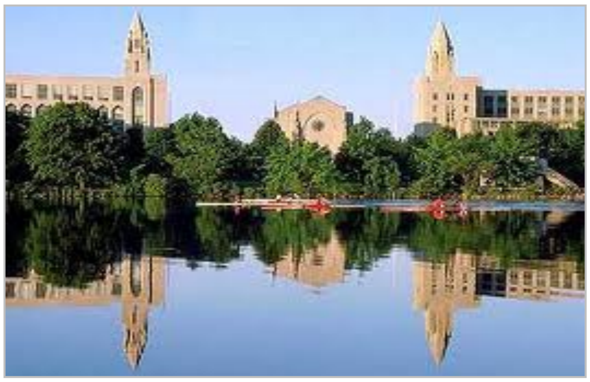
BOSTON UNIVERSITY



The Masters in Applied Biostatistics Program at Boston University

Program Handbook 2024-2025

Boston University School of Public Health

Biostatistics Program Contacts

Biostatistics Department
Sph.bu.edu/biostatistics
biostat@bu.edu
(p) 617-358-2222
(f) 617-378-2752

Academic Program Administrator
Kaitlyn Grevera
kgrevera@bu.edu
(p) (617)358-2784

MS Program Co-Directors

Chunyu Liu, PhD
liuc@bu.edu
617-358-5104

Yorghos Tripodis, PhD
yorghos@bu.edu
617-358-2628

Other Contacts

Biostatistics Department Chair
Scarlett Bellamy
bellamys@bu.edu

Mission Statements

The mission of the Boston University School of Public Health is to improve the health of local, national and international populations, particularly the disadvantaged, underserved and vulnerable, through excellence and innovation in education, research and service.

The mission of the Department of Biostatistics:

- To teach students the proper conduct of research studies through rigorous study design and appropriate descriptive and analytic methods that enable valid, interpretable conclusions to be drawn
- To collaborate in research projects to ensure that studies are properly designed, appropriately analyzed, and suitably interpreted
- To develop and evaluate new methods of biostatistical analysis and strategies for study design

Table of Contents

Section 1

Introduction

OVERVIEW

Biostatistics is the branch of statistics used in biomedical research, biology, and public health and is at the root of all major change in public health and discovery in biomedical sciences. Biostatisticians work with multidisciplinary teams to design, analyze, and summarize data from experimental science, genetics, clinical trials, and observational studies. Biostatisticians' work is compelling because it helps to distinguish real patterns from randomness, and ultimately leads to sound decisions that promote better health and higher quality of life around the world. From discussions with investigators about fine-tuning research questions to developing appropriate study designs, planning and implementing proper statistical analyses, and writing up the results, biostatisticians are involved in all aspects of research investigations.

Job prospects for biostatisticians are robust and track the projected growth of health care and related areas with a predicted 21% growth in employment opportunities over the next 6 years, according to *Fortune* in 2016. The Bureau of Labor Statistics predicts a 27% growth in employment opportunities for statisticians between 2017 and 2024, much faster than the average growth of most other occupations

There is a growing demand for biostatisticians with expertise in design and analysis of clinical trials and observational studies, statistical modeling skills for big data including genetic, genomic and health outcomes data, facility with multiple statistical computing programs, strong oral and written communication skills, and the ability to work effectively both independently and in interdisciplinary teams. Boston University's innovative 1-year MS program in Applied Biostatistics will provide you with comprehensive training in biostatistical methods, real-world experience through rotation/internship, and the chance to start building your professional network in Boston.

Section

2

MS in Applied Biostatistics

THE MASTER OF SCIENCE

The MS in Applied Biostatistics prepares students for the challenges of an ever-changing, technology-driven world, giving them the skills to adapt quickly to new data collection and analysis methods. The MS program is an accelerated training focusing on the practical skills needed for future work in fields such as biomedical research, pharmaceuticals, local and national government agencies, nonprofits, and contract research organizations. For a full-time student, the MS program will only take a year to complete, starting with an accelerated Advanced Statistical Training in August, which provides the probability, statistical inference, and computing skills necessary for a solid background in biostatistics. Through the fall and spring semesters, students take all of the necessary classes to acquire the essential skills and knowledge of a biostatistician and perform a research rotation, which provides practical experience working in the field. The research rotation ideally will develop into practical training in the form of a paid or unpaid internship during mid-May, June and July. These rotations allow students to make contacts within the field of biostatistics, building valuable relationships, as well as gaining professional experience. The MS in Applied Biostatistics is meant to be a very practical training program giving students the background and experience they need to build a fulfilling career in the growing field of biostatistics.

Section 3 Admission Requirements

APPLICATION FOR ADMISSION

All applications for admission are to be completed online through SOPHAS. Review all of the application instructions carefully, including the Frequently Asked Questions. The priority application deadline for all applicants to the MS in Applied Biostatistics is February 15.

APPLICATION REQUIREMENTS

- SOPHAS online application
- Official transcripts in English or WES ICAP Evaluation (international applicants) from all colleges and universities attended
- Official report of GRE scores from within the past 5 years (use school code 3087 to send your scores)
- Three letters of recommendation
- Statement of Purpose and Objectives
- Proof of English Proficiency (international applicants)
- CV or Resume

PROGRAM PRE-REQUISITES

- At least the equivalent of a Bachelor's degree; no specific undergraduate major is required
- One year of calculus, including multivariate calculus
- One formal course in linear algebra (with a minimum of two credits)*

***Applicants who lack the linear algebra prerequisite can be accepted on the condition that they complete the requirement before the beginning of the Advanced Statistical Training.**

International students
Students from abroad must submit a WES ICAP evaluation to SOPHAS instead of their original transcripts. Directions can be found in the link above.

