The number of people diagnosed with HIV for the first time since 2012 annually exceeds the number of people diagnosed with chronic viral hepatitis for the first time, and since 2014 their number exceeded the number of cases of tuberculosis. In 2016, pediculosis and enterobiasis ranked first and second in the number of cases among the diseases under review (more than 200,000 cases), HIV ranked third (84,000 cases) followed by tuberculosis (77,000), chronic viral hepatitis (68,000), syphilis (31,000), drug abuse (16,000), hepatitis C (1,806) and hepatitis B (1,378).

Migration has traditionally been one of the factors in spread of infectious diseases, so it is not surprising that regions with highest prevalence of dangerous diseases such as HIV, tuberculosis and syphilis are geographically close to each other (see Table 1). The question put forward in the study is what role international labor immigration plays in the spread of these and other socially dangerous diseases in Russia.

To address this issue, we attempt to build probability panel models of spread of diseases in the Russian regions.

The panel multiple regression equation has the following form:

$$Y_{(t,R)} = a_0 + a_1 X_{1(t,R)} + \dots + a_n X_{n(t,R)} + \varepsilon, \quad (1)$$

where Y – explained variable, vector with time and space coordinates;

X_i – factors affecting the explained variable;

a_i – coefficients,

ε – remainder of the equation.

In our case, explained variables – **B1–B9** – denote the number of cases or first diagnoses per 100,000 people per year *t* in the region (Russia's constituent entity) *R*, *t* takes values from 1 in 2005 to 12 in 2016.

[5] Unified Interdepartmental Statistical Information System. Available at: https://fedstat.ru/organizations/ (accessed: 15.03.2018).

[6] The Ministry of Health provides statistics separately on "active tuberculosis" and "tuberculosis of respiratory tract". In the List of socially significant diseases at Rosstat website only "active tuberculosis" is listed, although the List approved by the Government of the Russian Federation contains "tuberculosis" without specification.

[7] Number of reported cases of infectious diseases: Available at: https://fedstat.ru/indicator/38208, https://fedstat.ru/indicator/38207 (accessed: 17.09.2018).

[8] Selected as the most common type of helminthiasis.

Table 1. Regions with highest and lowest incidence of socially dangerous diseases (per 100,000 people)

