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HIV AND HIV/TB COINFECTION: CLUSTER DISTRIBUTION OF REGIONS IN THE NORTHWESTERN FEDERAL DISTRICT OF RUSSIA

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Introduction. One of the main factors affecting TB burden is HIV progression and, in turn, PLWH predominantly die of TB.

The study purpose was to identify high risk regions of HIV, HIV/TB coinfection in NWFD of Russia between years of 2007 to 2018.

Materials and methods. K-means method was applied to identify HIV, HIV/TB incidence, prevalence and mortality rates, as well as share of heterosexual HIV transmission route clusters in 10 regions of NWFD. The need data were extracted from relevant forms of federal statistical observation between 2007 to 2018. NAO was excluded from cluster analysis due to absence of HIV/TB coinfection cases in study period. For holistic understanding of HIV/TB coinfection trends, TB incidence, prevalence and mortality rates were estimated too without including them in cluster analysis.

Results. Along with significant reduce in TB cases there was increase in HIV case data in most regions, especially in Arkhangelsk oblast where HIV incidence raised by 617.8% in period analyzed. Meanwhile Kaliningrad oblast became the only region where HIV incidence (–21.5%) and mortality (–65.6%), also HIV/TB incidence (–55.0%) is failed in 2007–2018. Heterosexual HIV transmission risk was high in almost all regions, especially in NAO (100.0%), Pskov (89.2%), Novgorod (78.8%) oblasts. K-means method detected the highest HIV spread in Arkhangelsk oblast (first cluster), lowest — in Kaliningrad, Leningrad, Murmansk oblasts and St. Petersburg (third cluster). Other regions with intermediate HIV case data formed second cluster. HIV/TB coinfection most rapidly spreads in Arkhangelsk, Pskov and Novgorod oblasts (first cluster), most slowly — in Kaliningrad, Leningrad oblasts and in St. Petersburg (third cluster). In other regions, spread of HIV/TB coinfection has average rate, forming second intermediate cluster.

Conclusion. Along with significant improvement in TB epidemic, spread of HIV and HIV/TB coinfection in regions of NWFD considered as uneven. In regions with high concentration of HIV cases, HIV and HIV/TB coinfection rates are slowed down. Conversely, highest rates of HIV cases, as well as of HIV/TB coinfection case data, are observed in regions with low HIV accumulation, indicating the need to strengthen TB measures in PLWH in regions with a low spread of HIV.

Keywords: HIV, HIV/TB coinfection, cluster analysis, Northwestern Federal District

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ВИЧ-ИНФЕКЦИЯ И КОИНФЕКЦИЯ ВИЧ/ТБ: КЛАСТЕРНОЕ РАСПРЕДЕЛЕНИЕ РЕГИОНОВ В СЕВЕРО-ЗАПАДНОМ ФЕДЕРАЛЬНОМ ОКРУГЕ РОССИИ

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Введение. Одним из основных факторов, влияющих на бремя туберкулеза (ТБ), является прогрессирование эпидемии ВИЧ-инфекции, в свою очередь, люди, живущие с ВИЧ, преимущественно умирают от ТБ.

Цель. Определение регионов высокого риска распространения ВИЧ-инфекции и коинфекции ВИЧ/ТБ в СЗФО России за 2007–2018 гг.

Материалы и методы. Для кластеризации территорий по динамике показателей заболеваемости, пораженности и смертности при ВИЧ-инфекции и ВИЧ/ТБ, а также доле гетеросексуального риска распространения ВИЧ-инфекции был применен метод к-средних в 10 регионах СЗФО. Анализируемые данные были получены из соответствующих форм федерального статистического наблюдения за период с 2007 по 2018 г. НАО был исключен из кластерного анализа из-за отсутствия случаев коинфекции ВИЧ/ТБ за исследуемый период. Также для целостного понимания тенденций распространения коинфекции ВИЧ/ТБ оценивалась динамика заболеваемости, распространенности и смертности от ТБ без включения этих данных в кластерный анализ.

