

SECTION 5. ONCOLOGY

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5.1 Impact of environmental pollution with benzapyrenene on respiratory cancer incidence

The rapid improvement of modern industrial technologies and motor transport has led to significant qualitative and quantitative changes in the composition and volume of harmful emissions into the atmosphere. This has caused a constant impact on humans due to a number of harmful anthropogenic factors, including carcinogens, which can lead to the development of cancer [207]. The most important aspect is the presence of carcinogens from the class of polycyclic aromatic hydrocarbons, in particular their main representative – benzo[a]pyrene. This substance, which has the property of being a local carcinogen when inhaled, contributes to the development of malignant tumors, mainly in the respiratory organs. According to the conclusions of experts from the International Agency for Research on Cancer, oncopathology is one of the indicators of the ecological disadvantage of the territory: chemical carcinogenic factors of the environment, everyday life and production determine the development of almost 80% of all malignant tumors [208].

According to the Resolution of the Cabinet of Ministers of Ukraine No. 303, it is envisaged to revise the standards for the content of pollutants in atmospheric air due to changes in national and European Union legislation on limiting the content of pollutants in exhaust gases and the impact of physical factors of mobile sources of atmospheric air pollution. According to the classification of the International Agency for Research on Cancer, benzo[a]pyrene is considered a compound that is definitely carcinogenic to humans [209]. The presence of this substance in atmospheric air is considered by experts as one of the key indicators of aerogenic carcinogenic load on humans.

The materials of the work [207] established stable long-term pollution of atmospheric air in populated areas with carcinogens of priority classes: polycyclic aromatic hydrocarbons (benzo[a]pyrene), nitrosamines (nitrosodimethylamine and

nitrosodiethylamine), heavy metals (cadmium, chromium, nickel, lead), formaldehyde.

In the materials of work [210], the prospects for using radioelectronic devices to measure environmental pollution parameters are considered, and in work [211], a functional scheme of a gas analysis system for monitoring atmospheric air pollution is proposed, as well as its software implementation is performed.

The impact on humans of a number of harmful anthropogenic factors [212], including carcinogens, in particular benzo[a]pyrene, can lead to the development of diseases [213-220], including oncological ones [221-228].

In the article [229], it is stated that the most toxic substance (among pollutants of the first hazard class) is a representative of the class of polycyclic aromatic hydrocarbons – benzo[a]pyrene, which is capable of exerting carcinogenic, mutagenic and other negative effects on living organisms even in nanoquantities.

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In the article [230] an improved mathematical model of pollutant concentrations in the filtrate of municipal solid waste (MSW) landfills was proposed, and in the work [231] the mathematical model of specific energy consumption for cleaning MSW landfill soils from heavy metal contamination was improved. In the materials of work [232], a regression hyperbolic dependence of the concentration of benzo[a]pyrene in the soils of the MSW landfill on the measurement depth was determined, with the help of which it was determined that the dangerous depth of chemical contamination of the soils of the MSW landfill with benzo[a]pyrene is 152 mm. In the materials of the article [233], a regression dependence of the concentration of petroleum products in the soils

on the distance to the MSW landfill was proposed, which made it possible to determine that the safe distance for the placement of MSW landfills from agricultural lands in terms of the level of chemical contamination of soils with petroleum products is 66 m. In the work [234], a regression dependence of the concentration of lead in the soils on the distance to the MSW landfill was determined, with the help of which it was determined that the distance from the MSW landfill at which soil contamination with lead does not exceed the background level (the boundary of the weak contamination zone) is 526 m. The scheme of the meter for the concentration of explosive gases in the air is proposed in the scientific work [235].

The materials of the scientific article [236] are devoted to determining the regression power dependences of the prevalence of diseases of different classes in the adult population of settlements adjacent to the place of MSW removal from the distance to the landfill, which are used to determine the safe distance of MSW landfills from settlements based on the prevalence of diseases of the circulatory system and respiratory pathologies.