Regions and years with highest incidence	Regions and years with lowest incidence
B1. HIV (2005–2016)	
Kemerovo Oblast (2011–138; 2012–219; 2013–217; 2014–**240**; 2015–238; 2016–202); Tomsk Oblast (2013–173; 2014–149; 2015–164); Sverdlovsk Oblast (2012–136; 2013–151; 2014–169; 2015–170; 2016–145); Irkutsk Oblast (2010–166; 2012–136; 2014–149; 2015–148; 2016–146); Novosibirsk Oblast (2013–140; 2014–149; 2015–144); Saint Petersburg (2005–133; 2010–146); Ulyanovsk Oblast (2008–136); Chelyabinsk Oblast (2015–136).	Chechen Rep. (2005–0.0); Rep. of Tyva (2005–2.3; 2006–0.0; 2008–1.3; 2016–2.9); Nenets Autonomous Okrug (2015–0.0); Jewish Autonomous Oblast (2005-2006–2.1; 2007–1.6; 2008–2.2); Stavropol Krai (2005–1.8; 2006–2.0); Karachay-Cherkess Rep. (2005–2.3); Omsk Oblast (2005–2.3; 2006–3.4); Rep. of Kalmykia (2005–2.4; 2010–3.2; 2013–3.2); Voronezh Oblast (2005–3.0); Rep. of Khakassia (2005–3.0); Arkhangelsk Oblast (2006–3.1); Kabardino-Balkar Rep. (2006–3.4).
B2. Active tuberculosis (2005–2016)	
Rep. of Tyva (2005–**250**; 2006–246; 2007–235; 2008–240; 2009–228; 2010–233; 2011–231; 2012–206; 2013–187; 2014–169; 2015–162; 2016–178); Primorsky Krai (2005-2006 –165; 2007–189; 2008–192; 2009–209; 2010–201; 2011–172; 2012–163); Jewish Autonomous Oblast (2005–159; 2007–167; 2008–190; 2009–170; 2010–174; 2011–176; 2012–173; 2013–176); Rep. of Buryatia (2005–159; 2006–174; 2008–159; 2009–168); Chukotka Autonomous Okrug (2016–172); Kemerovo Oblast (2005–157).	Chechen Rep. (2005–0.0; 2014–29.2; 2015–30.7); Nenets Autonomous Okrug (2010-2011–0.0; 2016–20.5); Belgorod Oblast (2013–29.3; 2014–28.9; 2015–27.1; 2016–21.5); Vologda Oblast (2015–29.7; 2016–21.7); Oryol Oblast (2016–26.7); Moscow (2014–28.0; 2015–28.1; 2016–28.6); Voronezh Oblast (2015–31.4; 2016–28.5);); Karachay-Cherkess Rep. (2015–29.2); Arkhangelsk Oblast (2016–29.6); Rep. of Dagestan (2016–30.2); Oryol Oblast (2015–30.2).
B3. Syphilis (2005–2016)	
Chukotka Autonomous Okrug (2005–504; 2006–**663**; 2007–264; 2008–180); Rep. of Tyva (2005–383; 2006–334; 2007–390; 2008–487; 2009–353; 2010–255; 2011–209; 2012–199; 2013–177); Rep. of Khakassia (2005–191; 2006–197; 2007–181; 2008–192; 2009–156); Jewish Autonomous Oblast (2007–155; 2008–172; 2009–167; 2010–144); Altai Rep. (2008–166); Amur Oblast (2005–158; 2006–162; 2007–158; 2008–157; 2009–152; 2010–142); Zabaykalsky Krai (2007–140; 2008–159; 2009–146).	Chechen Rep. (2005–0.0); Nenets Autonomous Okrug (2010–7.1; 2012–4.7; 2013–2.3; 2015–4.6); Rep. of Dagestan (2012–4.4; 2013–6.2; 2014–4.2; 2015–3.7; 2016–3.5); Chukotka Autonomous Okrug (2013–5.9); Kostroma Oblast (2016–5.2); Rep. of Karelia (2015–7.1; 2016–5.4); Rep. of Adygea (2016–5.8); Ryazan Oblast (2016–6.5); Tambov Oblast (2016–6.5); Kamchatka Krai (2016–6.6); Rep. of Kalmykia (2013–6.7; 2016–7.2); Komi Rep. (2016–7.2); Leningrad Oblast (2015-2016–7.4).
B4. Drug addiction (2005–2016)	
