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THE ANALYSIS OF THE EMISSION INFLUENCE ON THE HUMAN'S GENERAL CONDITION

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Currently, the problem of air pollution is topical. In this study, we described the question of environmental influence on human health. Sickness statistics over the past years (in compliance with the Health Ministry of the Russian Federation) were analyzed. National health deterioration and an increase in sicknesses are observed. During the last few years, respiratory diseases account for up to 46% of all cases. We studied the components of harmful substances of gasoline and diesel engine emissions and analyzed some of the chemical compounds of the exhaust (which cause a negative influence on the human respiratory system). The study aims to determine the impact of exhaust pollution on citizens' health conditions. Barnaul citizens participated in this research. The questionnaire was conducted with the help of Google Forms. The received data illustrate that 90% of the respondents use motor transport. Moreover, 76%–79% of motor service users experience the reduced general condition, dizziness, and nausea caused by exhaustion. Around 90% of participants understood the negative influence of exhaust on their health (in places with less concentration of cars, they feel better). To improve the situation of air pollution in cities, we suggest a multi methodology focused on a preventive approach: (1) restrict the usage of personal autos; (2) promote a healthy way of life; use of alternative eco gasoline (including electric cars); (3) develop infrastructure for pedestrians and bicycles; and (4) carry out vast landscaping of cities.

Keywords: health; respiratory organs; exhaust; emissions; air pollution; ecology

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АНАЛИЗ ВЛИЯНИЯ ВЫБРОСОВ НА ОБЩЕЕ СОСТОЯНИЕ ЧЕЛОВЕКА

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В настоящее время проблема загрязнения атмосферного воздуха является актуальной. В данном исследовании мы рассмотрели вопрос влияния окружа-

ющей среды на здоровье человека и проанализировали статистику заболеваемости за последние годы (по согласованию с Минздравом РФ). Наблюдается ухудшение здоровья населения и рост заболеваемости. За последние несколько лет на болезни органов дыхания приходится до 46% всех случаев. Мы изучили компоненты вредных веществ выбросов бензиновых и дизельных двигателей и проанализировали некоторые химические соединения выхлопных газов, оказывающие негативное влияние на дыхательную систему человека. Данное исследование направлено на определение влияния загрязнения выхлопными газами на состояние здоровья горожан. В исследовании приняли участие жители города Барнаула. Анкетирование проводилось с помощью Google Forms. Полученные данные свидетельствуют о том, что 90% респондентов пользуются автомобильным транспортом. Кроме того, у 76–79% пользователей автотранспортных средств наблюдается ухудшение общего состояния, головокружение и тошнота, вызванные истощением. Около 90% участников осознали негативное влияние выхлопных газов на их здоровье (в местах с меньшим скоплением автомобилей они чувствуют себя лучше). Чтобы улучшить ситуацию с загрязнением воздуха в городах, мы предлагаем комплексную методологию, ориентированную на превентивный подход: (1) ограничение использования личных автомобилей; (2) пропаганда здорового образа жизни; (3) использование альтернативного экологического бензина (включая электромобили); (3) развитие инфраструктуры для пешеходов и велосипедистов; (4) проведение обширного озеленения городов.

Ключевые слова: здоровье; органы дыхания; выхлопные газы; выбросы; загрязнение воздуха; экология

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Introduction

Nowadays, people cannot imagine their lives without cars, taxis, or public transport. With their help, one can reach any place in the city or even the outskirts. One can hardly imagine a person going to work or returning home walking a couple of kilometers.

Cities are the most significant aspect of citizens' lifestyle, and every day, it is becoming more difficult to single out a particular aspect influencing people's health [27]. The problem is not local - it is identified in countries and continents where residents use road transport [17; 20]. However, a lot of statistical scientific research from all over the world proves that respiratory organs' damage increases

in direct ratio to the rising level of air pollution [4]. Air pollution has been declared to be one of the eight causes of early death and, consequently, represents a critical danger to human health [12; 13; 26]. Air pollution by exhaust gases is a threat to human security and an argument to search for solutions to the problems of the current climate agenda [2]. This circumstance is particularly relevant when developing methodological tools to evaluate public health and the level of healthcare development in the regions of Russia, S. Ivanova stated [6]. The mass production of electric vehicles partially solved the problem of overcoming the toxicity of exhaust gases on human health [19]. Currently, when the COVID-19 virus has a negative impact on people's health globally (especially respiratory organs), the study of this topic becomes crucial and requires prompt measures [23].

