

## COMPARATIVE HYGIENIC CHARACTERIZATION OF AIR POLLUTION AND ITS IMPACT ON THE TBILISI POPULATION'S HEALTH

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One of the current problems among preventive medicine and public health is the state of the environment. To solve it, the concept of green economy, designed to ensure a healthy ecology, is important. Thus, the solution of this problem implies the complexity of economic and ecological-hygienic measures.

The state of atmospheric air occupies a leading place in the complex of environmental factors affecting human health [8,12]. Quantitative depiction of the damage caused to humanity by air pollution is difficult, although its scale is beyond doubt. For example, at the end of the 20th century, the damage caused by air pollution in the United States amounted to 16 billion, reached 250 million pound sterling in the UK, and 200 million yens in Japan; In Europe, the 36 kg of particulate matter suspended in the atmosphere falls per person on average, while 25% of the population is exposed to NO<sub>2</sub>. That is why the implementation of measures against air pollution should be considered as one of the important priorities of each state, especially considering that the so-called transboundary movement is typical for airborne pollutants [2].

It should be noted that a number of international conventions and agreements have been adopted on this issue, which provide for the need to improve the quality of ambient air and reduce its negative impact on public health [4,6,15], and that the Third Ministerial Conference on Environment and Health (London, United Kingdom, 1999) recognized that 50% of communicable diseases in the population are caused by environmental pollution [3].

The problem of atmospheric air protection is very urgent for our capital due to its peculiar geographical location, relief features and nature of construction, which often poses a serious problem for the natural ventilation of the celestial and other zones. There are studies according to which the degree of impact of ambient air on the health of the population is directly proportional to the intensity of pollution [11]. However, this impact is manifested not only in the direct cause of diseases, but also in the general reactivity of the organism, in the deterioration of well-being, in the ability to work, or in changes whose subjective assessment leads to the formation of certain nonspecific complaints in the population [14,9]. In this regard, it is interesting and informative to analyze by Tbilisi population the self-assessment data on the dependence of the state of own health on the air pollution. Such an analysis was conducted by us at the initial stage of the study, in 2017, on a relatively numerically limited contingent, which, consequently, revealed certain trends [7].

It is interesting, however, what kind of trend has emerged in the dynamics in this regard, given that the monitoring of the air condition of the capital has improved somewhat since 2016; in particular, the number of automatic stations has increased, and a gradual indicator survey of ambient air is also conducted annually [5].

The aim of the study was to investigate the dependence of the health self-assessment and well-being of the population of Tbilisi on the air pollution degree.

**Materials and methods.** To analyze the atmospheric air condition in Tbilisi, we used the data of the research conduct-

ed by the National Environmental Agency of the Ministry of Environment Protection and Agriculture of Georgia for years (2016-2019), in particular, average annual concentrations ( $\mu\text{g}/\text{m}^3$ ) of major air pollutants in Tbilisi by individual districts. We identified four districts according to the location of automatic air monitoring stations (Table 1). The population was surveyed by a special questionnaire to find out the nature of its connection with the self-assessment of its own health condition and its connection with air pollution. The questionnaire is based on a 2013 study by the WHO. We validated the questionnaire, after which the survey started in September 2017 and ended in March 2018. Respondents were selected through the door-to-door method in different districts of Tbilisi, taking into account the degree of air pollution. The visit was conducted in 830 families, out of which 335 female and 233 male respondents took part in the survey (568 in total). Criteria for inclusion in the anonymous study were relevant knowledge of the Georgian language knowledge, cognitive ability, age and living in the existing area for at least 5 years. 262 respondents were excluded from the study; 138 participants refused to participate, while 124 questionnaires were incompletely filled out and canceled. The questionnaire was statistically processed in the SPSS program.

The survey consists of three parts. The first part includes the respondent's passport data, while the second part includes questions about air pollution and the source of emissions in the existing area. The third part deals with the possible determination of the connection between the degree of air pollution and the deterioration of the state of health.

The survey data were processed using variational statistics methods; the reliability of the difference between the comparable values was assessed by the Student's reliability coefficient (t, P). The obtained data were processed using SPSS statistics.

### Results and discussion.

#### *A. Retrospective analysis of the air condition in the capital.*

According to the National Environment Agency of the Ministry of Environment Protection and Agriculture of Georgia, the level of air pollution in Tbilisi is average - data from automated stations in Tbilisi in 2017 show that the maximum concentrations of ozone, sulfur dioxide, nitrogen oxides and carbon monoxide in the air near the ground exceed the national maximum indicator (MAC) by 1.5-2 times [1,5].