Результаты и их обсуждение. Наряду со значительным снижением случаев ТБ, в большинстве регионов наблюдается рост распространения ВИЧ-инфекции, особенно в Архангельской области, где заболеваемость ВИЧ-инфекцией за анализируемый период увеличилась на 617,8%. Между тем Калининградская область стала единственным регионом, где в 2007–2018 гг. снизились заболеваемость (–21,5%) и смертность от ВИЧ (–65,6%), а также заболеваемость ВИЧ/ТБ (–55,0%). Риск гетеросексуальной передачи ВИЧ был высоким почти во всех регионах, особенно в НАО (100,0%), Пскове (89,2%), Новгороде (78,8%). Методом к-средних установлено наибольшее распространение ВИЧ-инфекции в Архангельской области (первый кластер), наименьшее — в Калининградской, Ленинградской, Мурманской областях и Санкт-Петербурге (третий кластер). Другие регионы с промежуточными данными о случаях ВИЧ-инфекции сформировали второй кластер. Коинфекция ВИЧ/ТБ наиболее быстро распространяется в Архангельской, Псковской и Новгородской областях (первый кластер), наиболее медленно — в Калининградской, Ленинградской областях и Санкт-Петербурге (третий кластер). В других регионах распространение коинфекции ВИЧ/ТБ имеет средние темпы, образовавшие второй промежуточный кластер.

Заключение. На фоне значительного улучшения ситуации по ТБ распространение ВИЧ-инфекции и коинфекции ВИЧ/ТБ в регионах СЗФО является неравномерным. В регионах с высокой кумуляцией случаев ВИЧ-инфекции распространение ВИЧ-инфекции и коинфекции ВИЧ/ТБ замедлилось. И наоборот, самые высокие показатели заболеваемости ВИЧ-инфекцией, а также самое высокое распространение коинфекции ВИЧ/ТБ наблюдаются в регионах с низким уровнем накопления ВИЧ, что указывает на необходимость усиления мер по борьбе с туберкулезом среди ЛЖВ в регионах с низким уровнем распространения ВИЧ-инфекции.

Ключевые слова: ВИЧ-инфекция, сочетание ТБ/ВИЧ, кластерный анализ, СЗФО

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Introduction. According to the World Health Organization (WHO) data approximately 10.0 million people are developed tuberculosis (TB) and 1.3 million died of the disease in HIV-negative population along with registration of additional 214 000 TB deaths in people living with HIV (PLWH) in 2020 [1, 2]. Human immunodeficiency virus (HIV) is one of the most important risk factors for active TB [3]. The

Russian Federation (RF) carries the one of the biggest burden of HIV in Eastern Europe and Central Asia with more than 80% of the sectoral HIV burden¹. On the other hand, TB burden in the country level is reduced significantly in the past years, including penitentiary system which is remaining as a permanent source of the infection [4, 5]. Northwestern Federal District (NWFD), like the rest of seven RF

¹ ВИЧ-инфекция в странах Восточной Европы и Центральной Азии. Региональные достижения и проблемы. Семинар по результатам конференции IAS-2017. <http://www.hivrussia.info/wp-content/uploads/2019/01/VICH-infektsiya-v-stranah-VETSA.-Regionalnye-dostizheniya-i-problemy-IAS-2017.pdf>. Дата обращения: 24.12.2021.

districts, is plagued by the HIV epidemic being the second, after Central Federal District, with the level of TB prevalence [6, 7]. In 2018 NWFD identified 4.7% of HIV/TB cases from the total 41 428 coinfecting subjects in Russia as a whole [8].

