MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN

SULEYMAN DEMIREL UNIVERSITY

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Analysis and the development of a mathematical model of the incidence of tuberculosis among adolescents

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Аңдатпа

Туберкулез - бұл жоғары әлеуметтенген ауру. Туберкулезбен сырқаттанушылық пен халықтың өлім-жітімі туберкулезге шалдығу жағдайын сипаттайтын маңызды эпидемиологиялық көрсеткіштер болып табылады. Демографиялық және медициналық-ұйымдастырушылықтан басқа, жоғарыда көрсетілген көрсеткіштерді қалыптастыру үшін әлеуметтік-экономикалық факторлар белгілі бір үлес қосады.

Зерттеудің мақсаты - Қазақстан Республикасында туберкулезбен сырқаттанушылық пен өлімге әлеуметтік-экономикалық факторлардың әсерін зерттеу.

Қазақстан Республикасында туберкулез ауруына шалдығудың мүмкіндігіне медициналық қызмет пен әлеуметтік-экономикалық факторлардың әсерін анықтау үшін корреляциялық және көпөлшемді регрессиялық талдау жүргізіледі.

Annotation

Tuberculosis is a disease that is highly socialized. Tuberculosis morbidity and mortality of the population are important epidemiological indicators that characterize the tuberculosis infection situation. In addition to demographic and medico-organizational, a certain contribution is made socio-economic factors to the formation the above indicators.

The study's objective is to study the impact of socio-economic factors on tuberculosis incidence and mortality in the Republic of Kazakhstan.

The correlation and multiple regression analysis is carried out to define influence of medical service and socio-economic factors on incidence of tuberculosis in the Republic of Kazakhstan.

Аннотация

Туберкулез - это болезнь, которая сильно социализирована. Заболеваемость и смертность от туберкулеза являются важными эпидемиологическими показателями, характеризующими ситуацию с туберкулезной инфекцией. Помимо демографических и медико-организационных, определенный вклад вносят социально-экономические факторы в формирование вышеуказанных показателей.

Целью исследования является изучение влияния социально-экономических факторов на заболеваемость и смертность от туберкулеза в Республике Казахстан.

Проводится корреляционный и множественный регрессионный анализ, чтобы определить влияние медицинского сервиса и социально-экономических факторов на заболеваемость туберкулезом в республике.

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INTRODUCTION

i) Motivation

TB is one of the top 10 death causes and the leading cause of one infectious agent (above HIV / AIDS). Every year, millions of people continue to become sick with TB. TB caused an estimated 1.3 million deaths (range, 1.2–1.4 million) among HIV-negative people in 2017, and an additional 300,000 deaths from TB among HIV-positive people (range, 266,000–335,000).

Overall, the best estimate is that in 2017 10.0 million people (range, 9.0–11.1 million) developed TB disease: 5.8 million men, 3.2 million women, and 1.0 million children. There were cases in all countries and age groups, but overall 90 % were adults (age ĩ5), 9 % were people living with HIV (72 % in Africa), and two thirds were in eight countries: India, China, Indonesia, the Philippines, Pakistan, Nigeria, Bangladesh, and South Africa[11].

Drug-resistant TB remains a crisis of public health. The best estimate is that 558 000 people worldwide (range, 483 000–639 000) developed rifampicin-resistant tuberculosis (RR-TB), the most effective first-line drug, in 2017, of which 82 % had multidrug-resistant tuberculosis (MDR-TB). Nearly half of the world's MDR, RR-TB cases accounted for three countries: India, China and the Russian Federation.

TB mortality rates (i.e. TB deaths among HIV-negative people per 100 000 population per year) are falling by about 3 percent per year and the overall decrease was 42 percent between 2000 and 2017.

The incidence rate of TB is falling around 2 percent per year worldwide. From 2013 to 2017, the fastest regional declines were in the European region of the WHO and the African region of the WHO. In the same five years, particularly impressive reductions (4–8 percent per year) occurred in southern Africa (e.g., Eswatini, Lesotho, Namibia, South Africa, Zambia and Zimbabwe), following a peak in the HIV epidemic and the expansion of TB and HIV prevention and care; and in the Russian Federation (5 percent per year), following intensified efforts to reduce the burden of TB and progress scrutiny.

ii) Aims and objectives

Tuberculosis at children arises most often directly after contact with a source of a tuberculosis infection, and, therefore, the indicator of incidence of children theoretically has to reflect rather reliably the general epidemic situation on tuberculosis [9]. At infection of children the absence or formal isolation of the patient, first of all plays a role in the bacillar centers [1]. According to the Mitino L.A., the risk of infection of children from the centers of tuberculosis is 22 times higher, than children from a healthy environment. The incidence of tuberculosis of children and teenagers depends on many factors in the centers including preventive actions, terms of detection of a disease and also from efficiency of treatment of adult patients that does a problem of early diagnostics of one of the most current problems of modern phthisiology. Also development of methodology and organizational technologies of complex estimation of antitubercular activity as bases of optimization of management of service is relevant.

By means of mathematical methods to make calculation of a coefficient of correlation of epidemiological indexes of incidence of tuberculosis of teenagers from the centers of a tuberculosis infection and effectiveness about the TB specialistы of the events held in the republic in 10 years. Clarification of correlation communication of indexes will promote development of methodology and assessment of antitubercular activity of service of TB specialists.

1. ABOUT TUBERCULOSIS

Nowadays, tuberculosis (TB) is the leading infectious cause of death. It is transmitted by airborne droplets and can hit any of us. More than 5,000 women, men and children continue to die from tuberculosis every day. Its consequences for society and the economy are devastating and mean poverty, stigma and discrimination. This disease can be cured and prevented, but global action and investment is well below the level needed to eradicate the tuberculosis epidemic in the world.

Tuberculosis (TB) is one of 10 leading causes of death in the world. In 2017 10 million people, and 1.6 million people got sick with tuberculosis (including 0.3 million people with HIV) died of this disease.

Tuberculosis is main reason of mortality of HIV-positive people. By estimates, in 2017 1 million children got sick with tuberculosis, and 230,000 children died of it (including children with the HIV-associated tuberculosis).

Tuberculosis with multiple drug resistance (MDR-TB) still represents crisis in the field of public health care. By estimates of WHO, there were 558,000 new cases of tuberculosis to rifampicin resistance ? to the most effective drug of the first line, ? from which in 82 % of cases there was MDRTB.

On a global scale the incidence of tuberculosis decreases approximately by 2 % a year. For achievement of the control indicators for 2020 provided by Strategy for elimination of tuberculosis, it is necessary to accelerate these rates of decrease to 4–5 % a year.

By estimates, from 2000 for 2017 thanks to diagnostics and treatment of tuberculosis 54 million human lives were saved. One of tasks in the field of health care within the Purposes in the field of sustainable development is in that by 2030 to finish tuberculosis epidemic.

The causative agent of tuberculosis is the bacterium (Mycobacterium tuberculosis most of which often affects lungs. Tuberculosis is curable and preventable[11].

Tuberculosis extends from the person to the person by air. At cough, sneezing or expectoration people with pulmonary tuberculosis allocate in air of a bacterium of tuberculosis. For infection it is enough to person to inhale only insignificant quantity of such bacteria.

About one quarter of world's population have latent tuberculosis. It means that people are infected with tuberculosis bacteria, but (for the present) did not ache with this disease and cannot transmit it.

The risk that the people infected with tubercular bacteria throughout the life will get sick with tuberculosis is 5 – 15 %.However people with the weakened immune system, such as people with HIV, insufficiency of food or diabetes or the people using tobacco are exposed to much higher risk of a disease.

When at the person the active form of tuberculosis develops, symptoms (cough, fever, night sweat, loss of weight, etc.) can be moderate within many months. It can lead to the overdue request for medical care and transfer of bacteria to other people. For a year of people, the TB patient, can infect till 10-15 other people with whom it has close contacts. Without appropriate treatment on average of 45 % of HIV-negative people with tuberculosis and almost all HIV-positive people with tuberculosis will die.

Tuberculosis affects mainly adults in their most productive years. However all age groups are exposed to risk. More than 95 % of cases and death take place in developing countries.

At the people infected with HIV, the probability of development of an active form of tuberculosis increases at 20-30 times. Also the people suffering from other disturbances of health weakening the immune system are exposed to higher risk of development of active tuberculosis.

In 2017 1 million children (0–14 years) got sick with tuberculosis and 230,000 children (including children with the HIV-associated tuberculosis) died of this disease.

The tobacco use considerably increases risk of a disease of tuberculosis and death from it. 7.9 % of cases of tuberculosis in the world are connected with smoking.

Tuberculosis is present everywhere at the world. In 2017 the greatest number of new cases of tuberculosis took place in regions of Southeast Asia and the Western part of the Pacific Ocean of which 62 % of new cases were the share. Further the African region where 25 % of new cases were registered follows.

In 2017 87 % of new cases of tuberculosis took place in 30 countries with a heavy burden of tuberculosis. On a share of eight countries – India, China, Indonesia, Philippines, Pakistan, Nigeria, Bangladesh and South Africa – two thirds of new cases of tuberculosis were necessary.

The general symptoms of active pulmonary tuberculosis are cough sometimes with a phlegm and blood, the stethalgia, weakness, loss of weight, fever and night sweat. For diagnosing of tuberculosis many countries still rely on the used method called by phlegm smear microscopy long ago. Specially trained laboratory assistants investigate phlegm smears under a microscope for the purpose of detection of tubercular bacteria. The microscopy allows to reveal only a half of cases of tuberculosis and does not allow to find medicines resistance.

Use of a rapid test of Xpert MTB/RIF® widely extends since 2010 when WHO for the first time recommended its use. By means of the test tuberculosis and rifampicin resistance – to the most important antitubercular drug at the same time come to light. The diagnosis can be made within two hours, and now this test is recommended to WHO as initial diagnostic test for all people with signs and symptoms of tuberculosis.

Diagnosing of tuberculosis with multiple medicinal resistance (MDRTB) and tuberculosis with broad medicinal stability and also HIV-associated of tuberculosis can be difficult and expensive. In 2016 four new diagnostic tests – a molecular rapid test for tuberculosis detection in peripheral medical institutions where there is no opportunity for test of Xpert MTB/RIF, and three tests for detection of resistance to anti-tuberculous remedies of the first and second line were recommended to WHO.

It is especially difficult to diagnose tuberculosis for children, and the only widely available test helping to find in them a disease, Xpert MTB/RIF meanwhile is.

Tuberculosis can be treated and cured. In case of a form of a disease, active, sensitive to drugs, the standard six-months course of treatment is conducted by four antimicrobial drugs when providing the patient with information, observation and support from the worker of health care or the volunteer assistant who had special training. Without such observation and support there can be difficulties in observance of medical instructions concerning treatment, and the disease can extend further. The vast majority of cases of tuberculosis can be cured on condition of appropriate providing and drug intake.