Students must also submit results of the Test of English as a Foreign Language (TOEFL), or the International English Language Testing System (IELTS) with minimum score

TOEFL ibt 100 or higher
TOEFL bpt 600 or higher
IELTS (academic exam only) 7.0 total band score

Applicants who do not meet the minimum requirements of English proficiency are not eligible for admission. This requirement is waived *only* if the student has received, or expects to receive, an undergraduate or graduate degree from a college or university in any of the following countries prior to enrollment in the MS in Applied Biostatistics: The United States, Canada, The United Kingdom, Australia, New Zealand, or Ireland. Studying in the medium of English in a country other than the ones previously listed or studying as an exchange student in an English-speaking country without completing a degree program is not sufficient to waive the English proficiency requirement.

Department-specific admissions questions should be directed to biostms@bu.edu. Questions about the general admissions process should be directed to the School of Public Health at asksph@bu.edu.

Section 4 MS Degree Requirements

OVERVIEW OF THE MS DEGREE

The Master of Science in Applied Biostatistics program is aimed primarily at students with the equivalent of a Bachelor's degree who wish to pursue advanced study in the practical application of biostatistics. It is an intensive one-year degree that will provide training in biostatistical methods, real-world experience through one rotation and one internship, and the opportunity to begin building a professional network. The program prepares students for successful careers in biomedical research enterprises, pharmaceutical companies, local and national government agencies, and research.

MS LEARNING OUTCOMES

By the end of the program, students will have the knowledge, skills and professional confidence to:

- Apply the statistical methods commonly used in biomedical research, including
  - Analysis of variance
  - Linear regression, logistic regression and log-linear models
  - Survival Analysis
  - Mixed models and analysis of correlated data
  - Bayesian Analysis
  - Statistical computing
  - Analysis of observational studies
- Apply basic principles and methods to design, plan, conduct, and interpret biomedical studies in
  - Clinical trials
  - Observational studies
  - Big genomic and genetics data
- Provide effective biostatistical advice as a member of a team with strong
  - Consultancy skills
  - Oral and written communication skills

Students will gain these competencies through a blend of active learning opportunities including in-class and field-based experiences.

MS DEGREE REQUIREMENTS

The Boston University School of Public Health requires students pursuing a Master of Science in Applied Biostatistics to complete:

- the 34-credit curriculum
- the Professional Development Course
- 100 hours of Research Rotation
- 400 hours of Practical Training

All students are required to complete the degree within five years.

MS Curriculum

Full-time students in the MS program must complete a total of 34 credits as follows:

<table>
<tr><th>August</th><th colspan="2">Fall (16 cr)</th><th colspan="2">Spring (16 cr)</th><th>May-July</th></tr>
<tr><td rowspan="5">BS800 (2cr). Accelerated statistical training</td><td colspan="2">PH746. Professional development course</td><td colspan="2">Research Rotation in Biostatistics (100 hours)</td><td rowspan="5">400 hours practical training</td></tr>
<tr><td colspan="2">BS806 (4cr). Multivariable Analysis for Biostatisticians</td><td colspan="2">BS853 (4cr). Generalized Linear Models</td></tr>
<tr><td colspan="2">BS852 (4cr). Statistical Methods in Epidemiology</td><td colspan="2">BS857 (4cr). Analysis of Correlated Data</td></tr>
<tr><td colspan="2">BS858 (4cr). Statistical Genetics I</td><td colspan="2">BS851 (4cr). Applied Statistics in Clinical Trials I</td></tr>
<tr><td>BS803 (2cr). Statistical Programming for Biostatisticians</td><td>BS728 (2cr). Public Health Surveillance</td><td>BS849 (2cr). Bayesian Modeling</td><td>BS831 (2cr). Analysis of Big Genomic Data</td></tr>
</table>

*BS800 needs to be taken before Fall I, unless applicants can show equivalent material already completed

Grade Requirements: Students must earn a grade of B- or better in all courses applied to the degree.

Policies

All students must adhere to all Boston University School of Public Health academic policies and the University's Administrative Policies. Note that this information may change at any time.

MS Part-time Option

Students in the MS program may opt to complete the required 34 credits in two years. A possible part time schedule could look like this:

	Year 1		
August	Fall I (8 cr)**	Spring I (8 cr)***	May-July
BS800 (2cr). Accelerated statistical training	**PH746** Professional development course		
	BS806 (4cr). Multivariable Analysis for Biostatisticians	**BS853 (4cr).** Generalized Linear Models	
	BS852 (4cr). Statistical Methods in Epidemiology	**BS851 (4cr).** Applied Statistics in Clinical Trials I**	
	Year 2		
	Fall II (8 cr)**	Spring II (8 cr)***	May-July
		Research Rotation in Biostatistics (100 hours)	400 hours of practical training
	BS858 (4cr). Statistical Genetics I	**BS857 (4cr).** Analysis of Correlated Data	
	BS803 (2cr). Statistical Programming for Biostatisticians **BS728 (2cr)**. Public Health Surveillance	**BS849 (2cr).** Bayesian Modeling **BS831 (2cr).** Analysis of Big Genomic Data	

*BS800 needs to be taken before Fall I, unless applicants can show equivalent material already completed

** BS806 and BS852 must be taken in Fall I and BS853 must be taken in Fall II.

*** BS851 could be swapped with block (BS849 & BS831) between Spring I and Spring II

Note For Students Conducting Practical Training Outside of MA (within the U.S.)

The Massachusetts Department of Higher Education, in its capacity as the State Authorization Reciprocity Agreement (SARA) portal entity for Massachusetts, reviews and evaluates student complaints regarding distance education activities offered by Boston University in accordance with 610 CMR 12.07. This includes practicums taking place outside of Massachusetts. The Boston University state authorization approval and related complaint resolution process can be found on the State Authorization and Distance Education website at www.bu.edu/state-authorization. Additional information can be found on the BU Compliance website and the Academic Bulletin regarding ways that students can report concerns and utilize University complaint procedures.

Section

5

Research Experience Policies and Procedures

1. Background Information

Every MS student admitted to the Boston University MS in Applied Biostatistics Program is required to fulfill a 100-hour biostatistics or bioinformatics research experience during the Fall, Spring and Summer semester supervised by a Boston University faculty. Full-time students complete the research experience **by May**, while part-time students may continue working over the Summer semester. The work does not have to be remunerated as it is a necessary degree requirement of the MS program. This document describes expectations and guidelines related to the Research Experience Module of the MS in Applied Biostatistics.

