MINISTRY OF HEALTH OF UKRAINE
NATIONAL UNIVERSITY OF PHARMACY
Faculty of Pharmaceutical Technologies and Management
Department of Educational and Information Technologies

STATISTICAL METHODS IN PHARMACY

(Course Name)

WORK PROGRAM
of the course

training for Master of Pharmacy
(Higher Educational Level Name)

field of knowledge 22 Public Health
(Code and Knowledge Field Name)

in specialty 226 Pharmacy, Industrial Pharmacy
(Code and Specialty Name)

of educational program Pharmacy for foreign students
(Educational Program Name)

specialization _____
(Specialization Name)

2021
year of creation

Work program of a course "**Statistical Methods in Pharmacy**" in specialty **226 Pharmacy, Industrial Pharmacy** of educational program **Pharmacy for foreign students** for applicants of higher education of 2nd year of study.

Educational course team:

Prof. Stanislav POGORELOV Doctor of Physical and Mathematical Sciences, Prof. of the Educational and Information Technologies Department,

Dr. Ihor KRASOVSKYI Candidate of Physical and Mathematical Sciences, Assoc. Prof. of the Educational and Information Technologies Department

(indicate the authors' full names, their positions, scientific and academic degrees)

Work program of the course have been considered and approved at the Educational and Information Technologies Department Meeting

Record from «01» September 2021 № 1

Head of the Department _____ Prof. Lidiia KAIDALOVA

(signature) (Name and SURNAME)

Work program of the course have been approved at the Meeting of Methodical Profile Commission on Distance and Postgraduate Pharmaceutical Education

Record from «20» September 2021 № 1

Head of Specialized Committee _____ Prof. Larisa GALIY

(signature) (Name and SURNAME)

1. The Description of the Course

Language of study: English
Couse Status: Elective

Entrance qualification for studying the course: basic knowledge in Mathematics, Physics, Informatics, Chemistry, Biology.

The purpose statement of studying the course "Statistical Methods in Pharmacy" is the processing and analysis of pharmaceutical research data by statistical methods.

The study of this discipline forms in students the basic ideas about the general possibilities of collecting and statistical evaluation of medical and pharmaceutical information, methods and methods of their analysis, as well as the possibility of forecasting on the basis of regression analysis.

The course "Statistical methods in pharmacy" creates a foundation for further study of many natural sciences, using statistical methods of analysis (chemical experiments, biological processes, basics of pharmaceutical management and marketing, analysis and diagnosis of pharmaceutical companies).

Information volume of academic course. To study the course is given 90 hours, 3 ECTS credits.

2. Objectives and Tasks of the Course

The objective of teaching the course "Statistical Methods in Pharmacy" is the acquisition by students of the general basics of statistical science, methodology and practical skills of pharmaceutical and statistical analysis, modern methods of calculation and analysis of socio-pharmaceutical indicators that characterize pharmaceutical processes and phenomena at micro and macro level, skills on the use of statistical research methods.

In the process of studying the discipline "Statistical methods in pharmacy" students master the theory and practice of analysis of pharmaceutical and medical and biological information. In addition, master the basic theoretical knowledge of the basics of probability theory and mathematical statistics, necessary for the study of general and professional disciplines and their further application, master the methods of processing and analyzing the results of chemical experiments and biomedical research.

The **main tasks** of the course **"Statistical Methods in Pharmacy"** are:

- mastering by students of the basic principles and theoretical positions on the theory of probabilities and mathematical statistics;
- development, collection, systematization of pharmaceutical research data;
- processing of pharmaceutical research data by statistical methods;
- obtaining a statistical conclusion about the object of study;
- formulation of statistical hypotheses, analysis and obtaining a statistical conclusion based on the results of their verification;
- formation of students' abstract way of thinking, the ability to systematically analyze the studied phenomena.

Achieving these goals will allow students of pharmacy to acquire the necessary knowledge and skills necessary for the direct formation of a pharmacist-professional in their field, as well as for the study of other educational theoretical and applied disciplines.

