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1 INTRODUCTION

This handbook describes the academic programs for the Master of Science in Biostatistics offered by the Department of Biostatistics at Harvard University. The Department offers courses of study leading to the Doctor of Philosophy and Master of Science degrees in Biostatistics. Both the Ph.D. and SM programs provide rigorous training in theory and practical experience in statistical and bioinformatics methods used in the biomedical sciences. Our programs are designed to prepare students for careers in the theory and practice of biostatistics, bioinformatics, and data science, especially as applied to the biomedical and health sciences. The Ph.D. program includes training in the application and development of methodology, consulting, teaching, and collaboration on a broad spectrum of health-related problems. The SM program includes training in designing research studies, analyzing and interpreting quantitative data, using modern computational methods, and collaboration and communication skills. There are opportunities for SM students to work with faculty on ongoing research projects and to serve as a teaching assistant for departmental courses. About sixty faculty participate in these programs.

The sections of this handbook include information and Departmental regulations concerning entrance requirements, program descriptions, degree requirements, and other Departmental policies for our Master of Science in Biostatistics programs. The Ph.D. Program is overseen by the Graduate School of Arts and Sciences and has a separate Graduate Student Handbook, whereas the SM degree is governed by the T.H. Chan School of Public Health. Policies and official requirements of the Graduate School of Arts and Sciences are set forth in the Graduate School of Arts and Sciences Handbook (http://handbook.gsas.harvard.edu/). Policies and official requirements of the School of Public Health are set forth in the Harvard T. H. Chan School of Public Health Student Handbook (https://www.hsph.harvard.edu/student-handbook/). Each graduate student is responsible for general knowledge of, and adherence to, the policies and requirements of the degree program in which the student is enrolled. Additional departmental information is available at https://www.hsph.harvard.edu/biostatistics/. Vitally important for our community is that all members demonstrate respect for each other and our discipline. For all members of the community, respect is demonstrated by attending all scheduled classes or meetings, and arriving on time, fully prepared, and ready to participate.

This handbook was prepared by the Director of Master of Science Programs and approved by the Faculty of the Department of Biostatistics. The Director is responsible for reviewing the student’s program of study, and has the authority to consider exceptions to the rules and regulations established by the Department. Recommendations of the Director are forwarded to the Chair of the Degree Program Committee for final approval. Both the Director and the Department Chair welcome suggestions and comments.
2 THE MASTER OF SCIENCE PROGRAMS

The Master of Science programs in Biostatistics train students in the basics of statistical theory, methods in planning studies, conducting analyses, and writing reports, the interpretation of numeric data for scientific inference in studies in medicine and public health, and the ability to collaborate and communicate effectively with scientists in related disciplines. Application areas include observational studies, clinical trials, computational biology and quantitative genomics, statistical genetics, and medical and public health research, among other areas.

The Department of Biostatistics offers several Master of Science programs, with the appropriate program dependent on the student’s background and interests. The two-year Master of Science (SM2) degree provides training in statistical theory and a variety of statistical, computational, bioinformatics, and data science methods for application in medicine and public health. The SM2 program is appropriate for students considering doctoral level work or Master’s level medical research positions upon completion. The one-year Master of Science (SM1) degree is designed for students with a prior graduate degree and the mathematical and statistical background sufficient to achieve a level of proficiency after one year of study comparable to that obtained in the SM2 program. The 60-credit Master of Science (SM60) degree has an applied emphasis and is designed for students seeking medical research positions in biostatistics upon completion.

All Master of Science programs in Biostatistics prepare students in four specific competencies:

1. Designing research studies in medicine and public health, including study design and population selection, sample size justification, data analysis plans, methods of data acquisition and organization, data management methods, data analysis plans, and protocol development.

2. Analyzing and interpreting quantitative data for scientific inference, including graphical and tabular displays, descriptive statistics, statistical inference, and choice of appropriate statistical software for the data analysis.

3. Using modern computational methods to effectively analyze complex medical and public health data, including regression methods, survival data analysis, bioinformatics, and statistical genetics.