According to the Ministry of Health of the Russian Federation, respiratory diseases have improved in the 21st century (see Table 1) [5]. That, in turn, proclaims the significance of the comprehensive study of the problem about the negative influence of the environment (including exhaust pollution) on human health.

Table 1.

Morbidity rate in 2000–2019 according to Health Ministry of Russian Federation

Year	Total medical conditions (thousands)	Respiratory diseases (thousands)	Respiratory diseases rate (%)
2000	106328	46170	43
2001	104322	43012	41
2002	106742	43005	40
2003	107385	44560	41
2004	106287	41946	39
2005	105886	41915	40
2006	108842	42338	39
2007	109571	42958	39
2008	109590	43221	39
2009	113877	48148	42
2010	111428	46281	42
2011	113922	48437	43
2012	113688	47381	42
2013	114721	48568	42
2014	114989	48708	42
2015	113927	49464	43
2016	115187	51573	45
2017	114382	51905	45
2018	114841	52833	46
2019	114512	52278	46

Vehicle movement occurs due to thermal energy conversion into mechanical energy, which is released during fuel combustion. The fuel was burned in an internal combustion engine, and the repeated action of this process ensured continuous vehicle movement. Water vapor and carbon dioxide are released if the fuel is burnt completely, like any organic matter. However, the fuel combustion temperature can be too high or too low, which leads to incomplete combustion. The quality of the fuel and impurities plays a significant role in this process. All these factors lead to the emergence and release of harmful substances-emissions [7; 18].

Exhaust (waste gases) is a mixture of gases, a product of complete and incomplete combustion of hydrocarbon fuel. Emissions are the primary cause of air pollution, with toxic and carcinogenic substances that exceed the permissible concentrations in the atmosphere. The compositions of harmful substances in the engine exhaust of two types (gasoline and diesel) are presented in Table 2 [8; 21]. As mentioned before, emissions are one of the causes of urban air pollution and smog formation.

Table 2.

**The composition of harmful substances of the exhausts
of gasoline and diesel engines**

Emissions type	The components of waste gases Content by volume, %		Commentary
	Engines		
	gasoline	diesel	
Nitrogen	74,0–77,0	76,0–78,0	Non-toxic
Oxygen	0,3–8,0	2,0–18,0	
Water vapor	3,0–5,5	0,5–4,0	
Carbonic dioxide	5,0–12,0	1,0–10,0	Toxic
Carbonic oxide	0,1–10,0	0,01–5,0	
Lower paraffin hydrocarbons	0,2–3,0	0,009–0,5	Toxic
Non-cancerogenic			
Alcohol oxide	0–0,2	0,001–0,009	
Sulfuric acid anhydride	0–0,002	0–0,03	
Colloidal carbon	0–0,04	0,01–1,1	
Benzopyrene	0,01–0,02	< 0,01	Cancer-causing chemical

Carbonic oxide is transparent, tasteless, odorless, toxic, lighter than air, and poorly water-soluble. Carbonic oxide is a product of incomplete combustion of

fuel. It can react with hemoglobin in the blood, forming carboxyhemoglobin, which cannot transport oxygen. As a result, the necessary gas exchange does not occur, hypoxia starts, and the functions of the whole organism, in general, are disrupted [10].

Nitrogen oxides are one of the most toxic components of emissions. More than 90% of its content is occupied by nitrogen monoxide (NO), which is subsequently oxidized to NO₂. Nitrogen oxide is several times more toxic than carbon monoxide. It affects the lungs and bronchi of a person, leading to asthma, bronchitis, and other respiratory tract diseases. This effect appears because, when inhaled, oxides react with the moisture on the mucous membranes of the respiratory tract, forming nitric and nitrous acids. Nitrous oxide (N₂O, laughing gas) has a narcotic effect [8; 21].

Hydrocarbons are also toxic. The exhaust contains over 200 different types of hydrocarbons, and the incomplete combustion of the fuel caused their release. They exert a narcotic effect on the nervous system, cause chronic diseases, and have a toxic effect.

Materials and Methods

The toxicity and harm of the exhaust are obvious. Some studies confirm the relationship between air pollution and the suicidal thoughts of residents [14]. It is crucial to determine their significance in a person's everyday life. To answer this question, we surveyed a group of residents of a Barnaul city, Altai Territory.

The purpose of this research is to study the health conditions of citizens in a situation of exhaust pollution.

Objectives:

- Study literary sources on the topic;
- Conduct a study of the health condition of citizens in a situation of exhaust pollution;
- Provide recommendations on precaution measures to improve the population's health and reduce the number of emissions in the atmosphere.

