



THE GEORGE
WASHINGTON
UNIVERSITY
WASHINGTON DC

**Columbian College of Arts and Sciences
and
School of Public Health and Health Services**

**Master of Science (MS) in Biostatistics
2011-2012**

Note: All curriculum revisions will be updated immediately on the website <http://www.gwumc.edu/sphhs>

Program Director and Academic Advisor:

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The Master of Science (MS) degree program in Biostatistics is a 33 credit degree program jointly administered by the Department of Statistics in the Columbian College of Arts and Sciences (CCAS) and the Department of Epidemiology and Biostatistics in the School of Public Health and Health Services (SPHHS), and its associated research facility, The Biostatistics Center. This degree program is accredited by the Middle States Council on Higher Education through the CCAS and by the Council on Education for Public Health through the SPHHS. Regulations and requirements for this graduate degree have been designed to be compatible with policies and scholarship requirements of both the CCAS and SPHHS. The degree is conferred by the CCAS.

At the completion of the MS program in Biostatistics students will be able to:

- Understand and the theory and principles behind statistical methods most commonly used in biomedical research (contingency tables, survival analysis, mixed models, and missing data).
- Understand and apply the underlying principles and methods to design, plan, and conduct biomedical studies.
- Provide biostatistical advice as a member of a team engaged in a biomedical research project. Includes manipulation and analysis of data.

Admissions Requirements

Applicants must hold an undergraduate degree from an accredited institution of higher learning. Applicants should have academic backgrounds of excellence, usually with majors, or equivalent, in the fields in which they intend to study for advanced degrees. Normally, a B average (or equivalent) from an accredited college is required. With evidence of special promise, such as high Graduate Record Examination scores, an applicant whose academic record falls short of a B average may be accepted on a conditional basis. Meeting the minimum requirements does not assure acceptance. The departments may, and often do, set higher admission standards. Moreover, the number of spaces available for new graduate students limits the number who can be accepted. Students who apply in their senior year must provide evidence of the completion of their baccalaureate work before registration in Columbian College is permitted. Applicants should be aware that graduate courses taken prior to admission while in non-degree status are not used in assessing admissibility to degree programs and may not be transferable into those programs.

If desired, a student may complete the M.S. program prior to admission to the Ph.D. degree program, in which case no more than 24 credit hours from the M.S. degree may be applied to the Ph.D. course work requirements. In this instance the student will be required to take a minimum of 27 additional credit hours of coursework. The distribution of these courses between statistics and public health would depend on the nature of the Master's degree and whether the transferred credit hours would be used to defray statistics or public health course work. Full information is available in the online Graduate Admissions Application at www.gwu.edu/~gradinfo. A detailed description of admissions policies is also available online at <http://columbian.gwu.edu/grad/>.

Minimum Prerequisite Courses for Admission Consideration (or equivalents to these GW courses)

The courses listed below (or equivalents) are prerequisites for admission consideration, and **MUST** appear on your transcript. Submit your MS Biostatistics program admission application only after you have completed all of the following courses:

MATH (031)	1231	Single-Variable Calculus I	3	Limits and continuity. Differentiation and integration of algebraic and trigonometric functions with applications.
MATH (032)	1232	Single-Variable Calculus II	3	The calculus of exponential and logarithmic functions. L'Hopital's rule. Techniques of integration. Infinite series and Taylor series. Polar coordinates. Prerequisite: Math 1231
STAT (118)	2118	Regression Analysis	3	Lecture 3 credits, laboratory 1 hour. Simple and multiple linear regression, partial correlation, residual analysis, stepwise model building, multicollinearity, and diagnostic methods, indicator variables. Prerequisite: Introductory Statistics

Additional Course Requirements

The courses listed below are "Additional Course Requirements." Applicants lacking these courses (or equivalents to these GW courses) will be considered for admission, but, if admissible, will be admitted conditionally with the expectation that these courses will be satisfactorily completed within two semesters following matriculation in the program. These credits do not count as credit toward the 33 credit graduation requirement, nor are grades earned in these additional courses reflected in the overall grade point average.

