

## **PREDICTION OF BIOMEDICAL INDEXES AS BASIS OF DEVELOPMENT OF THE PRIORITY DIRECTIONS IN PREVENTIVE MEDICINE**

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### **ABSTRACT**

In order to prevent morbidity among the military servicemen, the main preventive measure is regular medical monitoring of the health of servicemen. We conducted a study of the morbidity of Russian servicemen for the period of 2009-2015, and, based on the analysis of morbidity data, forecasted the incidence rates for 2020-2030. The following research methods are used in the work: mathematical statistics, programming and modeling, clinical and epidemiological analysis. The scientific research is aimed at identifying the presence of a stable trend in the changes of incidence rates over a certain period of time and constructing a prognosis based on the data obtained separately for each nosological form. The forecast period is from 2020 to 2030. Equally important is the ability to develop proposals and recommendations for the planning of treatment and preventive measures based on the data obtained from the research, taking into account the results of the prognosis and the risk factors that lead to the occurrence of diseases. The reliability of forecasts depends on several factors. Such factors include the degree of inertia of the phenomenon subjected to forecasting, the degree of revealing the trend of the development of the phenomenon and the choice of the method for making the forecast. The period of forecasting plays an equally important role; long periods are less accurate. And vice versa, the shorter the forecast period is, the more accurate the forecast is.

**Keywords:** forecast of morbidity, mathematical statistics, simulation, forecasting, clinical and epidemiological analysis.

### **INTRODUCTION**

In recent years, more emphasis has been placed on the prevention of morbidity in the population. One of the main priority conditions for the growth of the economic power of any state is the health of its population, since the working capacity of the population of the country directly depends on the state of health. The defensibility of each state and the creation of guarantees for the country's military security depends on the health of servicemen [1,2,3]. In recent years, the Armed Forces of the Russian Federation have undergone radical reforms. In modern society, the guarantor of the security of any state is the health of those who protect the state. Consequently, the requirements to the state of health of both conscripted and contract servicemen and prevention of morbidity of servicemen have been increased [3]. As in any other state, to ensure the military power and security of the Russian Federation, it is necessary to staff all types of troops taking into account the level and structure of the morbidity of both conscripts and contract servicemen. In this regard, in recent years, the issue of the medical fitness of conscripts and contract draftees has become acute. It is definitely noted that the tendency to deterioration of the health of conscripts and contract draftees is conditioned by an increase in the incidence of chronic diseases among young men of conscript age [4,5,6].

The dynamics of changes in the health of servicemen is tracked in the analysis using generalized medical and statistical indicators. When tracking changes, it is necessary to conduct a comparative analysis of

similar indicators for other periods, with other parts of the troops. The characteristics of both personnel and activities of the troops must be taken into account [7,8].

The data obtained during the analysis make it possible to identify the leading forms and classes of diseases. Inclusion of the incidence rate in the analysis allows obtaining data for the medical service of the military unit to plan the order and urgency of the treatment and preventive measures. Therapeutic and preventive measures should be designed to minimize the morbidity of personnel. Recently, in medicine, more emphasis has been placed on new systemic approaches to diseases. One of such approaches is predictive medicine, or disease prediction [9,10].

Objective of this study is to analyze and forecast the health status of both conscripted and contract servicemen in the Armed Forces of the Russian Federation.

## METHODS

The chosen object of the study is the morbidity of the conscripted and contract servicemen of the Armed Forces of the Russian Federation. During the research, general information was used on the overall morbidity of the conscripted and contract servicemen serving for the period from 2009 to 2015.

The approach we used in the study is based on extrapolation of the main trends in the development of the process over time. Under the influence of some factors, these trends constantly change. As a result, events that occurred some time ago may not have a significant effect on the dynamics of changes in the studied indicator. In these conditions, classical statistical methods, assuming the permanence of the trend over the period under study, turn out to be not flexible, because the methods for estimating model coefficients using all the a priori information with the same value cannot provide an effective assessment of the deterministic basis of the process of change.