It should be noted that the National Environmental Agency, in addition to constant monitoring through automatic stations, annually conducts an indicator survey of air pollution in four stages, several times a quarter: in March, June, September and December. The most congested streets in different parts of the capital have been selected for indicator survey in the capital. Concentrations of nitrous oxide, benzene and ozone in the air are measured as part of the indicator study. In 2019, at all four stages of this study, the maximum concentrations of NO<sub>2</sub> on Rustaveli Avenue (Mtatsminda-Sololaki district) were 2.1-2.5 times higher than the corresponding MAC (40  $\mu\text{kg}/\text{m}^3$ ); in the first and second stages, Melikishvili (Vake district) and Ketevan Tsamebuli (Isani-Samgori district) avenues were also distinguished in this respect, where the concentration was 1.85 times and, respectively, 1.93 times higher than allowed. In the second

phase of the study, the concentration of this gas exceeded MAC (1.88 times) in Varketili as well. It is noteworthy that very few of the surveyed locations were clean; almost in all the streets, especially Ushangi Chkheidze (Didube-Chugureti district), Irakli Abashidze (Vake district), Ioane Petritsi (Saburtalo district), Tsofne Dadiani (Didube-Chugureti district), as well as on Tsereteli and Gamsakhurdia avenues (Didube-Chugureti and Saburtalo districts, respectively), nitrogen oxide concentration was 1.03–1.7 times higher than the MAC.

Since 2016, as mentioned above, the number of automatic stations in Tbilisi has increased, although no significant change in the content of these pollutants, either in positive or negative terms, according to the maximum single concentration rate, has been observed. Average annual concentrations of major atmospheric air pollutants over a relatively long (2016-2019) observation period are determined along with the maximum single

concentrations [5]. The picture revealed as a result of the research conducted in all three years in this direction is presented in the table below.

As can be seen from the table, the average annual rates of dust and nitrous oxide, since 2016, remain steadily rising on Tsereteli Avenue (49 µg/m<sup>3</sup>- 63 µg/m<sup>3</sup>) and, partly, on Kazbegi Avenue (35 µg/m<sup>3</sup> - 42 µg/m<sup>3</sup>).

**B. Population survey results.** As mentioned above, the selection of respondents took into account their residential area and the degree of air pollution in this area. The diagram presented below shows that most respondents were selected from the most polluted Vake-Saburtalo, Didube-Chugureti and Gldani-Nadzaladevi districts, relatively few - from Isani-Samgori and Mtatsminda-Sololaki districts. At the same time, most of them, i.e. 386 people out of 568 (68%) live in the district for more than 10 years, and 81 (14.3%) for 5 to 10 years.

Table. Average annual concentrations (µkg/m<sup>3</sup>) of major air pollutants in Tbilisi City by individual districts

Weather Station	Location	PM10 (µkg/m <sup>3</sup> )				PM2.5 (µkg/m <sup>3</sup> )				NO2 (µkg/m <sup>3</sup> )			
		2016	2017	2018	2019	2016	2017	2018	2019	2016	2017	2018	2019
Air quality monitoring automatic weather station	Tsereteli Ave. 105, Tbilisi	63	59	51	49	29	26	23	24	58	58	56	38
	Kazbegi Ave. (Red Garden), Tbilisi	35	41	42	37	18	18	17	17	41	37	35	33
	Varketili, Tbilisi	33	39	38	39	19	20	19	20	30	29	9	35
	Marshal Gelovani Ave., 6 (mobile weather station)	-	-	36	35	-	-	17	19	-	-	36	35
	MAC	40 µkg/m <sup>3</sup>				25 µkg/m <sup>3</sup>				40 µkg/m <sup>3</sup>			

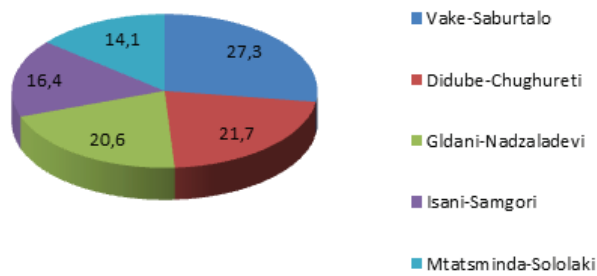


Fig. 1. Distribution of respondents by residential districts AQEDAN

62.3% of the respondents (354 people) think that the air condition in the area around their home is moderately or heavily polluted, while 37.7% (214 people) think that the air is less or not polluted at all. These respondents were therefore grouped into groups of appropriate names (less polluted and highly polluted).