By estimates, 54 million human lives were saved from 2000 to 2017 thanks to diagnostics and treatment of tuberculosis. Probability that at the people living with HIV the active form of tuberculosis will develop at 20-30 times exceeds a similar indicator among the people who are not infected with HIV. HIV and tuberculosis represent a deadly combination and accelerate development of each other. In 2017 about 0.3 million people died of the HIV-associated tuberculosis. By estimates, in 2017 there were 0.9 million new cases of tuberculosis among HIV-positive people whose 72 % took place in Africa.

To decline in mortality of WHO recommends to apply 12-component approach to ensuring complex services to a double infection of TB-HIV, including actions for prevention and treatments of an infection and a disease[11].

Antituberculous remedies are used for a number of decades. In each country where researches are conducted, the strains steady against one or several drugs are registered. Medicinal stability arises at inadequate use of antitubercular drugs, their wrong appointment of the medical and sanitary help as suppliers, bad quality of drugs or the premature termination of treatment by patients.

Tuberculosis with multiple drug resistance (MDR-TB) – the tuberculosis form caused by the bacterium which is not reacting at least on an isoniazid and rifampicin, two most powerful antitubercular drugs of the first line. MDR-TB can be treated and cured, using drugs of the second line. However such options of treatment are limited and demand carrying out extensive chemotherapy (treatment by duration up to two years) drugs which differ in the high cost and toxicity.

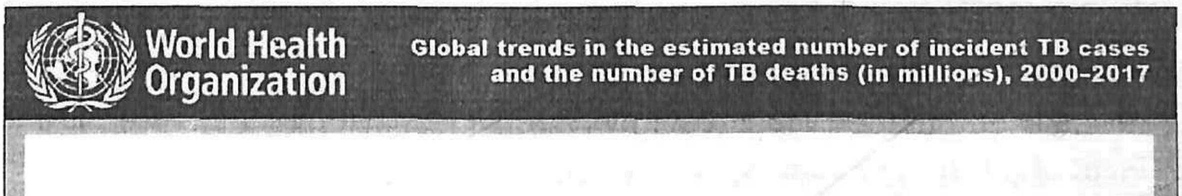
In certain cases more serious medicinal stability can develop. Tuberculosis with extensively drug-resistant (XDR-TB) is more severe form of MDR-TB caused by the bacteria which are not reacting to the most effective antitubercular drugs of the second line at which patients quite often have no further options of treatment.

In 2017 MDR-TB remains crisis and threat for safety in the field of public health care. By estimates of WHO, there were 558,000 new cases of TB to rifampicin resistance ? to the most effective drug of the first line, ? from which in 82 % of cases there was MDR-TB. The greatest burden the problem of MDR-TB lays down on three countries – India, China and the Russian Federation – to the share of which nearly a half of all cases in the world in total falls. In 2017 approximately 8.5 % of patients with MDR-TB had XDR-TB.

Now around the world success of treatment of MDR-TB is reached at 55 % of patients. In 2016 WHO approved use of the short standardized scheme of treatment for patients with MDR-TB who are not infected with the strains steady against antitubercular drugs of the second line. Treatment is carried out within 9–12 months and there is much less traditional course which can proceed up to two years. However patients with XDR-TB or stability to antitubercular drugs of the second line cannot use this scheme and need longer courses of treatment of XDR-TB which can include in addition reception of one of new drugs (bedaquiline and delamanid).

In July, 2018 the independent group of experts called by WHO analysed the latest actual data about treatment of drug resistant TB. WHO issued the operational message about the main changes in recommendations about treatment of TB with multiple medicinal resistance which at the end of this year the release of the updated and generalized guidelines will follow.

In 2016 WHO also approved a diagnostic rapid test for expeditious identification of such patients. Sixty two countries started use of the accelerated schemes of treatment of MDR-TB. By the end of 2017 62 countries reported that they for the purpose of increase in efficiency of courses of treatment of MDR-TB began to apply bedaquiline, and 42 countries - delamanid.



Picture 1.

The basis of the National Program of fight against tuberculosis in the Republic of Kazakhstan is made, designated by the President of the Republic of Kazakhstan, 100 concrete steps on realization of five institutional reforms corresponding to the strategy of WHO "To finish with tuberculosis epidemic till 2035" and to the Action plan for fight against tuberculosis for the European region of WHO for 2016-2020, the State program of development of health care of RK "Densaulyk" on the 2016-2019th. and also the Resolution of the government of the Republic of Kazakhstan of May 31, 2014 No. 597 "About the statement of the Comprehensive plan on fight against tuberculosis in the Republic of Kazakhstan on the 2014-2020th." and normative legal acts on tuberculosis.

For implementation of the main directions of the National Program for TB strategy of the integrated control of tuberculosis in Kazakhstan for 2016-2025 was developed also is, now, the priority direction in the program.

The integrated model represents vertical centralization of all antitubercular organizations (further Anti-TBO) at the level of regional, city, regional antitubercular clinics and horizontal – transfer of all dispensary offices (tubercular offices) of Anti-TBO in legal maintaining PHC network which will promote real strengthening of a role and responsibility of PHC network for decrease the MDR/XDR-TB level will also provide a multidisciplinary pro-active form of maintaining TB patients.

The preparatory period of introduction of the integrated model passed in several stages:

- The model was discussed with heads of regional Managements of healthcare and it is provided to the Ministry of health and social development of RK, and received approval;

- 18.04.2016 it was provided to the Deputy Prime Minister of the Government of the Republic of Kazakhstan Nazarbayeva D.N. and approved by she;

- 26.04.2016 it is presented on the Interstate meeting of high level on to strengthening of health care systems for the purpose of improvement of prevention and treatment of tuberculosis in countries of Eastern Europe and Central Asia in Copenhagen (Denmark). These provisions got approval from heads of Euro WHO and Global Fund for fight against AIDS, tuberculosis and malaria;

- 25.05.2016 it is heard and approved at a meeting National Coordination council for health protection at the Government of the Republic of Kazakhstan with adoption of the following decision - "to provide effective and high-quality realization of the integrated model of control of tuberculosis, to provide continuous training of specialists primary health care, including the first heads, on questions early tuberculosis detection".

As a result of carrying out centralization of antitubercular hospitals in the way integration of number of the antitubercular organizations about the country with 89 decreased up to 40 (more than twice), and the number of beds is reduced from 10032 to 7687. It allowed to cut down administrative and utility expenses and effectively quickly to use available financial and human resources. Due to optimization and reduction of antitubercular beds were saved and reinvested on priority antitubercular actions (on diagnostics of tuberculosis, infectious control and out-patient treatment) in the amount of 1009866.8 thousand tenges.

Horizontal integration of antitubercular service with PHC is carried out on 88 % at the level of areas and for 26

For control of realization of the integrated model, quarterly at enlarged meetings of the Republican headquarters reports of chief physicians of regional, city and regional antitubercular clinics were heard. Besides, for the purpose of qualitative holding actions for the priority directions of antitubercular service, in 2016 28 regional conference calls were held.

For the end of 2016 in the country there were 29 independent antitubercular the organizations with a bed power of 8254. As a result of restructuring on the republic 1788 sick-lists of tubercular round-the-clock beds were reduced. So, the number of PTO made 29 against 89 in 2015, i.e. the percent of reduction was 67.4. At the regional level antituberculous care was 14 PTO and 10 interdistrict antitubercular hospitals. 29 PTO are placed in 40 antitubercular buildings by the following in the way: 30 in standard buildings, 11 in non-standard, 3 in adapted, 2 in dangerous structures.

The volume of the saved means as a result of reduction of tubercular round-the-clock beds following the results of 2016 was 1009866.8 thousand tenges (on Aktobe, East Kazakhstan, West Kazakhstan, Kostanay, Mangystau, North Kazakhstan, Southern Kazakhstan regions).

The saved means are redistributed on purchase of reactants, expendables (374923.5 thousand tenges), on strengthening of material and technical resources of PTO with strengthening of measures of infectious control (103226.0 thousand tenges).

In compliance with the introduced strategy, day hospitals with a bed power of 520 are developed in 11 areas of the republic, but for the end of 2016 out-patient is not adjusted treatment of TB patients in 5 regions is in Atyrau, West Kazakhstan, Kostanay, Mangystau, North Kazakhstan regions.

The analysis of dislocation of specialized offices about the country showed that in 2016 patients with a bacteria excretion received treatment in 36 specialized antitubercular offices (1545 beds) that makes 18.7 % of all bed fund; patients without bacteria excretion in 42 offices (1540 beds, 18.7 %); sick MDR-TB received treatment in 65 specialized offices (3336 beds, 40.4 %); for compulsory treatment of the patients with a bacteria excretion evading from treatment 16 offices are organized (465 beds, 5.6 %); for palliative care by the patient 17 specialized offices are allocated (412 beds, 5 %).

Thus, for specialized offices on the republic 88.4 % of bed fund are taken away, and 11.6

Comparative data of the key epidemiological indicators on tuberculosis in to the country point to their further decrease. So, incidence of the population of tuberculosis decreased - from 58.5 in 2015 to 52.7 (for 9.9 %), and mortality from TB is also decreased from 4.1 to 3.4 (for 17.1 %) on 100 thousand population.

In a section of regions given on incidence of tuberculosis on 100 thousand population above a republican indicator (52.7) it was noted in 7 areas: North Kazakhstan -72.9; Akmola - 70.6; Atyrau – 66.2; Kyzylorda – 64.9; Kostanay - 62.1;Aktyubinsk - 58.3; Mangystau - 59.2.

It is also necessary to note decrease in an indicator of incidence of MDR-TB in 2016 on 3.7 % with 13.5 in 2015 to 13.0 on 100 thousand population.

Indicator of prevalence of tuberculosis, as one of the major indicators, in 2016 decreased by 13 % and made 80.6 against 92.6 on 100 thousand population. But, unfortunately, in certain regions this indicator several times exceeds republican indicators.

The analysis on age incidence of TB on the republic showed in general positive dynamics - decrease in an indicator among children and teenagers. Also positive fact is lack of registration within the last 2 years of incidence of tubercular meningitis among children. However, in 2016, in comparison with previous year, the number grew sick TB of children in age category till 1 year from 9 to 11 cases from the Akmola, Aktyubinsk, Atyrau, Jambyl, Karaganda, Mangystau regions and Astana in 1 case and from Southern Kazakhstan - 3.

Along with decrease in registration of incidence of tuberculosis at women in a puerperal period with 346 in 2015 up to 274 cases in 2016. On the contrary, the number of the patients with tuberculosis of pregnant women from 87 in 2015 increased to 97 cases.

One of reliable signs of decrease in a burden of tuberculosis in the country is reduction of an indicator initially recognized as disabled people on tuberculosis. In 2016 this indicator decreased from 16.6 to 12.1 on 100 thousand population (in absolute numbers from 2925 to 2168 patients, i.e. decrease on 757).

Rate of mortality (data without data of Republican Agency of statistics) in general decreased from 4.1 to 3.4 on 100 thousand population, but it remains high in 8 regions: Karaganda (6.9); Kostanay (4.8); Akmola (4.2); North Kazakhstan, East Kazakhstan and Almaty (on 3.9); Aktyubinsk and Jambyl (on 3.6).