2. Identification of a mentor

In the fall semester, MSAB directors work with the Biostatistics department to hold a 'Meet a Metor Meeting in **during September or October**. Boston University faculty members who are willing to mentor MSAB students are invited to present their research interests. Full-time MSAB students need to attend this meeting, identify potential mentor(s), and contact the potential mentor(s) to set up meeting(s) to discuss mutual interests, and to form mentor-student teams **by December 1**. Part-time MSAB students have a flexibility timeline to identify a mentor. Trainee and mentor must agree to a work schedule **by December 15** and need to submit MS Research Expectation Form **by December 31**.

3. Student Workload

Students are expected to devote no more than 20 hours per week to their research experience during any academic period (fall semester, spring semester, summer semester). The usual workload is 10-hours per week over a 10-week period. During official University break periods, such as intersession and spring break, or during any academic period in which students are not classified as full-time, they may work up to 40 hours per week.

4. Student Responsibilities

4.1 Set expectations. After a student and a mentor agree to work together, the research mentor and the student must discuss and document expectations. This may include short and long-term project goals; specific duties and responsibilities of the student; criteria/policies on collaboration & publication, and on confidentiality and research data protection; contingencies for sick and vacation absences; and the specific criteria that will be used for performance evaluation.

4.2 Student performance. Students are required to perform the work agreed to and specified by their research mentors for up to 20 hours a week. The usual workload is 10-hours per week over a 10-week period. Students are expected to work hard, respond to feedback, and be responsible in performing the duties of their research experience.

4.3 Feedback. The department will conduct an annual evaluation of Research experience that will be sent to students and research mentors separately. Students are encouraged to provide candid feedback at that time. If problems arise at any point during the year, students should work with their research mentors and academic advisors to resolve the problem; students and research mentors are welcome to consult with the program Co-Directors for guidance as needed.

5. Research Mentor Responsibilities

5.1 Set expectations. At the beginning of the research experience, the mentor and the student must discuss and document expectations. This may include short and long-term project goals; specific duties and responsibilities of the student, criteria/policies on collaboration & publication, and on confidentiality and research data protection; contingencies for sick and vacation absences; *and the specific criteria that will be used for performance evaluation.*

5.2 Performance evaluations. There must be an ongoing communication between the student and the research mentor with feedback on a regular basis about the student's performance. Any concerns related to the student's performance must be discussed with the student as soon as possible, and the research mentor should report those concerns to the Co-Directors. Additionally, every spring the department will send out student evaluation forms to both the research mentor and student, allowing each to provide feedback on their experience.

6. Required documents and timelines

6.1. MS Research Expectation Form (**December 31 for full-time students**). This form should include the following information: 1) student and mentor names, 2) main aims of the research experience, 3) brief descriptions of the planned research (e.g., background information, aims, methods, and expected outcomes), 4) the start and end dates of the research experience, and 5) hours per week. We provide an example of MS Research Expectation Form in Appendix.

6.2. MS Research Mid-term Evaluation Report (**March 15 for full-time students**). This report should include the following information: 1) student and mentor names, 2) main aims of the research experience, 3) aims that have been completed, 4) experience summary (good experience or challenges encountered). Codes and results generated from the research are optional to be submitted. We provide an example of MS Research Mid-Term Evaluation report in Appendix

6.2. MS Research Final Report (**May 10 for full-time students**). This report should include the following information: 1) student and mentor names, 2) main aims of the research experience, 3) a concise report of your project methods, results and conclusion. Figures and Tables can be included if necessary. We provide an example of MS Research Final report in Appendix

Research Experience Protocol

Research Experience Procedures and Requirements

All students in the MS in Applied Biostatistics need to complete a 100-hour research experience. Each research experience must last at least one semester with the expectation that the student devotes 10 hours per week for 10 weeks performing hands-on data-analysis.

The following details the process and timing for securing research experiences.

Research Experience Appendix 1

Table 1. Summary of Research Experience Procedures, Requirements and Timelines

Process and Timing	Fall	Spring
Step 1: Students are expected to attend the "meet the mentor meeting"	September/October	
Step 2: Select Research Experience Choose a research experience and contact a research mentor	October/November	
Step 3: Delineate Roles and Responsibilities. Student meets with the research mentor to discuss roles and responsibilities and will draft a document of expectations for the research experience and a brief description of the planned activities. A copy of the document must be submitted to the co-Directors for approval. The research experience form indicating approval of the document of expectations must be signed by the research mentor and by one of the co-Directors. The research experience form and a copy of the document must be submitted to the curriculum coordinator.	Before December 1st	
Step 4: Finalize Schedule Trainee and mentor must agree to a work schedule.	Dec 15	

Process and Timing, continued	***Fall***	***Spring***
Step 6: Mid-term evaluation Students need to submit an interim report to the co-Directors outlining the progress made, or arrange an in-person meeting to discuss the research experience.		March 15
Step 5: Final Report At the completion of the research experience, the student produces a report detailing skills acquired and lessons learned from the research experience. Students should address each of the objectives for the research experience and how each objective was met. The report should not exceed 5 pages with supporting tables/figures as needed. A copy of the document must be submitted to the co-Directors for approval. The research experience form and a copy of the final report must be submitted to the curriculum coordinator.		May 10th

Note that some research experience may require training in human subject research. Please consult the instructions about CITI training https://www.bumc.bu.edu/ohra/required-training/human-subjects-protection-training/initial-certification/**.**

Master of Science in Applied Biostatistics

Research Experience Form

Student Name: ______________________________ Date: __________________

Research Experience Start Date: __________________________

Research Experience:

- ☐ Genetics
- ☐ Bioinformatics
- ☐ Clinical Trials/Clinical Research
- ☐ Observational Studies

Document of expectations: ☐
(attach copy)

