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SOCIAL, MEDICAL AND EPIDEMIOLOGICAL FACTORS AFFECTING THE PREVALENCE OF TUBERCULOSIS AND THEIR PROGNOSIS

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ABSTRACT

The spread of tuberculosis is shaped by the complex and interrelated effects of social, medical, and epidemiological factors. This study analyzes the main social determinants influencing the spread of tuberculosis, including poverty, migration, living conditions, malnutrition, and issues of social stigma. In addition, the epidemiological significance of medical factors such as HIV infection, chronic noncommunicable diseases, harmful habits, and drug-resistant forms of tuberculosis is highlighted. Among epidemiological factors, the spread of infection in closed institutions, delayed diagnosis, subclinical forms of tuberculosis, and the impact of disruptions in the healthcare system during pandemic conditions are examined. The study substantiates the importance of using modern epidemiological and mathematical modeling methods in forecasting the spread of tuberculosis, noting that these approaches serve as an important scientific basis for planning preventive measures and strengthening disease control.

Keywords: Tuberculosis, epidemiology, TB/HIV coinfection, drug-resistant tuberculosis, migration, closed institutions, delayed diagnosis, epidemiological forecasting.

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The spread of tuberculosis among the population is a complex and multifactorial process that is shaped by the interaction of socioeconomic conditions, medical factors, and the epidemiological situation. Scientific literature emphasizes that the development of tuberculosis and the persistence of its high prevalence are primarily directly related to social inequalities within society and the capacity of the healthcare system [14]. Especially in large cities, the concentration of these factors at a single point leads to increased complexity of tuberculosis epidemiology.

Social factors are among the main determinants of tuberculosis. Poverty, unemployment, poor living conditions, housing problems, and malnutrition increase the risk of progression from tuberculosis infection to active disease [14]. Protein-energy deficiency weakens the immune system, creating favorable conditions for the proliferation of Mycobacterium tuberculosis. Overcrowded living conditions and a high number of people per household accelerate the spread of airborne infections [15].

Social stigma and discrimination associated with tuberculosis also play an important role. The social isolation of individuals diagnosed with tuberculosis, as well as pressure in the workplace or within the family, leads to delayed seeking of medical care [5]. As a result, the disease is detected at later stages, and the chain of infection transmission is not interrupted. This situation particularly increases epidemiological risk in urban environments.

Migration processes have a significant impact on tuberculosis epidemiology. In regions with high levels of internal and external migration, including the city of Tashkent, a persistently high level of tuberculosis indicators has been recorded [13]. Among migrants, poor living conditions, failure to undergo timely medical examinations, and limited access to healthcare services increase the risk of tuberculosis transmission.

Medical factors play a decisive role in the development and severe course of tuberculosis. HIV infection is considered one of the most important determinants

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of tuberculosis development. Numerous studies have reported that in patients with TB/HIV coinfection, tuberculosis progresses rapidly and is associated with high mortality rates [9]. In addition, diabetes mellitus, chronic kidney failure, cardiovascular diseases, smoking, and alcohol consumption contribute to a more severe course of tuberculosis [6].

Individuals who have previously had tuberculosis are at a higher risk of disease recurrence, which is often associated with incomplete adherence to treatment regimens or the development of drug resistance [6]. The epidemiology of drug-resistant tuberculosis (MDR/RR-TB) represents a particular challenge for healthcare systems and is characterized by the complexity and prolonged duration of treatment [3].

Among epidemiological factors, the high risk of tuberculosis transmission in closed institutions—such as prisons, boarding schools, military units, and healthcare facilities—deserves special attention [7]. Insufficient functioning of contact tracing and follow-up systems leads to widespread transmission of infection. In addition, the presence of minimal and subclinical forms of tuberculosis contributes to the hidden spread of the disease, making epidemiological control more difficult [12].

The COVID-19 pandemic had a significant negative impact on tuberculosis epidemiology. During the pandemic, the reallocation of healthcare resources, a reduction in preventive screenings, and limitations on access to medical facilities led to a decline in tuberculosis detection and treatment indicators [4]. This situation may result in a hidden increase in tuberculosis incidence in the future.

In recent years, the use of mathematical epidemiological models, agent-based modeling, and artificial intelligence technologies for forecasting the spread of tuberculosis has expanded. These approaches enable the identification of high-risk areas, efficient allocation of resources, and planning of preventive measures [1]. The use of forecasting models plays an important role in evidence-based decision-making within healthcare systems.

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In the scientific literature, the social determinants of tuberculosis spread are identified as leading factors, and the persistence of high tuberculosis rates is noted to be closely associated with social inequalities within society [14]. According to analyses, tuberculosis tends to be concentrated among lower socioeconomic groups, which provides a basis for considering the disease as a “social disease” [5].

Studies devoted to examining the relationship between living standards and tuberculosis have found that individuals living in conditions of poverty have a several-fold higher risk of developing tuberculosis [14]. In low-income households, poor nutritional quality, inadequate sanitary and hygienic conditions, and limited access to healthcare services contribute to the activation of tuberculosis infection. Some authors emphasize that explaining tuberculosis development solely by medical factors is insufficient, and that the root causes of the disease lie in social problems [15].

In urban environments, particularly in the city of Tashkent, the social factors influencing the spread of tuberculosis become even more complex. In areas with high population density, temporary housing, and multi-storey residential buildings, the risk of airborne transmission of infection increases [10]. According to sources, population mobility and постоянные migration flows are cited as distinctive features of tuberculosis spread in megacity settings.

