

MINISTRY OF HEALTH OF UKRAINE
O.O. BOGOMOLETS NATIONAL MEDICAL UNIVERSITY

“Approved”

at the methodological conference of hygiene
and ecology department

Head of the department

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GUIDELINES
FOR STUDENTS

<i>Subject</i>	Hygiene and ecology
<i>Module № 1</i>	Assessment of the environment and its impact on the population health
<i>Submodule №1</i>	General questions of hygiene and ecology
<i>Topic of the lesson</i>	Methodological and methodical background for assessment of the environmental factors impact on population health.
<i>Course</i>	6
<i>Faculty</i>	medical
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Kiev

Topic: Principles of methodology, technique and basic assessment scheme of the environmental factors impact on population health.

Subtopics

1. Methodology and technique principles of hygiene.
2. Method of monitoring area selection.
3. Methodic principles of complex hygienic assessment of environmental conditions.
4. General procedure of study of the complex of environmental factors influence on the population health, indices and methods of medical statistics.

1. Learning objective

1.1 Master theory fundamentals and basic assessment scheme of environmental factors' influence on population health.

1.2 Master the method of complex hygienic assessment of state of environment and its influence on population health

1.3 Master the procedure of calculation of the integral index of population health and the procedure of assessment of this index in connection with the influence of environment.

2. Basics

2.1. You should know:

2.1.1. Methodological and technique principles of common hygiene (in the extent of the previous lecture courses and practical studies on given discipline).

2.1.2. Methodic principles of complex hygienic assessment of environmental conditions.

2.1.3. Population health as the integral criterion in environmental condition assessment.

2.1.4. General procedure of study of the complex of environmental factors influence on the population health, indices and methods of medical statistics.

2.2. You should have the following skills:

2.2.1. To examine environmental objects for sanitation purposes, to wield basic methods of hygienic research used for studying the influence of complex environmental factors on the population health.

2.2.2 To calculate main statistical criteria.

2.2.3. To use reference information materials.

2.2.4. To assess the environmental objects for hygienic and sanitary purposes, to apply the sanitary-and-descriptive method and the most widely used methods of assessment of organism response to the effects of the unfavourable environmental factors.

2.2.5. To acquire the technique of complex hygienic assessment of the state of environment (qualitative or conceptual and quantitative one).

3 Self-training questions

3.1. Methodology and methodic study principles of environmental factors' influence on population health.

3.2. Population health as an integral environmental factor. Health indices that characterize it.

3.3. Principal scheme of work conditions, way of life and environment factors sanitation control.

3.4. Basic study and assessment scheme of environment factors and population health relation.

3.5. 3.6. Quantitative (conceptual) technique of population health level analysis and its usage in medical practice.

3.6. Qualitative technique of population health level analysis and its usage in medical practice.

3.7. Quantitative (conceptual) technique of environment state analysis and "normalized" forecasting of population health level changes based on the state of the ambient air, water and soil pollution, noise situation.

3.8. Quantitative technique of environment state level analysis (by pollutants' summation, expertise rating, advantages of the first approach against rating).

3.9. Monitoring areas. Definition. Selection requirements for their selection.

3.10. Epidemiological method of population health study, and main principles of its realization:

3.10.1. Sanitary and statistical research.

3.10.2. Medical examination of population.

3.10.3. Clinical observation.

3.10.4. Field epidemiological experiment.

3.11. Concept of elementary diagrams of study of environmental influence on population health:

3.11.1. "factor – health criterion" type.

3.11.2. "factor – group of health criteria" type.

3.11.3. "group of factors – health criterion" type.

3.11.4. "group of factors – group of health criteria".

3.11.5. "inverse approach to the study of the influence of environmental factors on the population health".

3.12. Procedure of quantitative analysis of atmospheric air pollution by summarizing all pollutants' objective factors. Its benefit over numerical estimation of the atmospheric air pollution.

3.13. Expertise procedure of atmospheric air, water, foodstuffs, soil, noise pollution and summarized environmental pollution rating. Expertise of living conditions of population (in points).

3.14. Methods of detection of the environmental factors impact on the population health.

3.15. Scheme of integral assessment of the level of population health.

4 Self-training assignments

4.1. Write down into the protocol book schemes: “Work conditions, life and environment factors”; “Determination and evaluation of environment factors and population health correlation”.

4.2. Learn capabilities of mathematic modeling methods of correlation of numerical factors of population health level and state of environment.

4.3. Write down into the protocol book the scales of the “normalized” prediction of changes of the population health level according to the level of the atmospheric air, water, soil pollution, the level of ambient noise.

5. Structure and content of the lesson (duration of the lesson 160 min + 10 min break)

5.1. Preamble – 5-10 min.

5.2. Test control for assessment of students’ knowledge datum level – 10-15 min

5.3. Theoretical training – 30-40 min.

5.4. Typical situational tasks “Krok-2” solution – 30-40 min.

5.5. State exams situational tasks solution – 30-40 min.

5.6. Test control for assessment of students’ knowledge final level – 10-15 min.

Appendix 1

Philosophic fundamentals of population health study

Methodology is a teaching about method of research study, ways and means of scientific perception of reality, theoretical and practical activity, and ascertainment of truth.

General philosophic and Subject (i.e. methodology of separate scientific disciplines) *methodologies* are distinguished.

General philosophic methodology is meant as a teaching about methods and techniques of learning of nature, society and thinking. This trend is called materialistic dialectics.

