

**O. V. Bereziuk, Dr. Sc. (Eng.), Associate Professor; T. B. Vasenko;
S. M. Horbatiuk, Cand. Sc. (Biology), Associate Professor; I. M. Klymchuk**

DEPENDENCE OF THE ADULT POPULATION TRANSIENT ISCHEMIC ATTACKS MORBIDITY ON THE EFFICIENCY OF THE INCINERATION PLANT

Flue gases of the incineration plants are complex multi component mixture of 27 ingredients, which may cause the diseases of the human respiratory system and blood circulation system, in particular, transient ischemic attacks. That is why, determination of the regression dependence of the population ischemic attacks morbidity on the efficiency of the incineration plant, which can be used for the determination of the morbidity indices is a relevant scientific-technical problem.

***Objective of the research** is the construction by means of the regression analysis the regression dependence of the adult population transient ischemic attacks morbidity on the efficiency of the incineration plant, which can be used for the prediction of the indices of such morbidity. In the process of the research the method of regression analysis of the results of single-factor experiments and other paired dependences with the selection of the most adequate type of function from the sixteen most widely used variants by the criterion of maximum value of the correlation coefficient, was used.*

Regression was carried out on the base of the linearizing transformations, which enable to reduce the non-linear dependence to linear one. Determination of the coefficients of the regression equations was performed, applying the method of the least squares by means of the developed computer program "RegAnaliz". Regression dependence of the adult population transient ischemic attacks morbidity on the efficiency of the incineration plant has been obtained, it can be used for the prediction of the indices of such morbidity. Graphic dependence of the adult population transient ischemic attacks morbidity on the efficiency of the incineration plant has been constructed, it enables to illustrate this dependence and show the sufficient coincidence of the theoretic results with actual ones. It is established that the propagation of the adult population transient ischemic attacks morbidity is growing with the increase of the efficiency of the incineration plant according to hyperbolic exponential dependence.

***Key words:** incineration plant, solid municipal waste, morbidity, transient ischemic attacks, regression analysis.*

Introduction

Solid municipal waste (SMW) represent serious threat for human health and environment [1]. Annual volume of SMW formation on the territory of Ukraine is more than 54 mil. m³, greater part of the solid municipal waste is buried on 6107 landfills and dump sites, their total area is 7700 ha, the waste is only partially recycled or disposed at the incineration plants (2 %), unlike high developed countries, where modern recycling and disposing technologies of SMW are widely implemented [2]. Due to the growth of prices for organic fuel, especially natural gas, the problem of SMW usage as the energy fuel became actual. That is why, the spreading of waste combustion in such developed countries as Danmark and Netherland is 54.3 % and 36.6 %, correspondingly [3]. Only in the period of 1995 – 2014 the spreading of SMW combustion in EU increased almost 2 times [4]. Also it is expedient to dispose SMW at the available municipal thermal power plants with generating capacity of 12 MW, these plants can operate on the energy fuel, that is a mixture of SMW, dehydrated to 20 % of the relative humidity and coal with weight part of 16 % with the calculated low combustion value 10.99 MJ/kg [5]. At the same time, thermal methods of SMW disposal nowadays got controversial assessment in the world practice, as the operation of any incineration plant is accompanied by complex contamination of the atmosphere. Flue gases of the incineration plants is complex multicomponent substance, where 27 ingredients are identified and quantitatively determined [6]. These components may cause the diseases of the respiratory system and blood circulation of humans [7], in particular, cerebral stroke and transient ischemic attacks.

Problem set-up

In accordance with the text of the Resolution of the Cabinet of Ministers of Ukraine № 265 the provision of the control over the operating and closed landfills of SMW to avoid harmful impact on the people's health and environment is one of the priority directions of solid municipal waste management in Ukraine [8]. That is why, determination of the regression dependence of the adult population transient ischemic attacks morbidity on the incineration plant efficiency, which can be used for the prediction of such morbidity indices, is the relevant scientific-technical problem.

Analysis of the recent research and publications

Materials of the paper [9] contain the regression models of the propagation of such basic methods of SMW management as burial and combustion. Low combustion value of the humid SMW is 6.285...8.38 MJ/kg and on the condition of SMW humidity decrease from 43 % to 20 % low combustion value of SMW is 9.14 MJ/kg and calculated low combustion value of the mixture of coal and SMW – 10.99 MJ/kg [5]. In the paper [10], using the suggested humidity meter [11], the study of the processes of SMW dehydration by means of the worm press applying experiment planning of the second order was carried out, the performed study enabled to determine the adequate regression models of the dehydration indices on basic parameters of impact. In the research [12] the scheme of the SMW dehydration and compaction hydraulic drive in the dust carts during their loading was suggested. Study of the properties of SMW combustion in the stationary bed [13] established the following dependence of the combustion speed on the size of the particles: decrease of the average size of the particles from 30 to 10 mm leads to the increase of the flame propagation rate from 0.6 cm/min to 0.8 cm/min, in its turn this considerably increases the SMW burning rate and controls maximum carrying capacity of the waste during the obtaining of the complete burning.