Fig. 2 shows how the respondents of the groups distribute the main causes of atmospheric air pollution in the area around their dwelling according to the share of each of them. In particular, both groups believe that the main cause of ambient air pollution is motor vehicle exhaust gases, followed by atmospheric dust. It is noteworthy that both groups consider the share of industrial emissions to be very small (P > 0.5).

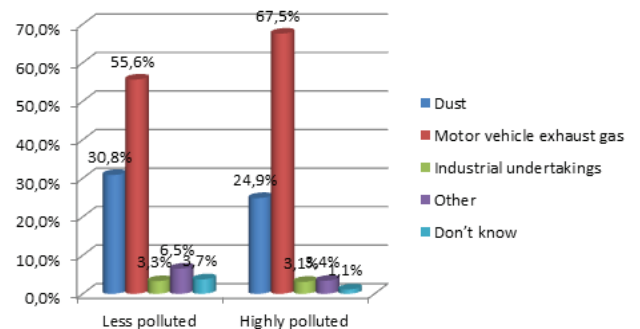


Fig. 2. What is the main cause of air pollution within the territory adjoining your lodging?

Interestingly, respondents in both groups had almost identical opinions when self-assessing the incidence of respiratory diseases (diagram 3). Namely, 44% of both groups believe that the incidence of respiratory diseases has really increased significantly, particularly in recent years; Slightly different but significant proportions of both groups deny the increase in the incidence of respiratory diseases during this period; also slightly different in number from each other, although a small proportion of both groups fails to observe such effects, and therefore does not have a clear opinion on this issue (P > 0.5).

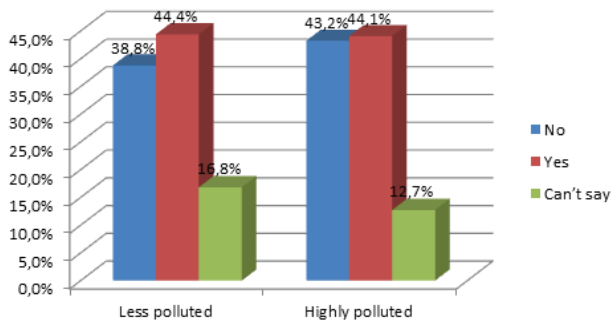


Fig. 3. Did respiratory disease incidence increase among respondents during the last five years?

What do respondents relate the increase in respiratory disease incidence in recent years to? Respondents from both groups gave similar answers to this question (Fig. 4). In the group that considers air to be highly polluted, 42.4% (150 respondents) attribute the increase in these diseases to motor vehicle exhaust gas; 38.4% (135 respondents) are not bothered by this problem. Presumably, this is the contingent that denies the increasing incidence of respiratory diseases in recent years. In the second group, 31% (67 respondents) also consider motor vehicles to be the cause of the increase in respiratory diseases; although about as many do not suffer from this problem.

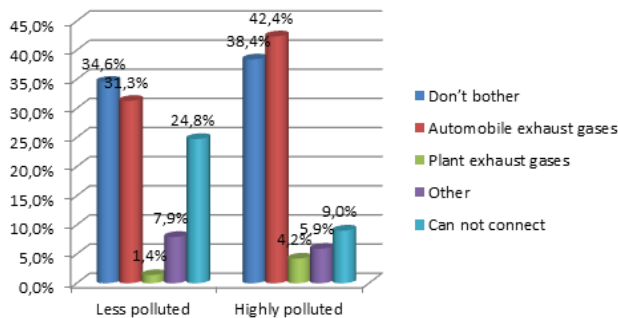


Fig. 4. What is the cause of prevalence of respiratory disease?

A very large proportion of respondents (76-87%) in both groups believe that air pollution in the area around their home affects their health status and a relatively small proportion do not consider the impact of these factors to be very significant ( $P > 0.5$ ) (Fig. 5).

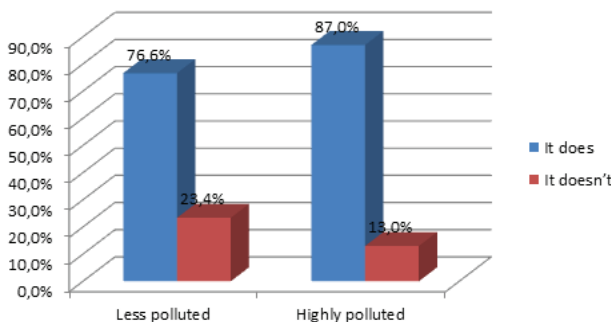


Fig. 5. Does the polluted environment affect your health?

A significant proportion of respondents in both groups (70-85%) also negatively assess the role of air pollution in general and consider it as a risk factor not only for their own health but also for the health of the population as a whole ( $P > 0.5$ ) (Fig. 6).