The author of the article [237] proposed a methodology for engineering calculations that can be used during a practical lesson "Research on environmental pollution by municipal solid waste and calculation of machine and equipment parameters to minimize negative impact on it" in the discipline of life safety, which will contribute to the deepening of knowledge on environmental protection of future specialists [238-244].

The results of modeling the specific energy consumption of cleaning soils of municipal solid waste landfills from heavy metal contamination are given in the article [245], and the determination of energy consumption for cleaning soils around MSW landfills from heavy metal contamination is published in the paper [246].

The dependence of the level of bacteriological soil contamination on the distance to the municipal MSW landfill is determined in the article [247].

Table 1 shows the concentrations of benzo[a]pyrene in the soils of the Mykolaiv MSW landfill (Velyaka Korenykha village, Mykolaiv region) [248], supplemented by the results of research [229].

Table 1.

Benzo[a]pyrene concentrations in MSW landfill soils [248, 229]

Measurement depth, cm	2.5	12.5	60	150
Concentration of benzo[a]pyrene C ₂₀ H ₁₂ in soil, mg/kg	0.05645	0.03246	0.0059	0.005
Literary source	[229]	[229]	[248]	[248]

Table 2 shows the incidence rates of respiratory cancer in the population of Kyiv for different concentrations of benzo[a]pyrene in ambient air [207].

Table 2.

Incidence rates of respiratory cancer in the population of Kyiv for different concentrations of benzo[a]pyrene in ambient air [207]

Concentration of benzo[a]pyrene C ₂₀ H ₁₂ in atmospheric air, ng/m ³	1.99	2.65	2.82	3.00	3.09	3.18
Prevalence of respiratory cancer per 100 thousand population	24.5	28.5	34.4	26.5	26.2	35.7
Concentration of benzo[a]pyrene C ₂₀ H ₁₂ in atmospheric air, ng/m ³	3.57	3.79	3.97	4.10	4.81	
Prevalence of respiratory cancer per 100 thousand population	30.8	31.6	31.8	37.7	38.1	

The regression data were carried out on the basis of linearization transformations, which allow reducing the nonlinear dependence to a linear one. The coefficients of the regression equations were determined by the least squares method using the developed computer program "RegAnaliz", which is protected by a certificate of copyright registration for the work [249], and is described in detail in the works [250, 251].

The computer program "RegAnaliz" allows for regression analysis of the results of single-factor experiments and other pairwise dependencies with the selection of the best type of function from the 16 most common options according to the criterion of the maximum correlation coefficient with saving the results in MS Excel and Bitmap format.

The results of the regression analysis are given in Table. 3, where the cells with the maximum value of the correlation coefficient R are marked in gray.

Table 3

Results of regression analysis of the impact of environmental pollution with
benzapyrene on the incidence of respiratory cancer

No.	Type of regression	Correlation coefficient R	
		$C_{C_{20}H_{12}} = f(h)$	$P_{RC} = f(C_{BP})$
1	$y = a + bx$	0.79876	0.73041
2	$y = 1 / (a + bx)$	0.90309	0.73504
3	$y = a + b / x$	0.93210	0.70527
4	$y = x / (a + bx)$	0.96806	0.78037
5	$y = ab^x$	0.86158	0.73327
6	$y = ae^{bx}$	0.86158	0.73327
7	$y = a \cdot 10^{bx}$	0.86158	0.73327
8	$y = 1 / (a + be^{-x})$	0.61791	0.71440
9	$y = ax^b$	0.96975	0.73349
10	$y = a + b \cdot \lg x$	0.96081	0.72412
11	$y = a + b \cdot \ln x$	0.96081	0.72412
12	$y = a / (b + x)$	0.90309	0.73504
13	$y = ax / (b + x)$	0.74575	0.73572
14	$y = ae^{b/x}$	0.82869	0.72088
15	$y = a \cdot 10^{b/x}$	0.82869	0.72088
16	$y = a + bx^n$	0.65155	0.72544

herefore, according to the results of the regression analysis based on the data in Tables 1 and 2, the following regression dependencies were finally accepted as the most adequate [232, 252]:

$$C_{C_{20}H_{12}} = 0.1187h^{-0.6542} \text{ [mg/kg];} \quad (1)$$

$$P_{RC} = \frac{C_{BP}}{0.04961 + 0.01694 C_{BP}} \text{ [cases per 100 thousand people],} \quad (2)$$

where $C_{C_{20}H_{12}}$ – concentration of benzo[a]pyrene $C_{20}H_{12}$ in soil, mg/kg;

h – measurement depth, cm.

