

# The University of North Carolina at Chapel Hill Department of Biostatistics

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## Introduction

The Department of Biostatistics in the Gillings School of Global Public Health has a distinguished past, a celebrated present, and bright future. With a commitment to groundbreaking research, excellence in training students, and public health service, the department has established its role as a leader in the biostatistics community. The department is committed to its mission “to forge dramatic advances in health science research that benefit human health in North Carolina, the US and globally, through the development of profound and paradigm-shifting innovations in biostatistical technology and the thoughtful implementation of biostatistical methodology to solve public health problems” (The University of North Carolina at Chapel Hill Department of Biostatistics [2011](#)).

## Greenberg Years (1949–1972)

The Department of Biostatistics was established in 1949 through the Institute of Statistics as a joint venture between the Departments of Statistics at the University of North Carolina (later renamed The University of North Carolina at Chapel Hill (UNC-CH)) and North Carolina State College at Raleigh (later renamed North Carolina State University (NCSU)). The original mission of the department was to offer public health statistics courses in the UNC-CH School of Public Health

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(SPH), to provide consulting services and to perform research in public health statistics. Drs. Gertrude Cox and Harold Hotelling were instrumental in the formation of the Department of Biostatistics and selected Dr. Bernard Greenberg to lead the new department (Nourse 1978). Greenberg, a recent graduate from North Carolina State College with a doctorate in experimental statistics, was only 29 years old when he was appointed as chairman.

Although degree programs were not initially part of the department's mission, the role was soon expanded to include graduate degrees. The first student graduated with a Master of Public Health (MPH) in 1951, and the first Master of Science in Public Health (MSPH) soon followed. Prior to 1965, doctoral students fulfilled their coursework requirements at either the Department of Statistics at North Carolina State College or the Department of Statistics at UNC-CH. The dissertation of a biostatistics student could be directed by faculty members in any of the three departments. These first PhD degrees were conferred beginning in 1953 as joint degrees. Dr. Harry Smith was the first student to receive a joint PhD degree. Smith subsequently had a distinguished career in the department before becoming Chairman of the Department of Biomathematical Sciences at Mt. Sinai School of Medicine. The SPH awarded PhD degrees in Public Health with an emphasis on Biostatistics during the 1950s and 1960s. Dr. Ahmed Sarhan, coauthor of the monograph *Contributions to Order Statistics*, was the first graduate from this program in 1955. In 1965, the department was authorized to grant the PhD in Biostatistics degree. The Master of Science (MS) degree in Biostatistics was initiated in 1969, followed by the DrPH degree in Biostatistics in 1970.

In its first two decades, the department pioneered efforts to establish the practice of cooperative multicenter trials. The National Cancer Institute awarded the department a contract in 1955 to become the statistical coordinating center for the Southeastern Cooperative Cancer Chemotherapy Study Group (SCCCS). Faculty from ten medical schools and the coordinating center, under the direction of Greenberg and Dr. James Grizzle, collaborated to investigate the effectiveness of chemotherapy agents. Research at the SCCCS led to the examination of the two-period crossover design and showed the limitations of its use in clinical trials (Grizzle 1965). A subsequent Veterans Administration grant supported research that introduced randomization of surgical procedures in the treatment of duodenal ulcers and led to important findings in the treatment of the condition. Greenberg published the well-known, first article regarding the design and conduct of collaborative clinical trials in the *American Statistician* in 1959. In 1967, Greenberg chaired the committee commissioned by the National Heart Institute of the National Institutes of Health (NIH) to develop procedures for conducting large, multicenter, clinical trials. The Greenberg Report (1967) is widely considered the landmark paper in this area. Another highly influential clinical trials paper (Freiman et al. 1978) exposed the widespread problem of under-powered trials.

The department grew rapidly in the 1950s with respect to faculty, students, space, and funding. However, Greenberg commented, "as additional burdens and responsibilities have mounted geometrically, there has been only an arithmetic increase in funds available for personnel" (Korstad 1990, p. 87). In 1953, the

National Heart Institute of the NIH awarded one of the first training grants to the department to train biostatisticians as health consultants. As part of this grant and others, the department was able to attract distinguished visiting professors such as David Cox, J.O. Irwin, David Duncan, David Newell, Ahmed Sarhan, Herbert David, Robert Elston, and Ruben Gabriel, some of whom remained at UNC-CH as faculty.