Jewish Autonomous Oblast (2016–**66.8**); Irkutsk Oblast (2005–56.7); Kemerovo Oblast (2005–45.9; 2006-2007–52.9; 2008–51.9; 2009–49.0); Primorsky Krai (2005–42.9; 2015–43.5; 2016–52.6); Sverdlovsk Oblast (2008–50.9; 2009–47.8; 2010–42.8); Rep. of Adygea (2005–45.8; 2006-2007–50.2); Karachay-Cherkess Rep. (2005–41.6; 2006-2007–45.3); Perm Krai (2006-2007–44.5); Irkutsk Oblast (2006-2007–43.4); Krasnodar Krai (2006-2007–43.3).	Chechen Rep. (2005–0.0; 2012–2.0; 2013–1.2; 2014–0.4; 2015-2016–1.1); Nenets Autonomous Okrug (2016–0.0); Chukotka Autonomous Okrug (2010–0.0; 2012–0.0; 2014-2016–0.0); Rep. of Kalmykia (2013–0.4; 2014–1.1; 2015-2016–0.4); Rep. of Ingushetia (2010–0.6; 2011–1.2; 2012–0.7; 2013–1.4); Astrakhan Oblast (2015–0.8; 2016–1.0); Arkhangelsk Oblast (2005–1.5; 2006-2007–1.4); Chuvash Rep. (2014–1.7; 2015–1.5); Belgorod Oblast (2016–1.6); Kirov Oblast (2012–1.6).
B5. Enterobiasis (2009–2016)	
Nenets Autonomous Okrug (2009–614; 2011–550; 2014–502; 2015–608; 2016–**677**); Rep. of Tyva (2009–509; 2012–483; 2013–498; 2014–586); Udmurt Rep. (2009–545; 2016–497); Jewish Autonomous Oblast (2010–506; 2016–481); Altai Rep. (2010–482).	Rep. of Ingushetia (2009–34; 2010–38; 2012–33; 2013–38; 2014–27; 2015–40; 2016–31); Krasnodar Krai (2016–31); Moscow (2015–33; 1016–35); Rep. of North Ossetia (2011–43; 2016–36); Chechen Rep. (2015–39)
B6. Pediculosis (2010–2016)	
Moscow (2010–1471; 2011–1470; 2012–1438; 2013–1434; 2014–**1596**; 2015–1273; 2016–1075); Nenets Autonomous Okrug (2010–371; 2012–293); Magadan Oblast (2013–289; 2014–371; 2015–305); Arkhangelsk Oblast (2010–300).	Chechen Rep. (2010–0,3; 2011–0,0; 2012–0,1; 2013-2014–0,0; 2015–0,5; 2016–0,0); Karachay-Cherkess Rep. (2010–7,1; 2011–3,6; 2012–5,7; 2013–0,8; 2014–5,1; 2015–6,6); Rep. of Ingushetia (2010–1,2; 2011–0,9; 2013–7,8).
B7. Chronic viral hepatitis (2010–2016)	
Kamchatka Krai (2010–**233**; 2011–218; 2012–204; 2013–170); Saint Petersburg (2010–194; 2011–188; 2012–180; 2013–182; 2014–170; 2015–152; 2016–146); Sakhalin Oblast (2011–186; 2012–151); Yamalo-Nenets Autonomous Okrug (2010–184; 2011–169; 2012–151; 2013–165).	Chechen Rep. (2010–2.4; 2011–4.2; 2012–6.5; 2013–2.4; 2014–1.3; 2015–0.8; 2016–2.2); Rep. of Ingushetia (2010–2.9; 2011–5.6; 2012–3.6; 2014–6.5; 2015–6.8; 2016–6.3); Rep. of Dagestan (2010–4.9; 2011–5.4); Kabardino-Balkar Rep. (2016–8.2).
B8. Acute viral hepatitis *B* (2010–2016), average for the period	
Tomsk Oblast (3.47). Vladimir Oblast (3.40). Tyumen Oblast excluding Autonomous Okrug (2.51). Moscow (2.50). Ivanovo Oblast (2.46). Kurgan Oblast (2.42).	Rep. of Buryatia (0.06). Oryol Oblast (0.09). Rep. of Ingushetia (0.22). Kabardino-Balkar Rep. (0.38). Arkhangelsk Oblast (0.41). Rep. of Khakassia (0.45).
B9. Acute viral hepatitis *C* (2010–2016), average for the period	
Kurgan Oblast (3.76). Tyumen Oblast excluding Autonomous Okrug (3.55). Yamalo-Nenets Autonomous Okrug (3.27). Sverdlovsk Oblast (3.25). Chelyabinsk Oblast (3.23). Khanty-Mansi Autonomous Okrug (3.15).	Altai Rep. (0.07). Rep. of Buryatia (0.18). Rep. of Dagestan (0.22). Rep. of Kalmykia (0.25). Karachay-Cherkess Rep. (0.33). Oryol Oblast (0.37). Rep. of Ingushetia (0.45), Ryazan Oblast (0.49).
Source: EMISS data.	