Despite the importance of HIV/TB coinfection and the epidemiological and clinical correlation between the two diseases, there are still few publications on their geographical cluster distribution. We found only a number of studies from each country endeavored to observe spatial clustering patterns between HIV, TB and HIV/TB coinfection. In the study provided in 1990th in New York metropolitan region the authors found out that the high HIV prevalence in certain region have accompanied by a high number of TB cases [9]. A study provided in Uganda identified space cluster of each infection (HIV, TB and HIV/TB coinfection), and concluded that TB and HIV rates were significantly affected each other [10]. Another analysis conducted in China identified five prefectures in Western part of country as the high risk clusters of TB [11]. In South Africa, also was showed an uneven concentration of TB cases in the country [12]. Heterogeneous concentration of HIV/TB cases were identified in the regions of Kenya and Brazil [13, 14]. In Ethiopia, despite the dramatically decrease in HIV prevalence, there are still have remained unique risk factors that accelerated HIV transmission forming high risk regions [15].

In Russia there were no publications identified the high risk regions of HIV, TB and their combination by geographical cluster distribution. We found very few cluster studies related to HIV and TB risk factors and molecular epidemiology of TB. So, Yakovlev A.A. analyzing the factors influencing on TB in Primorskiy Kray, identified the poverty, unemployment, alcohol consumption and drug use, also pollution and TB mortality as the negative clusters [16]. A molecular epidemiological study conducted in Omsk oblast has demonstrated that 77.0% of clustering isolates of *Mycobacterium Tuberculosis* belonged to the Beijing genetic family [17]. Considering the external migration as the HIV risk factor, and clustering the regions of Asia and Africa by certain HIV patterns, Dmitriev R.V. concluded that the major contribution to the HIV epidemic in Russia have made migrants from Asia, especially from former Soviet countries [18]. Cluster analysis provided in Perm Kray showed that one of the criteria for choosing the optimal antiretroviral treatment (ART) regimen is the assessment of the patterns of gender, HIV/AIDS stage at the beginning of ART,

comorbidity, HIV transmission risk [19]. Fedyeva O.N and coauthors clustering of HIV-infected patients by patterns of adherence to ART, identified that the key factors of non-adherence of patients to the treatment were marital status, education, alcohol consumption, change in ART regimen, polypharmacy, neuropathy, unknown fever, high viral load [20].

We have to say, that we did not find any cluster analysis related to the HIV/TB coinfection challenges in Russia, though the method can most accurately identify the high risk regions which is helpful in prioritizing resource assignment. Thus, the aim of our study was to identify the high risk regions of HIV and HIV/TB coinfection in NWFD of Russia by cluster method in order to know where the targeted interventions are most needed.

Materials and methods. An analytical epidemiological study in 11 regions of NWFD predominantly from 2007 to 2018 was conducted. For cluster analysis of 10 regions of NWFD by estimating of HIV and HIV/TB coinfection incidence, prevalence and mortality rates along with a share of heterosexual HIV transmission risk in 2017, considered as the most intensive route promoting the generalization of the HIV epidemic, the k-means method was used with a normalization of variables to the maximum indicator. The optimal number of clusters was validated by a preliminary grouping of regions and constructing a hierarchical tree. The Nenets Autonomous Okrug (NAO) due to the absence of HIV/TB coinfection cases in the region in the study period was excluded from cluster analysis. The HIV/TB mortality was estimated by applying to proportion of TB deaths among all died PLWH, as well as among HIV/TB patients died of all causes in the period from 2007 to 2015. The timeframe from 2007 to 2015 for analysis of TB deaths among PLWH in the study has been chosen due to stopping to register these data separately in the country since 2016. NAO has been a part of Arkhangelsk oblast until 2008, so the regional HIV, TB and HIV/TB coinfection data were available only from 2009. For holistic understanding of the HIV/TB coinfection trends in NWFD the TB incidence, prevalence and mortality rates in 2007–2018 were evaluated too, but without including them in cluster analysis due to the almost equal changes of TB patterns in regions in the period analyzed. Statistical measures of obtained data were performed on the SPSS 17.0 platform.

Epidemiological data were extracted from the relevant forms of federal statistical observation: No. 61

«Information on the patients with HIV infection», renamed in 2015 to «Information on the disease caused by the human immunodeficiency virus», No. 33 «Information on patients with tuberculosis», No. 8 «Information on active tuberculosis» and No. 4 «Information on the HIV testing». The study was approved by the Ethic Committee of St. Petersburg Research Institute of Phthisiopulmonology in 2020 (protocol no. 85/1).