Migration processes have a significant impact on tuberculosis epidemiology, and many studies report that tuberculosis incidence among migrants is higher than among the local population [13]. Migrants often constitute a high-risk group due to living in temporary and overcrowded conditions, irregular medical examinations, and exclusion from social protection systems. Some authors emphasize that migration plays an important epidemiological role in the spread of tuberculosis infection to new areas [10].

The analysis of the medical determinants of tuberculosis indicates that HIV infection is one of the decisive factors in the development and severe course of

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this disease. In patients with TB/HIV coinfection, tuberculosis progresses rapidly and is associated with high mortality rates [9]. Some researchers consider the HIV epidemic to be one of the greatest threats to the global fight against tuberculosis. Diabetes mellitus and other chronic noncommunicable diseases are important factors that increase the risk associated with tuberculosis [6]. Scientific sources report that the risk of developing tuberculosis in individuals with diabetes is 2–3 times higher. In addition, chronic diseases reduce the effectiveness of tuberculosis treatment and increase the likelihood of disease recurrence.

Harmful habits, particularly smoking and alcohol consumption, play a significant role in the spread of tuberculosis. Smoking weakens the protective mechanisms of the respiratory tract, creating favorable conditions for the proliferation of Mycobacterium tuberculosis in the lungs [8]. Alcoholism is also identified as a factor leading to non-adherence to treatment and the development of drug resistance [6].

From an epidemiological perspective, the spread of tuberculosis infection in closed institutions deserves special attention. Numerous studies have reported that tuberculosis incidence among individuals in prisons, boarding schools, and military units is several times higher than in the general population [7]. This situation is explained by the high risk of infection transmission in closed settings and insufficient preventive measures.

The problem of drug-resistant tuberculosis (MDR/RR-TB) remains one of the main factors complicating tuberculosis epidemiology. Scientific literature notes that the increase in MDR-TB cases leads to greater complexity of the treatment process, longer treatment duration, and higher treatment costs [3].

In recent years, forecasting the spread of tuberculosis has become an important area of scientific research. The use of mathematical models, time series analysis, and artificial intelligence technologies in epidemiological forecasting makes it possible to identify high-risk areas and allocate resources efficiently [1].

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Integrating forecasting results into practical healthcare systems is of great importance for improving the effectiveness of tuberculosis control.

A comprehensive analysis of the factors influencing the spread of tuberculosis shows that the epidemiology of this disease is a complex and multilevel process in which social, medical, and epidemiological determinants are closely interrelated. Scientific literature emphasizes that studying these factors separately is insufficient; rather, it is necessary to assess their combined and synergistic effects [15]. This approach makes it possible to more deeply explain the reasons for the persistent presence of tuberculosis in urban areas, including the conditions of the city of Tashkent.

The interrelationship between social and medical factors plays an important role in the mechanisms of tuberculosis development. For example, in individuals living under poor socioeconomic conditions, malnutrition and chronic stress lead to weakening of the immune system, which creates favorable conditions for the activation of Mycobacterium tuberculosis infection [5]. At the same time, the level of utilization of healthcare services among such individuals is low, which leads to delayed diagnosis and prolonged maintenance of infectiousness.

Epidemiological factors also play an important role in the spread of tuberculosis. In closed and semi-closed environments, including multi-storey residential buildings, workers' dormitories, prison institutions, and places where people gather for long periods, the risk of airborne transmission of infection increases significantly [7].

Among the medical determinants of tuberculosis, the problem of delayed diagnosis deserves special attention. According to research findings, the proportion of patients who repeatedly sought medical care with tuberculosis symptoms but were not correctly diagnosed in a timely manner remains significantly high [2]. This situation is explained by the insufficient effectiveness of diagnostic algorithms within the healthcare system and the low level of tuberculosis awareness and vigilance among primary healthcare physicians.

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The formation and spread of drug-resistant forms of tuberculosis have created a qualitatively new risk factor in tuberculosis epidemiology. Scientific literature indicates that MDR/RR-TB is often associated with non-adherence to treatment, inappropriate treatment regimens, and insufficient social support [3]. This situation increases epidemiological risk not only for individual patients but also for the entire population, as cases of transmission involving resistant strains are steadily increasing.

In recent years, forecasting the factors influencing the spread of tuberculosis has become an important direction of scientific research. The use of time series analysis, regression models, and mathematical simulation methods in epidemiological forecasting makes it possible to assess future disease dynamics in advance [1]. Some sources emphasize the necessity of including social indicators in forecasting models of tuberculosis epidemiology, as these factors determine the long-term trends of the disease.

Recent scientific studies have placed special emphasis on the use of artificial intelligence and machine learning technologies. These approaches enable the analysis of large volumes of epidemiological data, identification of high-risk groups, and targeted allocation of resources [11]. Such models are considered promising tools for planning tuberculosis control strategies.

The importance of forecasting for urban areas is particularly high, as factors such as population density, migration, and transport mobility have a direct impact on tuberculosis dynamics. Under the conditions of the city of Tashkent, developing forecasting models that consider these factors makes it possible to scientifically plan tuberculosis control measures [15].

Conclusion:

Thus, the social, medical, and epidemiological factors influencing the spread of tuberculosis are characterized by complex interrelationships, and their comprehensive analysis and forecasting serve as a necessary scientific basis for

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improving the effectiveness of tuberculosis control. Poverty, migration, HIV infection, and chronic diseases remain leading determinants in tuberculosis epidemiology. The high risk of infection transmission in closed institutions, as well as the presence of minimal and subclinical forms, leads to the hidden spread of the disease. The application of modern forecasting methods serves as an important scientific foundation for enhancing the effectiveness of tuberculosis control.

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