The indicators reflecting the socio-economic and migration situation, climate and some other characteristics of the region were tested as factors.

To calculate the indicators characterizing the level of labor immigration in the regions we used data from Rosstat on *legal employment of foreign citizens* in Russian regions and on the *number of foreign citizens* (at the place of residence).

The level of legal employment of foreign citizens (**M1**) is the number of foreign citizens with a valid work permit or a valid employment patent per 1,000 people at the end of the year. This indicator has certain drawbacks. First, data on patents by region are available only since 2013, although purchase of patents for foreigners was introduced in the middle of 2010. Second, the greatest number of foreign employees in Russia is usually observed in the second and third quarters, rather than at the end of the year. Third, until 2011, the number of granted permits during a year was published, rather than the number of valid work permits at the end of the year. Thus, the data do not fully meet the comparability criterion.

The index of international migrant arrival in the region (**M2**) is calculated as follows. First, we calculate the international migrant arrival coefficient per 100,000 people. Then, for each region and each year we calculate the index of international migrant irrival, which represents the percentage of arrival coefficient to the region to arrival coefficient to Russia in a given year, i.e. the national level is taken as 1. It is noteworthy that the rules of statistical accounting of international migration for the period 2005–2016 changed many times and even more significantly than statistics on labor migration. As a result, Rosstat data do not reflect the real changes in migration over time, although they help compare regions with each other in each year. In this regard, we apply the above two-step method. As a result, we get an indicator more consistent with the criterion of comparability in time and space.

Variables **M1** and **M2** complement each other and both reflect the level of labor immigration, as most foreign citizens arriving in the region for a period of 9 months or more are labor migrants. Some of them, however, move to Russia for permanent residence. Unlike **M2**, **M1** does not include labor migrants from countries of the Eurasian Economic Union (EAEU), but includes labor migrants who arrive for a period of 3–9 months. It can be assumed that illegal migrants are attracted to the same regions as legal ones. Variables **M1** and **M2** can then be considered to indirectly reflect the impact of illegal labor immigration as well.

We selected the following indicators of the socio-economic situation in a region.

Level of education index in an entity (**ILE**) which is calculated according to census data as the sum of products of share of people with a certain level of education and the score assigned to this level. Including: no education – 0, primary general education – 1, secondary general and primary vocational education – 3, secondary vocational education –4, incomplete higher education and bachelor's degree – 5, higher education and postgraduate studies – 6. For years between censuses it is accepted that the level of education was changing linearly.

Data on *living space per person* at the beginning of the year (LS); the share of households *without sewage* (WS) and *hot water* (WHW) are also taken from censuses. We also assume the between the censuses, the situation was changing linearly.

Employment rate (**ER**) is the share of employed among people aged 15–72. *The level of monetary income* (**LMI**) is calculated as the ratio of per capita monetary income of the population to living wage in the region. That is, monetary incomes equaling living wage are taken as 1. In both cases – Rosstat data are used.

Data on alcohol abuse per 10,000 people (**Alc**) are taken from EMISS (rate per 100,000 people).

Climate indicators can influence people's physiological functions and behavior and are therefore included in the list of variables. The average monthly air temperature in January (**T1**) and July (**T7**) is taken as the average monthly air temperature (data of the Federal Service for Hydrometeorology and Environmental Monitoring).

Moreover, region's characteristics such as population density (**PD**), share of urban population (**SUP**), total fertility rate (**TFR**), that is, the number of children born per 1,000 people, the share of children (%) and adolescents aged 1–4 years (**C0104**), 5–9 (**C0509**), 5–14 and 15–19 (**C1519**) at the beginning of the year, as well as the number of abortions per 1,000 people (**TAb**) were tested. By adding TAb(t) to TFR(t+1) we obtain an approximate representation of the share of pregnant women (**TPr**) in the region in year *t*. This makes sense since pregnant women are subject to mandatory medical examination. This is the variable that was tested in models; TAb and TFR performed an auxiliary role. We also introduce a fictitious **NatR** variable, which equals 1 if the region is "national" (republic or autonomy), and 0 – if otherwise.

Research results

Preliminary correlation analysis (*Table 2*) shows that the spread of a number of socially dangerous diseases (tuberculosis, syphilis and enterobiasis) is closely related to the general socio-economic situation in the region (poverty, poor housing conditions, alcohol abuse, low employment rate). Some others (HIV, chronic viral hepatitis, pediculosis), on the contrary, are more common in economically prosperous regions. There may be problems identifying these diseases in poor regions. Drug addiction occupies an intermediate position: it has no significant correlation with socio-economic

Table 2. Correlation coefficients between morbidity rate in Russian regions and various indicators