3. Competence and Planned Educational Outcomes

The course "**Statistical Methods in Pharmacy**" provides acquisition of competencies by applicants for higher education:

- **integrated:**

ability to solve typical and complex specialized and practical problems in professional pharmaceutical activity in the field of health care on a socially-oriented basis or in the learning process, which involves chemical, biopharmaceutical, biomedical sociological and other research and/or implementation of innovations and is characterized by uncertainty of conditions and requirements; integrate knowledge, critically comprehend and solve complex issues, make decisions in complex unpredictable conditions, formulate judgments in the presence of incomplete or limited information, taking into account aspects of

social and ethical responsibility; clearly and unambiguously communicate their conclusions and knowledge, reasonably substantiating them, to professional and non-professional audience;

- **general:**

- **GC. 2.** Ability to apply knowledge in practical situations, make informed decisions;
- **GC. 4.** Ability to think abstractly, analyze and synthesize, learn and be modernly trained;
- **GC. 9.** Skills in the use of information and communication technologies;
- **GC. 11.** Ability to evaluate and ensure the quality of work performed;

- **specialized (professional):**

- **PC. 5.** Ability to monitor the effectiveness and safety of the use of drugs by the population according to the data on their clinical and pharmaceutical characteristics, as well as taking into account subjective signs and objective clinical, laboratory and instrumental criteria for examination of the patient;
- **PC. 8.** Ability to organize pharmacy activities to provide the population, health care facilities with medicines and other products of the pharmacy range and implement appropriate reporting and accounting systems (management, statistical, accounting and financial) in accordance with the requirements of National Medical Policy, Good Pharmacy Practice (GPP)) and carry out commodity analysis, administrative record keeping taking into account the organizational and legal norms of pharmaceutical legislation;
- **PC. 9.** Ability to analyze and forecast the main economic indicators of pharmacies, to calculate basic taxes and fees, to form prices for medicines and medical devices in accordance with current legislation of Ukraine;
- **PC. 11.** Ability to analyze socio-economic processes in pharmacy, forms, methods and functions of the pharmaceutical supply system and its components in world practice, indicators of need, efficiency and availability of pharmaceutical care in terms of health insurance and reimbursement of the cost of drugs;
- **PC. 17.** Ability to organize and carry out general and marketing management of assortment, product innovation, pricing, sales and communication policies of pharmaceutical market participants based on the results of marketing research and taking into account market processes in national and international markets, manage risks in the pharmaceutical system
- **PC. 20.** Ability to develop methods for quality control of medicines, including active pharmaceutical ingredients, medicinal plant raw materials and excipients using physical, chemical, physicochemical, biological, microbiological, pharmacotechnological and pharmacoorganoleptic control methods.

Integrative final **program learning outcomes (PLO)**, the formation of which is facilitated by the discipline

- **PLO. 2.** Apply knowledge of general and professional disciplines in professional activities;
- **PLO. 4.** Demonstrate the ability to independently search, analyze and synthesize information from various sources and use these results to solve typical and complex specialized tasks of professional activity.
- **PLO. 9.** Carry out professional activities using information technology, "Information Databases", navigation systems, Internet resources, software and other information and communication technologies.
- **PLO. 11.** Use methods of assessing performance indicators; identify reserves to increase labor efficiency.
- **PLO. 12.** Analyze information obtained as a result of scientific research, summarize, systematize and use it in professional activities.
- **PLO. 17.** Use clinical, laboratory and instrumental research data to monitor the efficacy and safety of medicines.
- **PLO. 20.** Implement a set of organizational and managerial measures to provide the population and health care facilities with medicines and other pharmaceutical products. Carry out all types of accounting in pharmacies, administrative records, and processes of commodity analysis.
- **PLO. 21.** Calculate the main economic indicators of pharmacies, as well as taxes and fees. Form all types of prices (wholesale, purchase and retail) for medicines and other pharmaceutical products.

- **PLO. 23.** Take into account data on socio-economic processes in society for the pharmaceutical supply of the population, determine the effectiveness and availability of pharmaceutical care in terms of health insurance and reimbursement of the cost of medicines.
- **PLO. 32.** To determine the main organoleptic, physical, chemical, physicochemical and pharmacotechnological indicators of medicines, to substantiate and choose methods of their standardization, to carry out statistical processing of results in accordance with the requirements of the current State Pharmacopoeia of Ukraine.