4. Collaborating and communicating effectively with research scientists in related disciplines.

The SM1 and SM2 programs in Biostatistics have a fifth specific competency:

5. Using probabilistic and statistical reasoning and theory to effectively analyze non-standard problems arising in medicine and public health and assisting biostatistical researchers in the conduct of methodologic research.

The SM60 program in Biostatistics also has a fifth specific competency:

5. Disseminating new knowledge in a research discipline through the preparation of written reports of biostatistical analyses, comparison of different statistical methodologies, and oral presentation of results.

Specific program requirements are described below. Some requirements are common to all Master of Science programs, while others are specific to the degree program.

2.1 Admissions Procedures and Requirements

2.1.1 Harvard T. H. Chan School of Public Health Requirements

Application for admission to the SM program is available online on the Admissions Office website (https://www.hsph.harvard.edu/admissions/admissions/how-to-apply/application-requirements/). For information
on general requirements for admission, contact the Admissions Office by phone (617/432-1031) or through their website (https://www.hsph.harvard.edu/admissions/).

### 2.1.2 Departmental Requirements

All candidates for admission to the SM programs should have successfully completed calculus through multivariable integration and one semester of linear algebra. Knowledge of a programming language is also required. Evidence that these requirements have been fulfilled should form part of the application. In addition, applicants are encouraged to have completed courses in probability, statistics, advanced calculus, and numerical analysis. Practical knowledge of a statistical computing package such as SAS, R, Stata, or SPSS is also desirable. Additional background in advanced mathematics, regression methods, biology, and computing using a scripting language such as Python or Perl or relational databases as well as prior research experience can also be beneficial.

Students who have a Master’s degree in one of the mathematical sciences or a doctorate in a quantitative field may be qualified for a one-year SM program. To be admitted, applicants must have a mathematical and statistical background sufficient to achieve a level of proficiency after one year of study comparable to that achieved by the two-year program.

### 2.2 Advising and Degree Program Approval

#### 2.2.1 Academic Advisor

The Director of Master of Science Programs provides guidance and assistance to all Biostatistics SM students and can be approached with any questions a student may have. In addition, all entering students are assigned an academic advisor to help plan course loads and explain Departmental requirements. At the earliest possible date, the student and the academic advisor will develop a program of study. Should a student wish to change his/her academic advisor, he or she is encouraged to discuss this with the Director of Master of Science Programs. In addition, the Department and SPH provide services for all students with clinically documented learning and/or physical disabilities.

#### 2.2.2 Departmental Approval of Program

The Master’s program plan must be submitted to the Department for approval, using the Master’s Degree Program form specific to the student’s degree provided by the Department. The program must be approved by the student’s faculty advisor and the Director of Master of Science Programs. This plan should be submitted at least one semester prior to the expected graduation date for Master’s students.

#### 2.2.3 Epidemiology Requirement

The School of Public Health requires that Masters students must successfully pass one Epidemiology course. The Department requires that EPI 201 be taken to satisfy this requirement. Ordinarily, this is taken during the first semester in residence. Any change from that requires the approval of the Director of Master of Science Programs.

#### 2.2.4 Research Ethics Requirement

Students must satisfy a research ethics requirement by completing a course in responsible conduct of research or by completing an online training course during the first year in the program. Students who feel they have already completed an equivalent training program must submit adequate documentation to, and receive approval from, the Director of Master of Science Programs during the first semester in residence.

### 2.3 Satisfactory Progress Requirements

For students in the SM2 program, a minimum of 60 ordinal credits is required. For students in the SM60 program, a minimum of 45 ordinal credits is required. For students in the SM1 program, a minimum of 30
ordinal credits is required. In addition, SPH students must remain in good academic standing, must complete program requirements within the designated time to degree, and must maintain a cumulative average of 2.70 or above. All ordinal grades for courses used to satisfy Departmental requirements specified in Sections 2.4.1, 2.5.1, 2.6.1 (depending on your program) must be at the level of B- or higher. Courses taken on a pass/fail basis cannot be used to satisfy ordinarily graded Departmental requirements.