In this case, the use of so-called discounted methods seems to be more expedient. Assigning to each observation its own weight results in minimization of the criterion  $Q = \sum_k \alpha_j (x[k] - \hat{x}[k])$  in the process of finding the coefficients of the trend, where  $k = 1, 2, \dots, j = 0, \dots, n - 1$ .

In this case, the application of the method of exponential smoothing is most effective. This method consists in the fact that, according to the data of the indicator  $x[n]$ ,  $k = 1, 2, \dots, n$ , it is necessary to make a forecast  $\hat{x}[n]$  for time moments  $n + 1$  in such a way that later observations would be assigned more weight as compared to earlier ones. Exponential smoothing makes it possible to estimate the coefficients

$$Q = \alpha \sum_{k=0}^{n-1} (1 - \alpha)^k [x[n - k] - \sum_{i=0}^p \frac{\varphi_i}{i!} (n - k)^i]^2$$

of the polynomial predictor by minimizing the criterion for  $\Phi_j$  (where  $\Phi_j$  are the coefficients of the predictive model), equivalent to the criterion of the minimum of the weighted sum of squares.

The forecast in all cases shall be in accordance with the expression  $\hat{x}[n + l] = \varphi_0[n] + \varphi_1[n]l + \frac{1}{2}\varphi_2[n]l^2 + \dots + \frac{1}{p!}\varphi_p[n]l^p$ .

Working with the values of indicators represented by time series, recursive estimates of the coefficients of the predictive model were used:

$$\begin{cases} \varphi_0[n] = x[n] + (1 - \alpha)^2 (\hat{x}[n] - x[n]), \\ \varphi_1[n] = \varphi_1[n - 1] - \alpha^2 (\hat{x}[n] - x[n]), \end{cases}$$

$$\begin{cases} \varphi_0[n] = x[n] + (1 - \alpha)^3 (\hat{x}[n] - x[n]), \\ \varphi_1[n] = \varphi_1[n-1] + \varphi_2[n-1] - \frac{3\alpha^2}{2} (2 - \alpha)(\hat{x}[n] - x[n]), \\ \varphi_2[n] = \varphi_2[n-1] - \alpha^3 (\hat{x}[n] - x[n]), \end{cases}$$

$$\hat{x}[n] = \mu_0[n-1] + \mu_1[n-1] + \frac{1}{2} \mu_2[n-1], \quad \hat{x}[n] = \mu_0[n-1] + \mu_1[n-1] + \frac{1}{2} \mu_2[n-1]$$

as well as forecasts for the linear and parabolic model, respectively. All of the above can be used to forecast indicators with polynomial trends.

Polynomial predictors constructed with the methods of least squares and exponential smoothing give acceptable forecasts of time series in the event that the oscillations of these series are insignificant.

The initial information for constructing the predictor is the mean values of the series, its variance and autocorrelation. Linking models to data was achieved by a procedure based on structural identification and evaluation (parametric identification).

$$\hat{x}[n+l] = \sum_{k=0}^p \mu_k x[n-k]$$

For forecasting, we used a model with the following equation:

By solving a system of algebraic equations, the optimal estimates of the coefficients of the model were found

$$\begin{cases} \frac{\partial Q}{\partial \varphi_k} = -2C_{k+l} + \sum_{j=0}^p C_{k-j} \varphi_k = 0, \\ k = 0, 1, \dots, p, \end{cases}$$

$C_i$  in this case is the corresponding auto-covariances.

## RESULTS

Based on the analysis with the use of generalized medical and statistical indicators, it was found that the rates of general morbidity, primary morbidity, hospitalization, lost worktime and dismissal of servicemen tended to increase from 2009 to 2015. In the forecast periods, the growth of these indicators is expected. While morbidity among military personnel moves downwards.

Both conscripted and contract servicemen have a tendency to growth of indicators of group 7 of class 4 in terms of nosological form - obesity and other kinds of excessive nutrition by 19.79%. In groups 5-6 - malnutrition, there is a significant decrease by 48.97%.

The conscripted servicemen tend to increase in the group 2, class 11 indicators of the nosological form of the esophageal, stomach and duodenal diseases by 14.88% in the forecast period, compared with 2015. The contract draftees are forecasted to have growth by 19.21%.