As a result of studying the course, the applicant for higher education will be able to

know:

- subject, methods and tasks of statistics;
- general foundations of statistical science;
- principles of organization of state statistics;
- current trends in the development of statistical accounting;
- basic methods of collecting, processing, analyzing and visualizing information;
- probability theory as a basis of genetics, metrology, mathematical statistics;
- basic laws of distribution of discrete random variables and their characteristics;
- basic laws of distribution of continuous random variables and their characteristics;
- boundary laws of probability theory and their applied significance;
- methodology for assessing the law and characteristics of the distribution of the studied feature according to the sample;
- methodology for statistical testing of hypotheses;
- analysis of variance of the influence of factors on the studied trait;
- correlation and regression analysis.

be able to apply:

- methods of collecting and summarizing primary statistics;
- statistical methods of analysis of indicators;
- methods of analysis of the influence of factors on the results;
- methods of interpretation and use of statistical research results;
- methodology of statistical research of economic processes in the circulation of medicines and physicochemical processes in medicinal substances;
- modern methods of collection, processing and analysis of statistical indicators;
- modern methods of constructing calculation models of objects of pharmaceutical analysis, phenomena and processes in pharmacy;
- methods and techniques of statistical analysis of phenomena in pharmacy and medicine;
- modern methods of calculation and analysis of economic and physicochemical processes in pharmacy and medicine.

4. Course Structure

Names of content modules and topics	The amount of hours											
	full time study						part time study					
	the whole amount	including					the whole amount	including				
		lec.	sem.	p.l.	lab	self-study		lec.	sem.	p.l.	lab	self-study
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
Content module 1. Theory of statistical research in pharmacy												
Topic 1. Methods of pre-processing and exploratory analysis of quantitative and qualitative data. Descriptive statistics. Histogram, box plot, visualization.	11	1		4		6						
Topic 2. Discrete and continuous random variables probability distributions. Testing for outliers.	9	1		4		4						

Topic 3. Statistical inference method. Statistical criteria, their significance and power. Confidence probability and p-level.	9	1		2		6						
Topic 4. Goodness of fit. Normality tests.	9	1		2		6						
Topic 5. Parametric and Non-parametric tests for comparing two or more independent groups.	9	1		4		4						
Topic 6. Parametric and Non-parametric tests for comparing two or more dependent groups.	9	1		4		4						
Topic 7. Analysis of variance (ANOVA). Kruskal–Wallis one-way analysis of variance.	9	1		4		4						
Topic 8. Correlation and regression analysis.	7	1		2		4						
Topic 9. Correlation analysis of qualitative data. Contingency table. Chi-square test, Fisher's exact test. Content module control 1.	6	1		2		3						
The whole amount of hours for the content module 1	**78**	**9**		**28**		**41**						
The final test	12			2		10						
The whole amount of hours of the course	***90***	***9***		***30***		***51***						

5. Content of the Course

Content module 1. Theory of statistical research in pharmacy

Topic 1. Methods of pre-processing and exploratory analysis of quantitative and qualitative data. Descriptive statistics. Histogram, box plot, visualization.

Population and sample. Discrete variation series. Graphical representation of a discrete variation series. Empirical distribution function for a discrete trait.

Interval variation series. Histograms. Empirical distribution function. Box-plot. Using variation series to describe biosystems.

Estimation of parameters of distribution of the investigated trait. Point and interval estimates. Estimation of mean, variance and standard deviation. Mode. Median. Quartile. Quantile. QQ-plot.

Topic 2. Discrete and continuous random variables probability distributions. Testing for outliers.

The concept of discrete random variable. Law and distribution function of a discrete random variable and their properties. Basic numerical characteristics of discrete random variables and their properties. Laws of distribution of discrete random variables. Bernoulli test scheme. Binomial distribution law and its characteristics. Bernoulli's formula. Poisson distribution as an approximation of the binomial distribution law for rare events.

The concept of a continuous random variable. Probability density functions (PDF) of a continuous random variable and their properties. Numerical characteristics of continuous random variables. Laws of distribution of continuous random variables. Uniform distribution and its characteristics. Exponential distribution. Normal distribution. Study of the Gaussian curve. Characteristics of normal distribution. Standard normal distribution.

Determining the correspondence of the distribution of the studied experimental data to a certain distribution law. Detection of outliers. Dixon Q test for outliers. Walsh's outlier test. Significance of outliers.

Topic 3. Statistical inference method. Statistical criteria, their significance and power. Confidence probability and p-level.

Statistical criteria ($\chi 2$-distribution, Student's and Fisher's distributions). Bilateral and unilateral critical regions. The significance level. Confidence probability and confidence level. Statistical criteria, their significance and power.

Interval estimates. Probable interval for the mathematical expectation (expected value) of a normally distributed trait. Probable interval for variance and standard deviation of the normally distributed trait. The standard error (SE) of a statistic.

Topic 4. Goodness of fit. Normality tests.

Goodness of fit. Testing the hypothesis about the distribution law. Normality tests. Pearson's chi-square test. Kolmogorov–Smirnov test. Shapiro–Wilk test

Topic 5. Parametric and Non-parametric tests for comparing two or more independent groups.