General philosophic methodology is based on the idea of general development and uses its specific methods and techniques of learning (analysis and synthesis, induction and deduction, historical and logical modeling, system-and-structural approach, etc), which are created by human intuition, experience and intellect.

In particular by applying these methods and techniques for learning of objective reality, i.e. phenomena and processes that occur in environment irrespective of people will and consciousness, a man has discovered and formulated common philosophic laws and categories, which reflect general and universal character.

Therefore thoroughness and universality of philosophical laws and categories consist in possibility of their application in any area of scientific knowledge and in any scientific discipline.

There are three fundamental laws of materialistic dialectics:

- the law of the transformation of quantity into quality and vice versa;
- the law of the unity and strife of opposites;
- the law of the negation of the negation.

Besides these laws, materialistic dialectics use such philosophical categories that are also used universally. Examples of such universal categories may be:

- cause and effect;
- need and contingency;
- form and content;
- the whole and the parts;
- probability and reality.

It should be noted that in hygiene one of three named general philosophical laws is most often used – the law of quantity and quality transformations.

Thus, many environmental factors, social and economic conditions, level of culture etc. may influence the human organism either positively or negatively only as the result of achievement of some quantitative threshold – so-called threshold of deleterious effect.

Knowledge of laws and categories of materialistic dialectics helps physicians of different specialization:

First – to correctly explain causes of phenomena they observe;

Second – to give proof of the research direction;

Third – to specify one’s position during creation of general concepts and theories.

Except general philosophical methodology, hygiene, as an independent field of medicine, has its own subject methodology.

Subject methodology of hygiene means a set of scientifically based methods and techniques that are used for the study of physical, chemical, biological, external and environmental psychogenic factors and social and economic conditions influence on human organism, and for study of human physiological, living and industrial activity influence on environment.

Method is a way of learning reality, natural phenomena, its regularities and laws.

Technique is a set or a system of particular means, techniques of appropriate fulfillment of some task, scientific research, and a component of the subject methodology.

It should be mentioned here, that medicine in the whole as a research object studies biological characteristics of a man when they are in norm and in pathology and their changes under the effect of different factors.

A specific study object of therapeutic medicine is a sick person. Philosophical category that reflects a condition of a sick person is such concept (category) as “the disease”. It is important that therapeutic medicine study disease neither of a collective, nor of a group of people but individually, i.e. a particular disease.

Specific study object of preventive medicine, or hygiene, are healthy people (more precisely - practically healthy people). Philosophic category that expresses the state of a healthy man is “the health”.

In particular specific character of the object under research in hygiene defines need of use of specific techniques for its study.

There are five specific techniques for hygiene:

1. Epidemiological method of population health study;
2. Method of sanitary examination:
 - sanitary-topographic;
 - sanitary-technical;

- sanitary-epidemiological.
- 3. Method of hygienic experiment (full-scale and laboratory);
- 4. Method of sanitary expertise;
- 5. Method of sanitary education (hygienic training and education of population).

Fundamental difference of these methods and those ones that are used in therapeutic medicine is the fact that they are directed not at diagnostics, but at treatment, not at rehabilitation of a patient, but at definition of the level of population or of an individual person health.

Peculiarity of these methods is that availability and character of relation between population health level and environmental factors or risk factors are assigned with their help.

Therefore, subject methodology means also its specific self-laws and categories that are used for revealing regularity of all external and environmental factors action on people health.

Subject methodology:

1. Specific laws and categories of materialistic dialectics that reflect its peculiar methods and techniques.
2. Specific laws, principles, postulates and hygiene categories that reflect its peculiar methods and different techniques.
3. Specific methods of hygienic research.
4. Particular hygienic techniques and techniques of other disciplines that are used in a study of population health and external and environmental factors influence on it.

Therefore, hygienic technique schematically may be represented in the form of a cone.

The foundation, the basis of the cone is the general philosophical methodology. It is represented by universal method of reality perception – method of materialistic dialectics with its principal laws and categories. Hygienic methods and categories with certain philosophic content like health, disease, biosphere, noosphere, internal and external habitats and environment comes close to this foundation. Then at the top of the cone there come specific hygienic methods and specialized techniques that are used in the hygienic science and practice.

Appendix 2

POPULATION HEALTH AS AN INTEGRAL CRITERION FOR THE ENVIRONMENT ASSESSMENT

Population health on Earth in past times was characterized by epidemics. Significance of population health problem has recently increased as a result of intensive anthropogenic denaturizing of environment because the state of people health has changed sufficiently and new regularities of people pathology spread and character has appeared. Demographic processes have changed the course of their running.

Therefore, in 80-90-s some scientists-hygienists, such as academicians Yu.G. Goncharuk, G.I. Sydorenko, M.F. Izmerov, Yu.I. Kundyev, professors Yu.V. Voronko, Y.Y. Zvin'atskivski, V.G. Bardov, K.A. Bushtuyeva etc. offered an alternative evaluation approach to the state of environment.

This alternative, non-traditional approach can be formulated as follows: “The state of environment depends on population health level.”

What were the presuppositions for such conclusion?

First: specific weight of the state of environment in population health formation is about 20%.

Second: there are many hygienic standards, but not all factors can be measured and rated thereafter, it is not always possible to follow them.

Third: among 9 principles of sanitary control there is the principle of threshold and the principle of MAC relativity, i.e. any agreed rule of hygiene is not the absolute truth and may be revised.

First of all it is significant that the category “health” is a complex concept, which cannot be characterized simply, barely by one index.

On the one hand – this concept is a methodological, philosophical one.

On the other hand – this must be practical concept, which may be used in everyday activity of medical personnel.