A detailed presentation of SPH’s regulations for Master’s students is found at https://www.hsph.harvard.edu/student-handbook/. All Master’s students and their advisors should make sure that SPH and Departmental requirements are met according to schedule.

2.4 Degree Requirements for the Two-Year SM (SM2) in Biostatistics

A total of 80 credits are required for the SM2 program. The SM2 program is aimed at students who are considering doctoral level work in biostatistics, statistics, bioinformatics, or allied fields such as epidemiology, environmental health, or medicine. The SM2 program is also appropriate for students seeking to take more varied and advanced courses but who are considering Master’s level medical research positions upon completion.

2.4.1 Course Requirements for the SM2 in Biostatistics

SM2 students can develop a flexible program in statistical methods, statistical theory, statistical computing, bioinformatics, and health decision sciences, depending on the student’s background and interests. Fifty credits of ordinarily graded courses must be taken from the two-year Biostatistics Master’s core (at least 35 credits must come from courses with a BST prefix), including:

BST 210 Applied Regression Analysis
BST 212 Survey Research Methods in Community Health
BST 214 Principles of Clinical Trials
BST 216 Introduction to Quantitative Methods for Monitoring and Evaluation
BST 217 Statistical and Quantitative Methods for Pharmaceutical Regulatory Services
BST 222 Basics of Statistical Inference
BST 223 Applied Survival Analysis
BST 226 Applied Longitudinal Analysis
BST 227 Introduction to Statistical Genetics
BST 228 Applied Bayesian Analysis
BST 230 Probability I
BST 231 Statistical Inference I
BST 232 Methods I
BST 233 Methods II
BST 234 Introduction to Data Structures and Algorithms
BST 235 Advanced Regression and Statistical Learning
BST 238 Advanced Topics in Clinical Trials
BST 249 Bayesian Methods in Biostatistics
BST 254 Sec 3 Measurement Error and Misclassification
BST 260 Introduction to Data Science
BST 261 Data Science II
BST 262 Computing for Big Data
BST 263 Applied Machine Learning
BST 267 Introduction to Social and Biological Networks
BST 280 Introductory Genomics & Bioinformatics for Health Research
BST 281 Genomic Data Manipulation
BST 282 Introduction to Computational Biology and Bioinformatics
BST 283 Cancer Genome Analysis
Other advanced courses in Biostatistics, including many of the special topics or Wintersession courses, and courses at MIT and the Faculty of Arts and Sciences (FAS) that are offered at an advanced level, may also be acceptable. Students are advised to consult with the Director of Master of Science Programs prior to enrolling in the courses in question.

Students can then choose electives depending on their background and interests. Students are strongly encouraged to take appropriate training in areas of application such as the biological sciences, biophysics, cancer, computational biology, environmental health, epidemiology, health policy, infectious diseases, international health, nutrition, psychiatry, social health, or other allied fields to prepare them for interdisciplinary collaborative research. Some students may wish to supplement their training by including additional courses in advanced mathematics, computer science, or other areas.

2.4.2 Culminating Experience for the SM2 in Biostatistics

SM2 students must write up a summary of a culminating research experience that has been performed beyond standard course work. This could involve activities arising from a research assistantship, summer internship, independent study, job experience while a student in the program, or related work. The summary should be approximately 5-8 double-spaced pages excluding tables, figures, and references. An alternative approach is to create a presentation of the summary material in poster or slide set form or the submission of a complete draft manuscript for which the student is the primary author.

In the summary, the student should include the development of an appropriate research question, the statement of hypotheses, development and implementation of an analysis plan, and summary of findings. The purpose is to integrate knowledge acquired in Biostatistics coursework with general knowledge in medicine and public health, to show skills in the analysis and interpretation of quantitative data using modern computational methods for non-standard problems, and to demonstrate effective collaboration and communication skills. It is important for the written summary or other alternative materials to demonstrate each of these competencies.