	B1	B2	B3	B4	B5	B6	B7	B8	B9
M1	0.105	0.057	0.190	0.138	-0.066	**0.365**	**0.394**	0.123	0.217
M2	0.063	-0.082	-0.143	0.015	**-0.255**	0.006	**0.342**	0.147	**0.263**
LMI	0.238	**-0.288**	-0.225	0.094	-0.184	**0.360**	**0.269**	0.146	**0.273**
LS	0.119	**-0.382**	**-0.317**	-0.192	**-0.278**	-0.059	-0.119	0.012	0.051
WS	**-0.276**	**0.437**	**0.399**	-0.076	**0.544**	-0.223	-0.245	-0.177	-0.231
WHW	-0.244	**0.380**	**0.299**	-0.103	**0.483**	**-0.274**	**-0.262**	-0.170	-0.231
ILE	**0.298**	**-0.270**	**-0.293**	-0.003	**-0.346**	**0.509**	**0.374**	0.195	0.191
Alc	-0.176	0.242	**0.379**	0.138	0.140	0.060	**0.268**	0.134	0.230
ER	0.234	-0.192	-0.125	0.017	-0.143	**0.299**	**0.376**	0.079	0.246
T1	**-0.297**	**-0.544**	**-0.420**	-0.178	**-0.413**	-0.050	**-0.300**	-0.003	-0.129
T7	-0.184	**-0.283**	**-0.278**	-0.192	**-0.294**	-0.125	**-0.462**	-0.001	-0.195
PD	0.071	-0.186	-0.052	0.031	-0.176	**0.779**	**0.277**	0.170	0.040
SUP	**0.351**	-0.048	-0.057	**0.250**	-0.183	**0.406**	**0.381**	0.205	**0.340**
NatR	**-0.256**	0.013	0.104	-0.156	**0.303**	-0.135	-0.076	-0.243	-0.147
TFR	0.019	**0.281**	**0.265**	-0.059	**0.356**	-0.092	0.114	-0.080	-0.051
TAb	-0.161	**0.537**	**0.555**	0.226	**0.502**	-0.028	**0.345**	0.059	0.206
C0104	0.027	0.132	0.066	-0.110	**0.426**	-0.171	0.024	-0.184	-0.091
Period	2005–2016	2005–2016	2005–2016	2005–2016	2009–2016	2010–2016	2010–2016	2010–2016	2010–2016

indicators. Apparently, other factors are more important for it, the correlation with which was not considered. Significant correlation coefficients are highlighted in bold in the table. A strong correlation between TAb and detection of new cases of diseases such as tuberculosis, syphilis and chronic viral hepatitis is noteworthy. It is possible that the diagnose could be one of the reasons why women decide to terminate their pregnancy.

Judging by the table of correlation, it can be assumed that international immigration has an impact on the spread of pediculosis and viral hepatitis in Russia. On the other hand, both diseases are more common in economically prosperous regions attractive to migrants, so the correlation may be accidental. Econometric modeling provides a more accurate image.

Tables 3–5 present the results of simulation. Equation coefficients are random values, so after each in brackets its standard deviation (standard error) is specified. The significance level of coefficients is indicated by asterisk: * – 0.1, ** – 0.05, *** – 0.01, **** – 0.001; N – number of observations, R^2 – determination coefficient.

Minor factors were excluded from the models except for migration indicators. A factor was also excluded from the model if it could be assumed that the sign of a coefficient is distorted as a result of multicollinearity. In Table 1, we see that for each disease there are hotspots of highest prevalence, with the situation changing rather slowly from year to year. Therefore, each model includes an additional factor – morbidity in the previous period.

Interpretation and discussion of results

The most important role in identifying new cases of each of the diseases under review belongs to the situation with the same disease in the previous year. These variables reflect the impact of factors operating in previous periods,

Table 3. Models to identify new cases of HIV, active tuberculosis and drug addiction

Factors	Explained variable		
	B1	B2	B4
Constant	3.42** (1.72)	13.92**** (3.31)	10.11**** (2.96)
M1(*t*-1)	-0.0714* (0.0381)	–	–
M2(*t*-1)	0.0647 (0.5833)	–	–
M1	–	0.0328 (0.0235)	0.0328** (0.0130)
M2	–	-0.293 (0.347)	-0.277 (0.196)
ILE	–	–	-3.275**** (0.977)
WS	-0.129*** (0.041)	–	–
Alc	-0.149** (0.073)	0.0213**** (0.0048)	–
ER	–	-0.190**** (0.057)	–
SUP	–	–	0.0649**** (0.0148)
T1	-0.405**** (0.076)	–	–
B1(*t*-1)	0.914**** (0.015)	–	–
B2(*t*-1)	–	0.935**** (0.008)	–
B4(*t*-1)	–	–	0.843**** (0.016)
B1	–	0.0317**** (0.0084)	–
B4	0.188**** (0.045)	–	–
t	–	-0.495**** (0.102)	-0.144**** (0.055)
Note			
N	906	907	911
R^2	0.868	0.949	0.798
Period	2006–2016	2006–2016	2006–2016