Such lack of “health” constructive, universal definition causes big difficulties and considerable ambiguity concerning research study results that are related to evaluation of different factor action on people health.

Existing definitions, including ones that are given in the introduction to Statute of the World Health Organization, are based on the principle: “health” is not only the absence of diseases and corporal defects, but a state of full physical, mental and social well-being”, are not quite constructive because in most cases health is interpreted as the absence of disease.

Besides, ideas of social well-being are subjective, and social deficiency of a person is not necessarily the case for being determined (especially by qualitative criteria).

American sociologist-hygienist I.B. Richmond has rightly noticed in his monograph devoted to tendencies of medical aid and education development that “medicine has been so much dissolved in different concepts of disease, that we have neither terminology nor classification of health. Especially it relates to social and psychological aspects of health, where only rough terms are used and where required classification is absent”.

In order to define the health one must consider the following “fundamentals”:

1. there is no absolute health;
2. individual and population health are inseparable;
3. health is not characterized by only one factor but by a complex of characteristics;
4. definition of health is impossible without estimate of correlation between an individual and the environment;
5. health rating is impossible without load, required tests etc.

Thus, indeed, different meanings of the concept “health” have the right for existence, but application of each of them is constrained by the purpose of its use.

Therefore, some concepts of “health” of different content are distinguished:

First – it is general pathological (or philosophical) concept of health.

General pathological health is an interval within the limits of which quantitative variations of psycho-physiological processes are able to hold live system on the level

of functional optimum (optimal area, within which organism doesn't come out to pathological level of self-regulation).

Second – population health, i.e. health of a group of people, community, population.

Population health is a conditionally statistical concept, which is rather fully characterized by demographic factor complex, the level of physical development, disease incidence and frequency of premorbid states, disablement of certain group of population.

Third – individual health or health of an individual person.

At the same time individual health should be considered from two viewpoints:

First viewpoint – theoretical, as the highest possible optimum for a person, which is to be aspired to ideally, but which is actually very difficult to be achieved.

Individual theoretical health is a state of full social, biological and psychological well-being, when functions of all organs and systems of human organism and environment are balanced; any diseases, disease states and physical states are absent.

Another viewpoint is practical, as the actual characteristic of health level of a definite person.

Individual real health is a state of organism at which it can valuably fulfill its social and biological functions.

There is health complex approach as to a statistical average, which may be characterized by following theses:

1. State of health is defined in groups with identical socio-economic conditions.
2. "Normal" state of health is a state of those people who form 95% of confidence interval of population.
3. Confidence interval is considered also as an optimal area, within which organism doesn't move to pathological level of self-regulation.

Three basic groups of health rate are used for health characterization:

First group – medical indices.

Second group – indices of social well-being.

Third group – indices of mental health.

First group of medical indices includes:

- 1) morbidity rate;
- 2) death-rate (common and infantile);
- 3) physical development;
- 4) disablement.

Second group of social well-being indices includes:

- 1) demographic situation;
- 2) state of environment;
- 3) way of life;
- 4) medical care level;
- 5) social and hygienic factors.

Third group of mental health indices includes:

- 1) mental disease morbidity;
- 2) occurrence frequency of neurotic states and psychopathies;
- 3) psychological microclimate.

Also it should be noted that World Health Organization (WHO) has made a list of social well-being criteria. Such list includes:

1) percent of national produce, which is spent on health protection requirements; According to WHO global average medico-sanitary care spending is 8% of global gross domestic product.

2) availability of medico-sanitary first aid;

There are such national programs in Ukraine as: “Children of Ukraine”, “Family planning”, “Genetic monitoring”, “Pancreatic diabetes”, “Elderly people health”, interindustrial program “Health of Nation” is developed.

3) safe water-supply embracement of population;

4) percentage of individuals who were immunized against six most widely spread among population infectious diseases like: diphtheria, whooping cough, tetanus, measles, poliomyelitis, tuberculosis.

5) percentage of womankind that are served by qualified personal during pregnancy and childbirth;

6) percentage of children that were born with insufficient body weight (below 2500 g);

7) life expectancy;

8) level of population sanitary education.

Integral assessment of the population health state assumes some stages of examination.

At the first stage we receive information on factors that indicate the state of population health (e.g. about level of morbidity, death-rate, disablement or physical development) from different information sources.

Such information sources may be:

1) official reports of patient care institutions, hygiene and disease prevention services, agencies of health protection, social maintenance, state statistics, civil registration bureaus;

2) results of retrospective and prospective studies in patient care and prevention institutions;

3) population medical examination data;

4) clinical, laboratory and instrumental analyses data;

5) medical and sociological research results – polls, questionings of population;

6) results of mathematical modeling and forecasting.

At the second stage it is necessary to make the integral assessment of health level by having generalized all indices.

For that, conceptual analysis (also called “qualitative analysis”) and mathematical and statistical analysis are carried out.

As a result of conceptual “qualitative” analysis population is divided into health groups.

Health groups division criteria may be:

1) presence or absence of chronic disease;

2) resistibility of organism;

3) physical development level;

4) conformity of morphofunctional indices.

For instance, population division according to its state of health, that was developed in the Institute of Social Hygiene and Health Protection Management named after M.A. Semashko, which is related to registration of presence or absence of chronic diseases during medical examination is following:

First group – healthy people.

Second group – healthy people with functional deviations and some morphological defects.

Third group – ill people with long-term chronicity at retain of organism functional potential (compensated state).