The Republic of Kazakhstan is one of the few countries among the independent states where in all regional, city and regional bacteriological laboratories the advanced innovation laboratory technologies on the accelerated diagnostics of tuberculosis with a steady form of sensitivity of MBT by BACTEC MGIT-960 methods are introduced, Hain-test and Gene-Hpert.

In total in the country for diagnostics of MDR-TB 23 Gene-Hpert of the equipment function. 12 more equipment for Hain-testing are established, equipped and function. All laboratories of the Karaganda region are equipped with BACTEC MGIT960 installations. For ensuring full coverage with all diagnostic methods on early diagnostics of TB and MDR/XDR-TB. Since 2015 in all Anti-TBO the standard algorithm of bacteriological inspection of patients approved by the order of the Minister of Health is introduced and social development of the Republic of Kazakhstan of February 2, 2016 No. 77 "About a statement The standard of the organization of rendering antituberculous care in the Republic of Kazakhstan". Such equipment allowed to capture for 98 % the medicinal sensitivity test TB patients and to appoint adequate treatment and, thereby, to provide respect for the principles of infectious control, to increase efficiency of treatment.

Since January, 2017, within GFSTM grant on new model of financing on 2017-2019, further improvement of timely and high-quality diagnostics of tuberculosis and MDR/XDR-TB by expansion of introduction Xpert MTB/RIF of diagnostics in PHC network, purchase of the devices Xpert MTB/RIF, introduction of diagnostics of Xpert MTB/RIF is planned at the regional level in the Akmola, Aktyubinsk, East Kazakhstan regions and in Almaty and also ensuring full coverage express diagnostics of tuberculosis and MDR/XDR-TB by the automated MGIT and LPA methods.

Within Global Fund in 2017 providing with expendables and reactants is planned for express methods all regions.

Thanks to uninterrupted providing in Kazakhstan with antitubercular drugs of the first, second row, it was succeeded to increase efficiency of treatment as among for the first time the revealed suffering from tuberculosis lungs with a bacteria excretion and the kept medicinal sensitivity, and at sick MLU TB (a cohort of 2013) which made in 2016, according to 86.9 % and 74.8 % at the standard of WHO of 85 % and 75 % respectively.

Below an average republican value of efficiency of treatment of patients with a sensitive form of a pulmonary tuberculosis with a bacteria excretion are noted: in Karaganda (77.9 %), North Kazakhstan (81.7 %) and East Kazakhstan (80.6 %) areas. Among sick MDR-TB the low performance of treatment was noted in Karaganda (60.1 %) and Southern Kazakhstan (67.3 %) areas.

Coverage of sick MDR-TB treatment by antitubercular drugs of the second row, in comparison with the same period of 2015, grew and made 99 % against 98.8 % (the standard-99 of %). In general, received treatment of TAC of 9655 patients in the civil sector and 528 patients in institutions of the Ministry of Internal Affairs of Republic of Kazakhstan.

In regions, including Anti-TBO of penal system, treatment takes root sick XDR-TB, with inclusion in the scheme of treatment of antitubercular drugs III row. Now, on the republic receive treatment by drugs III of a number of 935 sick XDR-TB. The coverage treatment by row drugs III in the republic, following the results of 2016, was 92.8 % (standard of 90 %).

Epidemiological situation on tuberculosis in the system of penal correction system of the Ministry of Internal Affairs of RK in 2016, as well as in previous years, remains rather intense. So, basic reasons of current situation were: limited access for TB patients to the innovation to methods of the accelerated diagnostics of tuberculosis, a late initiation of treatment at persons with the laboratornopodtverzhdenny diagnosis of medicinal stability, lack of measures of infectious control in institutions for contents and treatment of TB patients with various types of medicinal sensitivity, non-compliance with measures of infectious control at to transportation of patients and not completeness TB specialist[3].

For the last 5 years it was succeeded to lower number for the first time of the revealed TB patients for 56 % (with 731 in 2011 to 322 in 2015), tuberculosis mortality for 67.4 % (with 86 to 28 in 2015), and the number of active TB patients is 1.7 times (from 2110 to 1215 in 2015).

Kazakhstan

Population 2017	18 million

Estimates of TB burden*, 2017	Number (thousands)	Rate (per 100 000 population)
Mortality (excludes HIV+TB)	0.16 (0.091–0.25)	0.89 (0.5–1.4)
Mortality (HIV+TB only)	0.037 (0.014–0.072)	0.2 (0.08–0.4)
Incidence (includes HIV+TB)	12 (7.8–17)	66 (43–94)
Incidence (HIV+TB only)	0.53 (0.34–0.75)	2.9 (1.9–4.1)
Incidence (MDR/RR-TB)**	3.8 (2.4–5.5)	21 (13–30)

Estimated TB incidence by age and sex (thousands)*, 2017	0-14 years	> 14 years	Total
Females	0.57 (0.23–0.91)	4.2 (1.7–6.7)	4.8 (2.2–7.4)
Males	0.64 (0.26–1)	6.6 (2.7–11)	7.2 (3.3–11)
Total	1.2 (0.69–1.7)	11 (6.1–15)	12 (7.8–17)

TB case notifications, 2017	
Total cases notified	12 942
Total new and relapse	12 449
- % tested with rapid diagnostics at time of diagnosis	*82%*
- % with known HIV status	*89%*
- % pulmonary	*88%*
- % bacteriologically confirmed among pulmonary	*86%*

Universal health coverage and social protection	
TB treatment coverage (notified/estimated incidence), 2017	100% (73–160)
TB patients facing catastrophic total costs	
TB case fatality ratio (estimated mortality/estimated incidence), 2017	0.02 (0.01–0.03)

TB/HIV care in new and relapse TB patients, 2017	Number	(%)
Patients with known HIV-status who are HIV-positive	443	4%
- on antiretroviral therapy	*417*	*94%*

Drug-resistant TB care, 2017	New cases	Previously treated cases	Total number***
Estimated MDR/RR-TB cases among notified pulmonary TB cases			3 600 (3 500–3 700)
Estimated % of TB cases with MDR/RR-TB	26% (25–28)	44% (42–46)	
% notified tested for rifampicin resistance	87%	79%	10 946
MDR/RR-TB cases tested for resistance to second-line drugs			
Laboratory-confirmed cases	MDR/RR-TB: 5 382, XDR-TB: 340		
Patients started on treatment ****	MDR/RR-TB: 5 840, XDR-TB: 300		

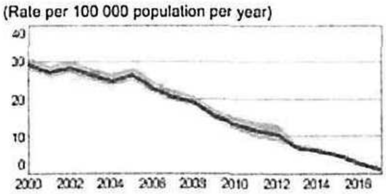
Treatment success rate and cohort size	Success	Cohort
New and relapse cases registered in 2016	88%	6 775
Previously treated cases, excluding relapse, registered in 2016	80%	246
HIV-positive TB cases registered in 2016	62%	230
MDR/RR-TB cases started on second-line treatment in 2015	78%	6 482
XDR-TB cases started on second-line treatment in 2015	32%	391

TB preventive treatment, 2017	
% of HIV-positive people (newly enrolled in care) on preventive treatment	44%
% of children (aged < 5) household contacts of bacteriologically-confirmed TB cases on preventive treatment	10% (9.4–11)

TB financing, 2018	
National TB budget (US$ millions)	138
Funding source: 92% domestic, 5% international, 3% unfunded	

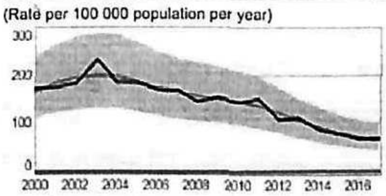
** Ranges represent uncertainty intervals*
*** MDR is TB resistant to rifampicin and isoniazid; RR is TB resistant to rifampicin*
**** Includes cases with unknown previous TB treatment history*
***** Includes patients diagnosed before 2017 and patients who were not laboratory-confirmed*

(Rate per 100 000 population per year)



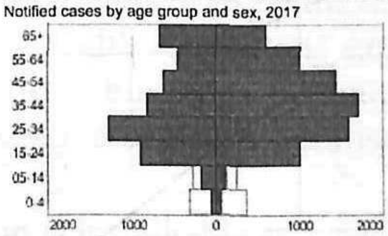
Mortality (excludes HIV+TB)

(Rate per 100 000 population per year)



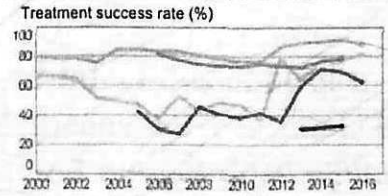
Incidence
Notified (new and relapse)
Incidence (HIV+TB only)

Notified cases by age group and sex, 2017



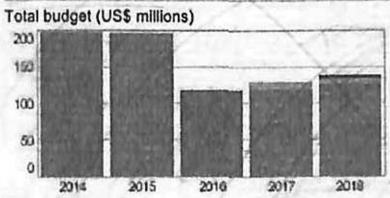
Females Males Incidence

Treatment success rate (%)



New and relapse
Retreatment, excluding relapse
HIV-positive MDR/RR-TB XDR-TB

Total budget (US$ millions)



Unfunded
Funded internationally
Funded domestically

Picture 2.

In 2016, in comparison with the same period of 2015, in the system of penal correction system of the Ministry of Internal Affairs of RK the number of again taken active patients decreased by dispensary accounting up to 230, against 322 patients and an indicator of incidence of tuberculosis of convicts in 2016 427.9 was against 643.0 in 2015 (decrease by 33.5 %) for 100 thousand prison population.

Rate of mortality of convicts from tuberculosis in 2016 also decreased by 33.5 % (with 55.9 to 37.2 on 100 thousand prison population).

For rendering antituberculous care by the condemned TB patient in the republic there are 4 penal correction systems TB facilities in Akmola, VKO and Karaganda areas with quantity of tubercular stationary beds 1190 (in 2013 – 7 on 1840 beds).

Taking into account a trend of decrease in registration of TB patients, optimization of antitubercular hospitals and in the system of penal correction system is carried out. So, in 2014 in Pavlodar and North Kazakhstan regions are reduced by 2 technical training colleges by 300 stationary beds. In 2016 it is reorientated antitubercular hospital on 300 beds in the Southern Kazakhstan area.

Thus, in the system of penal correction system 35.3 % of stationary tubercular beds are in recent years reduced.

According to requirements of the health regulations approved by the order MNE from 24.02.2015 No. 127 "About the approval of health regulations sanitary and epidemiologic requirements to health care facilities", buildings of antitubercular hospitals are equipped with the systems of positive-pressure ventilation with artificial motivation.

Now, the system of positive-pressure ventilation is installed in separate premises of institutions Karaganda (office of phthisiosurgery, the X-ray room) and East Kazakhstan (in all offices) areas.