MATH (033)	1233	Single-Variable Calculus III	3	Partial derivatives and multiple integrals. Vector-valued functions. Topics in vector calculus, including line and surface integrals and the theorems of Gauss, Green, and Stokes. Prerequisite: MATH 1232
MATH (084)	2184	Linear Algebra I	3	Linear equations, matrices, inverses, and determinants. Vector spaces, rank, eigenvalues, and diagonalization. Applications to geometry and ordinary differential equations. Prerequisite: MATH 1231
STAT (129) or STAT (183) or PubH (249)	1129 2183 6249	Introduction to Computing Intermediate Statistical Laboratory: Statistical Computing Packages Use of Statistical Packages: Data Management and Data Analysis	3 or 3 or 3 cr	Introduction to personal and mainframe computers and their operating system, spreadsheets with simple statistical applications, and programming with applications to technology. Fall and Spring Application of program packages (e.g., SAS, SPSS) to the solution of one-, two- and k-sample parametric and nonparametric statistical problems. Basic concepts in data preparation, modification, analysis and interpretation of results. Prerequisite: an introductory statistics course. Fall and Spring This course familiarizes the student with one of the most widely used database management systems and statistical analysis software packages, the SAS System, operating in a Windows environment. Throughout the course, several database management system techniques and data analytical strategies for the appropriate analysis of datasets obtained from a variety of studies will be presented. Statistical techniques covered include linear regression, analysis of variance, logistic regression, and survival analysis. Fall and Spring.

MS Biostatistics Degree Requirements

Course Distribution Summary	Credits
Core Courses <ul style="list-style-type: none"> • Statistics (18 Credits) • Public Health (7 Credits) Note: Each student must enroll in a public health topics course (PubH 6299) that covers a public health topic in environmental and occupational health, health administration, health policy or social behavioral sciences.	25
Approved Elective Courses (See Advisor)	6
Consulting	2
Total Credits	33
The Master's Comprehensive Examination The Master's Comprehensive Examination is a <u>written comprehensive examination</u> in the field of Biostatistics and is based on the course content PubH 8366- Biostatistical Methods. It is administered by the faculty of the School of Public Health and Health Services.	
Professional Enhancement Requirement (8 hours) Professional enhancement activities supplement the academic curriculum and help prepare students to participate actively in the professional community. They enhance practical knowledge and awareness of public health issues – either in general or in a student's specific area of study. Students can fulfill this requirement by attending workshops, seminars, or other relevant professional meetings, which are often held at SPHHS and in the metropolitan Washington, DC area. Examples of conference sponsors include the National Academy for State Health Policy, the Pan American Health Organization, the American Public Health Association, the American College of Healthcare Executives, the Area Health Education Center, the American College of Sports Medicine, and the National Athletic Trainer's Association. Opportunities for professional enhancement are regularly publicized via the SPHHS Listserv and through your department or advisor. MS students may fulfill the one day by participating in a poster presentation at GWUMC Research Day. <i>Students must submit documentation of Professional Enhancement activities to the Program Director, which includes a <u>prior approval</u>, a description of the program agenda, and proof of attendance before applying for graduation.</i>	



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Program-at-a-Glance
2011 – 2012

Required Core Courses (25 Total Credits)