Fourth group – ill people with long-term chronicity or individuals with corporal defects, development defects, aftereffect of traumas, lowered functional potential of organism (subcompensated state).

Fifth group – infirm people (decompensated state).

Population actual division into health groups is approximately the same as given in table 1.

Table 1

Population division into health groups

<i>Health group</i>	<i>Specific weight of population in group, %</i>	
	Men	Women
I	27-28	20-21
II	20-21	16-17
III	39-40	47-48
IV	11-12	14-15
V	1	0.8

These data may be used as comparison standard, considering them a relative norm of population.

Another type of analysis is mathematical and statistical (quantitative) analysis. Evaluation of generalized health index of given people group is a result of such analysis.

The final, third, stage of integral assessment of the state of population health is based on the requirement to find out the quantitative interdependence between environmental factors and health groups or indices.

To solve such a task one may use different methods:

- 1) personal experience and intuition;
- 2) expert's statements;
- 3) analysis of literature information;
- 4) statistical analysis;
- 5) experiment;
- 6) mathematical modeling;
- 7) system analysis.

Appendix 3

TECHNIQUE OF INTEGRAL ASSESSMENT OF THE ENVIRONMENT STATE

Technique of integral assessment of the state of environment includes qualitative and quantitative analyses.

Content of qualitative analysis of the state of environment is based on comparison results of instrumental or laboratory analysis to hygienic standards and their further assessment.

The assessment results may be the following:

- within standards;
- at standard level;
- exceeding the acceptable levels;
- the ratio of exceeding the acceptable levels.

This is a traditional assessment of the state of environment.

Based on its results one can “forecast” changes in population health level.

And, vice versa, according to character of changes in population health level one can forecast evaluation of MAC excess of a pollutant.

Thus, if we know the ratio of MAC excess of atmospheric pollutants:

- one time: typical is that there are no changes in the state of health;
- twice-thrice: changes in the state of health by some functional indices are observed;

- 4-7 times: marked physiological changes are defined;
- 8-10 times: increase of specific and nonspecific morbidity is typical;
- 100 times: acute poisonings are registered;
- 500 times and more: lethal poisonings will occur.

There are such assessment tables for water, soil and noise.

Such technique is simple, available, but the main disadvantage of it is that it doesn't give an idea of priority pollutants.

Therefore quantitative analysis of the state of environment is carried out.

There are two techniques of such quantitative analysis:

One is the calculation of integral environmental pollution index according to its MAC excess ration.

Another is evaluation in points (numerical score).

Appendix 4

GENERAL SCHEME OF IDENTIFICATION AND ASSESSMENT OF THE ENVIRONMENTAL FACTORS AND POPULATION HEALTH CORRELATIONS

General scheme of identification and assessment of correlations between environmental factors and population health includes realization of the following stages:

Stage 1: Purpose, tasks and research programs are defined.

Stage 2: Control area is selected.

Control area is an investigation and control territory that is characterized by identical living conditions and population activity. They differ in directivity, expansion

and action intensity of considered etiological environmental factors, and are limited by required quantity of observed contingents.

Stage 3: Hygienic and sanitary situation in control area(s) is evaluated.

Stage 4: Realization technique of epidemiological method of population health study is chosen.

- hygienic and statistical assessment.
- medical examination.
- clinical observation of specially selected people.
- full-scale epidemiological experiment.

Stage 5: Selection of research form.

All indicated above forms of realization of epidemiological method may be performed in the form of so-called transversal and longitudinal researches.

The essence of transversal (or one-stage) research is in the observation of environmental factors influence on population health at present, without the dynamic observation of health.

In other words transversal research allows to define the population health level at the moment of research.

Transversal research may be of two types: prospective and retrospective.

In case of the prospective research two groups of people are compared. The people of the first group are those who are influenced by researched factor, and the other group of people is one of those who are not exposed to such influence. That is research activities are directed from factor to health.

In case of retrospective research two other groups of people are compared: sick and healthy. That is research motion in reverse – from health (disease) towards possible factor.

Hence the prospective research is carried out mostly when hazardous factor is predetermined and retrospective research – when main acting factor is unknown and it should be ascertained.

Another form of assessment is a longitudinal epidemiological research.

The essence of longitudinal research consists in carrying out of a long dynamic observation of certain contingent of people.

Longitudinal research also may be of two types: parallel and nonparallel.

In case of parallel research the time period of research itself coincides with the period of time when the required information is collected.

And in case of the non-parallel research, the researched time period relates to the past (according to archive materials). Major disadvantage of this kind of research is the fact that required data and factors may not be found in archives.

Stage 6: Determination of minimal sample number.

Stage 7: Population health data collection.

Stage 8: Calculation of health rates and indices.

Stage 9: Assessment of the correlation between environmental factors and population health (mathematical modeling).

Modern methods of determination of the influence of factors, that have the most dramatic influence on population health, have the common methodical basis - theory of probability and mathematical statistics.

Correlation analysis allows determining direction, force, degree and authenticity of environmental factors influence on population health level.

Constraint force is evaluated by linear correlation coefficient (r): at values $r = 0.01-0.29$ connection is considered to be weak, at values $r = 0.30-0.69$ connection is average (medium), and at $r = 0.70-0.99$ connection is strong.

Degree of health level effect of each particular environmental factor is determined according to special scale taking into consideration determination index. Determination index shows in percent specific contribution of health effect of a given factor among other factors, result value of which makes up 100%.