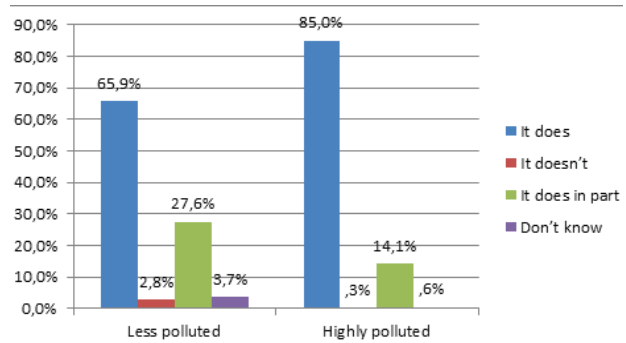


Fig. 6. Does the air pollution endanger the population's health?

It is important to note that the majority of respondents of both groups (53-54%) associate their own health with atmospheric air pollution in their residential area ( $P > 0.5$ ) (Fig. 7).

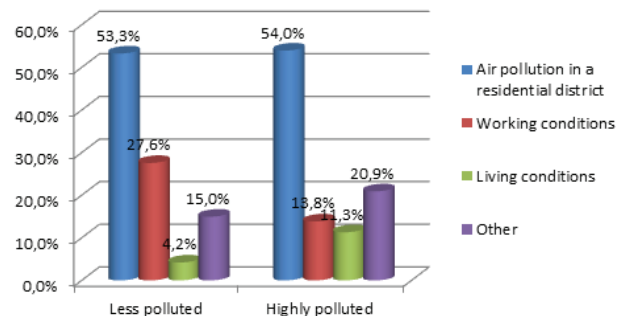


Fig. 7. What do you associate the deterioration of health with?

According to the results of the population survey, the residents of Vake-Saburtalo, Didube-Chugureti and Gldani-Nadzaladevi districts are among the representatives of the group of respondents who generally consider the air to be highly polluted. From the second group, the residents of Mtatsminda-Sololaki, Gldani-Nadzaladevi and Vake-Saburtalo districts characterize the air condition in the area around their residence as the most negative (Fig. 8).

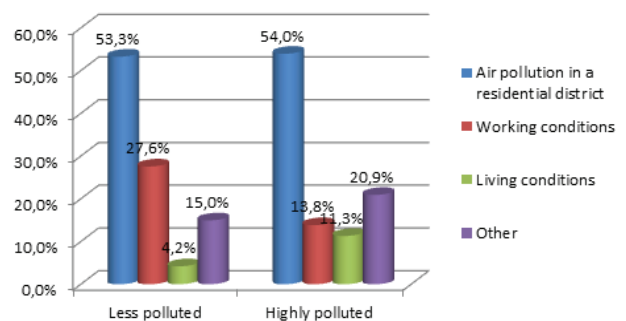


Fig. 8. Polluted air assessment by respondents according to districts

As we can see, dividing the respondents into two groups and discussing their responses in a differentiated manner did not reveal any significant differences in their self-assessments. In general, the vast majority of respondents consider the air in residential areas to be polluted (the most dissatisfied in this regard are the residents of Vake-Saburtalo, Didube-Chugureti and Gldani-Nadzaladevi districts), name motor vehicle emissions as

the main cause of pollution, connect the deterioration of their health condition with air pollution and realize the importance of polluted air as a risk factor, both for themselves and for the health of the whole population.

The survey data were compared with the objective data of the atmospheric air condition survey by individual districts of Tbilisi. As a result of their comparison, it can be concluded that the objective and subjective data of the survey are somewhat consistent with each other. The feelings of the majority of respondents surveyed in the districts allocated by us coincide with the results of the data of objective surveys conducted in the same districts. Self-assessment by the population of the atmospheric air status from data identifying the health factors correlates with the self-assessment of its impact on the health status and is consistent with objective indicators of air condition.

The survey results make it possible to develop the following appropriate preventive measures:

- Developing and adopting a national action plan in the field of air quality management; allocate financial resources and promote the establishment of best available technologies and practices for the elimination of existing air pollution in enterprises and municipalities.
- Developing and implementing specific air protection plans for the most problematic areas of the industry, based on the «polluter pays» principle.
- Carrying out complex studies and planning joint activities by the Ministry of Internally Displaced Persons from the Occupied Territories, Labor, Health and Social Affairs of Georgia and the Ministry of Environment and Agriculture to identify population health «hotspots» related to air pollution.
- Gradual implementing on the territory of Georgia of the legal norms established by the EU legislation in the field of protection from atmospheric air pollution.