P_{RC} – prevalence of respiratory cancer in the population, cases per 100 thousand people;

C_{BP} – concentration of benzo[a]pyrene $C_{20}H_{12}$ in atmospheric air, ng/m³.

Figure 1 shows the actual and theoretical graphical dependences of the impact of environmental pollution with benzapyrene on the incidence of respiratory cancer.

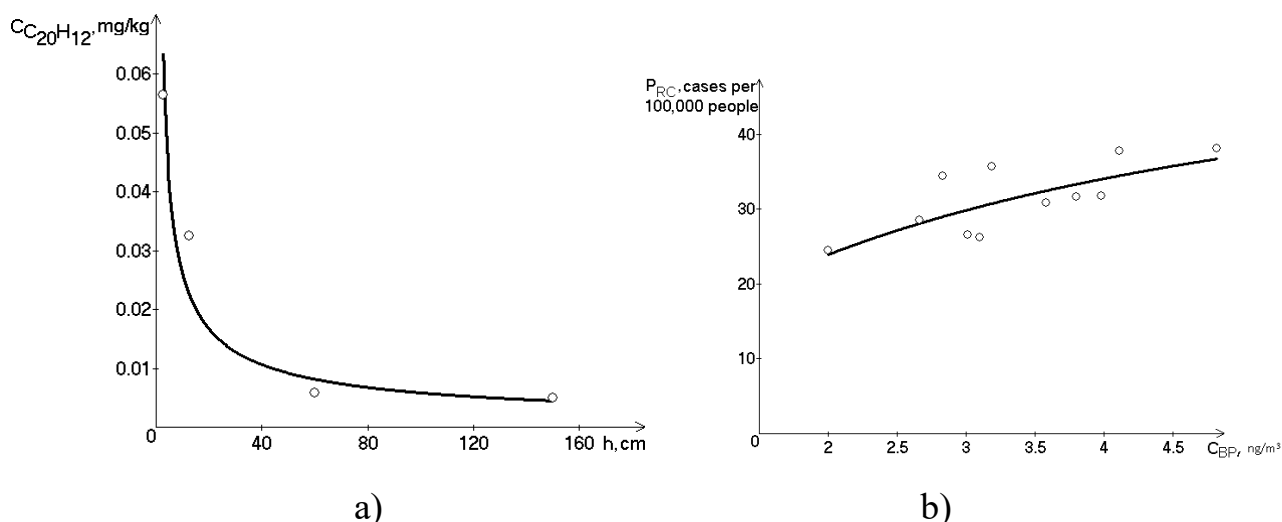


Figure 1. The impact of environmental pollution with benzopyrene on the incidence of respiratory cancer: actual $\circ$, theoretical — a) $C_{C_{20}H_{12}} = f(h)$, b) $P_{RC} = f(C_{BP})$

Comparison of actual and theoretical data showed that the theoretical impact of environmental pollution with benzopyrene on the incidence of respiratory cancer, calculated using the obtained regression equations (1, 2), does not significantly differ from the data given in the works [229, 248, 207], which confirms the previously determined sufficient accuracy of the obtained dependencies.

It is shown that the concentration of benzopyrene in the soils of the MSW landfill decreases according to a power dependence with increasing measurement depth, and the prevalence of respiratory cancer in the population increases with increasing concentration of benzopyrene in atmospheric air according to a hyperbolic dependence.

Thus, regression dependencies have been determined that describe the impact of environmental pollution with benzopyrene on the incidence of respiratory cancer, which can be used to predict the indicators of such incidence.