Assessment scale of environmental factor influence:

<i>Determination index, %</i>	<i>Degree of factor influence</i>
< 1	Very weak
1 – 4	Weak
5 – 9	Medium
10 – 14	Strong
15 and >	Very strong

Regression analysis allows to create a regression equation, which may be used as a model that describes “behavior” of health level when the intensity of influence of factors, included in it, changes. As a rule, regression analysis is carried out simultaneously with correlation analysis. In this case it is called correlation-and-regression analysis.

Factor analysis allows classifying environmental factors into homogeneous groups automatically.

Dispersion analysis determines reliability and degree of environmental factors’ influence on health level.

Discriminant analysis allows determining of reliability of distinctions among some groups of population simultaneously based on comprehensive health indicators.

Cluster analysis is a kind of a multifactor analysis, which allows to scientifically prove the grouping of population contingents under examination according to their health.

Stage 10: Development and introduction of preventive recommendations, their efficiency assessment.

Algorithms of “Sanitation of the working, living conditions and environmental factors” and “Identification and evaluation of correlations between the environmental factors and population health” are given schematically (see appendices 4 and 5).

SANITATION OF THE WORKING, LIVING CONDITIONS AND ENVIRONMENTAL FACTORS

1 stage: Development and substantiation of hygienic standards						
Research method selection						
Hygienic	Sanitary	Toxicological	Pathomorphologic	Physiological	Clinico-functional	Bacteriological
II stage: Adherence to hygienic regulations control						
Preventive national sanitary inspection			Regular national sanitary inspection			
Environmental observation			Laboratory analyses			

Introduction of wasteless technology	Measurement of chemical pollution levels	Measurement of noise, vibration, dust, radiation levels and microclimate parameters	Data registration	Analysis of air, water, soil, food substances' samples	Generalization of results	Drawing of sanitary conclusion
Automation and mechanization of production processes	III stage: Measures for correction of environmental factors' influence on organism					
Use of sanitary appliances and scheduled measures						
Measures for noise and vibration reduction						
Rational job placement						
Therapeutic and preventive measures						
Correction of hygienic regulations						
Sampling of air, water, soil, food substances						

IDENTIFICATION AND ASSESSMENT OF CORRELATIONS BETWEEN THE ENVIRONMENTAL FACTORS AND POPULATION HEALTH

Definition of purpose, tasks and research program			
Selection of control area(s)			
Evaluation of hygienic and sanitary situation in control area(s)			
Selection of realization technique of epidemiological method of population health study			
Hygiene and statistical investigation	Medical examination	Clinical observation	Full-scale epidemiological experiment
Selection of examination forms			
Transversal		Longitudinal	
Prospective	Retrospective	Parallel	Nonparallel
Determination of minimal sample number			
Population health data collection			
Calculation of health rates and indices			
Assessment of correlation between environmental factors and population health (mathematical modeling)			
Development and introduction of preventive recommendations, their efficiency assessment			

Principal schemes of hygienic studies of the environmental factors impact on health criteria

Monitoring areas – territories under test (test and control), which are characterized by identical living and working conditions of population, but differ in directivity, expansion and intensity of the influence of environmental etiological factors under consideration, are limited by requirement of the number of population groups to be observed.

It is recommended to pick out for investigation such groups of population, which are most sensitive and susceptible to studied factor during research.

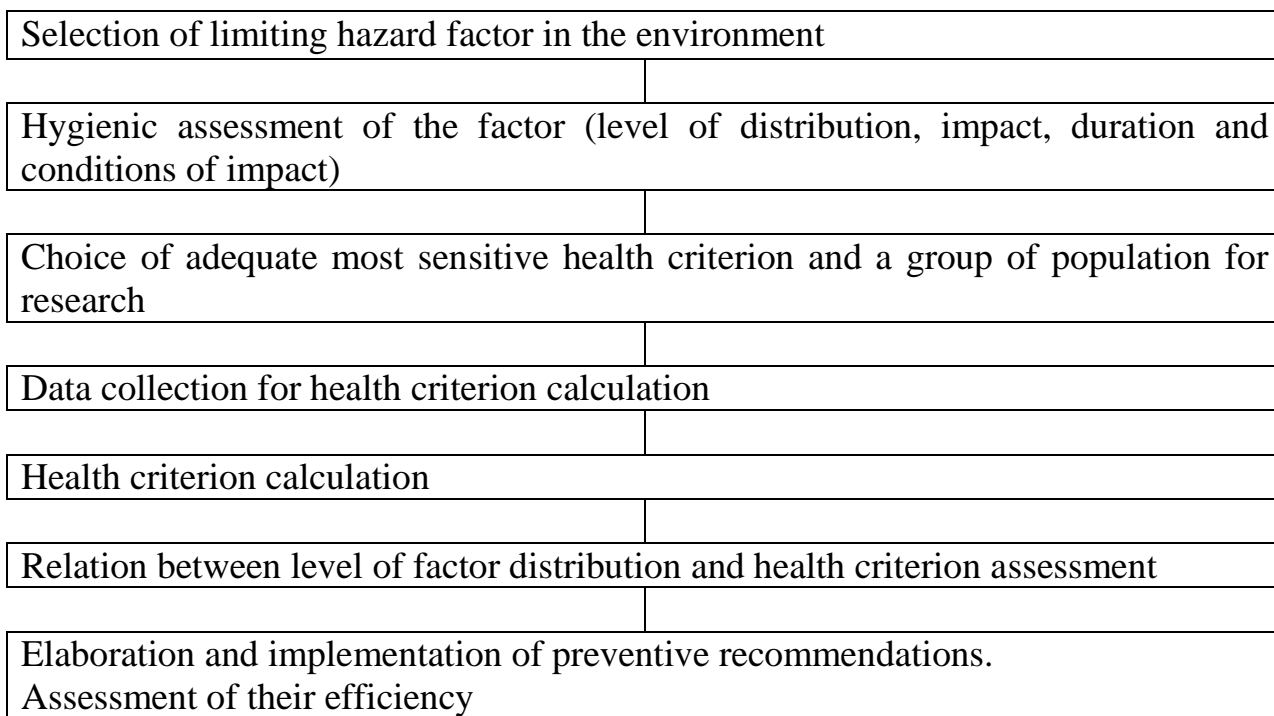
In the selected monitoring areas sanitary and hygienic situation is carefully examined, laboratory and instrumental researches of efficiency of all factors are carried out and their hygienic assessment is stated.

