

1. Introduction

Time spent outdoors, especially on playgrounds, plays an important role in a child's development, as a playground cannot only be a space for play [1–3]. Spending time on the playground can help to strengthen muscles, improve coordination and learn to concentrate on the space. Considering that a child spends an average of 2–2.5 hours in the playground, safety is important, not only for the quality of the equipment, but also for the location of the playgrounds.

There is currently a problem of the location of children's playgrounds near sources of environmental pollution in Ukraine. Examples of such sources can be highways, residential neighbourhood infill and others.

It should be noted that, despite the existing norms, most of the playgrounds do not meet the requirements that relate to the distance to residential buildings, roads, collection points for municipal solid waste (MSW). The factor of the presence of special-purpose territories (short-term parking areas), which must be fenced with green spaces at least 1.5 metres wide, is also not considered. The strip of green spaces around playgrounds must be at least 3 metres wide. According to this indicator, 99 % of playgrounds in Ukraine do not meet this norm.

The excessive impact of anthropogenic factors on the human body has aroused the interest of many researchers. There are many works which are devoted to the influence of various kinds of pollution on the health of children, since they are more vulnerable to negative effects.

A long-term study, namely, genetic biotesting in the cells of the oral mucosa of preschool children has shown that the level of genetic changes in somatic cells depends precisely on the level of anthropogenic load [4]. The link between vehicle emissions and different illnesses among children in pre-school educational institutions located near roads is confirmed [5–7].

It is impossible to omit the factor that the greatest amount of pollutants enters the environment from vehicles during braking or starting movement, which is confirmed by numerous studies [8, 9].

The physical health effects of noise pollution can occur as a direct or indirect result of noise exposure [10–12]. In severe cases, loud sounds can directly cause hearing impairment. Some research also suggests that noise pollution may indirectly contribute to other health conditions.

2. Methods

The materials used were: cress seeds (TM «Tradition», batch No. 2311, expiration date until 07.2021); growing seedlings (TM «Flora Plus», pH is 5.5–6.5); Petri dishes; a snow meter; 10×10 cm frame; sound level meter.

ANALYSIS OF ENVIRONMENTAL HAZARDS IN THE SYSTEM «CHILDREN'S PLAYGROUND – URBANIZED AREA»

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Abstract: The article presents the results of the study of environmental pollution by methods of biological indication. The objects of research are children's playgrounds which are influenced by the negative anthropogenic factors. A child's body is more vulnerable to anthropogenic stresses. Car exhaust gases can have a negative impact on the respiratory, cardiovascular, nervous and other systems. Excessive noise pollution not only affects your hearing, but also other organs and systems. In addition, noise can increase stress hormone levels. The aim of the study is to identify the main adverse factors affecting playgrounds in large cities. Despite there are the sanitary standards for the placement of playgrounds in large cities, it was found that about 50 % of all playgrounds were located in violation of environmental safety standards. As part of the work, an inventory of children's playgrounds and sports grounds in the cities of Kyiv, Kharkiv and Dnipro was carried out. The author carried out experimental research on some playgrounds using biological indication methods. The method of lichen indication revealed that four out of ten playgrounds in Kharkiv have a high level of air pollution, and two out of ten in Kyiv and Dnipro. This is confirmed by the biotesting method. It was found that one of the methods of solving the problem of excessive anthropogenic load on the objects of study is planting greenery. It is experimentally established that green plantations are able to reduce the level of noise pollution by 4–6 dB and absorb pollutants. In addition to reducing the anthropogenic load, the greening of playgrounds has an impact on improving the microclimate of the urban environment, and developing the visual qualities of urbanised landscapes.

Keywords: playgrounds, urban ecosystem, pollution, lichen indication, biotesting, greening, noise pollution.

The following methods were used: analytical method, method of observation, qualitative comparison, precise measurement and unique experiment.

3. Results

The author took an inventory of playgrounds in the large cities of Ukraine, **Fig. 1**. The inventory involved an analysis of the location of the playgrounds relative to various neighbouring objects, since it was not possible to obtain information of this kind from city and municipal services.

As a result of the inventory, it was found that about half of the playgrounds were located in the zone of the greatest impact of vehicles (in Kharkiv 51.6 %, in Kyiv 53.63 %, in Dnipro 58.57 %).

The biological indication method is one of the main methods for assessing the state of the environment in urbanized areas. This method makes it possible to determine the morphological and biochemical changes in the plant that are caused by anthropogenic factors.

Within the framework of this study, biological testing of melted snow sampled from the territory of playgrounds was carried out. The selection criteria were the location of the playground relative to the source of pollution, namely the road in this case.