Results and discussion. A trend of significant reduce in TB incidence, prevalence and mortality from 2007 to 2018 was registered almost in all regions of NWFD, excluding NAO, where TB prevalence during the period analyzed has increased by 47.1% (Table 1). Conversely, there was an increase in HIV data almost in all regions, except Kaliningrad oblast (Klg). The region, along with simultaneously improvement in the TB epidemic, was the only one in NWFD, where HIV incidence and mortality from period of 2007 to 2018 has declined by 21.5% and 65.6%, respectively, allowing the oblast

came out from the number of territories of the RF with a high HIV burden.

In St. Petersburg (SPT) and Leningrad oblast (Len), reduce in HIV incidence, and slowdown it in Murmansk oblast (Murm) (–36.7%, –47.8% and 2.9%, respectively) are leveled by a high rates of HIV prevalence (618.4%, 601.7% and 442.6%, respectively) compared to the average HIV prevalence rate in NWFD as a whole (10.2%) between 2007 to 2018.

In Arkhangelsk oblast (Arkh) increase in HIV incidence amounting to 617.8% in 2007–2018 has dramatically prevailed over its rates in other regions and NWFD as a whole (–13.5%). Meantime in the region a crucial improvement in the TB epidemic at the period analyzed is observed, what was confirmed by a highest decrease in TB prevalence (–82.6%) and mortality (–83.5%) rates to compare to data in other 10 regions of NWFD.

On the other hand, in St. Petersburg, Leningrad and Murmansk oblasts, along with a notable reduce in the spread of HIV, mainly determining by decrease or slowed down in HIV incidence (see above), the TB epidemic continues to remain as a big challenge. Thus, in St. Petersburg, TB incidence is declining much slowly than in NWFD as a whole (–22.0% versus –53.9%), in Leningrad and Murmansk oblasts, the TB prevalence is also decreasing more slowly than in NWFD as a whole, amounting to –46.2% and –52.0% versus –58.5%, respectively in 2007–2018. In Novgorod (Nov), Pskov (Pskov) oblasts,

NAO and Komi Republic (Komi), the HIV epidemic as well as the TB cases are equally considered as unfavorable. The similar situation was noted in Vologda oblast (Vol), but with the lower HIV and TB patterns rates than in the last listed regions.

In most regions, the heterosexual transmission risk of HIV is predominated in 2017, especially in NAO (100.0%), Pskov (89.2%), Novgorod (78.8%), Murmansk (63.4%) oblasts, thereby intensifying and exacerbating the generalization of HIV infection in the regions.

Based on the analyzed above variables and on preliminary constructed dendrogram, the regions of NWFD formed three clusters of «typical» territories (Fig. 1). Using the k-means method, Arkhangelsk oblast was assigned to the first cluster as the territory with the highest HIV patterns rates (Table 2).

Dendrogram obtained using the nearest-neighbor method
Grouping clusters by scalable distance

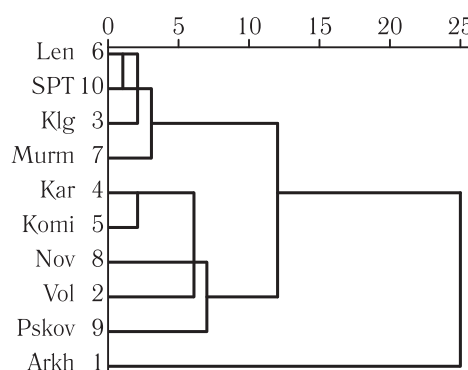


Fig. 1. Cluster distribution dendrogram of the regions of NWFD by HIV incidence, prevalence, mortality rates and share of heterosexual HIV risk

Рис. 1. Кластерная дендрограмма распределения регионов СЗФО по заболеваемости, распространенности, смертности от ВИЧ-инфекции и доле гетеросексуального риска заражения ВИЧ

The second cluster included Vologda, Novgorod, Pskov oblasts, Karelia (Kar) and Komi republics as regions with a relatively equal level of spread of HIV infection. The third cluster consisted of regions with high rates of decline in HIV case data in 2007–2018: Kaliningrad, Leningrad, Murmansk oblasts and St. Petersburg.