_____________________________________ _______________

Student's Signature Date

_____________________________________ _______________

Mentor's Signature Date

_____________________________________ ____________________

Director's Signature Date

Final Report: ☐ (needed for all research experience)
(attach copy)

_____________________________________ ___________________

Student's Signature Date

_____________________________________ ___________________

Mentor's Signature Date

__________________________________ ____________________

Director's Signature Date

Appendix 2a. MS Research Expectation Form

Template for MS Research Expectation Document

Student name:

Mentor name:

Goals of the research experience:

Brief description of work activity planned for the research experience:

Start date:

End date:

Hours planned per week for research experience work

Appendix 2b. MS Research Expectation Form (An example)

Student Name: xxxx

Mentor Name: xxx

Goals of the Research Experience:

Apply the knowledge and skill obtained through my program in biostatistics to assist and advise the research team on statistical matters related to their projects. In addition, learn about the roles of a biostatistician throughout the process of medical research.

Description of work activity planned for the research experience:

For the beginning portion of the research experience, it is expected that the student will perform descriptive statistics and regressions on a current project evaluating the association between patients with substance use disorder and [DISEASE X]. Once that project is completed, the student will work on other projects available and perform appropriate statistical analysis. There will be biweekly meetings with the mentor to plan tasks and objectives for each two week time period.

Start Date: December 28th, 2020

End Date: March 8th, 2020

Hours planned per week: 10

Appendix 3a. MS Research Mid-term Report

Student Name:

Mentor Name:

Goals:

Aims that have been completed:

Experience summary (good experience or challenges encountered):

Appendix 3b. MS Research Mid-term Report

Student Name:

Mentor Name:

For my 100-hour research rotation I have been working [mentor name] from the [institute] to analyze the impact of substance use disorder on [DISEASE X]. [Mentor's Name] has been kindly mentoring me regarding statistical methods throughout this process as well.

This experience has been very beneficial so far in testing and expanding my skills and knowledge. I started my rotation becoming IRB approved and gaining access to data on demographics, comorbidities, social history, symptoms, and clinical course from the electronic medical records of 409 patients with [DISEASE X] who were admitted to Boston Medical Center during the first month after the pandemic spread to Boston. The dataset includes 427 variables. The main goal at the beginning of my research was to develop a table one summarizing characteristics and outcomes of patients with [DISEASE X] stratified by the substance use disorder group vs controls. I also read literature surrounding the area of research to understand what other studies have done and what variables might be of interest for our study as well. I utilized SAS to look at the unadjusted associations between the substance use disorder group vs controls for variables of interest. The procedures I used in SAS include proc contents, proc sql, proc univariate, proc freq, proc sort, proc means, and proc t-test. I then utilized R to combine datasets, manipulate the data, and create a presentable table 1 for publication using the package "CreateTableOne" and "KableExtra".

This experience has not only helped my coding skills in R, but has challenged me to deal with a large number of variables and being able to communicate statistical terminology and findings to people with little to no statistical background. It has also brought together many different concepts from the courses I have taken so far in this program. Instead of specific instructions to use methods specific for a course project, I have the responsibility to use my best judgement on what statistical analysis should be applied to this dataset and what would be best for the researcher's goals. I am currently working on models for a few main outcomes of interest for those with [DISEASE X] to understand the impact of substance use disorder and some of the directed therapies. This has challenged me to determine which variables are statistically and clinically relevant, whether missing data is at random or not, checking assumptions of models, and investigating new approaches to modeling such as the different generalized linear models. I am also helping to write and edit a paper to potentially be published that summarizes the work myself and the researchers have accomplished since December. Starting the 21st I will begin another project on outcomes for patients with obstructive sleep apnea and COVID.

Appendix 4a. MS Research Final Report

Student Name:

Mentor Name:

Appendix 4b. MS Research Final Report (an example)

Student Name:

Mentor Name:

For my 100-hour research rotation I have been working with [Mentor name] from the Boston Medical Center to analyze the impact of substance use disorder on [Disease X].

The goals originally set for this research experience were to apply the knowledge and skills obtained through my program in biostatistics to assist and advise the research team on statistical matters related to their projects. Additionally, another goal was to learn about the roles of a biostatistician throughout the process of medical research. I believe that these goals have been met and even exceeded. This experience has been very beneficial in testing and expanding my skills and knowledge. I started my rotation becoming IRB approved and gaining access to data on demographics, comorbidities, social history, symptoms, and clinical course from the electronic medical records of 409 patients with [DISEASE X] who were admitted to [Hospital Y] during the [period]. This dataset includes 427 variables. The main objective at the beginning of my research was to develop a table one and two summarizing characteristics and outcomes of patients with [DISEASE X] stratified by the substance use disorder group vs controls. I also read literature surrounding the area of research to understand what other studies have done and what variables might be of interest for our study as well.

To carry this out, I utilized SAS to look at the unadjusted associations between the substance use disorder group vs controls for variables of interest as specified by the researchers. The procedures I used in SAS include proc contents, proc sql, proc univariate, proc freq, proc sort, proc means, and proc t-test. I then utilized R to combine datasets, manipulate the data, and create a presentable table one and two for publication using the package "CreateTableOne" and "KableExtra". Once descriptive tables were created, I built three different models in R to assess the impact of substance use disorder on death, length of stay in the hospital, and receiving biologics. For the first model with the outcome of death (coded 1-yes and 0-no) I used a logistic regression. For the outcome of length of stay in the hospital, since it is a count variable and not normally distributed, I first fit the data with a poisson regression. However, I found that there was overdispersion so negative binomial was used as the distribution for length of stay in hospital. Finally, for the outcome of biologics (coded 1-yes and 0-no) I again used a logistic regression. There was a difficulty at first choosing out of the 427 variables available which to include in these models. I dealt with this problem by speaking with the researchers to better understand what variables may be clinically relevant for each of the outcomes. I also ran univariable analyses with the outcome of interest and all variables that were included in tables one and two. Associations that had a p-value of 0.2 or less in univariable analyses were considered in the models. Once all potential variables were included in the models, manual backwards elimination was utilized. The lowest AIC assisted in choosing the best model. For the outcome of death, since there were only 36 events in total and 9 of those in the substance use disorder group, there was a limitation to the number of predictor variables included in the model in order to not overfit the model. I also found that there were some variables with missing values so I analyzed whether the missingness created any bias. Variables that had a lot of missing observations ended up not being used in the models.