Population health study is carried out in the areas, which are selected for research using epidemiological method and principal techniques of its realization – sanitary and statistical examinations, medical examination, clinical observation and field epidemiological experiment.

Depending on methodological direction, hygienic research of environmental factors influence on the population health can be brought to five principal study schemes.

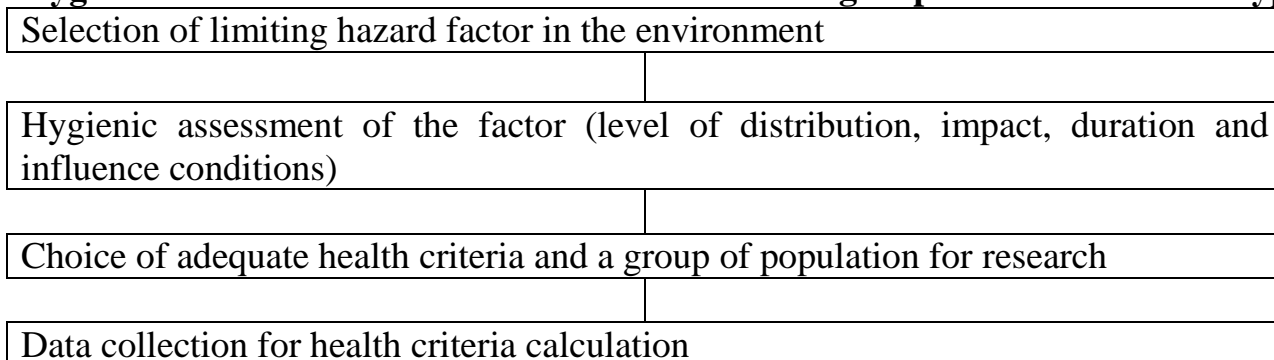
Scheme 1

Hygienic assessment of the “factor– health criterion” type



Scheme 2

Hygienic assessment of the “environmental factor– group of health criteria” type



Calculation of health criteria	
Integration of evaluated/calculated health indices into health index, decision concerning the health group	
Relation between level of factor distribution and some health criteria assessment	
Elaboration and implementation of preventive recommendations. Assessment of their efficiency	

Scheme 3

Hygienic assessment of the “group of environmental factors– health criterion” type

Making a list of etiological environmental factors	
Hygienic description of distribution of selected factors (numerical assessment, determination of routes, duration and conditions of impact on organism)	
Determination of the most sensitive health criterion for a monitored population group	
Data collection for determined health criterion assessment and its calculation	
Assessment of multifactor relation between different etiological factors and health criterion using mathematical modelling	
Elaboration and implementation of preventive recommendations. Assessment of their efficiency	

Scheme 4

Hygienic assessment of the “group of environmental factors– group of health criteria” type

Making a list of etiological environmental factors	
Hygienic description of selected factors’ distribution (numerical assessment, determination of routs, duration and conditions of impact on organism)	
Making a list of adequate health criteria and selection of a monitored population group	
Data collection for assessment of defined health criteria and their calculation, health index assessment	

Assessment of multifactor relation between different etiological factors and health criterion (health index) using of mathematical modelling

Elaboration and implementation of preventive recommendations.
Assessment of their efficiency

Scheme 5

Inverse method of study of the environmental factors impact on population health

Population health level assessment

Foundation of “normalized” forecast of the change of the population health level

Making a priority list of environmental factors

Elaboration and implementation of preventive measures

Assessment of preventive measures of population health level efficiency

Appendix 8

FORMULAS FOR CALCULATION OF THE ATMOSPHERIC AIR POLLUTION

1. Atmospheric air is polluted by one substance. In this case levels of the atmospheric air pollution in monitoring areas are compared on the basis of monthly average concentrations with approximation of 98%.

For that, first, monthly average concentration of pollutant is calculated by the following formula:

$$C = \frac{C_1 + C_2 + \dots + C_n}{n} = \frac{\sum C_i}{n},$$

**where: C_1, C_2, C_n – concentrations according to analysis results;
 n - number of analyses per month.**

For calculation one should use maximal one-time or average daily concentrations excluding “extreme” results of analysis from calculation.

Further root-mean-square deviation (b):

$$\delta = \sqrt{\frac{C_v^2 - n\bar{C}^2}{n}}$$

and coefficient of variation (C_v) are calculated:

$$C_v = \frac{\delta}{C} \times 100$$

Knowing coefficient of variation (C_v) coefficient (a) which is required for assessment of monthly average concentration C^M with approximation of 98% is determined from the graph by formula:

$$C^M = a \times C$$

Exactly by monthly average concentration value C^M the levels of atmospheric air pollution in monitoring areas are compared.