In the materials of the paper [14] the dependence of SMW burning propagation with the disposal of energy in the developed countries on such factors of impact as density of the population, value of gross domestic product per capita, index of human potential development, average geographical altitude of the country is investigated. Paper [15] contains statistical data regarding the propagation of the methods of SMW burning in Ukraine in the period of 2012 - 2019. It was established [16] that the number of the incineration plants in different countries, among the investigated factors is influenced by the volume of GNP per capita mostly, and average geographical altitude has the least impact on the number of the incineration plants, index of human potential development influences indirectly by means of the effects of the factors interaction. Besides, adequate regression dependence of the number of the incineration plants in different countries has been obtained in the form of quadratic regression in logarithmic coordinates with the effects of interaction of the first order, that can be used in the process of development of the strategy, complex of machines and equipment for SMW management.

Authors of the work [17] revealed the trend to the decrease of the morbidity rate, both of the adult population on the whole and the population of the active working age on cerebral strokes and transient ischemic attacks. In the paper [18] main modified risk factors of transient ischemic attacks and/or strokes have been analyzed, ways of correcting the behavioral factors of transient ischemic attacks risk and/or stroke have been shown. The research [19] determines regression power dependences of the propagation of the diseases of various classes among the adult population of the settlements, adjacent to the places of SMW emission on the distance to the landfill, which are used for the determination of the safe distance for the landfills location from the settlements by the indications of the pathologies of the respiratory organs and blood circulation system propagation. However, the authors did not reveal specific mathematic dependences of the transient ischemic attacks morbidity among the adult population on the efficiency of the incineration plant as a result of the analysis of the known publications.

Objective and task of the paper

Objective of the paper is the construction by means of regression dependence of the transient ischemic attacks of the adult population of the active working age morbidity on the efficiency of the incineration plant, these dependences can be used for the prediction of the morbidity rate.

Methods and materials

The following methods are used for the determination of the regression dependence of the transient ischemic attacks morbidity of the adult population on the efficiency of the incineration plant: regression analysis of the results of single-factor experiments and other paired dependences, computer simulation.

Results of the research

Table 1 contains the indices of the transient ischemic attacks morbidity of the adult population in Darnytsia District of Kyiv where the incineration plant "Energy" is located, these indices are determined by the authors of the work [17], depending on the efficiency of the incineration plant.

Table 1

Indices of transient ischemic attacks morbidity of the adult population, depending on the efficiency of the incineration plant [17]

Year	2015	2016	2017	2018
SMW burnt, ths. t [13]	256.4	259.3	245.6	206.5
Propagation of the transient ischemic attacks per 100.000 population	90.2	91.6	91.7	62.8

It was planned, on the base of the data from Table 1, to obtain paired regression dependence of the transient ischemic attacks morbidity of the adult population on the efficiency of the incineration plant.

Regression was carried out on the base of linearizing transformations, which enable to reduce non-linear dependence to linear. Determination of the coefficients of the regression equations was performed, applying the method of the least squares [20], using the developed computer program "RegAnaliz" [21], protected by the Certificate of the state registration of the right to the copyright object and is described in details in the work [22, 23].

Program "RegAnaliz" enables to perform regression analysis of the results of single-factor experiments and other paired dependences with the selection of the most adequate type of function from 16 most widely-spread variants by the criterion of maximum correlation coefficient, storing the results in MS Excel and Bitmap format.

Results of the regression analysis are presented in Table 2, where cells of the regression with maximum value of the correlation coefficient R are marked in grey color.

Thus, by the results of the regression analysis on the base of the data from Table 1, as the most adequate the following dependence is taken

$$P_{tia} = \frac{1}{0.01097 + 2.381 \cdot 10^{87} e^{-m_{\text{burntSMW}}}} \text{ [Case per 100.000 of population]}, \quad (1)$$

where P_{TIA} – is the propagation of transient ischemic attacks, cases per 100.000 of population; $m_{\text{burnt.SMW}}$ – is annual mass of burnt SMW, ths. t.

Fig. 1 shows actual and theoretical graphic dependence of transient ischemic attacks morbidity of the adult population on the efficiency of the incineration plant.

Table 2

Results of regression analysis of the dependence of transient ischemic attacks morbidity propagation among the adult population on the efficiency of the incineration plant

№	Type of regression	Correlation coefficient R	№	Type of regression	Correlation coefficient R
1	$y = a + bx$	0,96480	9	$y = ax^b$	0,97097
2	$y = 1 / (a + bx)$	0,96673	10	$y = a + b \cdot \lg x$	0,96997
3	$y = a + b / x$	0,97451	11	$y = a + b \cdot \ln x$	0,96997
4	$y = x / (a + bx)$	0,86379	12	$y = a / (b + x)$	0,96673
5	$y = ab^x$	0,96585	13	$y = ax / (b + x)$	0,97625
6	$y = ae^{bx}$	0,96585	14	$y = ae^{b/x}$	0,97546
7	$y = a \cdot 10^{bx}$	0,96585	15	$y = a \cdot 10^{b/x}$	0,97546
8	$y = 1 / (a + be^{-x})$	0,99944	16	$y = a + bx^n$	0,95897