Table 4. Models to identify new cases of syphilis, enterobiasis and pediculosis

Factors	Explained variable		
	B3	B5	*Ln*(B6)
Constant	-5.43 (5.64)	-103.7**** (13.6)	-0.910** (0.417)
M1	0.0008 (0.0552)	-0.168 (0.131)	0.00121 (0.00159)
M2	0.665 (0.731)	0.319 (1.464)	0.00581 (0.01494)
LMI	-2.92*** (1.06)	–	–
WHW	–	0.447**** (0.133)	0.00474*** (0.00152)
ILE	–	–	0.174* (0.102)
NatR	–	11.33**** (3.10)	–
SUP	–	0.675**** (0.141)	0.00692**** (0.00186)
Ln(PD)	1.99**** (0.47)	–	–
TPr	0.650**** (0.179)	–	–
C0509	–	–	0.0230** (0.0113)
T1	-0.395**** (0.108)	–	–
B3(*t*-1)	0.785**** (0.016)	–	–
B5(*t*-1)	–	0.959**** (0.014)	–
Ln(B6(*t*-1))	–	–	0.865**** (0.020)
T	-0.857**** (0.207)	5.11**** (0.60)	–
Note			
N	907	581	491
R^2	0.871	0.928	0.900
Period	2006–2016	2010–2016	2011–2016

Table 5. Models to identify new cases of chronic and acute viral hepatitis

Factors	Explained variable		
	B7	B8	B9
Constant	-8.71*** (3.12)	0.7630**** (0.1956)	-0.7358*** (0.2743)
M1	-0.0021 (0.0542)	0.0032 (0.0029)	-0.0035 (0.0036)
M2	-0.526 (0.553)	0.0000 (0.0328)	0.0857** (0.0359)
LMI	2.01** (0.87)	–	0.0013** (0.0006)
NatR	–	-0.1833*** (0.0665)	–
SUP	0.0842** (0.0409)	–	0.0051* (0.0029)
Ln(PD)	–	0.0364** (0.0159)	–
TPr	–	–	0.0154* (0.0070)
B1	–	0.0014* (0.0007)	–
B3	0.0926**** (0.0207)	–	–
B4	–	–	0.0110*** (0.0039)
B7(*t*-1)	0.857**** (0.016)	–	–
B(*t*-1)	–	0.5030**** (0.0321)	–
B9(*t*-1)	–	–	0.5781**** (0.0307)
T	–	-0.0497*** (0.0180)	–
Note			
N	492	496	498
R^2	0.909	0.492	0.581
Period	2011–2016	2011–2016	2011–2016

included and excluded from the models. Thus, the correlation table and the table with model coefficients complement each other.

Econometric simulation has established a clear link between the spread of HIV, drug addiction, active tuberculosis, and acute hepatitis B and C. Drug addicts remain one of the main HIV and hepatitis C risk groups. HIV-positive people are at high risk of contracting tuberculosis and they more often diagnosed with hepatitis B than other population groups.

Among the diseases under review HIV is currently the greatest threat to the Russian population not only due to the severity of consequences, but also due to the fact that HIV epidemic in Russia is happening on a massive scale, although in 2016 the number of first diagnoses was less than in 2014–2015. According to the model, a typical region with the largest number of new cases detected is an entity with cold winter and low degree of alcohol abuse, without any significant problems with sewage. In other words, these are mostly relatively prosperous places. Perhaps, the reason is that HIV came to the USSR from abroad and the residents of more prosperous regions had more foreign contacts. At the same time, drug addiction incidence factor is significant in the model. From all this, it can be concluded that there is a problem with detecting HIV infection in the country. Drug addicts are diagnosed with HIV not only because they are one of the main risk groups (for comparison: in 2014, 21,000 people were diagnosed with drug addiction for the first time and the number of infected with HIV through intravenous drugs in the same year amounted to 22,468 people[9]), but also because they are obligatory examined for this disease. However, it can be argued that there is no widespread high prevalence of HIV infection yet, warm "national"[10] regions with a high share of rural population seem the most prosperous in this regard. However, the performance of the correlation coefficient between B1 and TPr is alarming: from -0.161 in 2005 to 0.033 in 2015 and 0.121 in 2016. This may indicate that the official number of HIV cases detected in 2016 has decreased, largely due to the fact that the number of examined people has decreased. Immigration and legal employment of foreign citizens do not affect HIV incidence for the reason that mostly migrant workers come from countries where HIV prevalence is much less than in Russia (exception – Ukraine).

