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Estimation of the epidemiologic situation by the generalized criterion

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A rationale for the use of an aggregate generalized index in conducting an integral estimation of epidemiologic situation and/or population health status is presented. The approach was demonstrated on the case of tuberculosis infection in the Sakha Republic (Yakutia) over a 19 year period (1990–2008), using 4 statistical measures: incidence, morbidity, bacterial load and mortality.

Keywords: methodological approach, generalized measurements, epidemiologic situation, health status.

Brief introduction. Complex estimation of an epidemiologic well-being or ill-being of a defined area and/or health level in some population group is based mainly on comparison between separate statistical measures (such as incidence, morbidity, mortality, disability etc.). The necessity and importance of such approaches is undeniable, but this sort of analysis is sometimes insufficient to make an objective and comprehensive conclusions about the changes in epidemiological situation over several years or over different areas. In these cases, additional use of a generalized index to support the analysis makes sense, as the correct estimation of similar objects in time and space becomes sometimes extremely difficult without such an index. It is, of course, easier to come to final conclusions, when all the observed health measures change in uniform direction (either increase, or decrease). Then it is possible to make a reliable conclusion about differences in epidemiologic situation between different areas or on the same area over time, without generalized quantitative estimation. And even in such cases, a generalized estimation would be still useful, as it allows to establish a generalized quantitative measure of difference. When the changes observed in health measures are non-uniform and a reliable conclusion is needed, the logical analysis needs to be supported by an integral generalized index.

Hence, the aim of this report is to give rationale for the use of an aggregate generalized index as an additional quantitative tool for estimating the epidemiological situation and/or population health status.

Analysis of the data presented was done using statistical data for tuberculosis infection in the Sakha Republic (Yakutia), an area of high tuberculosis transmission risk, judging by seasonal, socioeconomic and living conditions of the majority of population, and this was witnessed during the years of socioeconomic crisis [1;4]

Materials and methods.

4 measures have been employed to analyze the epidemiologic situation: incidence, morbidity, bacterial load and mortality. The incidence dynamics was assessed for 39 years (from 1970 to 2008), while for the rest of measures (including incidence), the dynamics was assessed for 19 years (from 1990 to 2008). Data were subjected to conventional methods of epidemiologic analysis: comparison of mean levels and increase rates, the dynamics of which were calculated using the data smoothed by least squares method. Besides these, time series trends reliability test technique and correlation analysis for paired and multiple correlations were used [3].

To perform the generalized description of epidemiologic situation, we used a method, earlier proposed for a generalized estimation of environment [2]. The method consists essentially in aligning divergent health measures into a unified system, by applying a universal statistical test, defined as the amount (percentage) of a defined characteristic within the analyzed set of parameters, and is expressed as a relative deviation from the average status.

First, we analyzed each of the individual statistical measures, by calculating an individual index (II) of epidemiologic situation, using the formula:

$$\mathrm{II} = \frac{a_i}{M},$$

where:

ai – is the value of a defined *i*th annual (monthly, etc.) measure;

M – is the mean value of all measures over a respective observation period.

Next, we obtain the cumulative epidemiologic situation index (ESI) – this is the basic index, and is calculated as the mean value of all the individual indexes (II) included to the analysis:

$$ESI = (II_1 + II_2 + \dots + II_n) / n$$

This approach has found quite a wide application in epidemiologic studies for description of intra-annual dynamics of statistical measures (the so called "seasonality index"). But all such applications of seasonality index imply that estimation is made based on only one data set (e.g., incidence). We propose an approach, which permits to aggregate all the individual indexes of epidemiologic situation into one generalized index.

Next phase of the analysis is the ranking of ESIs, followed by construction of a rating scale. Ranking is done by arranging the indexes in ascending order. The resulting continuous series is then distributed to discrete classes (groups), and value ranges are calculated for each class, which can be ranging within the CI limit, below, or above the confidence limits.

