Urbanization-related factors as triggers of the development of type 1 diabetes mellitus*

L. A. Soprun[1], I. M. Akulin[1], V. J. Utekhin[1], A. N. Gvozdetskiy[1], L. P. Churilov[1,2]

[1] St. Petersburg State University,
7–9, Universitetskaya nab., St. Petersburg, 199034, Russian Federation

[2] St. Petersburg Research Institute of Phthisiopulmonology, Health Ministry of Russia,
2–4, Ligovskiy pr., St. Petersburg, 191036, Russian Federation

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The proportion of autoimmune pathology increases along with urbanization. A cohort retrospective-prospective study was performed to analyze the prevalence of type I diabetes mellitus in 83 regions of the Russian Federation during the period from 2008 to 2017 and the influence of urbanization factors on type I diabetes mellitus incidence. The main urbanistic factor obtained during mathematical modeling contributing to the development and distribution of the incidence of type I diabetes mellitus is air pollution with solid dust particles, namely air emissions from the stationary sources, highways density and the number of buses. The urbanization factors are controlled and, therefore, many of the adverse effects on human health can be prevented by using organizational and methodological recommendations as well as new regulations on air pollutants.

Keywords: geoepidemiology, autoimmune diseases, pollutions, type I diabetes mellitus, urbanization, solid dust particles.

Introduction

As civilization evolves, urbanization and life expectancy increase the proportion of autoimmune pathology also increases [1; 2]. Despite the notable success in understanding the pathogenesis of a large number of autoimmune diseases [3], causal factors for many selected nosological forms continue to be a subject of debate [4; 5].

Materials and research methods

During the period from 2008 to 2017, a cohort retrospective-prospective study analysing the prevalence of type 1 diabetes mellitus (T1DM) in 83 regions of the Russian Federation. The "**All Population**" group was taken as an analyzed group, *and the incidence with the first established diagnosis of type 1 diabetes mellitus per 100 000 of population was taken as an indicator under study*.

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The following factors were selected as **urbanization factors**:

- registered amount of pollutants emissions into the air emanating from the stationary sources in each individual region in thousands of tons from 2005 to 2015 (hereinafter — air);
- registered amount of polluted wastewater discharge into the surface water sources in each individual region of the Russian Federation in millions of m^3 from 2005 to 2015 (hereinafter — water);
- geographical network density of public paved roads per 1000 km^2 in terms of the total length of roads at the end of 2005–2015 (hereinafter *road*);
- number of public buses per 100 000 population (hereinafter — *bus*).

Descriptive statistics included the arithmetic mean and standard deviation (Mean (sd)), medians, 1 and 3 quartiles (Median [Q1; Q3]), and indications of the minimum and maximum values (min-max).

To identify the influence of urbanization factors on the type 1 diabetes mellitus incidence, the regression analysis was used. At the first stage, the assumed factors were included **in the model taking into account all possible interactions between them (model No. 1)**. The modeling was done using the function glm. nb. (MASS) in the programming language R v3.5.2. The syntax of function was as follows:

fit <- glm.nb
(incidence~log(bus)*log(road)*log(air)*log(water)+offset(log(1000))).

We searched for the optimal models using the lowest value of the Akaike's information criterion (AIC) applying reverse selection or manually. The maximum likelihood logarithm (LR) statistics was used to compare the selected models. Models 2, 3, 4, 5 and 6 were obtained as a result of the procedure for finding the optimal model. **Model 2** considers the additive (joint) effect on the type 1 diabetes mellitus incidence and the number of buses. **Model 3** regards the multiplicative effect of the paved road network density, the number of buses and air emissions from stationary sources on the type 1 diabetes mellitus incidence. **Model 4** demonstrates the multiplicative effect of air pollution and paved roads' network density, and the independent effect of the number of buses on the type 1 diabetes mellitus incidence.

Model 5 presents the multiplicative effect of the number of buses and the paved roads' network density, and the independent effect of air pollution on the incidence of T1DM. **Model 6** considers multiplicative effect of air pollution, the number of buses, and additive effect of paved roads' network density.

The obtained results were presented in the form of **an incidence rate** (IRR) and its 95 % confidence interval based on the regression coefficient in compliance with the syntax: exp(coef(fit)), (error (p) less than 0.005).

Results of the study

We calculated variation series indicators for urbanization-related factors on the territory of the Russian Federation, which could be used as the first stage of descriptive statistics.

It was found, that **model 1 with an account for all possible interactions among the selected urbanization factors** did not contain any statistically significant regression coefficients linking the factors of urbanization with regional incidence of type 1 diabetes mellitus. Models 2, 3, 4, 5 and 6 were obtained as a result of the procedure for finding the optimal model. Each model can be considered optimal, since they do not differ significantly from the model 1 ($p > 0.05$).

Discussion

We carried out a large-scale cohort retrospective-prospective research to study the prevalence of type 1 diabetes mellitus in a country with a globally largest territory and broadest known variety of climatic and geographical zones. In addition, mathematical modeling allowed identifying new urbanization-related factors that affect the type 1 diabetes mellitus development and distribution.

Conclusion

The main urbanistic factor obtained during mathematical modeling contributing to the development and distribution of the incidence of type I diabetes mellitus is air pollution with solid dust particles, namely air emissions from the stationary sources, paved roads geographical density and the number of buses.

The urbanization factors are controlled and, therefore, many of these adverse effects on human health can be prevented by using organizational and methodological recommendations as well as new regulations on air pollutants.

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Authors' information:

Lidia A. Soprun — MD, PhD; lidas7@yandex.ru,
Leonid P. Churilov — MD, PhD (Medicine), Full Member of the International Academy of Sciences (Health and Ecology), Associate Professor; elpach@mail.ru
Igor M. Akulin — MD, D. Sci. (Medicine), Professor; akulinim@yandex.ru
Vladimir J. Utekhin — MD, PhD, Associate Professor; utekhin44@mail.ru
Anton N. Gvozdetskiy — MD, Postgraduate Student; comisora@yandex.ru