The due date is the first of the month approximately 6-8 weeks prior to the graduation date (e.g., April 1 for May graduates). The summary will be reviewed by a committee of three faculty members, chaired by the Director of Graduate Studies. The focus of the review will be the demonstration of the competencies above. A written evaluation will be provided to the student. The Director of Graduate Studies can be consulted if there are any questions regarding this culminating research experience summary.

2.5 Degree Requirements for the 60-credit SM (SM60) in Biostatistics

The SM60 program has an applied emphasis and is geared toward students with an undergraduate degree in one of the mathematical sciences or an allied field (e.g., biology, psychology, or economics). At least 40 credits of course work are required, including 20 credits of required courses and a minimum of 15 credits of elective Biostatistics courses. The program culminates with a Master’s thesis and oral defense, summarizing work accomplished during a collaborative research practicum. The SM60 program is aimed at students seeking a terminal Master’s degree. Typically of 17 months duration (though dependent on how long the
student takes to finish and defend their Master’s thesis), the focus of the SM60 program is on training graduates for applied biostatistics positions involving medical or epidemiologic research in academic hospitals, universities, research organizations, and the pharmaceutical and biotechnology industries.

### 2.5.1 Course Requirements for the SM60 in Biostatistics

A total of 60 credits are required for the SM60 degree. SM60 students follow a structured program of required courses, and then choose electives depending on the student’s background and interests. Specific requirements of this program include the following 20 credits of required ordinally graded courses:

- **BST 210** Applied Regression Analysis
- **BST 222** Basics of Statistical Inference
- **BST 223** Applied Survival Analysis
- **BST 226** Applied Longitudinal Analysis

In addition, students select a minimum of 15 credits of ordinally graded courses in Biostatistics to round out their program. At least 10 of these credits should have a BST prefix and a at most 5 of these credits can come from relevant courses in computer science, risk and decision sciences, statistics, or quantitative epidemiology, with the approval of the Director of Master of Science Programs, and students are advised to consult with him prior to enrolling in the courses in question.

### 2.5.2 Thesis Requirements for the SM60 in Biostatistics

An SM60 student must complete a 10-20 credit ordinally graded Master’s Thesis and Collaborative Research Practicum (BST 325), usually taken after the required course work has been completed. This will typically involve data analysis for a research project under the direction of one or more mentors. The project could be supervised primarily by a faculty member in Biostatistics, or co-supervised by a doctoral-level investigator (at Harvard or elsewhere) and a faculty member in Biostatistics.

In this Collaborative Research Practicum, a student will perform activities related to the design, conduct, and analysis of research studies with a focus on data analysis and scientific presentation. The student will carry out an extensive data analysis, often including data summaries and graphical displays, regression methods, data interpretation, and comparison of alternative methods. Usually these projects will involve interacting with a group of people with varied disciplinary backgrounds. The student will then write a Master’s thesis of approximately 20-25 double-spaced pages excluding tables, figures, and references that describes the medical or public health problem of interest, summarizes the appropriate data analyses, and provides a scientific interpretation of the data, in a standard scientific writing style. The student will also orally present this work in a seminar of approximately 30 minutes in length. The Master’s thesis and oral presentation will primarily be the work of the student, with only advisory input from the mentor(s). This work serves as the Culminating Experience for SM60 students.

The Master’s thesis and oral presentation will be evaluated by a review committee consisting of three members. The members will include the student’s Practicum mentor(s), the Director of Master of Science Programs, and other Biostatistics faculty members or surrogates as needed. The Master’s thesis must be submitted to the review committee at least two weeks prior to the oral presentation. A written evaluation will be provided to the student.

### 2.6 Degree Requirements for the One-Year SM (SM1) in Biostatistics

Students who have a Master’s degree in one of the mathematical sciences or a doctorate in a quantitative field may be qualified for the one-year Master’s program. To be admitted, applicants must have a mathematical and statistical background sufficient to achieve a level of proficiency after one year of study comparable to that achieved by the two-year program.
2.6.1 Course Requirements for the SM1 in Biostatistics

A total of 42.5 credits are required for the one-year Master’s program. A minimum of 25 credits of ordinally graded courses must be taken from the one-year Biostatistics Master’s core, including:

- BST 214 Principles of Clinical Trials
- BST 216 Introduction to Quantitative Methods for Monitoring and Evaluation
- BST 217 Statistical and Quantitative Methods for Pharmaceutical Regulatory Services
- BST 222 Basics of Statistical Inference
- BST 223 Applied Survival Analysis
- BST 226 Applied Longitudinal Analysis
- BST 227 Introduction to Statistical Genetics
- BST 228 Applied Bayesian Analysis
- BST 230 Probability Theory and Applications I
- BST 231 Statistical Inference I
- BST 232 Methods I
- BST 233 Methods II
- BST 234 Introduction to Data Structures and Algorithms
- BST 235 Advanced Regression and Statistical Learning
- BST 238 Advanced Topics in Clinical Trials
- BST 249 Bayesian Methods in Biostatistics
- BST 254 Sec 3 Measurement Error and Misclassification
- BST 260 Introduction to Data Science
- BST 261 Data Science II
- BST 262 Computing for Big Data
- BST 263 Applied Machine Learning
- BST 267 Introduction to Social and Biological Networks
- BST 280 Introductory Genomics & Bioinformatics for Health Research
- BST 281 Genomic Data Manipulation
- BST 282 Introduction to Computational Biology and Bioinformatics
- BST 283 Cancer Genome Analysis
- BST 290 Advanced Computational Biology and Bioinformatics

Other advanced courses in Biostatistics, including many of the special topics or Wintersession courses, and courses at MIT and the Faculty of Arts and Sciences (FAS) that are offered at an advanced level, may also be acceptable, provided that least 20 credits come from courses with a BST prefix. Students are advised to consult with the Director of Master of Science Programs prior to enrolling in the courses in question.

2.6.2 Culminating Experience for the SM1 in Biostatistics

SM1 students must write up a summary of a culminating research experience that has been performed beyond standard course work. This could involve activities arising from a research assistantship, summer internship, independent study, job experience while a student in the program, or related work. The summary should be approximately 5-8 double-spaced pages excluding tables, figures, and references. An alternative approach is to create a presentation of the summary material in poster or slide set form or the submission of a complete draft manuscript for which the student is the primary author.

In the summary, the student should include the development of an appropriate research question, the statement of hypotheses, development and implementation of an analysis plan, and summary of findings. The purpose is to integrate knowledge acquired in Biostatistics coursework with general knowledge in medicine and public health, to show skills in the analysis and interpretation of quantitative data using modern computational methods for non-standard problems, and to demonstrate effective collaboration and communication skills. It is important for the written summary or other alternative materials to demonstrate each of these competencies.
The due date is the first of the month approximately 6-8 weeks prior to the graduation date (e.g., April 1 for May graduates). The summary will be reviewed by a committee of three faculty members, chaired by the Director of Graduate Studies. The focus of the review will be the demonstration of the competencies above. A written evaluation will be provided to the student. The Director of Graduate Studies can be consulted if there are any questions regarding this culminating research experience summary.

2.7 Biostatistics SM Program for Students in Another SPH SD Program

In certain cases, the Department may entertain applications for an SM1 or SM2 program in Biostatistics from students already enrolled in another SPH SD program. The student would need to meet the eligibility requirements for the SM1 or SM2 program and would be required to fulfill the SM degree requirements described above, following all SPH student guidelines. Further information is available from the Director of Master of Science Programs.
A  MASTERS DEGREE FORMS

- **Biostatistics SM2 Degree Program Form**
  https://content.sph.harvard.edu/biostats/publications/bio-sm_handbook/SM2_Degree_Form_BIO.pdf

- **Biostatistics SM60 Degree Program Form**
  https://content.sph.harvard.edu/biostats/publications/bio-sm_handbook/SM60_Degree_Form.pdf

- **Biostatistics SM1 Degree Program Form**
  https://content.sph.harvard.edu/biostats/publications/bio-sm_handbook/SM1_Degree_Form.pdf

- **Biostatistics SM60 Thesis Committee Nomination Form**

- **Biostatistics SM60 Thesis Defense Scheduling Form**