Once I completed the majority of the analysis for the impact of substance use disorder on [DISEASE X] outcomes, I had the opportunity to contribute to writing the statistical methods in the paper that will potentially be published. I also began to look at the impact of obstructive sleep apnea on [DISEASE X] outcomes. The data for this was taken from the same dataset as substance use disorder and many of the variables of interest were the same, so similar code was used. I am still in the process of tweaking this table and translating findings to the researchers. All tables that I have created for the substance use disorder project have been included in the appendix.

This experience has not only helped my coding skills in R, but has challenged me to deal with a large number of variables and being able to communicate statistical terminology and findings to people with little to no statistical background. It has also brought together many different concepts from the courses I have taken in the applied biostatistics program. Instead of specific instructions to use methods for a course project, I have the responsibility to use my best judgement on what statistical analysis should be applied to this dataset and what would be best for the researcher's goals. I have been challenged to determine which variables are statistically and clinically relevant, whether missing data is at random or not, checking assumptions of models, and investigating different generalized linear models. I have had many great conversations with [Mentor's Name] about modeling such confounding variables, collinearity, interactions, and remembering to keep in mind the clinical reasons for decisions we make as statisticians, not just completely relying on the numbers. Not only have I applied my knowledge and skills from my coursework, but I have been able to better understand the role of biostatistician in medical research. The job of a statistician is not just about manipulating data and plugging in variables into models. I learned that it is important to be able to communicate why you are performing certain methods and how to translate your findings. I found that it is also crucial to be able to work in a collaborative team setting across disciplines and never hesitate to ask questions.

I am grateful for this opportunity that has taught me many lessons, solidified my understanding of statistical methods, connected me to mentors, and has given me a better understanding as to what a biostatistician role in research may look like.

Appendix

Table 1. Characteristics of Patients by Substance Use Disorder Status (content deleted)

Table 2. Patient Disease summary (content deleted)

Table 3. Patient Outcomes by Substance Use Disorder Status (content deleted)

Table 4. Multivariable logistic regression model for the outcome of death (content deleted)

Table 5. Multivariable negative binomial model for the outcome of length of stay in hospital (content deleted)

Table 6. Multivariable logistic regression model for outcome of receiving biologics (content deleted)

SAS code and output

Section 6

Course Descriptions

MS IN APPLIED BIOSTATISTICS COURSE DESCRIPTIONS

Comprehensive and up to date course descriptions can be found at https://www.bu.edu/phpbin/course-search/index.php.

BS800 - Accelerated Statistics Training

This course is designed for the newly developed MS in Applied Biostatistics program and will cover concepts of descriptive statistics and exploratory data analysis, measures of association in epidemiological studies, probability, statistical inference and computing in R and SAS. It is intended to equip students enrolling in the MS in Applied Biostatistics program with sufficient probability, statistics and computing background to enter 800 levels courses and finish the MS program within a year. The course will be offered during the 3 weeks preceding the Fall semester, and will involve 15 day-long modules. Modules will generally run from 10am to 5pm, combining a traditional lecture (10am to 12pm), a practice session in which students will practice the notions learned in class through exercises (1pm to 2:30pm), and a computer lab (3pm to 5pm) in which the students will learn basic computing in R and SAS and also apply the notions learned in class to real data. [2 cr.]

SPH PH746 - Professional Development Course

This career development course is made up of 6 sessions, each 90 minutes long, designed to give students the tools and techniques to effectively market themselves during the job search process and advance in their career. It will also enable students to research potential career options and to manage job searches and careers as proactively and effectively as possible. [0 cr.]

SPH BS 728 - Public Health Surveillance, a Methods Based Approach

Thacker wrote, "Surveillance is the cornerstone of public health practice." This course will provide an introduction to surveillance and explore its connections to biostatistics and public health practice. Topics will include complex survey design, weighted sampling, capture-recapture methods, time series analyses and basic spatial analyses. Students will learn about available surveillance data, how to analyze these data, and how to write about their findings. Additionally students will propose a new surveillance system or modification of an existing system. [2 cr.]

SPH BS 803 – Statistical Programming for Biostatisticians
This course will cover concepts and skills of intermediate statistical computing and programming. This course will focus on manipulating and reshaping data objects, regular expressions, macros and functions and database management in SAS and R. It will also introduce statistical computing in a computer cluster environment using Linux as well as introducing programming in Python. [2 cr.]

SPH BS 806 – Multivariable Analysis for Biostatisticians
This course will discuss skills required for effective analysis of data set with multiple variables. This course will focus on multiple regression modeling and multivariate analysis, including one-way and multi-way ANOVA, multiple linear regression, non-linear regression, classification and regression trees, automated model search, model fit and diagnostic, experimental design and multivariate analysis (PCA and cluster analysis) with particular emphasis on applications in medicine and public health. [4 cr.]