2. If there are some substances in the atmospheric air that have no effect of biological summation, atmospheric air cumulative pollution index (K_{sum}) is calculated by the following formula:

$$K_{sum} = \frac{C^M_1}{M_1 \times MAC_1} + \dots + \frac{C^M_n}{M_n \times MAC_n} = \sum \frac{C_i^m}{M_i \times MAC_i},$$

where: C^M_1, C^M_n - concentration of some pollutants, mg/m^3 ;

C^M_i – integrated (generalized) monthly average concentration of all pollutants, mg/m^3 ;

MAC_1, MAC_n - maximum allowable concentration of pollutants, mg/m^3 ;

M - coefficient, which value depends on the pollutant hazard class:

I class (A) – extreme hazard, $M = 1.0$;

II class (B) – high hazard, $M = 1.5$;

III class (C) – medium hazard, $M = 2.0$;

IV class (D) – low hazard, $M = 4.0$.

3. If there are some substances in the atmospheric air that have biological summation effect, given concentration (C^M_{given}) is calculated by the following formula:

$$C^M_{given} = C^m_1 + C^m_2 \frac{MAC_1}{MAC_2} + \dots + C^m_n \frac{MAC_1}{MAC_n},$$

where: C^M_1 – concentration of the substance, which is the subject of summation, mg/m^3 ;

C^M_2, C^M_n – concentration of given pollutants, mg/m^3 ;

MAC_1 - maximum allowable concentration of a substance, which is the subject of summation, mg/m^3 ;

MAC_2, MAC_n - maximum allowable concentration of other pollutants, mg/m^3 ;

4. If there are substances in the atmospheric air that have biological summation effect and those ones that have no, atmospheric air cumulative pollution index (K_{sum}) is calculated by the following formula:

$$K_{sum} = \frac{C^m_{giv}}{MAC_{giv.}} + \sum \frac{C_i^M}{MAC_i},$$

where: C_{giv}^M – given concentration, mg/m^3 ;
 MAC_{giv} – maximum allowable concentration of the substance, which is the subject of summation, mg/m^3 ;

1. Level of atmospheric air pollution (in points) is calculated by the following formula:

$$M_{A(B,C,D)1,2, \dots n} = \sum \left[\frac{C_i}{MAC_i} \times b_i \times y \right],$$

where: A,B,C,D – hazard classes of substances;
 1,2...n – number of substances of the same class of hazard;
 C_i – monthly average concentration of the i -th pollutant;
 MAC_i - maximum allowable concentration of the i -th pollutant;
 b_i – weighting coefficient of this substance depending on the hazard class;
 y – environmental priority index (for the air = 3).

6. Noise level rating is evaluated by the following formula:

$$P = \sum \left[\frac{L_{eq.}}{MAL} \cdot b_i \cdot y \right],$$

where: L_{eq} – actual mid-equivalent noise-level, dBA;
 MAL – maximum allowable noise level, dBA;
 b – weighting coefficient;
 y – priority index (for the noise = 2).

7. Procedure assessment of levels of soil contamination by exogenous chemical agents is based on annual average territory load index. First, index for each ingredient individually is calculated:

$$P = \frac{\sum}{100n} M_i \times Z_i \times K_i,$$

where: M_i – number of technical preparations that were used for soil application in the monitoring area during some years, kg/ha;
 Z_i - percentage of active ingredient in technical preparation;
 n – number of years of application;
 K_i – average mark of the preparation, which considers such its properties as toxicity, stability, volatility and cumulation.

Then all indices that have been calculated for each ingredient are summarized and divided into their number (m): $\bar{P} = \frac{\sum P}{m}$

8. State of environment in the monitoring area, which is expressed in points, is estimated as a sum of points of separate biosphere environments and certain factors:

$$P = P_{atm} + P_{soil} + P_{water} + P_{noise} + P_{food}$$

9. Assessment of living conditions of population is carried out using the following formula:

$$P = \sum \left[K_{1,2,3} \times \frac{F_{1,2,3}}{M_{1,2,3}} \times y \right],$$

where: $K_{1,2,3}$ – group weighting coefficient ($K_1 = 1.0$; $K_2 = 1.0$; $K_3 = 2.0$);

$F_{1,2,3}$ – actual number of points for group of factors;

$M_{1,2,3}$ – maximum number of points for given factor ($M_1 = 10.0$; $M_2 = 12.0$; $M_3 = 10.0$);

y – priority index of factor.

Appendix 9

Study method of impact of the environment on the population health

Information about the indices which characterize the population health level (such as the morbidity, death, disablement or physical growth and development rate) is obtained from the different sources of information enumerated at the first lesson of this section.

We use mathematical and statistical technique for simulation of correlation within the «*environment – population health*» system and for determination of the quantitative value of such correlation; calculation of generalized indices of health, which characterize the population health level by integrating series of indices, is a result of application of this technique.

Requirements with respect to indices:

- 1) accessibility of data for index calculation;
- 2) completeness of population embrace;
- 3) quality (data should not vary depending on time and space);
- 4) calculability – simplicity and low cost of the calculation;
- 5) eligibility of calculation and evaluation procedure;
- 6) reproducibility by different specialists;
- 7) specificity (reflects changes only in those phenomena, which it reproduces);
- 8) sensitiveness to the changes of corresponding phenomena;
- 9) validity (measure of valid expression);
- 10) representativeness;
- 11) hierarchy;

12) correspondence to the objective.