Greenberg was a visionary with respect to human rights as well as racial and gender equality. In the mid-1960s, as racial demonstrations and student unrest were common, Greenberg communicated the department's commitment to racial equality by encouraging students to patronize only integrated establishments. He recruited talented female biostatisticians including Regina Elandt-Johnson, Elizabeth Coulter, and Mindel Sheps.

Two special sessions in the summers of 1963 and 1964 were extremely successful in training biostatistics students. Biostatistics courses were taught by prestigious faculty, including Byron Brown, Herbert David, Daniel Horvitz, Robert Elston, Carl Erhardt, and David Newell. More than 100 students participated in these programs each summer including Drs. Clarence (Ed) Davis (future Department Chair), Gary Koch, Daniel Solomon (future Chair of the Department of Statistics and, later, Dean of School of Physical and Mathematical Sciences at NCSU), and O. Dale Williams.

Dr. Pranab K. Sen accepted an offer to join the faculty at UNC-CH in 1965. Sen remarked, "Eventually, I realized that UNC was one of the best places for statistics in America, if not the world, and by being here I could not only strengthen my background but develop additional ties with Indian schools." (Ghosh and Shell 2008, pp. 555–556). With more than 600 publications in the biostatistics and statistics literature, Sen is an internationally celebrated author of books and articles in nonparametric statistics, large sample methodology, and sequential analyses. He was named the Cary C. Boshamer Distinguished Professor of Biostatistics in 1982. In 2010, Sen received the Samuel S. Wilks award, one of the ASA's most prestigious awards, for his pioneering contributions to statistics, including exceptional mentoring of several generations of doctoral students. Figure 1 shows the faculty shortly after Sen's hiring.

The NIH awarded the department, jointly with the Department of Statistics at UNC-CH, a grant to develop methodology related to multivariate analysis in the mid-1960s. The grant provided support leading to many important papers in crossover designs, dose response curves, and categorical data by researchers Grizzle, Koch, and Sen within the department and other colleagues outside the department (V.P. Bhapkar, S.N. Roy, C.F. Starmer). The development of statistical software for multivariate analysis of variance, categorical data analysis, and multivariate nonparametric methods also resulted from this grant.

Two training grants, in Environmental Statistics and Demography, were awarded to the department in 1971. Dr. Lawrence L. Kupper, who joined the faculty in 1970, played a prominent role in obtaining the Environmental Training Grant, which has been continuously funded by the National Institute of Environmental Health Sciences for more than 38 years. From 1972 to 2006, Kupper served



**Fig. 1** UNC-CH Department of Biostatistics, 1960s. Front Row: Robert Elston, Roy Kuebler, Elizabeth Coulter, Bernard Greenberg, Regina Elandt-Johnson, Forrest Linder, Dana Quade. Back Row: Herbert David, James Grizzle, Pranab K. Sen, Jay Glasser, Tony Lachenbruch, Harry Smith, Ruben Gabriel, Bradley Wells, Tom Donnelly

as the Director of the training grant which has supported hundreds of students with as many as 20 predoctoral and 8 postdoctoral students per year receiving support. The Demography Training Grant, directed by Dr. Chirayath Suchindran, was continuously funded for more than 30 years supporting many highly qualified trainees in population studies. Other training grants awarded during this period included the mental health training grant and the health services research grant.

Faculty members hired under Greenberg included Drs. Roy Kuebler and Ronald Helms. Kuebler, a beloved instructor, strengthened educational aspects in the program and was recognized with the first McGavran Teaching Award in 1975. During his academic career which spanned more than 30 years, Helms made important contributions in statistical methods and multiple collaborative areas such as sickle cell disease, asthma, and mental health. He cofounded Rho, a well-respected contract research organization, which continues to expand, and provide training opportunities for current graduate students.

Also hired during this period and making significant contributions were: Drs. Edmund Gehan, Thomas Donnelly, Bradley Wells, Bernard Pasternack, Dana Quade, Herbert David, James Abernathy, Peter Lachenbruch, Forrest Linder, Donna Brogan, Michael Symons, Lawrence Kupper, and David G. Kleinbaum.

When Greenberg went on to serve as the dean of the SPH at UNC-CH (from 1972 to 1982), the department had approximately 30 full-time faculty. In 1983,

Greenberg received the O. Max Gardner Award, awarded to one faculty member across all UNC campuses, for contributions to the welfare of the human race.