SPH BS 831 – Analysis of Big Genomic Data
The goal of this course is for the students to develop a good understanding and hands-on skills in the design and analysis of data from microarray and high-throughput sequencing experiments, including data collection and management, statistical techniques for the identification of genes that have differential expression in different biological conditions, development of prognostic and diagnostic models for molecular classification, and the identification of new disease taxonomies based on their molecular profile. These topics will be taught using real examples, extensively documented hands-on exercises, class discussion and critical reading. Students will be asked to analyze real gene expression data sets in their homework assignments and final project. Principles of *reproducible research* will be emphasized, and students will be required to become fairly proficient in the use of the statistical language R and associated packages (including Bioconductor), and in the use of R markdown (and/or electronic notebooks) for the redaction of analysis reports. [2 cr.] -

SPH BS 849 – Bayesian Modeling
Bayesian methods have enjoyed a growing popularity in science and technology and have become the methods of analysis in many areas of public health and biomedical research including genetics and genomics, disease surveillance, disease mapping. Competent biostatisticians nowadays are expected to have knowledge in Bayesian modeling and Markov Chain Monte Carlo methods to be effective collaborators in interdisciplinary research groups. This course will introduce Bayesian statistical reasoning through graphical modeling and describe Markov Chain Monte Carlo methods for Bayesian inference. The course will cover Bayesian methods for estimation of odds and risk in observational studies; methods for multivariable linear, loglinear and logistic regression; hierarchical models; latent class modeling including hidden Markov models and model-based clustering. These topics will be taught using real examples from genetics, genomics, and observational studies, class discussion and critical reading. Students will be asked to analyze real data sets in their homework assignments and a final project. [2 cr.]

SPH BS 851 - Applied Statistics in Clinical Trials I

This is an intermediate statistics course, focused on statistical issues applicable to analyzing efficacy data for clinical trials. Topics include design and analysis considerations for clinical trials, such as randomization and sample size determination, and the application of statistical methods such as analysis of variance, logistic regression and survival analysis to superiority and non-inferiority clinical trials. This course includes lectures and computer instructions. Upon completion of the course, the student will have a working knowledge of how to collect and manage clinical trial data; will be able to analyze continuous, dichotomous, and time-to-event clinical trial data; and will be able to contribute to the statistical portions of a clinical trial study design. The student will also gain the overall knowledge required to interpret clinical trial statistical results. [4 cr.]

SPH BS 852 - Statistical Methods in Epidemiology

This course covers study design and intermediate-level data analysis techniques for handling confounding in epidemiologic studies. Confounding is carefully defined and distinguished from interaction. Course content covers stratification and multivariable techniques for controlling confounding in both matched and independent sample study designs, including analysis of covariance, logistic regression, and proportional hazards models. Model fit and prediction are discussed. Students are required to apply these methods with the aid of computerized statistical packages. [4 cr.]

SPH BS 853 - Generalized Linear Models with Applications

This course introduces statistical models for the analysis of quantitative and qualitative data, of the types usually encountered in health science research. The statistical models discussed include: Logistic regression for binary and binomial data, Nominal and Ordinal Multinomial logistic regression for multinomial data, Poisson regression for count data, and Gamma regression for data with constant coefficient of variation. All of these models are covered as special cases of the Generalized Linear Statistical Model, which provides an overarching statistical framework for these models. We will also introduce Generalized Estimating Equations (GEE) as an extension to the generalized models to the case of repeated measures data. The course emphasizes practical applications, making extensive use of SAS for data analysis. [4 cr.]

SPH BS 857 - Analysis of Correlated Data

The purpose of this advanced course is to present some of the modern methods for analyzing correlated observations. Such data may arise in longitudinal studies where repeated observations are collected on study subjects or in studies in which there is a natural clustering of observations, such as a multi-center study of observations clustered within families. Students start with a review of methods for repeated measures analysis of variance and proceed to more complicated study designs. The course presents both likelihood-based methods and quasi-likelihood methods. Marginal, random effects and transition models are discussed. Students apply these methods in homework assignments and a project. [4 cr.]

SPH BS 858 - Statistical Genetics I

This course covers a variety of statistical applications to human genetic data, including collection and data management of genetic and family history information, and statistical techniques used to identify genes contributing to disease and quantitative traits in humans. Specific topics include basic population genetics, linkage analysis and genetic association analyses with related and unrelated individuals. [4 cr.]

Practical Training

Research Rotation in Biostatistics (100 hours)

The research rotation will provide students with an opportunity to work on a real problem in biostatistics under the supervision of a Biostatistics faculty member. Biostatistics faculty work in many interdisciplinary research teams and MS students will be able to join one of these research teams and take an active role in selected biostatistical analyses. Students are expected to work an average of 5 hours per week for 20 weeks for a total of 100 hours. Faculty from Boston University School of Medicine are supportive of this practical training and committed to provide research opportunities for MS students in their labs. Examples of rotation placements include research groups from the Framingham Heart Study, the New England Centenarian Study, and the Cancer Center. In addition we expect MS students to be able to conduct rotations at the Boston University Data Coordinating Center.

BS910 - Practical Training

Completion of 400 hours (40 hours per week x 10 weeks) of practical training will be required to obtain the degree. The training will start the 2nd week of May and continue through September 24th. This practical training can be based on extension of the research rotations, industry-based internships, or employment in the field of biostatistics. Students are required to write a research paper based on the practical training to be submitted by the end of August to complete the degree.

Section 7 Biostatistics Faculty

The Department of Biostatistics faculty are committed to the roles of teacher and mentor both inside and outside of the classroom. Their research brings depth and a real-life context to the classroom. The department's faculty has analyzed the multigenerational risk factors that contribute to heart disease, which led to a predictive tool for physicians to determine treatment strategies for patients with cardiovascular disease. In partnership with other academic institutions, members of the department have isolated and identified key factors that contribute to higher incidences of breast cancer and other diseases in African-American women. In addition, the department has designed and implemented an important comparative study that pinpoints risk factors for Alzheimer's disease. Members of the department are also actively engaged in clinical trials and methods for public health surveillance, designed to improve clinical treatments and aid the public health delivery system to identify disease hotspots. Faculty bios can be found here and information about faculty research can be found on the Research section of our website.