Snow from 10 playgrounds in Kyiv, Kharkiv and Dnipro was selected for the analysis. Sampling was carried out using a snow meter, the snow was melted at room temperature. Drinking water was used as water for the control sample. For the study, cress seeds (*Lepidium sativum* L., TM «Tradition», batch No. 2311, expiration date until 07.2021) were used. Seed germination was carried out according to the standard method in Petri dishes using soil for growing seedlings of TM «Flora Plus» from the same batch (No. 1423). The soil mixture consists of high-moor and low-moor peat, river sand, mineral additives and trace elements, pH is 5.5–6.5.

At the second stage of the study, the analysis of the level of air pollution by the lichen indication method was carried out. Within the framework of this method, a description of lichens growing on every fifth tree in the alley located along the playgrounds was carried out. Lone trees were also described on the very playgrounds. If there were no alleys, only lone trees were described. It is worth noting that the study was conducted at the same playgrounds as the biotesting method.

For the study, a 10×10 cm frame was used, which was divided into 1 cm² squares, by means of which the percentage of lichen coverage on the trunk on both sides was determined. After conducting field studies, the Le Blanc and De Slover air purity index was calculated.

Based on the analysis results, the level of atmospheric pollution was determined, **Fig. 2**.

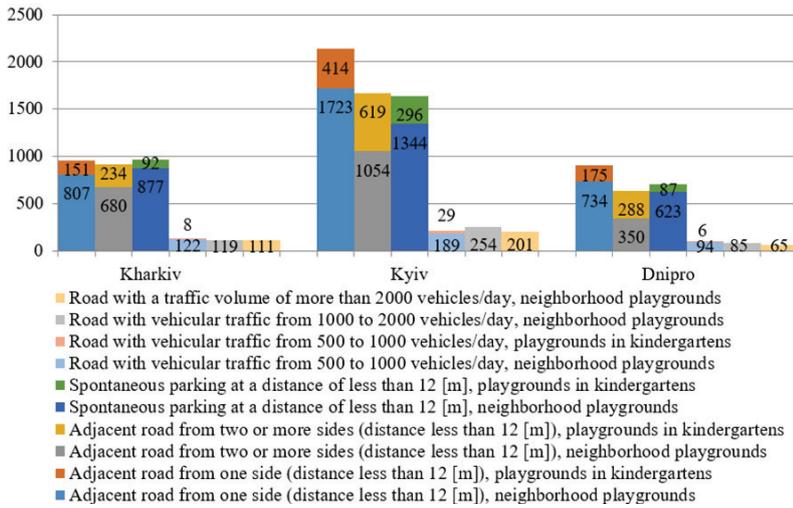


Fig. 1. The results of the inventory of playgrounds

According to the research results, it was discovered that the most polluted air in Kharkov was on Poltavskiy Shliakh street, on Moskovskiy Avenue, and Gagarin Avenue, which was confirmed by the method of biological testing, since cress seeds are not resistant to pollution. In the city of Kyiv, the smallest number of seeds grew in samples that were watered with melt water sampled from Petrov Boulevard and Darnitskoe Highway. Regarding lichen indication, it was determined that the level of air pollution was characterized as high. In the city of Dnipro, as well as in Kyiv, two streets were identified, which are characterized by severe environmental pollution – Krivorozhskaya and Bolshaya Deevskaya streets.

Greening of children’s playgrounds and sports grounds is the most effective and affordable way to improve the situation in already equipped territories.

To prove the feasibility of greening, a control playground was allotted in Kharkiv, located at the intersection of Bolshaya

Panasovskaya Street and Reznikovskiy Lane. It has a rectangular shape (20.5×10.3 m), situated at a distance of 9 metres from the road and 7 metres from the place of an unauthorized parking lot, 5 metres from the solid waste storage pit. Before the creation of a hedgerow along its perimeter, the average noise level on it was 72 dB, the level of atmospheric air pollution was determined by lichen indication as severely polluted, and the number of germinated seeds was 36 %.

On April 25, 2019, along the perimeter (after agreement with the utilities), 70-centimetres high, 2-year-old bushes of common lilac shrubs (*Syringa vulgaris* L.) were planted. Six months later (October 25, 2019), the height of the bushes was 93 centimetres. Noise level decreased to 69 dB. Table 1 shows the subsequent results of the experiment.

Table 1
Research results at the control playground

| Noise level | | Lichen indication | | Biotesting | |
|-------------|----------------|-------------------|---------------------|------------|---------------|
| Date | The result, dB | Date | The result | Date | The result, % |
| 25.10.19 | 69 | 25.10.19 | Severely polluted | 25.12.19 | 36 % |
| 25.04.20 | 68 | 25.04.20 | Severely polluted | 25.02.20 | 40 % |
| 25.10.20 | 66 | 25.10.20 | Moderately polluted | 25.12.20 | 41% |

The results of the study indicate a decrease in the level of noise pollution and an increase in the number of germinated seeds at the control children’s playground. It should be noted that the number of lichens has increased significantly and the level of air pollution has decreased.