		Credits	Semester Offered	Grade
Required Statistics Core Courses (18 Credits)				
STAT 6201	Mathematical Statistics I	3	Fall	
STAT 6202	Mathematical Statistics II	3	Spring	
STAT 6210	Data Analysis	3	Spring	
STAT 6227	Survival Analysis	3	Fall	
PubH 8365	Design of Medical Studies	3	Spring	
PubH 8366	Biostatistical Methods <i>Basis for Master's Comprehensive Examination</i>	3	Fall	
Required Public Health Core Courses (7 Credits)				
PubH 6001	Biological Concepts for Public Health	2	Summer, Fall, Spring	
PubH 6003	Principles and Practice of Epidemiology	3	Fall, Spring, Sum 10 wk	
PubH 6299	Electives - Take 2 credits of elective/topics courses	2	Summer, Fall, Spring	
Approved Elective Courses (6 Total Credits)				
Approved Statistics Elective Courses		Credits	Semester Offered	Grade
STAT 3187	Introduction to Sampling	3	Fall	
STAT 4181	Applied Time Series Analysis	3	Spring	
STAT 4188	Nonparametric Statistical Inference	3	Fall, even years	
STAT 6215	Applied Multivariate Analysis I	3	Alternate years	
STAT 6216	Applied Multivariate Analysis II	3	Alternate years	
STAT 6217	Design of Experiments	3	Fall, alternate years	
STAT 6223	Bayesian Statistics: Theory and Applications	3	Spring, alternate years	
STAT 6231	Categorical Data Analysis	3	Fall, alternate years	
STAT 6242	Regression Graphics/Nonparametric Regression	3	Spring, alternate years	
STAT 6287	Modern Theory of Sample Surveys I	3	Fall , alternate years	
STAT 8226	Advanced Biostatistical Methods	3	Spring	
STAT 8265	Multivariate Analysis	3	Fall, alternate years	
STAT 8273	Stochastic Processes I	3	Alternate years	
STAT 8281	Advanced Time Series Analysis	3	Spring	
STAT 8288	Modern Theory of Sample Surveys II	3	Spring , alternate years	
Approved Public Health Elective Courses				
PubH 6004	Environmental and Occupational Health in a Sustainable World	2	Summer 1, Fall, Spring	
PubH 6007	Social and Behavioral Approaches to Public Health	2	Summer 1, Fall, Spring	
PubH 6121	Environmental and Occupational Epidemiology	3	Spring	
PubH 6242	Clinical Epidemiology and Decision Analysis	2	Spring	
PubH 6244	Cancer Epidemiology	2	Spring	
PubH 6245	Infectious Disease Epidemiology	2	Spring	
PubH 6246	Injury Epidemiology and Prevention	2	Spring	
PubH 6248	Epidemiologic Methods in Older Populations	2	Fall	
PubH 6250	Epidemiology of HIV/AIDS	2	Fall	
Consulting (2 Credits)				
PubH 6299.58	Consulting Practicum and Advanced Topics in Biostatistical Consulting	1	Summer, Fall, Spring	
		1	Spring	



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Statistics Course Descriptions

STAT (187)	3187	Introduction to Sampling	3	Problems of sampling and sample design. Simple random, stratified, systematic, cluster, and multi-stage designs. Control of sampling and non-sampling errors. Prerequisite: STAT 1091 or equivalent. Fall
STAT (181)	4181	Applied Time Series Analysis	3	Autoregressive integrated moving average (ARIMA) modeling and forecasting of univariate time series. Estimation of spectral density functions, white noise tests, and tests for periodicities. Theory and applications using SAS. Prerequisite: MATH 1233, STAT 4157-4158 or STAT 2118. Spring
STAT (188)	4188	Nonparametric Statistical Inference	3	Statistical inference when the form of the underlying distribution is not fully specified. Nonparametric procedures for estimation and testing hypotheses. An introduction to robust procedures. Prerequisite: STAT 1091 or equivalent. Fall, Even Years
STAT (201-202)	6201-6202	Mathematical Statistics I-II	3, 3	Probability, distribution theory, sampling theory, estimation, sufficient statistics, hypothesis testing, analysis of variance, multivariate normal distribution. Prerequisite: MATH 1233, 2184. Academic Year
STAT (210)	6210	Data Analysis	3	Review of statistical principles of data analysis, using computerized statistical procedures. Multiple regression and the general linear model, analysis of contingency tables and categorical data, logistic regression for qualitative responses. Prerequisite: STAT 2118, either STAT 2183 or demonstrated proficiency in computer programming, and one semester of mathematical statistics STAT 4157 or STAT 6201). Spring
STAT (215)	6215	Applied Multivariate Analysis I	3	Application of multivariate statistical techniques to multidimensional research data from the behavioral, social, biological, medical and physical sciences. Prerequisite: STAT 3119, 4157-4158; MATH 2184. Alternate academic years
STAT (216)	6216	Applied Multivariate Analysis II	3	Application of multivariate statistical techniques to multidimensional research data from the behavioral, social, biological, medical and physical sciences. Prerequisite: STAT 3119, 4157-4158; MATH 2184. Alternate academic years
STAT (217)	6217	Design of Experiments	3	Design and analysis of the single- and multiple-factor experiments. Includes block designs, repeated measures, factorial and fractional factorial experiments, response surface experimentation. Prerequisite: STAT 3119, 4157-4158; MATH 2184 Fall Alternate Years
STAT (223)	6223	Bayesian Statistics: Theory and Applications	3	An overview of Bayesian statistics, including its foundational issues, decision under uncertainty, linear models, expert opinion, and computational issues. Prerequisite: STAT 6201-6202 Spring, Alternate Years
STAT (227)	6227	Survival Analysis	3	Parametric and nonparametric methods for the analysis of events observed in time (survival data), including Kaplan-Meier estimate of survival functions, logrank and generalized Wilcoxon tests, the Cox proportional hazards model and an introduction to counting processes. Prerequisite: STAT 6201-6202 or permission of instructor. Fall