The contract servicemen are forecasted to have an increase in group 1, class 1 indicators of the nosological form of intestinal infection by 19.41% and more in the forecast period, compared to 2014. The draftees are forecasted to have a decline in these indicators.

Both conscripted and contract servicemen are forecasted to have an increase in group 3, class 9 indicators of the nosological form of disease, characterized by high blood pressure, by 28.6% and more in the forecast period, compared to 2015.

The analysis showed that the overall result of morbidity indicators moves upwards, with a decline in 2014-2015. In the forecast periods, morbidity rates are expected to increase by 10-12% in both groups of servicemen.

## **DISCUSSION**

Based on the results of the conducted analysis of the indicators of general morbidity, primary morbidity, hospitalization, lost worktime and dismissal of both conscripted and contract servicemen of the Armed forces of the Russian Federation, we made a forecast of morbidity for the period from 2020 to 2030. The main objective of the study was to identify a stable trend in the studied data from 2009 to 2015, with the further separate forecasting for each nosological group.

In the course of the study, a reliable growth trend of such indicators as general morbidity, primary morbidity, hospitalization, lost worktime and dismissal was revealed. There is a reliable tendency to reduction in mortality rates among both the conscripted and contract servicemen of the Armed Forces of the Russian Federation.

A tendency to increase in nosological form such as obesity and other types of excessive nutrition is observed in both groups of study; in parallel with this, these groups have a decline in indicators of nosological form, such as malnutrition.

Based on the results of the study, the presence of significant growth in the nosological form, such as diseases of the esophagus, stomach and duodenum among the conscripted and contract servicemen of the Armed Forces of the Russian Federation was established.

The analysis of the research data showed a tendency to growth of nosological indicators, such as intestinal infections, among the contract servicemen, and the reduction in the same indicators in conscripts.

The results of the study make it possible to identify in both the conscripted and contract servicemen of the Armed Forces of the Russian Federation a sustained growth of nosological indicators, such as diseases characterized by high blood pressure.

## **SUMMARY**

1. The indicators of general morbidity, primary morbidity, hospitalization, lost worktime and dismissal of servicemen tended to increase from 2009 to 2015. In the forecast period of 2020-2030, these indicators are expected to continue growing significantly. Mortality of the military personnel moves downwards.

2. It was established that both conscripted and contract servicemen have a tendency to growth of group 7, class 4, indicators of nosological form - obesity and other kinds of excessive nutrition by 19.79%. In groups 5-6 of nosological form - malnutrition, with a significant decrease by 48.97%.

3. The conscripted servicemen tend to increase in the group 2, class 11 indicators of the nosological form of the esophageal, stomach and duodenal diseases by 14.88% in the forecast period, compared with 2015. The contract servicemen are forecasted to have a reliable growth by 19.21%.

4. It was established, that the contract servicemen are forecasted to have an increase in group 1, class 1 indicators of the nosological form of intestinal infection by 19,41% and more in the forecast period, compared to 2014. The conscripted draftees are forecasted to have a reliable decline in these indicators.

5. Both conscripted and contract servicemen are forecasted to have an increase in group 3, class 9 indicators of the nosological form of disease, characterized by high blood pressure, by 28.6% and more in the forecast period, compared to 2015.

The analysis of data for morbidity among the conscripted and contract servicemen of the Armed Forces of the Russian Federation showed that the overall result of morbidity indicators tends to grow. In the forecast periods, morbidity rates are expected to increase by 10-12% in both groups of servicemen.

## CONCLUSIONS

We analyzed the dynamics of the state of health of the conscripted and contract servicemen of the Armed Forces of the Russian Federation. As a result of our study, we obtained the dynamics of changes in the health of servicemen being tracked in the analysis with the use of generalized medical and statistical indicators. When tracking changes, we conducted a comparative analysis of similar indicators of other parts of the troops. The characteristics of both personnel and activities of the troops were taken into account.

Based on the results of the analysis, we identified the prevailing forms and classes of diseases.

As a result of the study, we revealed the presence of a tendency for individual nosological forms among the conscripted and contract servicemen.

Based on the conducted research and data studied, we made a forecast of the morbidity status of servicemen for the period from 2020 to 2030.

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