General principles of statistical testing of hypotheses. Checking the sample for homogeneity and detecting errors. Checking the method of analysis for systematic error. Scheme for testing a statistical hypothesis.

Parametric methods: Z-test, Student's t-test, Fisher's F-test. Nonparametric methods: Kolmogorov–Smirnov λ-test, Mann-Whitney U-test, Van der Waerden X-test.

Topic 6. Parametric and Non-parametric tests for comparing two or more dependent groups.

Z-test for dependent groups. Testing the hypothesis of equality of the mean values of two normal general populations in the case of known standard deviations. Testing the hypothesis of equality of the mean values of two normal general populations in the case of an unknown standard deviation. Testing the hypothesis of equality of standard deviations of two normal general populations in the case of unknown distribution parameters. Comparison of central trends of dependent samples with arbitrary distribution by nonparametric criteria. The McNemar test (Sign test). The Wilcoxon signed-ranks test.

Topic 7. Analysis of variance (ANOVA). Kruskal–Wallis one-way analysis of variance.

One-way analysis of variance. Basic concepts of analysis of variance. One-way analysis of variance for a parametric model. One-way analysis of variance for a non-parametric model. Kruskal–Wallis one-way analysis of variance. The concept of analysis of variance of multifactorial experimental plans. Application of analysis of variance in the search for dependencies in the data of medical and pharmaceutical experiments.

Topic 8. Correlation and regression analysis.

Correlation analysis. Statistical relationship between continuous traits. Correlation dependence. Regression equation. Empirical regression line. Correlation coefficient. Estimation of correlation coefficient and analysis of its significance.

Scattering diagram. Regression analysis. Modeling of regression equation. Linear regression model. Analysis of the significance of linear correlation based on analysis of variance. Coefficient of determination as a universal measure of the dependence of one random variable on many others. Forecast of statistical data of pharmaceutical experiments by means of MS Excel spreadsheet.

Topic 9. Correlation analysis of qualitative data. Contingency table. Chi-square test, Fisher's exact test.

Methods of processing and analysis of qualitative data. Methods for detecting the correlation between qualitative characteristics. Application of contingency tables. Correlation between rank and quality data. Rank correlation coefficients. Biserial correlation coefficient for qualitative data.

Content module control 1.

The final test

6. Names of Lectures

№	Name of topic	The amount of hours	
		Full time study	Part time study
1	Methods of pre-processing and exploratory analysis of quantitative and qualitative data. Descriptive statistics. Histogram, box plot, visualization.	1	
2	Discrete and continuous random variables probability distributions. Testing for outliers.	1	
3	Statistical inference method. Statistical criteria, their significance and power. Confidence probability and p-level.	1	
4	Goodness of fit. Normality tests.	1	

5	Parametric and Non-parametric tests for comparing two or more independent groups.	1	
6	Parametric and Non-parametric tests for comparing two or more dependent groups.	1	
7	Analysis of variance (ANOVA). Kruskal–Wallis one-way analysis of variance.	1	
8	Correlation and regression analysis.	1	
9	Correlation analysis of qualitative data. Contingency table. Chi-square test, Fisher's exact test.	1	
The whole amount of hours		**9**	

7. Topics of Seminars

(Seminars workshop is not provided by the working curriculum)

8. Topics of Practical Lessons

№	Name of topic	The amount of hours	
		Full time study	**Part time study**
1	Methods of pre-processing and exploratory analysis of quantitative and qualitative data. Descriptive statistics. Histogram, box plot, visualization.	4	
2	Discrete and continuous random variables probability distributions. Testing for outliers.	4	
3	Statistical inference method. Statistical criteria, their significance and power. Confidence probability and p-level.	2	
4	Goodness of fit. Normality tests.	2	
5	Parametric and Non-parametric tests for comparing two or more independent groups.	4	
6	Parametric and Non-parametric tests for comparing two or more dependent groups.	4	
7	Analysis of variance (ANOVA). Kruskal–Wallis one-way analysis of variance.	4	
8	Correlation and regression analysis.	2	
9	Correlation analysis of qualitative data. Contingency table. Chi-square test, Fisher's exact test. Content module control 1	2	
10	Final test	2	
The whole amount of hours		**30**	

9. Topics of Laboratorial Lessons

(Laboratory workshop is not provided by the working curriculum)