STAT (231)	6231	Categorical Data Analysis	3	A study of the theoretical bases underlying the analysis of categorical data. Measures and tests of association; mantel- Haenszel procedure; weighted least squares and maximum likelihood estimators in linear models; estimating equations; logistics regression; loglinear models. Prerequisite: STAT 6201-6202. Fall, alternate years
STAT (242)	6242	Regression Graphics /Nonparametric Regression	3	Linear regression, nonparametric regression, smoothing techniques, additive models, regression trees, neural networks, and dimension reduction methods. Prerequisite: Stat 2118; Math 1233, 2184, or equivalent. Spring, alternate years
STAT (287)	6287	Modern Theory of Sample Surveys I	3	Practical aspects and basic theory of design and estimation in sample surveys for finite populations. Simple random, systematic, stratified, cluster multistage and unequal-probability sampling. Horvitz-Thompson estimation of totals and functions of totals: means, proportions, regression coefficients. Linearization technique for variance estimation. Model-assisted ratio and regression estimation Prerequisites: Stat 4157-4158 or equivalent. Fall semester. Alternate academic years.
STAT (226)	8226	Advanced Biostatistics Methods	3	Statistical methods for the analysis of longitudinal data: nonparametric, fixed effects, mixed effects, generalized estimating equations. Methods for the analysis of emerging data: group sequential analysis, Brownian motion, Bayesian methods, and stochastic curtailment. Other advanced topics of current research in biostatistics. Prerequisite: STAT 6201-6202 or permission of instructor. Spring
STAT (273)	8273	Stochastic Processes I	3	Fundamental notions of Markov chains and processes, generating functions, recurrence, limit theorems, random walks, Poisson processes, birth and death processes, applications. Prerequisite: STAT 4189-4190, and 6201-6202. Alternate academic years
STAT (281)	8281	Advanced Time Series Analysis	3	Autoregressive integrated moving average (ARIMA) modeling and forecasting of univariate and multivariate time series. Statespace or Kalman filter models, spectral analysis of multiple time series. Theory and applications using the University computer. Prerequisite: Math 1233, Stat 6201 - 6202 or equivalent. (Spring)
STAT (288)	8288	Modern Theory of Sample Surveys II	3	Second semester of Stat 6287. In this course two-phase sampling and sampling on two occasions, non-response effects, imputation, and other selected topics will be discussed. Prerequisite: Stat 6287. Spring semester. Alternate academic years.
PubH (465)	8365	Design of Medical Studies	3	Design of medical investigations, including the randomized clinical trial, observational cohort study, and the retrospective case-control study. Specific methods regarding sample size, power and precision and statistical procedures for randomization and sampling. Ethics of clinical trials and the intention-to-treat principle. Prerequisite: PubH 6002, Spring
PubH (466)	8366	Biostatistical Methods	3	Biostatistical methods for asymptotically efficient tests and estimates of relative risks and odds ratios from prospective and retrospective matched and unmatched studies. Fixed and random effects models. Logistic regression, conditional logistic regression. Poisson regression. Maximum likelihood and efficient scores. Prerequisites: STAT 6202 or Instructor's permission, Fall <i>Basis for Master's Comprehensive Examination</i>