Biostatistics Department Faculty

Faculty Name	Title	Areas of Expertise	Courses Taught	Email and Office
Alexa Beiser, PhD	Professor of Biostatistics; Associate Chair for Education, Biostatistics Department; Professor of Neurology	Analysis of longitudinal cohort data; survival analysis; lifetime risk analysis; statistical computing		alexab@bu.edu CT325
Howard Cabral, PhD	Professor of Biostatistics, Co-Director of Biostatistics Graduate Program	Analysis of longitudinal data, analysis of ordinal data, clinical trials, statistical computing, effects of missing data on estimation, and ethics in statistical practice.	BS805 Intermediate Statistical Computing and Applied Regression Analysis	hjcab@bu.edu CT310
Debbie Cheng, ScD	Professor of Biostatistics	Design and analysis of clinical trials, longitudinal data analysis, alcohol, substance use, and HIV/AIDS research.	BS722 Design and Conduct of Clinical Trials	dmcheng@bu.edu CT319
Serkalem Demissie, PhD	Associate Professor of Biostatistics	Statistical genetics; statistical computing; epidemiology; genome wide association study, meta-analysis, and multiple testing; modeling and clustering temporal data for gene expression experimental study		demissie@bu.edu CT315
Anita DeStefano, PhD	Professor of Biostatistics, Director of the Graduate Certificate in Statistical Genetics	Statistical genetics	BS401 Survey in Biostatistical Methods	adestef@bu.edu CT314
Gheorghe Doros, PhD	Associate Professor, Director of the Graduate Certificate in Biostatistics in Modern Clinical Trials	Censored data, data analysis, asymptotics, nonparametric estimation, and clinical trails	BS853 Generalized Linear Models with Applications, BS854 Bayesian Methods in Clinical Trials	doros@bu.edu CT331
Kimberly Dukes, PhD	Research Associate Professor	study designs, including randomized clinical trials (Phase I-IV, device, behavioral), prospective longitudinal cohort, opportunistic, observational, surveillance, and retrospective studies and clinical evaluations	SPHBS750 Essentials of Quantitative Data Management	dukeska@bu.edu FULLER - 902A

Susan Fish, PharmD	Professor of Biostatistics	Clinical trials, human subjects research, research ethics, study designs	BS722 Design and Conduct of Clinical Trials	sfish@bu.edu CT330
David Gagnon, PhD, MD	Research Professor of Biostatistics	Statistical computing, longitudinal data analysis, pharmacoepidemiology, survival analysis, categorical data analysis, phenotyping, machine learning, classification, validation studies, natural language processing, Bayesian analysis, and MCMC methods.	BS775 Applications of Advanced Statistical Methods in Clinical Research, BS821 Categorical Data Analysis	gagnon@bu.edu CT328
Timothy Heeren, PhD	Professor of Biostatistics; Director of MPH Certificate in Design and Conduct of Public Health Research	Biostatistics, analysis of scaled data	BS704 Biostatistics, BS740 Design and Conduct of Public Health Research, BS852 Statistical Methods in Epidemiology	tch@bu.edu CT309
Helen Jenkins, PhD	Assistant Professor of Biostatistics	Infectious diseases, analysis of spatial data	BS825 Advanced Methods in Infectious Disease Epidemiology BS852 Statistical Methods in Epidemiology	helenje@bu.edu CT347
Martin Larson, SD	Research Professor of Biostatistics; Research Professor of Mathematics & Statistics; Research Associate Professor of Medicine	Analysis of 'omics' and longitudinal data, statistical genetics, missing data		mlarson@bu.edu CT-328
Michael LaValley, PhD	Professor of Biostatistics; Co-Director of MPH Certificate in Epidemiology and Biostatistics	Meta-analysis, analysis of longitudinal and correlated data, analysis of survival data, analysis of ordinal and count data, predictive modeling, and arthritis research.	BS810 Meta-Analysis for Public Health and Medical Research, BS820 Logistic Regression & Survival Analysis	mlava@bu.edu CT322
Ching-Ti Liu, PhD	Associate Professor of Biostatistics	Development of statistical/computational approaches for genetics/genomics and bioinformatics studies	BS723 Intro to Statistical Computing BS730 Introduction to Statistical Computing in R, BS806 Multivariate Analysis for Biostatisticians BS860 Statistical Genetic II	ctliu@bu.edu CT329
Chunyu Liu, PhD	Research Associate Professor	Statistical genetics	BS805 Intermediate Statistical Computing and Applied Regression Analysis	liuc@bu.edu CT347
Sara Lodi, PhD	Assistant Professor of Biostatistics	Causal modeling, HIV	BS851 Applied Clinical Trial I	slodi@bu.edu CT316

Kathryn Lunetta, PhD	Professor of Biostatistics	Statistical genetics and genomics and genetic epidemiology	BS858 Statistical Genetics, BS859 Applied Genetic Analysis	klunetta@bu.edu CT313
Shariq Mohammed	Assistant Professor	Bayesian modeling, variable selection, geometric functional data analysis and applications to biomedical imaging data.	BS730 Introduction to R: software for statistical computing	shariqm@bu.edu
Joseph Massaro, PhD	Professor of Biostatistics	Pharmaceutical and biologic randomized clinical trials, medical device randomized clinical trials, non-randomized clinical trials, propensity score matching and adjustment, clinical trials in rare diseases, adaptive designs in clinical trials, non-inferiority clinical trials, and risk prediction.	BS851 and BS861 Applied Statistics in Clinical Trials I & II	jmm@bu.edu CT327
Jacqueline Milton, PhD	Clinical Assistant Professor	Statistical genetics and statistical education	BS401 Survey in Biostatistical Methods, BS704 Biostatistics, BS723 Intro to Statistical Computing, BS730 Introduction to Statistical Computing in R, PH717 Quantitative Methods for Public Health	jnmilton@bu.edu CT348
Kerrie Nelson, PhD	Research Associate Professor	Statistical methods for reliability, modeling longitudinal and clustered data, diagnostic testing		kerrie@bu.edu CT318
Prasad Patil, PhD	Assistant Professor of Biostatistics	Machine learning, genomics, personalized medicine, data visualization, prediction, study reproducibility	BS845: Applied Statistical Modeling and Programming in R	patil@bu.edu CT320
Gina Peloso, PhD	Assistant Professor of Biostatistics	Statistical genetics, mapping of complex traits, and cardiovascular risk factors	BS858 Statistical Genetics, BS805 Intermediate Statistical Computing and Applied Regression Analysis	gpeloso@bu.edu CT303
Sarah Rosner Preis, PhD	Research Associate Professor of Biostatistics	Cardiovascular and nutritional epidemiology, epidemiologic methods		srpreis@bu.edu CT327
Lisa Sullivan, PhD	Professor of Biostatistics; Associate Dean of Education, BUSPH	Design and analysis of epidemiological studies, risk functions, clinical trials, undergraduate education	BS700 Essentials of Biostatistics, PH717 Quantitative Methods for Public Health	lsull@bu.edu CT324