For the purpose of strengthening of measures of infectious control in technical training college, for 2016 are provided financial means for the total amount of 39,118 thousand tenges on development of design and budget documentation with passing of state examination for carrying out capital repair of a system of positive-pressure ventilation in rooms of high "risk" of technical training correction system of the Akmola, Karaganda regions. Departments of penal correction system of the specified areas the design and estimate documentation for capital repair of a system is approved positive-pressure ventilation for 2017-2018.

On special control of a measure of individual protection of personnel and TB patients.

Individual protection equipment (mask) for the condemned TB patients and also for the staff of penal correction system (respirators of high degree of protection) is annually acquired. In 2016 are acquired for the sum of 11,007.9 thousand tenges (33,005 pieces), for 2017 are provided 15,274.7 thousand tenges (19,050 pieces).

Besides, for the purpose of control of correctness of use of individual protection equipment, 64 pieces of fit-tests for definition of a dense fit of respirators for the total amount of 6021.1 thousand tenges in the current year are acquired.

In the system of penal correction system there is one bacteriological laboratory on the basis of antitubercular hospital AK-159/11 DUIS across the Karaganda region which is provided with the modern bacteriological equipment BD Bactec MGIT 960 and (Hain-test), put by Global fund in 2010. Expendables (including 2014), were provided at the expense of means of GFSTM.

Since 2015 the purchase of expendables is made at the expense of means of RB. In enough reagents for molecular and genetic and PTsR (Hain-test) of researches for the purpose of diagnostics of TB and MDR/XDRTB are bought (in 2016 reactants and expendables for the total amount of 3,464.0 thousand tenges purchased)[4].

In 2016 it is examined on tuberculosis of 95 thousand persons, from them by a microscopy method - 8.3 thousand, it is revealed 221 TB patients, efficiency of tuberculosis detection low also made 2.7 % against 2.4 % in 2015 (2014g-2,7 %).

For the purpose of early tuberculosis detection, the face of group of "risk", persons under investigation and convicts are covered by fluorographic survey. In 2016 86.7 thousand people are examined, revealed 491 TB patients, the efficiency of a method of fluorography was - 5.7 on 1000 examined. The contingent of active patients is equal to 814. On a symptomatic treatment there are 70 patients. In total patients on the IV category - 598, from them ShLU TB - 68, receiving treatment antitubercular drugs III of a row. Receive treatment of TAC for the end of reporting years - 528 patients. Measures for improvement of coverage by treatment of sick MDR-TB are taken drugs of the second row. The coverage of sick MDR-TB PTP II of a row was 98.5 %, coverage of PTP I row makes 100 %.

For achievement of coverage treatment not less than 85 % of TB patients, according to the WHO recommendation, for 2016 are allocated to 373,245,400 tenges for full coverage for acquisition of PTP treatment of TB patients. For 2017 on acquisition of PTP the sum 433 is provided 413 thousand tenges (including on TAC – 366,165 thousand tenges., PTR – 61,778 thousand tenges., the Party of Pensioners of Russia – 5,470 thousand tenges).

Since 2013 on the basis of AK-159/11 DUIS technical training College across the Karaganda region functioned ftiziologic office where operations on bodies of a thorax are performed with involvement of thoracic surgeons of a regional antitubercular clinic (in 2014 to year 44 operations, 2015 – 48, 2016 - 51 are performed).

The timely coverage dispensary observation and treatment of the TB patients released from Anti-TBO of penal correction system of the Ministry of Internal Affairs of RK remains not less important problem in the civil health sector. For the purpose of ensuring continuity of treatment on to constant basis work on escort of persons of the TB patients who are released from places of detention is carried out: Monthly the list, the released patients tuberculosis from penal correction system institutions with the indication of biographical particulars, with the addresses, departure term, go to MZSR RK and Committee on consumer protection of MNE.

For 2016 the persons released from places of detention made all 600, of them it is taken on dispensary accounting of Anti-TBO of the civil sector of 572 TB patients, in that number on IA to group of dispensary accounting - 49, on IB to group - 33, on I In group - 283, on IG to group - 44 patients, on the II group of dispensary accounting - 163. Were in search of 28 patients. In the Anti-TBO areas, together with territorial DGSEN and bodies of internal affairs department, take measures on search of the patients who "came off" treatment.

In 2016 to territorial authorities of internal affairs department TB specialists submitted addresses on search 667 persons evading from inspection and treatment. Number of addresses of Anti-TBO civil made sectors in bodies of internal affairs department 928, only on 609 (65.6 %) the addresses the answer was received from territorial authorities of internal affairs department.

As a result of appeals to territorial authorities of internal affairs department, 523 are involved in treatment (78.4 %) TB patients.

All Anti-TBO technical training College are provided in sufficient volume with bed fund and antitubercular drugs as I row, II ranks, and III ranks for treatment of patients with various types of medicinal sensitivity. Problems with transportation of infectious patients in the next Anti-TBO is noted. At the regional level the mechanism of transfer of the released patients from the system of penal correction system of the Ministry of Internal Affairs of RK to the civil sector is fulfilled. It is monthly carried out verification on the released TB patients specialists of OPTD and penal correction system institutions Ministry of internal affairs of Republic of Kazakhstan.

In 2016 in the republic arrived, according to regional department according to the statistics, 295493 external migrants, from them are examined fluorographic 228508 that made 77,3 %.

In total it is revealed suffering from tuberculosis – 213 migrants, from them new cases 125, MDR-TB - 72. The greatest number is revealed in Mangystau - 51 (23.7 %), Almaty areas - 35 (16.2 %). The term of stay of specified persons in the country from 10 days to 20 flyings.

The main problem of untimely identification of TB are not 100 % coverage driving fluorographic inspection.

A certain complexity consists in obtaining information in bodies of migratory police about the number of the arrived internal and external migrants. There are difficulties in interaction with territorial internal affairs department concerning joint search of "come off" from treatment of suffering from tuberculosis migrants, with Departments of justice on the organization of compulsory treatment and the mechanism of assistance in hospitalization on compulsory treatment, with the Almaty branch, regarding registration of migrants and granting temporary, especially at identification of sick migrants with a bacteria excretion.

For the purpose of identification of TB patients, in 2016 all 10458.3 thousand people are examined, it is slightly more than in 2015 (10318.6 thousand), and the coverage by method of fluorography decreased and was 8060.8 against 8573.0 in 2015. Identification of cases of tuberculosis is carried out by the differentiated survey by method of fluorography of the persons "risk groups" among adults and teenagers. In practice, efficiency of use of a method of fluorography on 1000 examined persons on the republic low also remain at the level of 0.9. A low indicator in The southern Kazakhstan area made 0.4, in East Kazakhstan - 0.5, in Almaty and North Kazakhstan – on 0.7 on 1000 examined. The revealed 7453

TB patients are taken on dispensary accounting and treatment.

Also the coverage of children a tuberculinodiagnosis grew from "risk group" and was 3047.7 thousand persons, against 2334.4 thousand people in 2015. The revealed 178 children are taken on dispensary accounting and treatment.

Efficiency of a method of microscopy in diagnostics of tuberculosis at the level of institutions PHC grew and is equal to 5 % against 4.4 % for the same period of 2015. At the same time, low the indicator is noted in Aktobe and Karaganda (on 4.3 %), Southern Kazakhstan areas - 4.4 %.

Strengthening of a system of infectious control in PTO remains one of priority tasks of the National program and a part of the national policy directed to minimization of risk of spread of tuberculosis among the population.

In this regard, in the majority the antitubercular organizations of the country of the room, where bacillar patients and rooms of high risk of cross infection contain, are equipped with the system of forced-air and exhaust and mechanical ventilation, at the same time the priority is provided to offices where hospital treatment is received sick with MDR/XDR-TB, institutions of compulsory and palliative treatment, bacteriological laboratories, bronchoscopy rooms, etc.

For the end of 2016 from 40 Anti-TBO in the republic 36 (90 %) are provided with the forced-air and exhaust ventilation system, the private security provided all 40 Anti-TBO (100 %), are enclosed with protections, to conforming requirements of infectious control, the territory 38 Anti-TBO (95 %). Workers of Anti-TBO in enough are provided with masks respirators with the corresponding filter, and TB patients - surgical masks.

For the purpose of reduction of cross contamination of patients with different types of medicinal stability, within the Comprehensive plan on TB, taking into account efficiency uses of out-patient treatment and psychosocial support of TB patients and MDR-TB tuberculosis by results of introduction of the first pilot project in Akmola areas, the project it extends and carried out in 3 areas (Aktyubinsk, Jambyl, Kyzylorda, Astana).

Within the Comprehensive plan of fight against tuberculosis in the Republic of Kazakhstan on 2014-2020, during 2016 the prepared Program of training of specialists is implemented antitubercular organizations for identification, diagnostics treatment of tuberculosis, management of tuberculosis and MDR/XDR-TB, for monitoring and assessment, TB/HIV, to infectious control.

On the basis of NCPT RK according to Program 005 "Professional development in the specialty "phthisiology" 5 cycles of training with coverage of 105 specialists from different areas are carried out republics.

Specialists of the Center carried out 22 exit cycles of training with coverage of 1252 specialists.

In total in 2016 specialists of NCPT RK trained 1467 doctors antitubercular service and PHC institutions.

Besides, in 2016 the phthisiology service of regions trained 3595 specialists PHC networks, including therapists and general practitioners – 3096 people, pediatricians of PHC - 460, child phthisiatricians-49 concerning management of tuberculosis and MDR-TB, TB/HIV, to infectious control.

Thus, in 2016 all 5062 specialists of PHC institutions are trained about the country.

The priority direction of antitubercular service is the coverage of specialists training in "phthisiology". So, in 2016 the doctors who underwent primary specialization in phthisiology 157 people made, persons in need equally in 9 specialists. Annually the number of the specialists who underwent improvement on increases adult phthisiology in 2014 - 126 people; in 2015-189; in 2016 - 281 persons, and last improvement on children's phthisiology made in 2014 - 47; in 2015 - 56; in 2016 - 86 person.

The aforesaid could not but affect the level of professionalism of phthisiatricians, including phthisiatricians of antitubercular sanatoria which are special criterion and is defined by assignment of qualification category. Level of professionalism of phthisiatricians remains high and is together, including all qualification categories - 68.4 %, and among child phthisiatricians there are-78.6 %.

Following the results of 2016 in actions of fight against tuberculosis at the level of PHC institutions on the republic 21,258 specialists who within a year were captured are involved training in topical issues of fight against tuberculosis in 57.3 % (12,177 people).

One of the factors allowing to implement successfully the antitubercular program in the republic is social support of TB patients and MDR-TB for increases in commitment of sick TB to treatment. In the republic it is carried out from year to year work on rendering the social help. With assistance of executive authorities areas, the volume of the allocated monetary allocations in 2016 in comparison with similar the period in 2015, grew from 714097.2 thousand tenges to 951918.1 thousand tenges that made 2.5 % from the budget against 0.4 % for the same period of 2015. In this plan it is well adjusted work in the Kyzylorda region: 139745.9 thousand tenges, in Southern Kazakhstan are allocated - 96811.4 thousand tenges, in West Kazakhstan - 73301.0 thousand tenges and Astana-76242.3 one thousand tenge.