Public Health Course Descriptions

PubH (201)	6001	Biological Concepts for Public Health	2	Provides an overview of current knowledge about biological mechanisms of major diseases causing death and disability in the US and globally; understanding and interpreting the reciprocal relationships of genetic,
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				environmental, and behavioral determinants of health and disease in an ecologic context; analyzing, discussing, and communicating biologic principles of disease from a public health perspective. Summer, Fall, Spring
PubH (203)	6003	Principles and Practice of Epidemiology	3	General principles, methods, and applications of epidemiology. Outbreak investigations, measures of disease frequency, standardization of disease rates, study design, measures of association, hypothesis testing, bias, effect modification, causal inference, disease screening, and surveillance. Case studies apply these concepts to a variety of infectious, acute, and chronic health conditions affecting the population. Fall, Spring, Summer 10 week
PubH (204)	6004	Environmental and Occupational Health in a Sustainable World	2	Examines the connection between population health and exposures to chemical, physical, and biological agents in the environment. Through the use of problem-solving frameworks, students will become familiar with data sources, methodologies and policy approaches being used to address the public health impacts of environmental and occupational health hazards, including the consequences of climate change, natural resource degradation, and industrial chemicals. The course will integrate key concepts of environmental health with principles of sustainability to illustrate how public policies and practices on the local, national and global level affect population health. Summer I, Fall, Spring
PubH (207)	6007	Social and Behavioral Approaches to Public Health	2	This course will emphasize social and behavioral science theories, models, and concepts that can be applied to public health problems and interventions. This course will describe the role of social and community factors, including race/ethnicity and culture, in both the onset and solution of public health problems and describe the inter-relationship between the social/behavioral science. Summer 1, Fall, Spring
PubH (209)	6299	Topics in Epidemiology and Biostatistics	1 to 3	In-depth examination of a particular facet of public health. Topics and prerequisites vary. Summer, Fall, Spring
PubH (209)	6299.58	Consulting Practicum	1	In this course students gain experience in applying their biostatistical skills to assist in projects being conducted by Medical Center researchers. The course director assigns projects to students according to their background and provides individual supervision. Prerequisite: PubH 6258. Summer, Fall, Spring
PubH (221)	6121	Environmental and Occupational Epidemiology	3	Epidemiologic methods for the study of environmental and occupational health problems. Epidemiologic exposure assessment methods and methods relevant to cohort, case-control, cross-sectional, and cluster investigation studies. Sources of and evaluation of biases and confounding, as well as survey and questionnaire design. Prerequisites: PubH 6003, 6002, Spring
PubH (242)	6242	Clinical Epidemiology and Decision Analysis	2	Quantitative and qualitative approaches to decision making, including risk- benefit analysis, decision analysis, and cost-effective analysis. Applications to technology assessment; development of clinical guidelines. Prerequisites: PubH 6002, 6003, Spring
PubH (244)	6244	Cancer Epidemiology	2	Epidemiology of specific cancers, with an emphasis on molecular and genetic epidemiology. Current research in the field. Prerequisites: PubH 6002, 6003, Spring
PubH (245)	6245	Infectious Disease Epidemiology	2	The role and conduct of laboratory and field investigations in the epidemiology of infectious diseases. Prerequisite: PubH 6003, Spring
PubH (246)	6246	Injury Epidemiology and Prevention	2	Epidemiologic knowledge and prevention strategies for intentional and unintentional injuries, including those occurring in transportation, occupational, home, and recreational environments. Research methods, sources of data, and application to injury prevention. Prerequisite: PubH 6003, Fall
PubH (258)	6258	Advanced Topics in Biostatistical Consulting	1	Principles and practice of biostatistical consulting in public health and medical research environments. Spring