10. Self-Study Work

№	Name of topic	The amount of hours	
		Full time study	**Part time study**
1	Methods of pre-processing and exploratory analysis of quantitative and qualitative data. Descriptive statistics. Histogram, box plot, visualization.	6	
2	Discrete and continuous random variables probability distributions. Testing for outliers.	4	
3	Statistical inference method. Statistical criteria, their significance and power. Confidence probability and p-level.	6	
4	Goodness of fit. Normality tests.	6	

5	Parametric and Non-parametric tests for comparing two or more independent groups.	4	
6	Parametric and Non-parametric tests for comparing two or more dependent groups.	4	
7	Analysis of variance (ANOVA). Kruskal–Wallis one-way analysis of variance.	4	
8	Correlation and regression analysis.	4	
9	Correlation analysis of qualitative data. Contingency table. Chi-square test, Fisher's exact test.	3	
10	Final test	10	
	The whole amount of hours	**51**	

Tasks for Self-Study Work

Students' independent self-study work includes preparation for in-class lessons, doing practical assignments for independent work, as well as in-depth study of course topics in the following areas:

In the content module 1.

1. Tasks for constructing the law of distribution of discrete random variables and finding their numerical characteristics.
2. Problems for determining the probability function, the probability density function of a continuous random variable and finding its numerical characteristics.
3. Problems for finding mathematical expectation and variance according to the basic laws of distribution of discrete and continuous random variables.
4. Solving problems to find the sample mean and variance.
5. Tasks for determining confidence intervals for mathematical expectation and variance.
6. Tasks for testing statistical hypotheses (parametric and non-parametric tests).
7. Tasks to test hypotheses about the influence of external factors on a random variable (analysis of variance).
8. Problems for calculating the correlation between random variables X and Y.
9. Problems for determining the regression equation Y on X.
10. Tasks for estimating the parameters of the regression model by the method of least squares.

11. Individual Tasks

(Individual tasks is not provided by the working curriculum)

12. Criteria and Evaluation Order of Educational Outcomes

Scheme of calculating and distribution of points:

Ongoing control (max pt)										Final test	Total
Content module 1										40	100
T1	T2	T3	T4	T5	T6	T7	T8	T9	CMC1		
7	7	3.5	3.5	7	7	7	3.5	3.5	11		

Evaluation order of educational outcomes of the course "Statistical Methods in Pharmacy" is graded on a 100-point scale, which is translated to the national grading scale ("excellent", "good", "satisfactory", "unsatisfactory") and the grading scale of the European Credit Transfer System (ECTS - A, B, C, D, E, FX, F), respectively. The final rating in the discipline is summed from rating of ongoing control and the final testing one.

The ***ongoing control*** is carried out at each practical lesson and it shows the result of work on individual assignments. It provides the evaluation of the theoretical knowledge and practical skills in the specified topics of higher education applicants (including self-studied material) on practical

lessons. In addition, the ongoing control involves score of the content modules tests. The control of the content module is estimated at a maximum of 11 points and a minimum of 6 points.

The forms of the ongoing control are:

1. Oral survey (frontal, individual, combined).
2. Verification of existing professional skills.
3. Test control (open and closed tests).

Practical lessons evaluation criteria *(for 2-hours lesson):*

3.5 points – the student gives correct, clear, logical and full answer all standardized questions of current topic, including theoretical and self-study questions. The student can link theory and practice closely, solves the problems with professional content of high difficulty level properly.

3.0 points – the student properly and essentially answers the standardized theoretical and self-study questions of current topics, uses the theoretical knowledge correctly in solution of practical problems. The student is able to solve the problems with professional content of low and medium difficulty level.

2.0 point – the student can answer the standardized questions of current topic incompletely and only with help of additional questions, is unable to build a clear and logical answer. The student makes mistakes in answers and demonstration of practical skills, is able to solve only the easiest problems.

1.0 points – the student knows the educational material of the current topic partially, cannot build a logical answer or answer the additional questions. The student makes mistakes in answers and demonstration of practical skills.

0 points – the student does not know the educational material of the current topic, cannot build a logical answer or answer the additional questions, does not understand the content of the educational material. The student makes serious and significant mistakes in answers and demonstration of practical skills.

The maximum number of points that can get a student for ongoing academic activity to take the admission to pass the final module control is 60 points.

The minimum number of points that student must collect for ongoing academic activity to take the admission to pass the final module control is 36 points.