The prevalence of tuberculosis is traditionally higher in poor and cold regions with poor housing conditions and relatively low levels of education. The simulation shows that new foci of active tuberculosis were more frequent in regions with higher levels of alcohol addictio, relatively low employment rate and higher HIV prevalence. It is not clear why there is a sustained high correlation between B2 and the share of pregnant women. There are two possible explanations. Either there are problems detecting the disease: it is detected where it is looked for, and pregnant women must be examined, or the reason is that in poor regions the birth rate is usually higher. The importance of the time factor with a negative coefficient indicates medical advances in fighting against tuberculosis. However, the HIV epidemic can reverse this process. This is evidenced by the fact that the correlation between B1 and B2 increases over time: from -0,030 in 2005 to

[9] HIV infection: information bulletin. No. 40. Central Research Institute of Epidemiology, Federal Research Center for HIV Prevention and Control. http://www.hivrussia.ru/files/bul_40.pdf

[10] In the southern republics, official statistics reflect the real situation even less than in other Russian regions as there HIV-infected are outcasts, so people refuse to be examined. Source: https://www.svoboda.org/a/29281743.html (accessed: 03.09.2018).

0,367 in 2016. The connection of tuberculosis with HIV infection is well known [11; 13; 16]. Immigration has no impact on the spread of tuberculosis, although in most countries of origin of migrant workers the incidence is higher, perhaps, for the reason that foreign citizens diagnosed with tuberculosis must leave the country[11]. Foreigners who are in the country without permits also pose a threat for the Russian citizens. Therefore, the state's objective is to stimulate legal employment for foreign citizens.

Models for B4 include a time factor with a significant negative coefficient, that is, in general, the severity of the drug addiction problem is reduced. The slowest decline in the number of new cases of drug addiction is in regions with a high share of urban population and a relatively low level of education, as well as in places attractive to labor immigrants. Drug addiction is the only disease where the coefficient under M1 variable is significant and positive. Therefore, either part of the migrants who apply for a patent to work in Russia are in fact drug distributors, or drug trafficking routes for some other reasons partly lie in the regions that attractive to labor immigrants. Perhaps in both cases we are talking about effective demand for drugs and migrant labor. This issue requires further research. It is noteworthy that the models for B4 have the lowest determination coefficient. Therefore, they probably lack some important factors that have not been considered here. Perhaps, if they were included in the model, the result would be different.

We have also found a statistically significant link between syphilis incidence and detecting chronic viral hepatitis, although syphilis incidence is declining rather rapidly and there is no progress in fighting against chronic viral hepatitis.

New cases of syphilis are most common in regions with low incomes, a relatively high share of pregnant women and a high population density. The last two factors suggest that there are serious problems detecting syphilis. After all, low population density can affect the access to health services. Unfortunately, official figures do not give an idea of what share of the region's population live in settlements without healthcare facilities. According to the model for B3, immigration has no impact on the spread of syphilis, which is probably explained by the fact that this is a disease which obliges a foreign citizen to leave the Russian territory if they are diagnosed with it.

Chronic viral hepatitis is a disease which is difficult to detect. This is evidenced by the correlation table and the model for B7. Apparently, people diagnosed with alcohol addiction (alcohol contributes to the transition of hepatitis B and C to a chronic form) and syphilis, as well as pregnant women must be examined for viral hepatitis, so these diseases are detected. The correlation with syphilis is stable decreasing with the incidence of alcohol addiction (from 0.364 in 2012 to 0.173 in 2016) and growing with the share of pregnant women (from 0.175 in 2010 to 0.280 in 2015). It can also be assumed that well-off urban residents of economically prosperous regions are most often examined on their own initiative. The factor of population density is also significant, that is in fact the factor in territorial accessibility of medical services.