The survey was conducted using Google Forms. The age range of the respondents was 12–35 years old. A total of 612 respondents participated in the survey. The emphasis was on the respondent's health conditions under certain circumstances and their attitude toward this problem. A list of multiple-choice questions is presented in Table 3.

Table 3.

The questions used in the survey

Questions	Answers
How often do you use a car or public transport?	<ul style="list-style-type: none"> • 1–2 times per week • 3–5 times per week • 6–7 times per week • Several times a day • Do not use
Do you feel unwell while being on transport or near the road?	<ul style="list-style-type: none"> • Often • Sometimes • Never
Have you experienced nausea or dizziness because of the smell of emissions?	<ul style="list-style-type: none"> • Often • Sometimes • Never
Do you feel that the air in the cities is more polluted and harder to inhale than the air in the outskirts?	<ul style="list-style-type: none"> • Yes • No
Do you consider that air influences your health condition in general?	<ul style="list-style-type: none"> • Yes • No
How important is the problem of air pollution?	From 1 to 5, where 1-not important, 5-particularly important

Results

We revealed the following results, studying the respondents' answers to the question of using vehicles (see Fig. 1).

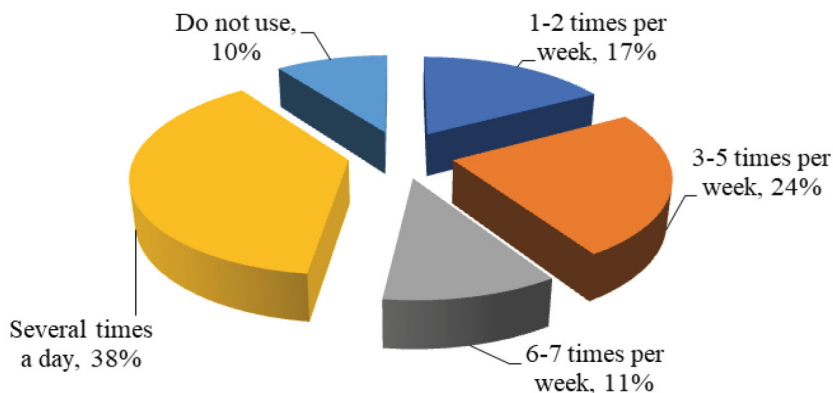


Fig. 1. The answers to the question “How often do you use a car/public transport?”

According to the obtained data, 90% of the respondents used cars or public transport. Furthermore, 38% of the respondents used it several times a day. Only 612 people participated in the study. The population of Barnaul for 2020 is 632,391 people [10]. In modern society, there is at least one car per family. In addition, the city has a well-developed public transportation system. Thus, the daily exhaust emission level is relatively high.

Analyzing the state of health of the respondents (including dizziness and nausea) when being close to the road or directly in the transport, we received the following answers (see Fig. 2 and 3).

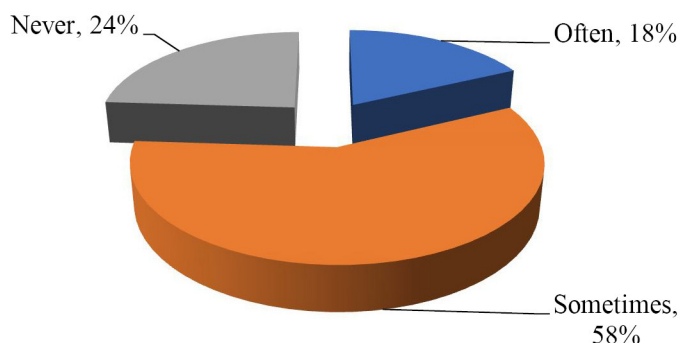


Fig. 2. The answers to the question “Do you feel unwell while being in transport or near the road?”

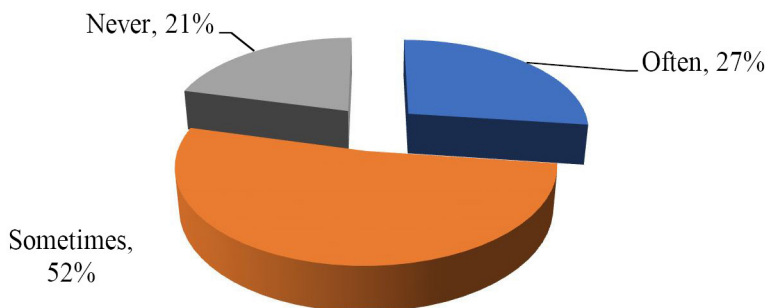


Fig. 3. The answers to the question “Have you experienced nausea or dizziness because of the smell of emissions?”