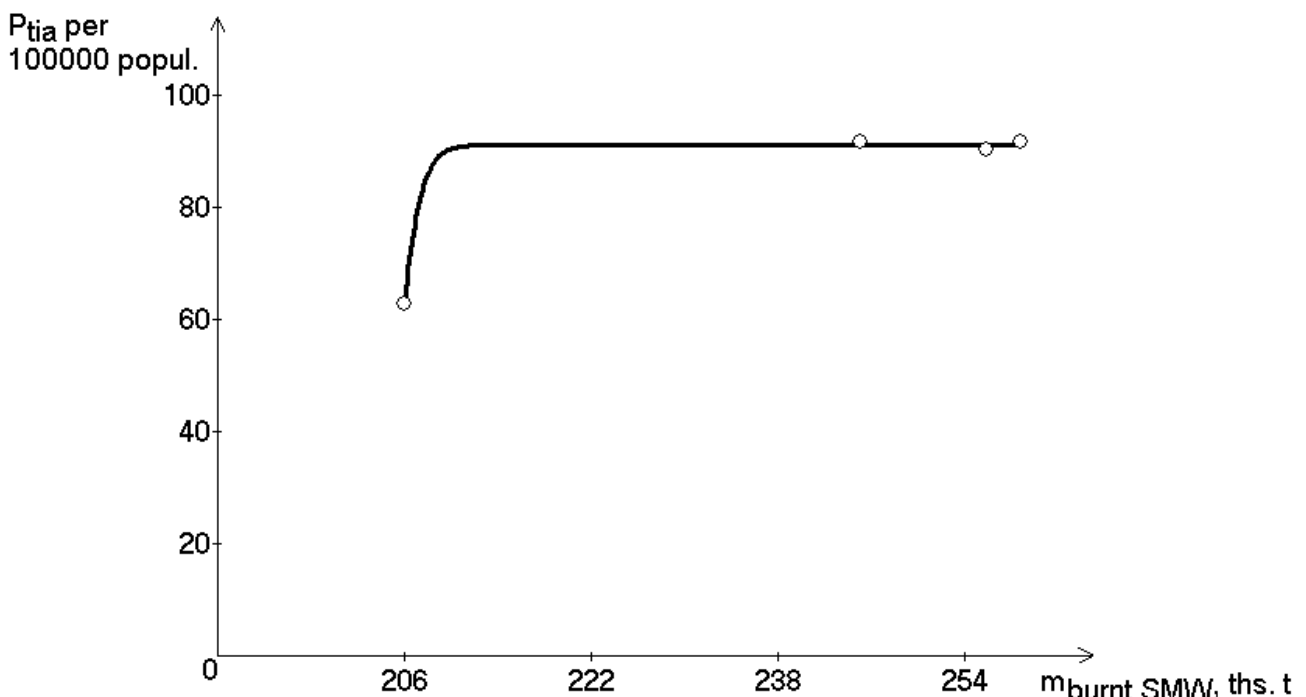


Fig. 1. Dependence of transient ischemic attacks morbidity propagation among the adult population on the efficiency of the incineration plant: actual \circ , theoretical —

Comparison of actual and theoretical data showed that the dependence of the theoretical propagation of the of transient ischemic attacks morbidity among the adult population on the efficiency of the incineration plant, calculated by means of regression equation (1) does not differ greatly from the data, presented in the study [17], this proves the sufficient accuracy of the obtained dependence, determined before.

Analysis of graphic dependence in Fig.1 showed that the propagation of transient ischemic attacks morbidity among the adult population grows with the increase of the efficiency of the incineration plant according to hyperbolic-exponential dependence.

Conclusions

Regression dependence of transient ischemic attacks morbidity propagation among the adult population on the efficiency of the incineration plant has been determined, it can be used for the prediction of the morbidity rate of this disease.

Graphic dependence of transient ischemic attacks morbidity propagation among the adult population

on the efficiency of the incineration plant has been constructed, it enables to illustrate this dependence and show the sufficient coincidence of the theoretical and actual results.

It has been established that the propagation of transient ischemic attacks morbidity among the adult population grows with the increase of the efficiency of the incineration plant according to hyperbolic-exponential dependence.

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Bereziuk Oleh – Dr. Sc. (Eng.), Professor with the Department of Health and Safety, Pedagogy of Safety, e-mail: berezyukoleg@i.ua.

Vinnytsia National Technical University.

Vasenko Tetiana – Assistant with Department of Medical Biology.

Horbatiuk Svitlana – Cand. Sc. (Biology), Associate Professor with Department of Medical Biology.

Klymchyk Irina – assistant with the Department of Medical Biology.

Vinnytsia M. I. Pirogov National Medical University.