Sanitary and educational work is an integral part National programs for control over tuberculosis which will be organized and carried out together with Anti-TBO, PHC and some other institutions.

Traditionally, within preparation by the World Day of fight against tuberculosis, specialists of the Center at the beginning of the month for tuberculosis the meeting with journalists on the correct illumination of a problem of TB and to decrease in a stigma in society is organized in the attitude towards TB patients and also in the main directions of realization of antitubercular actions, the press conference for journalists in the Kazakhstan press club with participation of specialists of NCPT RK and the scientific and practical center of sanitary and epidemiologic examination and monitoring of RK is held on March 17, 2016.

On March 24, 2016 the conference devoted to the World Day of fight against tuberculosis with broad participation of the medical public of the city of Almaty and the international partners with adoption of the resolution is held. The large-scale actions devoted to the world Day with lighting in media, took place in all regions of the republic. For the period annual month on fight against tuberculosis it is carried out on the basis of popular illumination of materials in the press at the republican and local levels and also performances specialists of antitubercular service, PHC institutions of regions in radio and television, organization of rentals of audio videos for tuberculosis.

Regional and city antitubercular clinics developed 56 types of information and education materials and is distributed to the population of 212002 pieces. For 2016 lectures, conversations about a problem of tuberculosis and measures of prevention, early identification and diagnostics captured 2290313 people, including 274613 pupils schools, 171337 students, 335450 pregnant women.

Sanitary and educational work captured TB patients on questions commitment to treatment, measures of infectious control. The coverage on the republic was more than 100 % of patients with active forms of tuberculosis.

Work is conducted as well with medical personnel of Anti-TBO, PHC institutions. 957 events with coverage of 47676 health workers of these institutions are held.

Large-scale actions are carried out in all regions of the country in the form of such actions as "Open Day", sports meets, various competitions, flashmobs, quizzes, surveys by mobile FG-car crew from doctors, nurses, radiologists (inspections were performed in places of the greatest congestion people). In total 174 large-scale actions during which questions of prevention of tuberculosis, the first symptoms of a disease, need of the appeal to policlinics at the place of residence, passings of flyuoroskrining were widely taken up are carried out. With the help mobile FG-cars only 376370 people are examined, 3136 persons having are revealed changes in lungs[5].

In 157 policlinics of the country "Open Days" during which antitubercular actions captured 27676 people are held.

On the websites of the antitubercular organizations where the telephone hotline and announcements for patients are specified, updating of information material for the population was also constantly carried out.

Everywhere press conferences and Round tables with participation of the speakers representing the following services were about the country held: antitubercu organization,

Managements of health care and formation of area, centers of a healthy lifestyle, HIV/AIDS centers, narcological service, power sheets (penal correction system, Department of Internal Affairs) and representatives Media. Results of a press conference were widely lit in media. In total for the specified period 65 press conferences, 294 Round tables, a debate, discussions were held about the country, touching on tuberculosis issues.

In all regions of the country questions of tuberculosis were widely taken up in mass media, namely on television, radio, in newspapers and magazines. About the country was 464 articles are published in various editions of republican and regional value.

The greatest number of articles devoted to a tuberculosis problem is published in South Kazakhstan region, Kyzylorda and Almaty regions.

Were devoted to questions of tuberculosis on television in 131 transfers, on radio – 96. The leading phthisiatricians of the country participated in a debate, gave an interview in the programs "7 days" and "Academic council" on republican channel "Habar", in the Fourth estate program on Kazakhstan shopping Mall.

At the same time, it is necessary to specify that in 80 % of cases involvement of media falls on the period of holding a month of fight against tuberculosis – February, March, April months.

The information and education products stated on audio and video carriers on subject of tuberculosis, is available in sufficient volume: two short videos about diagnostics and prevention of tuberculosis presented in the form of social advertizing lasting 33-40 sec.; two videos lasting 30-40 sec., one video, intended for the condemned persons. Rotation of videos was carried out everywhere in places of a congestion of people, namely in Service centers of the population, stations and policlinics.

There is a sufficient volume of the audio-video production, the population directed to the following target groups: the adult population, organized youth, TB patients condemned faces. Considering growth of steady forms of tuberculosis and also combined infections of tuberculosis and HIV/AIDS, need of release of the special video covering these problems ripened.

Hire of the available video production on television and radio remains problematic. It is well-known that a roller hire on television or on radio demands big financial expenses which are not provided in the budget of medical institutions. On public channels ("El-arna", "Habar", "Kazakhstan") for a hire of rollers of social character a certain limit of time, as a rule, in few – looked through is taken away broadcasting time (morning or night). Other TV channels are commercial and demand a reward for a hire.

On September 26-27, 2016 in Almaty NCPT RK, with assistance of structures of the public and non-state sector held the conference devoted "Integrated to control of tuberculosis in Kazakhstan".

Key questions of a conference were:

- Reforming of antitubercular service according to the strategy of WHO "To liquidate tuberculosis"; including reforming of the financial mechanism, revision of the regulatory base and strengthening of personnel potential.

- Expansion of out-patient treatment of tuberculosis with the patient - the focused approach, selection criteria of patients for treatment; Infectious control at stages of rendering an ambulatory care (PHC, a hospital at home, civil society / NGO). Approach to vulnerable groups taking into account specific requirements (HIV/TB); providing supporting medium from government institutions and civil societies.

- Expansion of use of the accelerated diagnostic methods of TB and MDR-TB; interaction specialized and PHC laboratory services at stages of out-patient treatments; calculation of need for laboratory reagents and expendables, service of the laboratory equipment.

- Introduction of schemes of treatment of MDR/XDR-TB with use of new antitubercular drugs (registration, drugs, selection of patients, side reactions, monitoring treatments, cohort analysis, etc.). New approaches to MDR/XDR-TB, use of surgical methods. Representatives of the Ministry of health and social development of RK, specialists of National programs for tuberculosis of the countries took part in work of a conference Central Asia of the Kyrgyz Republic, Republics of Tajikistan, Turkmenistan and Uzbekistan, People's Republic of China, Republic of Belarus, Russian Federation, United States of America, Ukraine, South Korea, World Health Organization, USAID, Global fund, HOPE Project, Center for control and prevention of diseases of the USA (CDC), Ratgers University and other international non-governmental organizations.

2. PRELIMINARIES

2.1 Correlation analysis

Correlation analysis is engaged in extent of communication between two variables, x and y. At first we assume that as x, and y the quantitative, for example growth and body weight. Let's assume, pair of sizes (x, y) are measured at each of n of objects in selection.

We can note the point corresponding to pair of sizes of each object on the two-dimensional schedule of scattering of points. Usually on graphics variable x have on a horizontal axis, and at – on vertical. Placing points for all n of objects, receive the schedule of scattering of points which speaks about a ratio between these two variables.

Ratio x and y is linear if the straight line drawn through the central part of a congestion of points gives the most suitable approximation of an observed ratio.

It is possible to measure as close there are observations to a straight line which best of all describes their linear ratio by calculation of a coefficient of correlation of Pearson who is usually called just by a coefficient of correlation.

Its true size is estimated at populations (a general coefficient of correlation) (a Greek letter of "rho") in selection as r (a selective coefficient of correlation) which is usually received in results of computer calculation.

Let (x1. y1), (x2, y2), . . . , (xn, yn) - selection of n of observations of couple of variables (X, Y).

The selective coefficient of correlation of r is defined as

$$r = \frac{\sum_{i=1}^{n}(X_i - \overline{X})(Y_i - \overline{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \overline{X})^2 \sum_{j=1}^{n}(Y_j - \overline{Y})^2}} \qquad (2.1.1)$$

where $\overline{x}$, $\overline{y}$ - the selective averages which are defined as follows:

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i \qquad (2.1.2)$$

$$\overline{y} = \frac{1}{n}\sum_{i=1}^{n} y_i \qquad (2.1.3)$$

Properties of a coefficient of correlation of r

- r changes in the range from – 1 up to 1.

- Sign r means whether one variable increases as another increases (positive r) or whether one variable decreases as another increases (the negative r).

- Size r specifies how points are close located to a straight line. In particular, if r = 1 or r = – 1, then is available absolute (functional) correlation on all points lying on the line (practically it is improbable); if, then there is no linear correlation (though there can be a nonlinear ratio). The r is closer to extreme points (± 1) the extent of the linear communication is more[6].

- The coefficient of correlation of r is dimensionless, i.e. has no units of measure.

- Size r is proved only in the range of values x and y in selection. It is impossible to conclude that it will have the same size by consideration of values x or y, which much more, than their values in selection.

- x and y can be interchanged, without influencing size r ().

- The correlation between x and y not necessarily means a ratio of cause and effect.

- r^2 represents a variability share y which is caused by the linear ratio with x.

When it isn't necessary to count r:

Calculation of r can mislead if:

- ratio between two variables non-linear, for example square;
- data include more than one observation in each case;
- there are abnormal values (emissions);
- data support pronounced subgroups of observations.

Let r designate the selective coefficient of correlation received on extracted from a bivariate normal distribution of couples of observations (x1, y1), . . . , (xn, yn).

The coefficient of correlation in population is unknown, but can be estimated on selection by means of a selective coefficient of correlation of r:

$$r = \frac{\sum_{i=1}^{n}(X_i-\overline{X})(Y_i-\overline{Y})}{\sqrt{\sum_{i=1}^{n}(X_i-\overline{X})^2\sum_{j=1}^{n}(Y_j-\overline{Y})^2}} \quad (2.1.4)$$

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i \quad (2.1.5)$$

$$\overline{y} = \frac{1}{n}\sum_{i=1}^{n} y_i \quad (2.1.6)$$

Let's check a significance of a coefficient of correlation.

The null hypothesis consists that the coefficient of correlation is equal to zero, the alternative - isn't equal to zero:

$$H_0 : \rho = 0$$

$$H_1 : \rho \neq 0$$

Apparently, the value of size r, rather big on an absolute value, will seek to disprove a null hypothesis.

There is a question.

How big absolute value of size r has to be?

To check a hypothesis, we have to know distribution of size r.

Own distribution of size r the quite composite therefore we will apply transformation:

$$t = \frac{r}{\sqrt{1-r^2}}\sqrt{n-2} \sim t_{n-2} \quad (2.1.7)$$

So, the sampling distribution of this statistics is a Student's distribution with n-2 degree of freedoms.

At the given significance level (α) we define critical t_{kp} value.

We make the decision on a deviation or not a deviation of a null hypothesis:

$|t| > t_{kp}$ - reject H_0

$|t| < t_{kp}$ - not reject H_0

To define the actual significance level of a coefficient of correlation we will write down:

$$SL = P(T \geq |t|) + P(T \leq -|t|) = 2P(T \geq |t|) \quad (2.1.8)$$

Where the T submits to a Student's distribution with n-2 degree of freedoms, and the value of size t is calculated according to formula (2.1.7).