The final test evaluation criteria

The final test is carried out to determine the state of success of applicants for higher education after the period of theoretical training. The final testing of students' knowledge has a form of classroom written test. Each ticket contains 8 test questions of a theoretical part and 4 tasks of a practical part. Accordingly, each correct answer to each of the tests of the theoretical part was evaluated in 3 points. Each correct answer to each task of the practical part was evaluated in 4 points.

The final testing is rated at maximum 40 points for a successful theoretical training and for mastering practical skills, and is considered as passed if the student is scored at least 24 points.

Total score accumulated applicant for higher education for all ongoing types of academic work on practical (seminar) classes and the final testing, indicates his degree of mastery of the discipline curriculum at a particular stage of its learning. During the semester, students can gain from 0 to 100 points, that are translated into national grading scale and ECTS grading scale, respectively. The score corresponds to a level of mastering the discipline:

The final rating	**The scale of ECTS**	**The national scale**	**Definition**
90-100	A	5 (excellent)	The student is completely and thoroughly mastered all the topics of the curriculum and is able to express the content of all topics of discipline freely; completely understands its importance for his professional training; is fulfilled all tasks of each topic and final testing as a whole. He took part in contests and conferences.
82-89	B	4 (very good)	The student has learned certain work program issues incompletely. He is able to present the content of the general topics of the discipline curriculum, has completed the task of

			each topic and final testing as a whole.
74-81	C	4 (good)	The student has learned certain work program topics in-completely. He is unable to present the content of the certain topics of the discipline curriculum He did not complete the specific objectives of each topic and final testing as a whole.
64-73	D	3 (satisfactory)	The student is mastered only the specific topics of the curriculum He does not know how to express the content of the basic topics of the discipline. The specific tasks on each topic in final testing are not done.
60-63	E	3 (sufficient)	The student has learned only a few questions curriculum. Cannot express the content of the main part of discipline curriculum questions. Has completed only the few tasks each topic and final testing as a whole.
35-59	FX	2 (fail)	The student is not mastered the curriculum, cannot express the content of most of the major issues of discipline, does not fulfilled the most of each topic and the final testing as a whole.
1-34	F	2 (fail)	The student is not mastered the curriculum, cannot present the content of every topic of discipline, does not pass the final testing.

13. Forms of Progress and Final Test of Academic Achievements

The ongoing control of academic achievements is carried out at each practical lesson by observational method and oral examination (frontal, individual, combined); the control of self-study work is based on the assessment the success of completed assignments for independent work.
The final test control consists of theoretical test (test multichoice questions) and practical tasks that cover all the topics of the course.
Form of the final control – Credit.

14. Teaching Course Materials

While studying “Information technology in pharmacy” the applicants of higher education will have access to the following teaching materials:

1. Presentations of lectures, video recordings of lectures;
2. Manuals for practical lessons;
3. Tasks and manuals for solving practical tasks for self-study work;
4. Tests;
5. Guidelines for self-study and training for final test.

15. Reading Suggestions

The Main Reading Suggestions

1. Primer of Biostatistics, 7 Ed. Stanton A. Glantz. McGraw Hill, 2012.
2. Fundamentals of Clinical Trials, 4th edition Friedman, LM, Furberg CD, DeMets DL, Springer, 2010.
3. Mathematics and Statistics: the textbook for applicants for higher education S.V. Pohorielov, I.V. Krasovskyi, F.H. Diahileva ; NUPh. - Kharkiv : NUPh : Golden Pages, 2019.

Supplementary Reading Suggestions

1. Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python, 2 Ed. Peter Bruce, Andrew Bruce, and Peter Gedeck, O'Reilly Media, 2020.
2. Cohen J: Statistical Power Analysis for the Behavioral Sciences, 2nd ed. Hillsdale, NJ: Lawrence Erlbaum, 1988.

3. CohenJ(ed), Cohen P, West SG, Aiken LS: Applied Multiple Regression: Correlation Analysis for the Behavioral Science, 3rd ed., Lawrence Erlbaum, 2002.
4. Gibaldi, M. Biopharmaceutics and Clinical Pharmacokinetics, 3rd Ed., Philadelphia: Lea & Febiger. 1984.
5. Montgomery, D.C. Design and Analysis of Experiments, 3rd Ed., New York: Wiley. 1991.

16. Electronic Resources

1. Center for distance learning technologies of NUPh. Access mode: http://pharmel.kharkiv.edu/moodle/login/index.php (date of the application: 28.08.2021).
2. Department of Educational and Information Technologies. Access mode: https://physics.nuph.edu.ua/en/.
3. Scientific Library National University of Pharmacy: e-mail: library@nuph.edu.ua.