The analysis of the trends of HIV/TB coinfection incidence rate also revealed a significant decrease in Kaliningrad oblast (–55.0%), after NAO, where there no HIV/TB coinfection case during the study period have been registered (Table 3).

In addition, in Kaliningrad oblast, assigned to the region with a high cumulation of HIV cases at the beginning of the HIV epidemic in Russia, the lowest

Table 1
HIV and TB case data rates and share of heterosexual HIV transmission risk in the regions of NWFD, 2007–2018
Показатели заболеваемости ВИЧ-инфекцией и туберкулезом и доля риска передачи ВИЧ гетеросексуальным путем в регионах СЗФО, 2007–2018 гг.

Variables/Regions	Arkh	Vol	Klg	Kar	Komi	Len	Murm	Nov	Pskov	SPT	NAO	NWFD
HIV infection												
Incidence												
2007, per 100 000 population	4.5	11.4	53.4	12.9	13.8	71.2	48.7	20.5	6.2	101.4	11.9	54.1
Rate in 2007–2018, %	617.8	243.9	–21.5	310.9	300.0	–36.7	2.9	172.7	225.8	–47.8	15.1	–13.5
Prevalence												
Heterosexual HIV risk factor in 2017, %	49.6	48.3	56.9	59.8	51.6	55.3	63.4	78.8	89.2	36.5	100.0	51.6
2007, per 100 000 population	18.3	83.9	444.3	70.1	95.9	602.8	247.0	139.2	42.9	764.5	31.0*	406.4
Rate in 2007–2018, %	118.8	163.0	502.6	226.0	261.3	618.4	442.6	366.6	153.4	601.7	118.2	10.2
Mortality												
2007, per 100 000 population	0.6	2.5	32.3	1.2	2.5	19.5	5.0	4.7	1.0	8.9	0.0	2.1
Rate in 2007–2018, %	200.0	36.0	–65.6	91.7	140.0	1.0	28.0	183.0	290.0	23.6	—	357.1
Tuberculosis												
Incidence												
2007, per 100 000 population	59.2	46.9	134.0	71.0	95.3	69.3	58.2	67.8	90.5	37.3	40.5	62.3
Rate in 2007–2018, %	–64.9	–66.3	–73.3	–70.3	–55.1	–57.0	–61.5	–46.2	–58.8	–22.0	–71.9	–53.9
Prevalence												
2007, per 100 000 population	99.6	101.3	261.2	150.8	167.3	126.5	129.5	179.7	188.0	107.2	14.0*	134.7
Rate in 2007–2018, %	–82.6	–63.5	–75.0	–54.3	–58.7	–46.2	–52.0	–59.2	–46.3	–52.6	47.1	–58.5
Mortality												
2007, per 100 000 population	12.7	10.0	18.3	21.7	14.2	24.2	10.0	8.2	15.4	13.1	0.0	15.7
Rate in 2007–2018, %	–83.5	–76.0	–82.0	–82.9	–57.0	–76.0	–71.0	–62.2	–52.6	–77.9	0.0	–77.1

* Data in 2009, until 2009 NAO was as a part of Arkhangelsk oblast.