The answers to the questions about the state of health were almost identical to the previous question. 76% of the respondents felt deterioration in their general medical condition (23% felt it quite often). The feeling of nausea and

dizziness occurred in 79% of the cases, 27% frequently experiencing these symptoms. The results indicate the indisputable influence of exhaust on the medical condition of a person.

The following results were obtained upon considering the respondents' answers regarding the correspondence between exhaust pollution and their health condition (see Fig. 4).

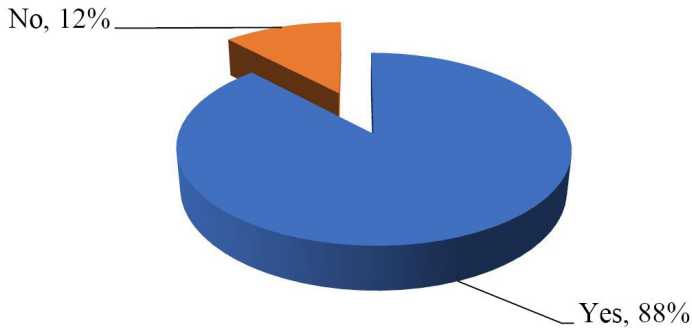


Fig. 4. The answers to the question “Do you feel that the air in the cities is dirtier and harder to inhale than the air on the outskirts?”

Furthermore, we studied respondents' opinions about air reception in the city (where the cluster of motor transport is large) compared to the outskirts with less traffic (see Fig. 5).

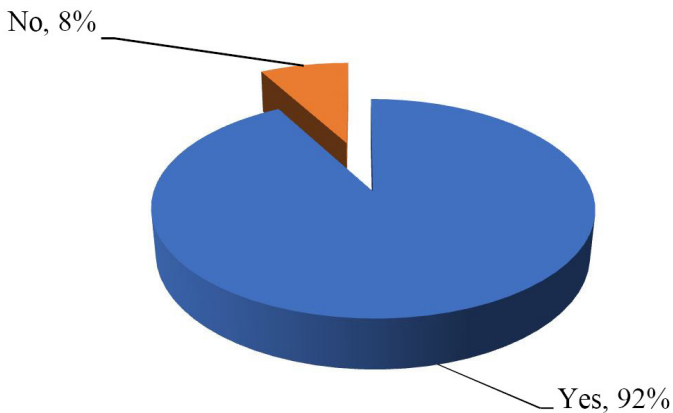


Fig. 5. The answers to the question “Do you feel that the air in the city is more polluted and harder to inhale than the air in the outskirts?”

According to the above results, the respondents believe that emissions have a negative impact on their general health condition. In their opinion, there is an obvious difference between urban air (polluted cars) and suburban air with a lower concentration of cars.

Apart from the questions mentioned above, we also asked the citizens to express their opinions about the problem of air pollution. We obtained the following results (see Fig. 6).

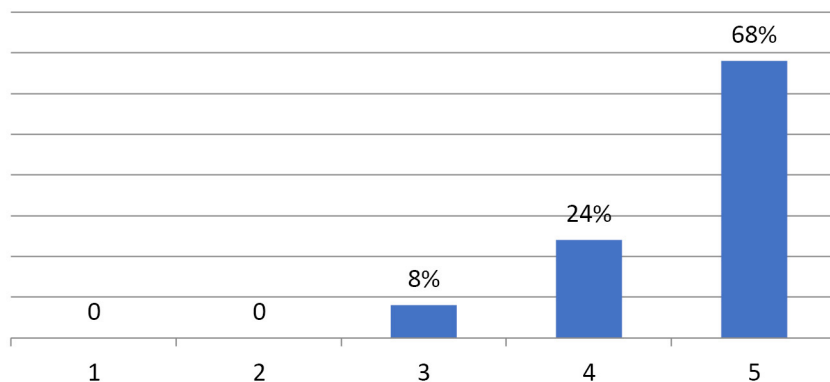


Fig. 6. The answers to the question “How important do you think the problem of air pollution is?”

The importance and high priority of air pollution are beyond controversy. Respondents shared the same opinion, and most respondents (68%) answered that this problem was highly significant.

Discussion

Many researchers are studying the impact of emissions on the general human condition. Since the composition and quantity of these emissions are constantly changing, studying also helps identify the different subjective perceptions of air pollution by people that determine human social well-being.

Researchers in Europe have identified the relationship between air quality and subjective well-being. They found that polluted air has a strong negative effect on the self-esteem of life satisfaction [15].