Integral assessment of the population health level	
Conceptual (qualitative) analysis	Mathematical and statistical (quantitative) analysis
Health groups	Generalized indices of health
Mathematical simulation	
Factors of environment (risk factors)	

Appendix 10

**Technique of the integral index of health calculation
(according to L.E. Polyakov and D.M. Malinsky)**

Stage 1: choice of the most informative indices, which characterize health of population within monitoring zone.

Stage 2: calculation of individual indices of health for each monitoring zone (M_i).

Stage 3: calculation of mean values for each monitoring zone (M) and mean square deviation of i-index within the monitoring zone (δ_i).

Stage 4: calculation of the normalized to mean level indices of health for each monitoring zone individually according to the formula (ω_i):

$$\omega_i = \frac{(M_i - M)}{\delta}$$

where ω_i – normalized index of health;

M_i – value of individual index of health;

M – mean value of the health index;

δ – mean square deviation of the index within monitoring zone.

Stage 5: substitution of the normalized indices (ω_i) by probabilistic units (β_i) according to the table:

**Table of substitution of the normalized health indices (ω_i)
by probabilistic units (β_i)**

ω_i	β_i	ω_i	β_i	ω_i	β_i
less -3.00	0.01	-0.51...-1.00	0.41	1.01...1.50	0.68
-2.51...-3.00	0.04	-0.01...-0.50	0.46	1.51...2.00	0.80
-2.01...-2.50	0.09	0	0.50	2.01...2.50	0.91
-1.51...-2.00	0.20	0.01...0.50	0.54	2.51...3.0-	0.96
-1.01...-1.50	0.32	0.51...1.00	0.59	3.01 and more	0.99

***Stage 6:* calculation of mean probabilistic unit (y) of the health indices for each monitoring zone according to the formula:**

$$y = \frac{\sum \beta_i}{n}$$

where $\sum \beta_i$ – probability sum of units with respect to monitoring zone;

n – number of chosen health indices.

Stage 7: calculation of the integral index of health (K): $K = (1-y) \times 100\%$

<i>Health indices</i>	<i>Monitoring zones</i>		<i>M</i>	δ	ω_i	β_i
1						
2						
3						
4						
5						

....						
n						
$\Sigma\beta_i$			-	---	---	---
y			-	---	---	---
K			-	---	---	---

Thus, we obtain numerical index, which may be compared to something. It should also be mentioned that this method of calculation is simple, accessible and informative one. If there is no error at any stage of calculation and the environment is absolutely safe, general index will approximately be equal to 65-70%.

Appendix 11

Classification of population on the health groups according to health criteria

<i>Health group</i>	<i>Health criteria</i>	<i>Quotient of population in the group, %</i>	
		male	female
I	Healthy: a) have not been ill with acute and chronic diseases during the observation period (3 years), and there have been revealed no abnormalities during medical examinations; b) have been ill with acute viral respiratory infection and other acute diseases for 1-3 times, but during medical examinations there have been revealed no abnormalities	27-28	20-21
II	Practically healthy: a) have been ill with acute viral respiratory infection and other acute diseases for more than 3 times, but during medical examinations there have been revealed no abnormalities; b) during medical examinations there have been revealed functional abnormalities, premorbid state or little consequences of the disease	20-21	16-17
III	Chronic patients at the stage of compensation	39-40	47-48
IV	Chronic patients at the stage of subcompensation	11-12	14-15
V	Chronic patients at the stage of decompensation	1	0.8

Appendix 12

Approximate scale of the structure of urban population primary morbidity according to the registered cases, %

<i>Class of disease</i>	<i>Male</i>	<i>Female</i>	<i>Both</i>
VIII – diseases of respiratory system	44-48	45-49	45-49

VI – diseases of nervous system and sense organs	8-9	9-10	10
VII – diseases of blood circulation system	6-7	10	7-8
I – infectious and parasitic diseases	6-7	6-7	6-7
XII, XIII – diseases of skin and locomotor system	6-7	6-7	6-7
XVII – accidents, poisonings, traumas	10	6	6
IX – diseases of digestive system	6	6-7	6

Appendix 13

Percentage of people of the I-II health groups in separate age-sex population groups

<i>Age group (years)</i>	<i>Male</i>	<i>Female</i>
0-4	75.6	79.2
5-9	66.9	71.8
10-14	70.1	67.7
15-19	75.0	70.8
20-24	60.3	49.0
25-29	53.3	35.5
30-39	39.9	24.8
40-49	21.1	11.0
50-59	11.6	7.3
60-69	4.3	3.0
70 and older	2.6	2.0
In average	41.9	30.6

6. Literature

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6.1.8. Lecture «Methodic fundamentals of the study of environmental attack on population health».

6.2. Additional:

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6.2.3. Славин М.Б. Методы системного анализа в медицинских исследованиях. – М.: Медицина, 1989. – 303 с.

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4. General nutrition: Study guide for the 4th accreditation level Medical School Students / edited by S.T. Omelchuk, O.V. Kuzminska. – Kyiv, 2016. – 146 p.

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7. Equipment required for the lesson

1. Table: Information sources about the state of population health.
2. Table: Classification of population health groups.
3. Table: Quantitative analysis of the environment condition according to MAC excess rate and in points.
4. Table: Detection and assessment of correlation of environmental factors and population health.
5. Formulas for calculation of atmospheric air pollution.
6. Town (region) map for selection of monitoring areas.
7. Table: Substitution of the normalized indices of health (ω_1) by probabilistic units (β_1).
8. Table: Classification of the population health groups according to health criteria.
9. Table: Structure of the population primary morbidity according to the registered cases.
10. Table: Age-sex health groups of population.