Table 2

Cluster distribution of the regions of NWFD by HIV rates and share of the heterosexual HIV transmission route (k-means method)

Таблица 2			
Кластерное распределение регионов СЗФО по уровню распространения ВИЧ-инфекции и доле гетеросексуального пути передачи ВИЧ (метод k-средних)			
Clusters	Regions		Number
	1	Arkhangelsk oblast	1
	2	Vologda, Novgorod, Pskov oblasts, Komi and Karelia republics	5
	3	Kaliningrad, Leningrad, Murmansk, and St. Petersburg	4
Valid	10		
Omitted	0		

share of TB deaths in all died PLWH (20.1%) was occurred in 2015 to compare to St. Petersburg (30.3%) and Leningrad oblast (23.0%) also considered as the regions with a high HIV prevalence [7]. So, Kaliningrad oblast, similarly to the case of the HIV epidemic, came out from the number of territories with a high HIV/TB coinfection burden.

Meanwhile, the highest increase in HIV/TB coinfection incidence is observed in the regions with a low cumulation of HIV cases [7]. These regions are Arkhangelsk, Pskov, Novgorod oblasts and Komi Republic, where HIV/TB coinfection incidence rates between 2007 to 2018 has raised by 600.0%, 220.0%, 120.8% and 266.7% respectively, when in the period analyzed in NWFD as a whole there was no change in HIV/TB coinfection incidence rate (0.0%). The HIV/TB coinfection prevalence also had a notable trend to rise in mentioned regions amounting by 150.0% in Arkhangelsk oblast, 565.0% in Pskov oblast, 587.5% in Novgorod oblast and by 211.5% in Komi Republic in period of 2007 to 2018. There are in Murmansk and Vologda oblasts an increase in HIV/TB coinfection incidence and prevalence was registered too, amounting respectively by 104.3% and 100.0%, by 311.8% and 190.9% in 2007–2018.

Interestingly in St. Petersburg and Leningrad oblast, as we noted above, belonged to the regions with a high HIV occurrence, the HIV/TB coinfection incidence rates were the lowest in NWFD after Kaliningrad oblast, amounting 14.8% and 79.6% respectively in the period analyzed. The most expression of slowing down of HIV prevalence in NWFD from 2007 to 2018 was registered in St. Petersburg (16.7%), then in Kaliningrad oblast (40.3%) and Leningrad oblast (82.0%) what significantly less than in regions with a low HIV prevalence.

Low rates of HIV/TB coinfection incidence, prevalence and proportion of TB deaths in PLWH in Karelia Republic is due to registration artifact when

incarcerated patients infected with HIV/TB arrived to the regional penitentiary TB facilities from other regions of R were taken into account in 2007.

The total number of HIV patients died of TB from 2007 to 2015 in NWFD was 43900 subjects which amounted by 25.2% of all deaths in PLWH and by 80.6% of those who coinfecting with HIV/TB and died of any causes in the period analyzed.

Dendrogram obtained using the nearest-neighbor method
Grouping clusters by scalable distance

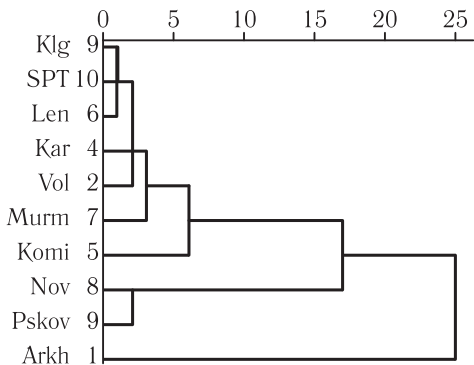


Fig. 2. Cluster distribution dendrogram of the regions of NWFD by HIV/TB coinfection incidence, prevalence rates (2007–2018) and share of TB deaths among PLWH (2007–2015)

Рис. 2. Кластерная дендрограмма распределения регионов СЗФО по заболеваемости коинфекцией ВИЧ/ТБ, ее распространенности (2007–2018 гг.) и доле смертей от туберкулеза среди ЛЖВЗ (2007–2015 гг.)

Figure 2 and Table 4 are illustrated that the cluster analysis using the k-means method identified the Arkhangelsk, Pskov and Novgorod oblasts as regions with the highest dynamical changes in the spread of HIV/TB coinfection in NWFD (the first cluster). Vologda and Murmansk oblasts, as well as Komi Republic, having an intermediate level of the HIV/TB coinfection spread, were included in the second cluster.