A. Levinson found that people interviewed on days with higher air pollution report a lower level of well-being and happiness [24].

Even earlier studies show that air pollutants in high concentrations can affect the emotional state of exposed people. The relationship between air pollu-

tion and well-being is clarified through the concepts of psychobiological stress [11; 16].

Empirical researchers put their efforts into studying how air pollution significantly reduces the subjective self-esteem of people's well-being [25].

Researchers from the neighboring region of Novosibirsk (Russia) conducted a survey among older residents and concluded that most respondents evaluate the environment as "unsatisfactory." Older adults noted that vegetation (both in the city and countryside) suffers from air pollution. They also noted that they experience discomfort from the noise and exhaust gases of cars emitting nitrogen oxides into the air, ethylene emissions, etc. [9].

Our research confirmed numerous studies on the negative state of health of a person near exhaust gas sources and awareness by respondents of the existing problem of air pollution.

Today, many different solutions have been developed to improve polluted air. However, the number of cases of respiratory diseases and a decrease in the overall subjective well-being of a person shows that the proposed solutions are poorly effective.

In addition to the statistical evidence, the opinions of respondents and experts [28; 29] comes down to the fact that the air in cities remains polluted. Every day, exhausts are inhaled and absorbed by a person through the skin. This is attested to by the health condition of people in transport and near roads. Their health is at its worst, and people feel this through dizziness/nausea. Daily feeling unwell can lead to respiratory diseases, including asthma [22].

Prevention has always been and remains the most effective way to combat the increase in morbidity.

Such preventive measures as a change of vehicle types of fuel to new ones (biodiesel, PHEV, bioethanol) showed that the impact of harmful emissions does not decrease [3].

Nowadays, health precautions are mainly reduced to visiting a doctor. Some people also perform physical exercises that are easily accessible on the Internet (YouTube, Instagram, V Kontakte, Moodle, Chatium, WhatsApp, TikTok). One can find recommendations from physical education doctors, theoretical and practical fitness exercises from different instructors, as well as marathons challenges.

However, as the statistics prove, none of the above-enumerated measures are sufficient. The complex approach, where several forces are simultaneously enforced:

- Federal Supervisory Natural Resources Management Service;
- Local Departments of Natural Resources Management and Environmental Protection;
- Healthcare benefits (informing the public about the preventive measures);
- Physical education of every individual (physical exercises and immune system reinforcement).

Conclusion. Health is one of the most critical aspects of human life, and every person tries to maintain their health condition at an appropriate level. However, environmental health is a significant aspect, and its condition directly influences every living creature on Earth, including human beings. The current situation regarding the volume of emissions in the air and the toxicity of the used fuel leaves much to be desired.

A general review of the literature shows that the morbidity level in Russia (including the diseases of respiratory organs) remains unsolved. This study analyzed the influence of exhaust components (gasoline and diesel fuels) on people's health, and the negative effects of most of the components were observed.

According to the survey results, one can emphasize the interconnected dependence between the level of the emissions in the air and the citizens' health condition, which in turn can cause problems with respiratory organs, as well as circulation organs and the central nervous system.

Thus, we suggested the following precautions to solve the stated problem. First, the most effective measure is to limit the usage of personal transport. For instance, 40 people can take their cars to get to the workplace or take a bus altogether every morning. In the latter case, the volume of the exhaust in the atmosphere is noticeably less.

Second, one should promote a healthy way of life, which will positively influence one's fitness, the immune system, and different physiological data. Today, people tend to choose an active lifestyle despite monotonous trips on motor transport.

Third, people should use alternative eco-friendly fuels. Specific studies were conducted in this sphere. Currently, hydrogen and biodiesel fuels are supplied by vegetable oils, and studies on algaoid fuels are still in progress [1].

Fourth, one should use electronic cars maintained by recharging stations located in the city. This solution also includes the autos supplied by condensed air or solar batteries. This trend has not yet been developed in the city of Barnaul, and one can rarely see hybrid cars that work on diesel and electricity. Although the stations for electro-cars are not yet available in the city, the alternative is impossible.

Fifth, it is crucial to develop the pedestrian and bicycle infrastructure, enlarge the number of bicycles and pedestrian tracks, and establish bicycle and electronic scooter rental points.

To sum up, one should increase the number of alleys, parks, and landscaping in cities. Poplars are usually one of the most commonly spread trees in cities, and the choice of wood was deliberate. Poplars have better air filtration characteristics than the other trees, and it absorbs carbonic oxide and produces oxygen. Poplars produce ten times more oxygen than conifers.

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