Calculation of a significance level is equivalent to determination of the area under the right and left-hand tails of the function limited to values - t and t.

Distribution of a selective coefficient of correlation the composite therefore often use Fischer's transformation for approximation of exact distribution of a coefficient of correlation.

At great values of n distribution of a selective coefficient of correlation of r aspires to normal z.

Fischer's transformation:

$$z = 0.5 * ln\left(\frac{1+r}{1-r}\right) \quad (2.1.9)$$

For the transformed z the standard error of an average is equal $SE = \frac{1}{\sqrt{n-3}}$

Thus, the bilateral fiducial interval for z will be defined:

Lower bound: $z_l = z - z_{1-\alpha/2} * SE$

Upper bound: $z_u = z + z_{1-\alpha/2} * SE$

For $\alpha = 5\%$ and $SE = \frac{1}{\sqrt{n-3}}$ we obtain interval:

$$CI_z = \left(z - 1.96 * \frac{1}{\sqrt{n-3}}, z + 1.96 * \frac{1}{\sqrt{n-3}}\right) \quad (2.1.10)$$

For creation of a fiducial interval for a coefficient of correlation we will make an inverse transformation, we will receive:

$$CI_\rho = \left(\frac{e^{2z_l}-1}{e^{2z_l}+1}, \frac{e^{2z_u}-1}{e^{2z_u}+1}\right) \quad (2.1.11)$$

2.2 Coefficient of determination and linear regression

The square of a coefficient of correlation of selection, as a rule, is designated and called determination coefficient.

The coefficient of determination estimates a share of dispersion (variability) of Y which has a talk with the help of X in prime linear regression model.

So, let we observe Xi values and the corresponding Yi values, for example, a dose of the medicinal preparation appointed to the patient and effect, an impurity share in copper and conductivity etc.

The selective coefficient of correlation is calculated on a formula:

$$r = \frac{\sum_{i=1}^{n}(X_i - \overline{X})(Y_i - \overline{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \overline{X})^2}\sqrt{\sum_{i=1}^{n}(Y_i - \overline{Y})^2}} \qquad (2.2.1)$$

Let's show how the coefficient of correlation and coefficient of determination is bound to the linear regression.

Let on observations the linear regression model be constructed:

$\hat{Y} = aX + b$, where coefficients of a, b are estimates on a method of least squares.

The general change of Yi of rather mean value can be spread out as follows:

$$\sum_i \left(Y_i - \hat{Y}\right)^2 = \sum_i \left(Y_i - \hat{Y}_i\right)^2 + \sum_i \left(\hat{Y}_i - \overline{Y}\right)^2 \qquad (2.2.2)$$

where $\hat{Y}_i$ - the predicted values Y. Formula (2.2.2) is the main identity of the regression analysis.

Expression (2.2.2) can be transformed:

$$1 = \frac{\sum_i(Y_i - \hat{Y}_i)^2}{\sum_i(Y_i - \overline{Y})^2} + \frac{\sum_i(\hat{Y}_i - \overline{Y})^2}{\sum_i(Y_i - \overline{Y})^2} \qquad (2.2.3)$$

Then we apply property of least squares of regression model that the selection covariance between the predicted values and oddments is equal to zero.

Thus, the selection coefficient of correlation between the observed and predicted values is equal:

$$r(Y, \hat{Y}) = \frac{\sum_i(Y_i - \overline{Y})(\hat{Y}_i - \overline{Y})}{\sqrt{\sum_i(Y_i - \overline{Y})^2 * \sum_i(\hat{Y}_i - \overline{Y})^2}} = \frac{\sum_i(Y_i - \hat{Y}_i + \hat{Y}_i - \overline{Y})(\hat{Y}_i - \overline{Y})}{\sqrt{\sum_i(Y_i - \overline{Y})^2 * \sum_i(\hat{Y}_i - \overline{Y})^2}} =$$

$$\frac{\sum_i\left[(Y_i - \hat{Y}_i)(\hat{Y}_i - \overline{Y}) + (\hat{Y}_i - \overline{Y})^2\right]}{\sqrt{\sum_i(Y_i - \overline{Y})^2 * \sum_i(\hat{Y}_i - \overline{Y})^2}} = \frac{\sum_i(\hat{Y}_i - \overline{Y})^2}{\sqrt{\sum_i(Y_i - \overline{Y})^2 * \sum_i(\hat{Y}_i - \overline{Y})^2}} = \sqrt{\frac{\sum_i(\hat{Y}_i - \overline{Y})^2}{\sum_i(Y_i - \overline{Y})^2}} \qquad (2.2.4)$$

From here we receive that the square of a coefficient of correlation between observed and predicted is equal to a share of dispersion which is explained by X in the linear regression model.

$$r(Y, \hat{Y})^2 = \frac{\sum_i(\hat{Y}_i - \overline{Y})^2}{\sum_i(Y_i - \overline{Y})^2} \qquad (2.2.5)$$

2.3 T-criteria

The t-criterion for one selection allows to check a hypothesis of equality of a selective average to some given number.

In so-called one-selective t-criteria, the observed average (calculated on selection realization) is compared to expected (or reference) a selection average μ (i.e. to some theoretical average).

$$H_0 : \overline{X} = \mu \quad (2.3.1)$$

$$H_1 : \overline{X} \neq \mu \quad (2.3.2)$$

Statistics of criterion: $t = \frac{\overline{X}-\mu}{s/\sqrt{n}}$ has a t-Student's distribution with (n-1) a degree of freedom. The selective standard deviation of s is estimated on observed realization of selection:

$$s = \sqrt{\frac{\sum_{i=1}^{n}\left(X_i-\overline{X}\right)^2}{n-1}} \quad (2.3.3)$$

The calculated value t is checked regarding hit in a critical region (the critical value can be found according to tables).

If the calculated value t gets to a critical region, then say that h0 is rejected at the level α in favor of an alternative.

For example, let some fixed efficiency factors of activity of the trading company are established: level of profitability of commodity turnover - 20 %. Thus, having data on profitability (we will tell, on months) we can apply one-selective t-criterion to check of a hypothesis of equality of the average level of profitability to the preset value.

Let's note that in this case it is necessary to apply unilateral criterion since violation of effectiveness of commercial activity will happen only in case of decrease in an index of profitability of rather normative[7].

the t-criterion for two independent selections (two-sample t-criterion) checks a hypothesis of equality of averages in two selections (the normality of distribution of variables and also equality of dispersions of selections is supposed). The criterion is applied, for example, if it is necessary to compare results of marks in the Unified State Examination at two different schools.

$$H_0 : \overline{X_1} = \overline{X_2} \quad (2.3.4)$$

$$H_1 : \overline{X_1} \neq \overline{X_2} \quad (2.3.5)$$

$$t = \frac{\overline{X_1}-\overline{X_2}}{s*\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}} \sim t_{(n_1+n_2-2)} \quad (2.3.6)$$

where $s = \sqrt{\frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}}$. The algorithm of making decision on a deviation or not deviation of a null hypothesis is similar considered above.

Kolmogorov's theorem

The well-known theorem of Kolmogorov forms a mathematical basis of neural networks.

Kolmogorov's theorem states that any continuous function f defined on n-dimensional single cube can be presented in the form of the (2n+1) sum of superpositions of the continuous and monotone mappings of single pieces:

$$f(x_1, ..., x_n) = \sum_{q=1}^{2n+1} g_q \sum_{p=1}^{n} \phi_{pq}(x_p)$$

At the left in this formula there is the arbitrary continuous function defined on a multidimensional cube, on the right the functions defined on pieces [0, 1].

Of course, it must be kept in mind that mappings ϕ_{pq} have enough complex structure.

Notice that the monotone continuous maps ϕ_{pq} don't depend on concrete function f.

In the light of this theorem the problem of construction and tutoring of network is put on strictly mathematical basis.

2.4 F - test of homogeneity of dispersions

The F-criterion is intended for check of a hypothesis of uniformity of dispersions in two normally distributed sets (n1 - the volume of the first selection, n2 - the volume of the second selection):

$H_0 : \sigma_1^2 = \sigma_2^2$ (2.4.1)

$H_1 : \sigma_1^2 \neq \sigma_2^2$ (2.4.2)
(a bilateral alternative, also use and a unilateral alternative is possible).

Statistics of criterion of F is defined as the relation of selective dispersions (in numerator it is put larger of dispersions) and has Fischer's distribution with numbers of degree of freedoms $(n_1 - 1)$ and $(n_2 - 1)$

$$F = \frac{s_1^2}{s_2^2} \quad (2.4.3)$$

At the given significance level of criterion α define (for a bilateral alternative) critical values $F_{1-\alpha/2;(n_1-1,n_2-1)}$ and $F_{\alpha/2;(n_1-1,n_2-1)}$. If $F < F_{\alpha/2;(n_1-1,n_2-1)}$ or $F > F_{1-\alpha/2;(n_1-1,n_2-1)}$, then H_0 is rejected in favor of an alternative.

Otherwise H_0 isn't rejected.

According to a standard algorithm of a test of hypothesis similarly work also in case of unilateral alternatives.

Special case is check of a hypothesis of value of dispersion of normal set. Let on the random sample taken from a normal universe dispersion assessment be received

It is required to check a hypothesis

$H_0 : s^2 = \sigma_0^2$ (2.4.4)

where σ_0^2 - some concrete numerical value.

When checking this hypothesis use critical statistics

$$F_h = \frac{n*s^2}{\sigma_0^2} \quad (2.4.5)$$

which according to Fischer's theorem in the conditions of validity is distributed under the law with a degree of freedom.

3. LITERATURE REVIEW

3.1 Researches of incidence of tuberculosis

Considering the high level of prevalence and the expressed social importance of tuberculosis of a respiratory organs, not only studying of its medico-social aspects, but also use of the obtained information for forecasting of incidence of the population of tuberculosis of a respiratory organs on medico-social factors of risk is extremely relevant.

In this regard, the purpose of the real work was use of medico-social factors of risk of incidence of the population of tuberculosis of a respiratory organs for forecasting of its development.

For achievement of a goal during 2006-2008 on the basis of a hospital of the Voronezh regional clinical antitubercular clinic of N.S. Pokhvisneva the medico-social research 483 suffering from tuberculosis respiratory organs on the developed program covering 102 medico-social characteristics of patients was conducted on the basis of what the computer database was created [1].

On the basis of expert estimates by a special technique, for the further analysis, all indicators were transformed to a numerical look [2, 3]. The importance of medico-social factors of risk was estimated on the basis of the calculated coefficients of pair correlation estimating interrelation of medico-biological and social and hygienic characteristics of a suffering from tuberculosis respiratory organs with value judgment of a condition of their health.