The third cluster is formed by Kaliningrad and Leningrad oblasts, also by St. Petersburg as the regions with the negative or lowest rates of HIV/TB coinfection data. The inclusion of Karelia Republic in

Table 3
HIV/TB coinfection incidence, prevalence and share of TB deaths in PLWH in the regions of NWFD, 2007–2018, 2007–2015
Таблица 3
Заболееваемость коинфекцией ВИЧ/ТБ, ее распространенность и доля смертей от ТБ среди ЛЖВ в регионах СЗФО, 2007–2018, 2007–2015 гг.

Variables/Regions	Arkh	Vol	Klg	Kar**	Komi	Len	Murm	Nov	Pskov	SPT	NAO	NWFD
HIV/TB incidence	2007 (per 100 000 population)	0.2	1.1	12.9	0.9	1.2	4.9	2.3	1.0	5.4	0.0	5.2
HIV/TB prevalence	Rates in 2007–2018 (%)	600.0	100.0	–55.0	77.8	266.7	79.6	104.3	220.0	14.8	0.0	0.0
TB deaths in all died PLWH in 2007–2015	2007 (per 100 000 population)	0.4	1.1	20.6	26.6	2.6	12.2	3.4	2.0	12.6	0.0	9.3
	Rates in 2007–2018 (%)	150.0	190.9	40.3	–69.5	211.5	82.0	311.8	565.0	16.7	0.0	49.5
	N	41	77	439	103	65	1015	100	40	2466	00	4390
	Share (%)	25.2	15.5	20.1	46.4	16.4	23.0	14.0	22.2	30.3	0.0	25.2
TB deaths in all died HIV/TB patients in 2007–2015 (%)		78.8	72.6	74.5	91.2	68.4	78.6	64.9	58.8	84.7	0.0	80.6

* The HIV/TB patients arrived to the penitentiary system of the region from other territories of Russia was taken into account.

** Учитывались пациенты с ВИЧ/туберкулезом, прибывшие в пенитенциарную систему региона из других территорий России.

Table 4
Cluster distribution of the regions of NWFD by HIV/TB coinfection data (k-means method), 2007–2018, 2007–2015
Таблица 4
Кластерное распределение регионов СЗФО по показателям коинфекции ВИЧ/ТБ (метод k-средних), 2007–2018, 2007–2015 гг.

Clusters	Регионы	Количество
1	Arkhangelsk, Pskov, Novgorod oblasts	3
2	Vologda, Murmansk oblasts and Komi Republic	3
3	Kaliningrad, Leningrad oblasts, St. Petersburg and Karelia Republic*	4
Valid	10	
Omitted	0	

* Artifact of registration of HIV/TB patients arrived to the penitentiary system of the region in 2007.

* Данные о регистрации больных ВИЧ/ТБ поступили в пенитенциарную систему региона в 2007 г.

this cluster is due to the registration artifact of HIV/TB coinfecting patients who arrived in the regional penitentiary system from other territories of Russia in 2007.

Conclusion. Our analysis shows that along with an overall improvement in the TB epidemic, there is geographical heterogeneity in spread of HIV and HIV/TB coinfection in NWFD. The HIV/TB co-infection, as well as the HIV epidemic, has the highest rates of spread in regions with a low cumulation of HIV cases, especially in Arkhangelsk, Pskov, Novgorod oblasts and Komi Republic. In St. Petersburg, Leningrad and

Kaliningrad oblasts, assigned as the regions with a high concentration of HIV cases, the rate of its spread, as well as the rates of HIV/TB coinfection cases, are significantly decreased or slowed down in the period analyzed. The most expression of the changes is observed in Kaliningrad oblast, allowing the region to come out from the number of HIV and HIV/TB coinfection high-burden areas during the study period. The study determines the need to strengthen TB measures in PLWH in regions with a low concentration of HIV cases, but with a high rate of spread of HIV along with a predominance of heterosexual transmission route.

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