4. Discussion

The solution to the problem of excessive impact of negative factors on the territory of children’s is to equip new playgrounds in accordance with the requirements, as well as improve the situation at already existing ones.

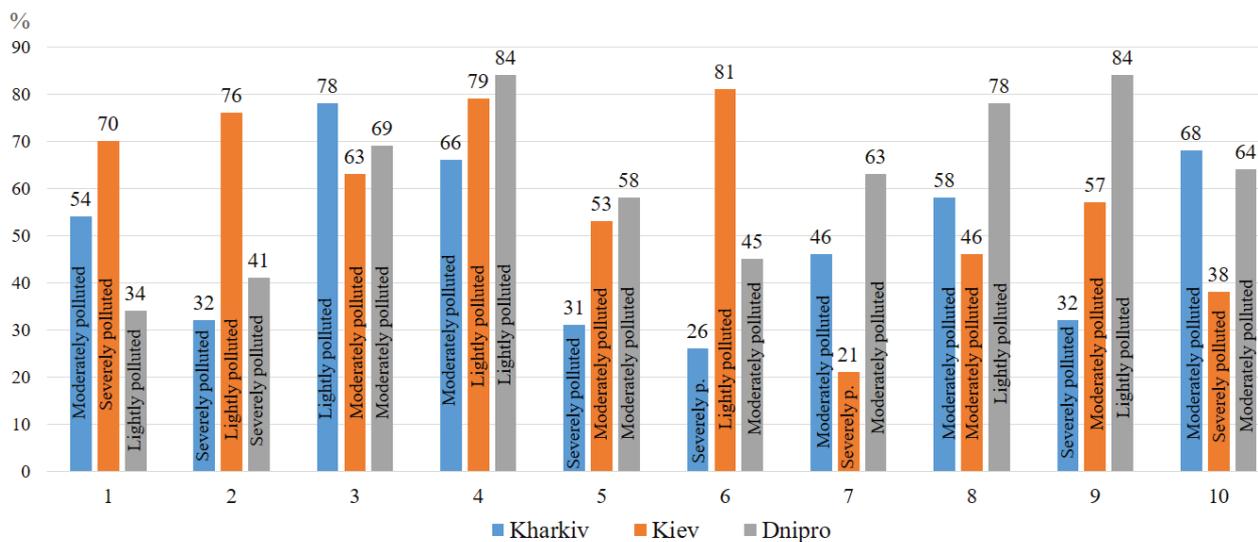


Fig. 2. The results of the study by the method of biotesting and lichen indication

The advantages of this method are as follows:

- 1) absorption of dust and gases polluting the atmospheric air;
- 2) decrease in the noise level due to the absorption of the energy of the mechanical vibrations that cause it;
- 3) increase in the relative humidity of the air and “smoothing” of its daily and seasonal fluctuations;
- 4) release of oxygen (as a by-product of photosynthesis) into the atmosphere;
- 5) increase in the concentration of negatively charged ions (positively affecting human health) in the atmosphere above tree and shrubby plantings;
- 6) release of biologically active substances that suppress the development of pathogenic agents in the atmosphere;
- 7) improvement of the visual properties of urbanized landscapes.

The correct approach to greening of playgrounds and compliance with the requirements for green spaces are especially important.

The main criteria for choosing plants:

- 1) absence of poisonous fruits and thorns;
 - 2) lack of abundant flowering and fruiting (so that the fruits do not litter the territory, and a large number of flowers do not attract insects);
 - 3) plants that have phytoncidal properties are welcome.
- Greening of the territory is provided in the form of:

- 1) rows of trees and shrubs (trees with a dense crown);
- 2) groups and single specimens of trees;
- 3) hedgerows of bushes.

As a result of the study, it was found out that more than 50% of children’s playgrounds (including those located on the territory of preschool institutions) did not meet the standards regarding the distance to the road and special-purpose areas. Moreover, a study of environmental pollution was carried out by the method of biotesting and lichen indication. As a result, it can be noted that only in 8 out of 30 areas, the level of atmospheric air pollution is characterized as low. The presence of a large amount of pollutants was confirmed by the biotesting method.

Greening will solve two main problems, since plants have the ability to absorb and retain pollutants as well as reduce noise pollution.

5. Conclusions

The conducted experimental studies have shown the effectiveness of greening of playgrounds equipped in violation of sanitary standards. It was also found out that there was no single document that recorded all children’s playgrounds at the level of city authorities. Utilities own only objects of playgrounds (slides, swings, carousels), but not the territory of playgrounds itself. Accordingly, control over the placement of playgrounds on the ground is actually absent, which leads to their chaotic and dangerous location.

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