As showed the analysis, the most significant medico-social factors affecting incidence of tuberculosis of a respiratory organs including, on an integrated indicator of weight of a course of tuberculosis of a respiratory organs, duration and number of cases of treatment in a tubercular hospital, groups of dispensary accounting, aggravations of tubercular process, duration of a disease of tuberculosis of a respiratory organs, are: number of hospitalization in other hospitals, duration of the working day, working capacity assessment, public professional group, imprisonment duration, stay in places of detention, alcohol intake, occupations in sports sections, existence of complaints, duration of viewing of telecasts, prevalence in a meat diet, the nature of the intra family relations, surgical intervention and inspection in connection with TB, assessment of quality of food, assessment of an exercise stress at work, duration of daily leisure, a phlegm research, the state of health of mother, assessment of financial position, number of researches of a phlegm.

For forecasting of a course of tuberculosis of a respiratory organs on medico-social characteristics of patients the models considering interrelation of the analyzed indicators are constructed. For creation of predictive models the linear regression equations were used.

When using methods of the regression analysis, performing the following conditions is necessary [4]:

- all experiments have to be made independently of each other in the sense that the accidents which caused a response deviation from regularity in one experience had no impact on similar deviations in other experiences;

- the statistical nature of these accidental components has to remain invariable in all experiences; are basic reasons of existence of the fact of unauthenticity of medical information: lack of a possibility of ensuring objectivity of estimates, difficulty or impossibility of quantitative assessment of quality indicators, write errors of data;

- the indicators which entered the regression equation as independent variables should not be connected with each other.

In relation to our case experience is understood as inspection of the next patient therefore the first two prerequisites of the regression analysis are carried out, proceeding from technology of data collection.

Their preliminary selection is necessary for achievement of independence of medico-social characteristics of the studied contingent, that is there is a need to exclude a number of parameters, and to choose those from them that bear information minimum[5].

3.2 Multiple linear regression in medicine

Statistics in medicine is one of analysis tools experimental data and clinical observations and also language, with which help reports the received mathematical results. However, it is not the only task of statistics in medicine. Mathematical apparatus it is widely applied in the diagnostic purposes, the solution of classification tasks and search of new regularities, for statement of new scientific hypotheses. Use of statistical programs assumes knowledge of the main methods and stages of the statistical analysis: their sequences, need and sufficiency. In the offered statement the main emphasis is put not on detailed representation of the formulas making statistical methods, and on their essence and rules of use.

Statistical processing of medical researches is based on the principle of that true for a random sample truly and for general sets (population) from which this selection is received. However to choose or to gather truly random sampling of population practically it is very difficult. Therefore it is necessary to aspire to that selection was representative in relation to the studied population, i.e. it is rather adequate reflecting all possible aspects of the studied state or a disease in populations that is promoted by accurate formulation of the purpose and strict observance criteria of inclusion and exception both in a research, and in statistical analysis[7].

Statistical data can be provided as quantitative (numerical continuous or discrete), and qualitative (categorial serial or nominal) variables. It is necessary it is accurate to specify type (look) of a variable when filling the database and precisely to adhere to the chosen type of data as can depend on it further processing of variables in many now in use 5 statistical programs. For example, it is impossible to bring in a column at the same time variables both numerical and text, even similar on sense, data: if filling "yes/no" in the form of 1 or 0 not to bring alphabetic abbreviations and on the contrary.

Quantitative (numerical) data assume that a variable accepts some numerical value. From them select discrete data, which can accept strictly certain values while continuous can be provided by any values. Unique example of quantitative data is representation of age two types: in the form of a continuous variable – the exact age of the patient, and is specified in a look the discrete variable – specifies only the number of full years (50.3 years and 50 flying; 50.9 years and 51 years)[8].

The categoriality is a basis of semantic understanding qualitative variables. Categorial data are applied to the description of a condition of an object by assignment to it number corresponding to category, to which this object belongs. An important condition for use of categorial data is belonging of one object of a research only to one possible category for one criterion.

Qualitative ratings are used in case categories are not ordered. Numbers in this case are only designation for conditions of an object also do not order this state. For example, on a floor: 1 – men's, 2 – women's.

Qualitative serial (rank, ordinary) data – data, for which categories can be ordered. For example, from feeling sick to to good: 1 – good, 2 – satisfactory, 3 – bad. In practice it is frequent the translation of quantitative data in qualitative categorial is used ordered representation, especially when calculating threshold values (cut-off) for the subsequent calculations of characteristics of risk or predictive importance with use of the table of associativity. For example, 1 – concentration of the general it is less cholesterol or it is equal to 5.2 mmol/l (the relation of risks of development of an ischemic heart disease less 6 1, the predictive value of a positive take is more than 80concentration of the general cholesterol more than 5.2 mmol/l (relation of risks of development The ischemic heart disease of more than 1, predictive value of a positive take is more than 80 %)[6].

At this analysis stage of data there is a research dependences between variables. Are for this purpose applied the correlation analysis (for establishment of the fact of existence or absence the dependence between variables expressed as numerical value), and also regression analysis (for finding of quantitative dependence between variables, expressed as the equation and/or the schedule), and it is frequent in lately - factor analysis.

Correlation – interrelation between two or more variable (in the last case the correlation is called multiple or cumulative). The purpose of the correlation analysis – establishment of existence or lack of this interrelations. In case are available two variable which values are measured in a scale of the relations, the coefficient of linear is used Pearson's correlations of r who accepts values from-1 to 1 (zero its value demonstrates lack of correlation).

The term "linear" demonstrates that existence is investigated linear communicatic between variables.

For the data measured in a serial scale it is necessary to use coefficient of rank correlation of Spirmen as it is nonparametric also catches a trend – changes of variables in one direction which is designated by rs and is defined by comparison ranks – numbers of values of the compared variables in their streamlining. The correlation coefficient of Spirmen is less sensitive, than correlation coefficient of Pearson.

It is important to note that close to plus unit or to minus unit the value of a correlation coefficient speaks about force of interrelation of variables direct or the return, but tells nothing about cause and effect relations between them.

Regression analysis.

Unlike the correlation analysis, the regression analysis — not only speaks about existence of dependence between an independent variable and one or several dependent variables, but also allows to define this dependence quantitatively. Independent variables call regressors or predictors, and dependent variables — criteria. Besides, terminology dependent and independent variables reflects only mathematical dependence of variables, but not cause and effect relations[8].

There are several types of linear and nonlinear regression the analysis, allowing to find mathematical dependence between several variables, however all these methods are parametrical that makes impossible their use for processing qualitative data. Nonparametric analog of multiple regressions logistic regression with two gradation dependent is sign (binary logistic regression) and more (multinominal logistic regression).

By means of a method of binary logistic regression it is possible to investigate dependence dichotomizing (binary, having only 2 categorial values) variables from independent variables, having any kind of a scale. As a rule, in a case with dichotomizing variables it is about some event which can take place or not to occur; binary logistic regression in that case calculates probability of approach of an event depending on values independent variables with a conclusion of regression coefficients for everyone such variable and its statistical importance.

In biological including medical researches is always available big total number of the studied bonds. However many of them will be statistically not significant, and in the absence of their clinical importance it is not necessary to take into account and to interpret. How many will be valuable from a point sight of goals of a research of interrelations – in advance to assume it is impossible. As a rule, statistically and clinically significant is 5- 25 % of all possible bonds.

Besides, many indicators can have among themselves variously the expressed dependences. Using them as an initial subset signs it is possible to put and solve a problem of designing on their basis more the difficult, integrated signs by means of factor analysis. At the same time the number of such complex signs (indexes) will be much less, than number of initial signs. As a result of this procedure we receive new signs which compactly bear in themselves the much bigger volume of information, than each of initial signs separately. As a result appears an opportunity to filter an accidental component and to receive more reliable information on structure as initial signs, and about structure studied groups of patients.

4. DATA AND METHODS

Data for a research were taken from the official site of the Ministry of Health of the Republic of Kazakhstan and also from the official site of the World Health Organization (WHO).

What is regression?

Let's consider two continuous x= variables (x1, x2., xn), y= (y1, y2..., yn).

Let's place points on the two-dimensional schedule of scattering and we will tell that we have the linear ratio if data are approximated by a straight line.

If we believe that y depends from x, and changes in y are caused by changes in x, we can define the line of regression (regression of y on x) which best of all describes a rectilinear ratio between these two variables.

Statistical use of the word "regression" proceeds from the phenomenon known as regression to an average, the attributed sir Francis Galton (1889).

It showed that though high fathers tend to have high sons, the average growth of sons is less, than at their high fathers. Average growth of sons "regressed" and "moved back" to the average growth of all fathers to populations. Thus, on average high fathers have lower (but after all high) sons, and low fathers have sons of higher (but after all enough low).

Line of regression

The mathematical equation which estimates the line of simple (pair) linear regression:

$$Y = a + bx \qquad (4.1)$$

x is called an explanatory variable or a predictor.

Y – effect variable or variable of a response. This value which we expect for y (on average) if we know size x, i.e. it "the predicted value y"

- a – the constant term (crossing) of the line of assessment; this value Y, when x=0.
- b – slope or a gradient of the estimated line; it represents the size by which Y increases on average if we increase also by one unit.
- a and b are called regression coefficients of the estimated line though this term is often used only for b.

Pair linear regression can be expanded, having included in it more than one explanatory variable; in this case it is known as a multiple regression.

Method of least squares

We make the regression analysis, using selection of observations where an and b – selective estimates of the true (general) parameters, α and β which define the line of the linear regression in population (universe).

The simplest method of determination of coefficients of an and b is the method of least squares (MLS).

Adjustment is estimated, considering oddments (vertical distance of each point from the line, for example, the rest = to observed y – the foretold y).

The line of the best trimming is chosen so that the sum of squares of oddments was minimum.

Assumptions of the linear regression

So, for each observed size the rest is equal to a difference and corresponding predicted Each rest can be positive or the negative. It is possible to use oddments for verification of the following assumptions which are the cornerstone of the linear regression[9]:

- Between there is also the linear ratio: for any couples data have to approximate a straight line. If to apply oddments on the two-dimensional schedule, then we have to observe accidental scattering of points, but not any systematic picture.
- Oddments are normally distributed with zero mean value;
- Oddments have the same variability (continuous dispersion) for all predicted sizes If to put oddments against the predicted sizes from we have to observe accidental scattering of points. If the schedule of scattering of oddments increases or decreases with increase that this assumption isn't carried out;

If assumptions of linearity, a normality and/or continuous dispersion are doubtful, we can transform or and calculate the new line of regression for which these assumptions are satisfied (for example, to use logarithmic transformation or other).

"Influential" observation if it is omitted, changes one or more estimates of parameters of model (i.e. slope or the constant term).

Emission (observation which contradicts the majority of values in a data set) can be "influential" observation and it can visually be found well, at survey of the two-dimensional chart of scattering or the schedule of oddments. Both for emissions, and for "influential" observations (points) use models, both with their inclusion, and without them, pay an attention to change of assessment (regression coefficients).

When carrying out the analysis you shouldn't reject emissions or points of influence automatically as simple ignoring can affect the received results. Always study the reasons of emergence of these emissions and analyze them.