Yorghos Tripodis, PhD	Research Associate Professor of Biostatistics	Longitudinal Studies, Correlated Data, Instrumental Variable Models, Time series modeling, and Measurement Error models.	BS723 Introduction to Statistical Computing BS803 Statistical Programming for Biostatisticians BS857 Analysis of Correlated Data	yorghos@bu.edu CT312
Janice Weinberg, ScD	Professor of Biostatistics	Design and analysis of clinical trials, correlated data analysis, and statistical consulting	BS722 Design & Conduct of Clinical Trials	janicew@bu.edu CT330
Laura White, PhD	Associate Professor of Biostatistics, Co-Director of Biostatistics Graduate Program	Spatiotemporal analysis, statistical modeling of disease outbreaks, infectious disease epidemiology, tuberculosis, and public health surveillance.	BS728 Public Health Surveillance, a Methods Based Approach; EP800 Microbes and Methods: Selected Topics in Outbreak Investigations	lfwhite@bu.edu CT325
Qiong Yang, PhD	Associate Professor of Biostatistics	Biostatistics, statistical genetics	BS845 Applied Statistical Modeling and Programming with R	qyang@bu.edu CT325

Adjunct Faculty

In addition to the faculty based at the School, BUSPH employs a number of experienced public health professionals from the community as adjunct faculty. These adjunct faculty bring a wealth of knowledge to the classroom as well as help build bridges between the communities that surround the Medical Campus. They often connect students with practica, research opportunities, and community events.

Faculty Name	BU Appointment	Primary Appointment/Position	BU Courses Taught	Email and Office
Mark Chang, PhD	Adjunct Professor	Executive Director of Department of Biostatistics and Data Management, AMAG Pharmaceuticals		mchang@amagpharma.com
Lori Chibnik, PhD	Adjunct Assistant Professor	Assistant Professor of Neurology, Harvard Medical School and BWH; Assistant Professor of Epidemiology at Harvard School of Public Health; Associated Scientist at Broad Institute		chibber@bu.edu
Theodore Colton, ScD	Professor Emeritus, Chairman Emeritus of Epidemiology, Boston University School of Public Health	Professor, Chairman Emeritus of Epidemiology, Boston University School of Public Health		tcolton@bu.edu
Kimberly Dukes, PhD	Adjunct Assistant Professor	President, CEO of DM-STAT, Inc.		kim.dukes@dmstat.com
Jayandra Himali, PhD	Research Assistant Professor	Research Assistant Professor, Neurology, BU School of Medicine	BS723 Introduction to Statistical Computing	jhimali@bu.edu
C. Robert Horsburgh, MD, MUS	Professor	Professor and Chair of Epidemiology, BUSPH		rhorsbu@bu.edu
William Evan Johnson, PhD	Associate Professor	Assistant Professor of Medicine, Division of Computational Biomedicine, Boston University School of Medicine		wej@bu.edu
Robert A. Lew, PhD	Associate Professor	Senior Biostatistician, Veterans Affairs	BS854 Bayesian Methods in Clinical Trials	rlew@bu.edu
Elena Losina, PhD	Adjunct Associate Professor	Associate Professor of Orthopedic Surgery, Brigham and Women's Hospital		elosina@partners.org
Sandeep Menon, PhD	Adjunct Assistant Professor	Director of Biostatistics, Bio-therapeutics Research, Pfizer		sandeep.m.menon@pfizer.com
Carly Milliren, MPH		Statistical Programmer, Children's Hospital Boston	BS723 Introduction to Statistical Computing	cmillire@bu.edu
Michael Pencina, PhD	Adjunct Associate Professor	Director of Biostatistics, Duke Clinical Research Institute		michael.pencina@duke.edu

Soe Soe Thwin, PhD	Adjunct Assistant Professor	Biostatistician, Veterans Affairs		sst@bu.edu
Moshe Vardi, MD	Adjunct Professor	Global Clinical Development Lead, Shire		vardi@bu.edu
Vanessa Xanthakis, PhD	Instructor	Instructor of Medicine, Investigator for the Framingham Heart Study, Section of Preventive Medicine and Epidemiology, Department of Medicine BUSM		vanessax@bu.edu

Biostatistics MS Degree Audit Sheet (34 credits)

I. AST: 3 week course (2 credits)	**Semester Completed**	**Grade Earned**	**Credits Earned**
AST BS800: Accelerated Statistics Training			
II. MS Degree Required Courses: (32 credits)	**Semester Completed**	**Grade Earned**	**Credits Earned**
SPH PH746 Professional Development Course			
SPH BS728 Public Health Surveillance			
SPH BS803 Statistical Programming for Biostatisticians			
SPH BS806 Multivariable Analysis for Biostatisticians			
SPH BS831 Analysis of Big Genomic Data			
SPH BS849 Bayesian Modeling			
SPH BS851 Applied Statistics in Clinical Trials			
SPH BS852 Statistical Methods in Epidemiology			
SPH BS853 Generalized Linear Models			
SPH BS857 Analysis of Big Genomic Data			
SPH BS858 Statistical Genetics			
III. Practical Training	**Date of Completion**		**Grade Earned**
Research Rotation in Biostatistics (100 hours)			
BS910: Practical Training (400 hours)			

MS Requirements Checklist:

□ Credits total: 32 MS graduate credits or approved transfer courses.
□ Grade of B- or better in all courses applied to the MS
□ All incomplete classes completed and grades posted
□ Submitted graduation application to SPH (2-3 months prior to graduation)