Results. Long-term analysis of tuberculosis incidence in the Sakha Republic (Yakutia) showed that a remarkable and statistically significant decrease (from 138.1 to 69.1 $^{0}/_{0000}$) was observed during the study period (1970–2008), with 1.4 % annual negative increase rates. At the same time, it was found, that the first 20 years (1970–1990) in the study period largely accounted for the generally favorable trend in incidence dynamics, with –4.2 % negative increase rates and with the incidence rate in 1990 dropping to a minimum (45.4 $^{0}/_{0000}$). Over the following period (1990–2008), we observed a stable and statistically significant increase of tuberculosis incidence ($p<0.0001$) with a 2.8 % positive average annual increase rate. The detection of this unfavorable incidence trend from 1990 to 2008 compelled us to take a closer look at the epidemiologic situation at this period. The main statistical values for epidemiologic situation are shown in Table 1.

As a result of the analysis, the presence of unfavorable trend was shown for incidence, mortality and bacterial load rates (increased by factors of 1.5, 1.3 and 1.1, respectively), while mortality rate had a negative increase rate (Table 1). ESI with a 1.2 increase rate is the aggregate epidemiologic situation index.

Correlation analysis (Table 2) showed a statistically significant association between the 'incidence–sputum positivity' pairs. The presence of a pronounced trend ($p<0.1$) was shown also for 'incidence–mortality' pairs. The fact that there is a correlation between ESI and each of the epidemiologic measures (except morbidity) speaks in favor of the use of generalized index in integral estimation of epidemiologic situation. Moreover, there are multiple correlations between

ESI and various pairs of standard epidemiologic measures. All these correlations are of the strong type with a high statistical significance (Table 3).

As a next phase of the study, we ranked the long-term ESIs and derived confidence intervals for the period analyzed. Aggregate epidemiologic situation indexes (ESI) corresponded to a 'normal' epidemiologic situation in a given area for a given period of time, if they were within the confidence limits. All values of aggregate indexes that were below or above the CI limits indicated that epidemiologic situation was either favorable (low level), or unfavorable (high level), respectfully.

An example of estimated epidemiologic situation using the proposed generalized index is shown in Table 4. Besides ranking of ESIs described here, a time series-based approach may be used to analyze the epidemiologic situation (Fig. 1).

Results and discussion. Application of the epidemiologic situation index permits to form an integral quantitative estimation of infectious disease incidence trends, using defined epidemiologic measures, no matter how much of them are included to analysis. This approach can be applied to any infectious disease surveillance and the final estimation of the data can be easily adjusted to various temporal clusters (months, years, etc.), as required. All this could serve as a methodological base to conduct complex estimation of population health, suitable for any given area for a defined period of time.

In this paper, we presented an example of estimated epidemiologic situation for tuberculosis in the Sakha Republic (Yakutia). It was shown, that although the trends for individual statistical health measures were divergent and non-uniform, a generalized quantitative measure of epidemiologic situation has been achieved, revealing an unfavorable dynamics of tuberculosis infection in this largest region of Russia over the last decade. The proposed approach let us identify several years within study period with relatively low and high estimated levels of epidemiologic situation. Also, use of this methodology let us conclude that in Yakutia from 1990 to 2000 there was a continuous aggravation of the epidemiologic situation for tuberculosis, while the period from 2000 to 2008 was characterized by improvement. The dynamics of ESIs during both of these periods was shown to be highly statistically reliable.

Conclusion. Epidemiologic situation index is proposed for use as an additional integral estimation of epidemiological situation.

Table 1

Epidemiologic statistics for tuberculosis in the Sakha Republic (Yakutia), 1990–2008.

Measure	Incidence	Morbidity	Bacterial load	Mortality
Intensive parameter, $^{0}/_{0000}$	64.5±1.5	242.9±5.4	86.9±1.3	8.7±0.2
Increase rate, %	2.8	- 1.3	1.0	1.1

Table 2

Correlation coefficients (CC) between individual epidemiologic statistical measures

Note. Here and elsewhere: Statistically significant CCs are given in boldtype

Table 3

Multiple correlations between ESIs and various pairs of standard epidemiologic statistical measures