At creation of the linear regression the null hypothesis that the general slope of the line of regression β is equal to zero is checked.

If the slope of the line is equal to zero, between and there is no linear ratio: change doesn't influence on For testing of a null hypothesis that the true slope is equal to zero it is possible to use the following algorithm: To calculate statistics of criterion equal to $b/SE(b)$ the relation which submits to t-distribution with (n-2) degree of freedoms where SE(b) a standard error of coefficient b.

$$b = \frac{\sum(x-\overline{x})(y-\overline{y})}{\sum(x-\overline{x})^2} \qquad (4.2)$$

$$SE(b) = \frac{s_{res}}{\sum(x-\overline{x})^2} \qquad (4.3)$$

$s_{res}^2 = \frac{\sum(y-Y)^2}{(n-2)}$ - assessment of dispersion of oddments.

Usually if the reached significance level $P < 0.05$ a null hypothesis deviates. It is possible to calculate 95 % a fiducial interval for general slope β:

$$b \pm t_{0.05} SE(b) \quad (4.4)$$

where $t_{0.05}$ - percentage point, t - distribution with degree of freedoms (n-2) that gives the probability of bilateral criterion 0.05. It is that interval which contains general slope with the probability of 95 %.

Evaluation test of the linear regression: coefficient of determination of R^2

Because of the linear ratio x and y we expect that y changes as changes x, and we call it a variation which is caused or is explained by regression. The residual variation has to be as little as possible. If this is so, then the majority of a variation speaks regression, and points will lie close to the line of regression, i.e. the line well corresponds to data.

The share of the general dispersion which is explained by regression is called determination coefficient, usually expressed through percentage ratio and designate R^2 (in pair linear regression it is size R^2, a square of a coefficient of correlation), allows to estimate quality of the equation of regression subjectively.

The difference $(100 - R^2)$ represents dispersion percent which can't be explained with regression. There is no formal test for assessment we are forced to rely on subjective judgment to define quality of a trimming of the line of regression.

Multiple linear regression

Problem of a multiple linear regression is creation of the linear model of communication between a set of the continuous predictors and the continuous effect variable. The following regression equation is often used:

$$Y = \sum_{i=1}^{n} a_i x_i + b_0 + e \quad (4.5)$$

Here a_i - regression coefficients, b_0 - the constant term (if it is used), e - the term containing a mistake - concerning it become various assumptions which, however, come down to a normality of distribution with a zero vector of an expectation and a complete correlation matrix more often.

Such linear model well describes many tasks in various subject domains, for example, to economy, the industry, medicine. It occurs because some tasks are linear by the nature.

Let's give a simple example. Let it is required to predict the cost of laying of the road in its known parameters. At the same time we have data on already paved ways with the indication of extent, depth of sprinkling, amount of working material, number of workers and so on. It is clear, that road cost as a result will become the equal sum of costs of all these factors separately. A quantity, for example, of crushed stone, with the known cost for ton, a quantity of asphalt also with the known cost will be required. Perhaps, for laying it is necessary to fell trees that will also lead to additional expenses. All this together will give the cost of creation of the road[10].

At the same time the constant term which, for example, will be responsible for organizational expenses (which are approximately identical to all installation and construction works of this level) or tax assignments will enter model. The mistake will include factors which we didn't consider at creation of model (for example, weather at construction - it in general can't be considered).

5. RESULTS AND DISCUSSION

5.1 Analysis of medical service

Y	X1	X2	X3
125,5	15982,4	131 668	120,8
105,3	16203,3	134 610	121,2
95,3	16440,5	136 475	120,0
86,6	16673,9	138 623	118,2
81,7	16910,2	132 456	117,4
73,4	17160,9	141 545	117,4
66,4	17415,7	140 912	114,5
58,5	17669,9	143 931	102,5
52,7	17918,2	144 515	100,1
52,2	18157,3	146 928	98,7

Table 5.1.1

	Y	X1	X2	X3
Y	1			
X1	-0,87464	1		
X2	-0,89175	0,807256	1	
X3	0,842722	-0,81567	0,85456	1

Table 5.1.2

Here we see a correlation between variables. I want to test them for multicolliniarity. If the result of multicolliniarity is greater than or equal to 10, then there are problems in our variables. I will do this only on the results of correlations. Multicolliniarity is checked by the formula[13]:

$$VIF = 1/tolerance$$
$$Tolerance = 1 - R^2 \quad (5.1.1)$$

We know that if a VIF model is greater than 10, then the multicolliniarity between coefficients is not. This brings us to the fact that the model will not be correct. In Table 2 we see the correlation between the variables. If we calculate them, then all variables less than 10 show that the multicoliriarity of intern variables is there and we can continue building our model.

Now we can consider the regression analysis of the Table 5.1.1.

R^2	F-test
0,866509	0,038113579

Table 5.1.3

of the significance level of the Fisher test (significance F) is han 0.05, which means the model is significant. The degree of ocess model description of the R-square is 0.866, which indicates ion accuracy (the model describes the process well).

	coefficients	P-value
Y	892,3586954	0,00153872
X 1	-0,03878036	0,00214735
X 2	-0,00039026	0,03504065
X 3	-0,6574285	0,01387476

Table 5.1.4

· the coefficient X1 is less than 0.05, which means this coefficient non-zero.

· the X2 coefficient is less than 0.05, which means this coefficient non-zero.

· the X3 coefficient is less than 0.05, which means this coefficient non-zero.

$$.3586 - 0.0387X_1 - 0.0003X_2 - 0.6574X_3 \quad (5.1.2)$$

s rate, X1 – population size, X2 - number of medical staff, X3 –

model incidence of tuberculosis as on the aforementioned, I ematic model and she showed me that the main factor is the lack s. The solution to this problem, as the equations showed, is the 1 means that more hospitals and facilities need to be built.

5.2 Analysis of social-economic factors

And now let's look from the economic side for this, I also took Y-sickness rate, X1 – population size, X2 - number of unemployed, X3 – average salary.

Y	X1	X2	X3
125,5	15982,4	557,8	60805
105,3	16203,3	554,5	62015
95,3	16440,5	496,5	65218
86,6	16673,9	473,0	68475
81,7	16910,2	474,8	68845
73,4	17160,9	470,7	71493
66,4	17415,7	471,2	70548
58,5	17669,9	473,8	78452
52,7	17918,2	471,9	100173
52,2	18157,3	465,7	105154

Table 5.2.1

	Y	X1	X2	X3
Y	1			
X1	-0,87464	1		
X2	0,861868	-0,78559	1	
X3	-0,80875	0,888104	0,86286	1

Table 5.2.2

Now we can consider the regression analysis of the Table 1.

R^2	F-test
0,877322	0,025297

Table 5.2.3

The accuracy of the significance level of the Fisher test (significance F) is significantly less than 0.05, which means the model is significant[14]. The degree of accuracy of the process model description of the R-square is 0.877, which indicates a high approximation accuracy (the model describes the process well).

	coefficients	P-value
Y	518,2866883	0,03204005
X 1	-0,03063718	0,03560306
X 2	0,137478386	0,0237586
X 3	0,021879755	0,03918198

Table 5.2.4

The p-value for the coefficient X1 is less than 0.05, which means this coefficient can be considered non-zero.

The p-value for the X2 coefficient is less than 0.05, which means this coefficient can be considered non-zero.

The p-value for the X3 coefficient is less than 0.05, which means this coefficient can be considered non-zero.

$$Y = 518.2866 - 0.0306X_1 + 0.1374X_2 + 0.0218$$

In this model, the equation shows that the unemployment rate exceeds most of all, it is light that the economy of the countries also affects the incidence of tuberculosis.

6. CONCLUSION

Tuberculosis is a disease that is highly socialized. Tuberculosis morbidity and mortality of the population are important epidemiological indicators that characterize the tuberculosis infection situation. In addition to demographic and medico-organizational, a certain contribution is made socio-economic factors to the formation the above indicators.

The study's objective is to study the impact of socio-economic factors on tuberculosis incidence and mortality in the Republic of Kazakhstan.

The correlation and multiple regression analysis is carried out to define influence of medical service and socio-economic factors on incidence of tuberculosis in the Republic of Kazakhstan.

Data for a research were taken from the official site of the Ministry of Health of the Republic of Kazakhstan and also from the official site of the World Health Organization (WHO).

As a result we obtained the equation of multiple linear regression $Y_1 = 892.3586 - 0.0387X_1 - 0.0003X_2 - 0.6574X_3$. We see in this model incidence of tuberculosis as on the aforementioned, I calculated the matematic model and she showed me that the main factor is the lack of beds in hospitals. The solution to this problem, as the equations showed, is the lack of beds, which means that more hospitals and facilities need to be built.

In this model, the equation shows that the unemployment rate exceeds most of all, it is light that the economy of the countries also affects the incidence of tuberculosis: $Y_2 = 518.2866 - 0.0306X_1 + 0.1374X_2 + 0.0218$

7. REFERENCES

1. Nikolaev V.A. Medico-social aspects of incidence of the population of tuberculosis of a respiratory organs at the municipal level and a way of its prevention in modern conditions. Voronezh, 2011. 24 p.

2. O.N. Choporov, N.V. Naumov, L.A. Kutashova, A.I. Agarkov. Methods of pretreatment of information in the system analysis and modeling of medical systems No. 6.2 (55). 2012. 382-390 pp.

3. O.N. Choporov, A.I. Agarkov, L.A. Kutashova, E.Yu. Konovalova. A technique of transformation of qualitative characteristics to numerical estimates when processing results of a medico-social research. the Messenger of the Voronezh institute of high technologies. Voronezh, 2012. No. 9. 96-98 pp.

4. Esaulenko I.E. Problems of health care of industrially developed region in modern conditions. Voronezh: Publishing house of Voronezh State University, 1999. 264 p.

5. http://vrach-aspirant.ru/articles/phthisiatry/13070/

6. Tandy, R.D. Technical Note: The Initial Stages of Statistical Data Analysis R.D. Tandy Journal of Athletic Training. 1998. P.69-71.

7. Wilson E.B. Probable inference, the law of succession, and statistical inference. E. B. Wilson Journal of American Statistical Association. 1927. №22.P. 209-212.

8. Brown, L.D. Interval estimation for a binomial proportion / L.D. Brown, T.T. Cai, A. Dasgupta Statistical science. 2001. №2. P. 101–133.

9. Bellman R. Mathematical methods in medicine. M.: WORLD, 1987. 200 p.

10. https://data.worldbank.org/indicator/SH.TBS.DTEC.ZS

11. Global Tuberculosis Report. WHO. 2018

12. http://www.nncf.kz/upload/2017.pdf

13. https://statisticalhorizons.com/multicollinearity

14. http://stat.gov.kz/

15. Incidence, Mortality and Prevalence as indicators oF Tuberculosis burden in WHO regions, countries oF the World and the Russian Federation Part 2. Tuberculosis mortality I. A. Vasilyeva, E. M. Belilovsky, S. E. Borisov, S. A. Sterlikov. Moscow