N. Kovalenko, a representative of the MOO "Together against hepatitis" patient organization, says: "a person diagnosed with hepatitis may simply not know about it.

[11] The list of Infectious socially dangerous diseases justifying the refusal to issue or cancellation of the temporary residence permit of foreign citizens and stateless persons, or residence permit, or patent, or work permit in Russia: Order of the Ministry of Health of the Russian Federation no. 384n, dated 29.06.2015.

The state merely does not provide funds for treating viral hepatitis. Patients is treated at the regional level"[12]. However, in most cases regions also lack funding. However, since the 2000s, mandatory vaccination of children against hepatitis B has been introduced and any Russian under 55 can also be vaccinated free of charge[13]. However, social advertising in this regard in Russia is practically absent.

Viral hepatitis is often detected among HIV-positive people, hepatitis C being detected several times more often than hepatitis B [25; 26], however, from models for B7-B9, variable B1 is significant only in the model for B8, and the factor B4 – only in the model for B9. The latter can be explained by the fact that intravenous drug use is one of the main routes of both HIV and hepatitis C. The importance of factors such as population density (in the model for B8) and especially TPr (for B9) indicate that the detected cases of acute hepatitis B and C are only the top of the iceberg.

Immigrants are not obliged to undergo a medical examination to detect hepatitis, although a number of studies [19, 20] revealed a fairly high level of hepatitis among foreign citizens who arrive in Russia. The simulation shows that immigration is not a factor in spread of chronic viral hepatitis and acute hepatitis B in the Russian regions. However, factor M2 is significant in the model for B9 (acute hepatitis C).

Enterobiasis is called "a dirty hands disease" so it is not surprising that B5 has such a large correlation with lack of sewage and hot water. WHW factor is selected out of these two factors correlating among themselves for the model. Enterobiasis is also the only disease under review that is more common in national regions, especially with a high share of the urban population. The time factor indicates the deteriorating situation. In fact, in 2016 more cases were recorded in Russia (excluding Crimea) than in 2011–2015, although less than in 2009–2010. This may partly be due to the increasing share of young children as they get infected most often.

In the model for detecting pediculosis, the explained variable is taken in a logarithmic form as it has a log-normal distribution: the incidence rate in Moscow is several times higher than in the second and third worst regions for this indicator. It is quite a typical situation when urban primary school students have lice after visiting summer camps[14], so variables SUP and C0509 are significant in the model for *Ln* (B6). Other significant factors show the importance of sanitation at home, as wells the fact that more educated people prefer to consult a doctor, rather than self-medicate when they detects this delicate problem.

International migration has no impact on the spread of enterobiasis and pediculosis.

Thus, an econometric study has shown that immigration appears to have an impact only on the spread of drug addiction and acute hepatitis, and that other infectious diseases tend to be associated with poor sanitation and socio-economic conditions (tuberculosis, syphilis and enterobiasis), or there are problems detecting them, while the real incidence rate in the country is unknown (HIV and viral hepatitis). We also reveaed a significant statistical correlation between groups of diseases: 1) drug addiction, HIV, active tuberculosis,

[12] Hepatitis in Russia: standards of treatment and case patients are required. RIA news. Avaiable at: https://ria.ru/disabled_know/20150728/1151262234.html (accessed: 15.03.2018).

[13] Hepatitis B vaccination for adults. Available at: http://vrachmedik.ru/300-privivka-ot-gepatita-b-vzroslyim.html (accessed: 15.03.2018).

[14] Berishvilli N. Pediculosis spread to schools. *Isvestiya newspaper,* 2017. August 15th. Available at: https://iz.ru/628867/pedikulez-idet-v-shkolu (accessed: 15.03.2018).

acute hepatitis and 2) alcoholism, syphilis, chronic viral hepatitis.

It is noteworthy that the reliability of results of the econometric study is directly related to the quality of original statistics and unfortunately it cannot be considered satisfactory.

In general, the research results are consistent with the findings of the WHO regional office for Europe that there is no systematic link between migration and serious contagious diseases and that contagious diseases, including socially dangerous ones, are mainly linked to poverty.

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