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## SUMMARY

### COMPARATIVE HYGIENIC CHARACTERIZATION OF AIR POLLUTION AND ITS IMPACT ON THE HEALTH OF TBILISI POPULATION'S

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For the purpose of comparative hygienic characterization of the atmospheric air of Tbilisi, an analysis of the data of the National Environmental Agency of the Ministry of Environment Protection and Agriculture of Georgia on the Tbilisi City air condition according to separate districts was made. In addition, a population survey was conducted through a special questionnaire in order to assess the air pollution degree and its impact on the health. Respondents were selected in different districts of Tbilisi, taking into account the air pollution degree. According to the objective data of the survey, the air in different parts of Tbilisi is more or less polluted with dust and exhaust fumes; Vake-Saburtalo, Didube-Chugureti and Gldani-Nadzaladevi districts are especially distinguished in this respect. Subjective data are in some correlation with them: self-assessment of air condition by the population is related to self-assessment of its impact on health and corresponds to objective indicators of air condition. The obtained results form the basis for the development of appropriate preventive measures.

**Keywords:** Air Pollution, atmospheric air, state of health, self-assessment, air condition.

РЕЗЮМЕ

СРАВНИТЕЛЬНАЯ ГИГИЕНИЧЕСКАЯ ХАРАКТЕРИСТИКА ЗАГРЯЗНЕНИЯ ВОЗДУХА Г. ТБИЛИСИ И ЕГО ВЛИЯНИЕ НА ЗДОРОВЬЕ НАСЕЛЕНИЯ

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С целью сравнительной гигиенической характеристики атмосферного воздуха г. Тбилиси проведен анализ данных Национального агентства по окружающей среде Министерства охраны окружающей среды и сельского хозяйства Грузии о состоянии воздуха в городе Тбилиси по отдельным районам и опрос населения с помощью специальной анкеты с целью оценки степени загрязнения воздуха и его влияния на здоровье. Респонденты отбирались в разных районах Тбилиси с учетом степени загрязнения воздуха. Согласно

объективным данным исследования, воздух в разных частях Тбилиси загрязнен пылью и выхлопными газами, особенно выделяются районы Ваке-Сабуртало, Дидубе-Чугурети и Глдани-Надзаладеви. Субъективные данные находятся в некоторой корреляции с ними: самооценка состояния воздуха населением связана с самооценкой его влияния на здоровье и соответствует объективным показателям состояния воздуха. Полученные результаты послужат основой для разработки соответствующих профилактических мероприятий.

რეზიუმე

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ს. ბეზარაშვილი

თბილისის სახელმწიფო სამედიცინო უნივერსიტეტი, კვების, ასაკობრივი მედიცინის, გარემოსა და პროფესიული ჯანდაცვის დეპარტამენტი, საქართველო

ქ. თბილისის ატმოსფერული ჰაერის შედარებითი ჰიგიენური დახასიათების მიზნით ჩატარდა საქართველოს გარემოს დაცვისა და სოფლის მეურნეობის სამინისტროს გარემოს ეროვნული სააგენტოს მონაცემების ანალიზი ქ. თბილისის ატმოსფერული ჰაერის მდგომარეობის შესახებ ცალკეული უბნების მიხედვით. სპეციალური ანკეტის საშუალებით ჩატარდა მოსახლეობის გამოკითხვა ატმოსფერული ჰაერის დაბინძურების ხარისხის შეფასებისა და ჯანმრთელობაზე გავლენის თვითშეფასების მიზნით. რესპოდენტების შერჩევა ჩატარდა ქ. თბილისის სხვადასხვა რაიონში ატმოსფერული ჰაერის დაბინძურების ხარისხის

გათვალისწინებით. კვლევის ობიექტური მონაცემების თანახმად, თბილისის სხვადასხვა უბანში ატმოსფერული ჰაერი დაბინძურებულია მტკრითა და ავტოტრანსპორტის გამონაბოლქვი აირებით, განსაკუთრებით გამოირჩევა ვაკე-საბურთალოს, დიდუბე-ჩუგურეთისა და გლდანი-ნაძალადევის რაიონები. მოსახლეობის მიერ ატმოსფერული ჰაერის მდგომარეობის თვითშეფასება კავშირშია ჯანმრთელობის მდგომარეობაზე მისი გავლენის თვითშეფასებასთან და შეესაბამება ჰაერის მდგომარეობის ობიექტურ მანევრებლებს. მიღებული შედეგები საფუძველს ქმნის სათანადო პროფილაქტიკური ღონისძიებების შემუშავებისათვის.