Measure	Incidence							
	R	p	Morbidity					
Morbidity	-0.24	0.3316	r	P	Bacterial load			
Bacterial load	0.66	**0.0023**	-0.21	0.3976	r	p	Mortality	
Mortality	0.41	0.0789	-0.02	0.9308	0.19	0.4346	r	p
ESI_c	0.81	**<0.0001**	0.17	0.4621	0.62	**0.0044**	0.73	**<0.0001**

Measures	**Correlation coefficient (CC)**	**p**
incidence – morbidity	0.90	**< 0.0001**
incidence – bacterial load	0.82	**0.0001**
incidence – mortality	0.92	**< 0.0001**
morbidity – bacterial load	0.69	**0.0050**
morbidity – mortality	0.75	**0.0012**
bacterial load – mortality	0.88	**< 0.0001**

Table 4

Estimated tuberculosis epidemiologic situation in the Sakha Republic (Yakutia) based on ESI, using confidence interval (CI)

Ranked ESI	Year	Rank scale	ESI level
0.87	1990	< 0.97	Low

0.89	1994	(ESIs below CI limit)	
0.91	1992		
0.92	1991		
0.94	2007		
0.96	1995		
0.96	1993		
0.97	1998	0.97 – 1.03 (ESIs within CI limit)	Norm
0.98	2006		
0.98	1997		
1.00	1996		
1.03	2004		
1.04	2008	> 1.03 (ESIs above CI limit)	High
1.04	2005		
1.06	2002		
1.06	2003		
1.09	2001		
1.11	1999		
1.12	2000		

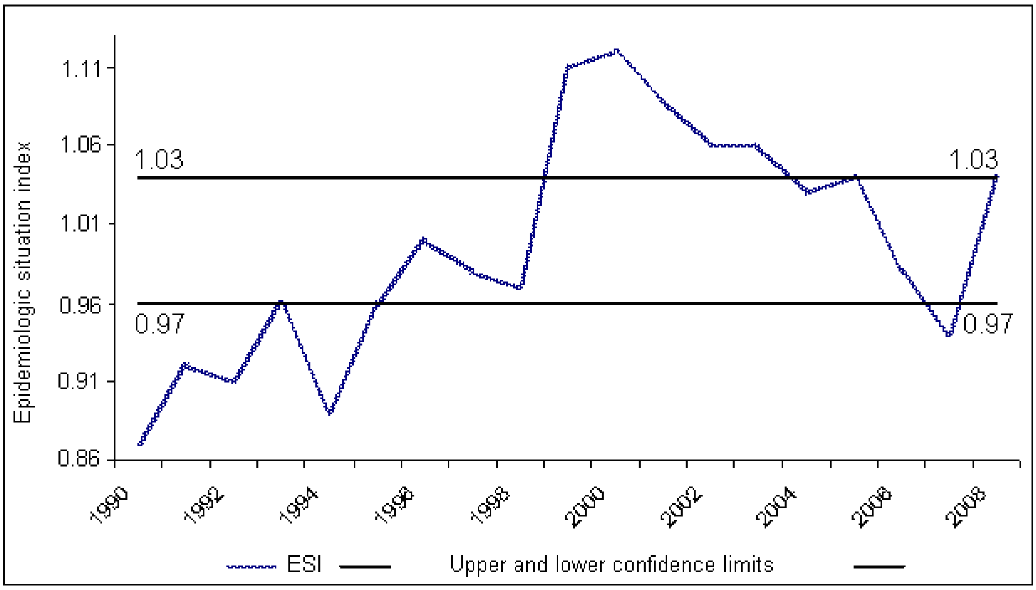

Figure 1. Long-term dynamics of epidemiological situation index for tuberculosis in Sakha Republic (Yakutia)

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Assessment of patients’ satisfaction with quality and availability of the specialized rheumatologic medical care in Republic Sakha (Yakutia)

Medico-sociological research of the population, received specialized rheumatologic medical care in hospitals of Yakutsk is conducted. Distinctions in respondents’ answers about conditions of rheumatologic care by rendering type (out-patient and in-patient care) are revealed. Results of sociological study testify to incomplete satisfaction of the population with quality and availability of the specialized rheumatologic care because of organizational aspects in its rendering.

Keywords: care quality, satisfaction, availability.

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