## Grizzle Years (1972–1987)

In 1972, when Dr. James Grizzle was appointed chair, the department “was by far the largest of its kind in the world, both in the size of its faculty and the number of students” (The Body Politic, Jan. 1973, p. 6). Grizzle, who joined the faculty in 1960, became well known for his research in randomized controlled trials (Ruffin et al. 1969), and in weighted least squares analysis of categorical data (Grizzle et al. 1969).

Prior to becoming chair, Grizzle was instrumental in securing an NHLBI award for the department to serve as the coordinating center for the Lipid Research Clinics Program (LRC; 1971–1990). This award strengthened the department’s leadership role in setting the standards for the coordination of large, multicenter studies, particularly in the areas of study design, data management, and statistical analysis. Grizzle was principal investigator (PI) of the original LRC coordinating center. He was succeeded by Drs. O. Dale Williams (1976–1990), Clarence Edward (Ed) Davis (1991–1997), Lloyd (Woody) Chambless (1997–2005), and Lisa LaVange (2005–present). Notable among the early LRC studies coordinated by the center is the Coronary Primary Prevention Trial (CPPT), which was the first major randomized controlled clinical trial to show that lowering cholesterol reduced mortality (JAMA 1984). The LRC Coordinating Center, renamed the Collaborative Studies Coordinating Center (CSCC) in 1986, is the oldest, continuously funded NIH Coordinating Center in the US, and has coordinated numerous studies involving hundreds of clinical centers throughout the US and the world. The longest-running such study is the NHLBI-funded Atherosclerosis Risk in Communities Study (ARIC), begun in 1986 and ongoing today. A cohort of over 15,000 persons, aged 45–64 years, living in four community areas across the US have been followed in ARIC to determine the incidence and risk factors of cardiovascular disease. Two other major studies administered through the CSCC with considerable public health impact include SOLVD (Studies of Left Ventricular Dysfunction, which examined the role of ACE inhibitors in reducing mortality in heart failure patients) and ACAS (Asymptomatic Carotid Atherosclerosis Study, which evaluated the efficacy of carotid endarterectomy in the reduction of stroke among asymptomatic atherosclerosis patients). In addition to innovations in statistical methods for multicenter studies, the CSCC has been an innovator in the field of data management, implementing remote data entry (1986) for the first time in an NIH multicenter study and developing Internet-based data management and tracking systems (2001).

The department is believed to be the first department of biostatistics to offer an undergraduate degree. Dr. Maura Stokes was the first recipient of this undergraduate degree in 1978 and went on to earn her doctoral degree in the department.

The Bachelor of Science in Public Health (BSPH) program, directed by Dr. Craig Turnbull until 2006, has graduated more than 200 talented students many of whom have pursued medical degrees or advanced degrees in biostatistics.

The field of demography became a departmental strength with significant contributions by Drs. Mindel Sheps, Forrest Linder, Bradley Wells, James Abernathy, and Chirayath Suchindran. The Laboratories for Population Statistics (POPLAB), begun in the late 1960s under the direction of Dr. Forrest Linder and funded by the Agency for International Development, conducted projects in the Philippines, Turkey, Ecuador, Kenya, Morocco, Indonesia, Mexico, Somalia, and Columbia. This cooperative project between the SPH and Carolina Population Center implemented new field survey methods for measuring birth rates and population growth in regions of the world where conducting a census of the population was not feasible.

In 1974, Dr. Gary Koch moved from Rosenau Hall to join Dr. Dennis Gillings and other young faculty in a temporary location, known as “Trailer 39.” The friendship and collaborative relationship that Gillings and Koch established in that environment drew students eager to work with these remarkable faculty members. As a former graduate student recalls, “the trailer, as everyone called it, wasn’t just a place to work—it felt like family.” (Spivey 2008, p. 25).

Koch joined the faculty of the Department of Biostatistics in 1967 even before completing his doctorate. “He was sort of a phenomenon as a graduate student because he was writing papers that were appearing in *Biometrics*,” (Spivey 2008, p. 24) according to Grizzle who hired Koch. Koch quickly established himself as an expert in the methodology of multivariate categorical data. For example, the research paper regarding the kappa statistic has been referenced more than 13,000 times (Landis and Koch 1977). In 1974, Koch received the Spiegelman Award given each year to an outstanding biostatistician under age 40. The Biometric Consulting Lab (BCL), directed by Koch since the mid-1980s, has provided biostatistical consulting services for investigators and training opportunities for biostatistics students. With more than 400 peer-reviewed publications, his legacy could easily be his contributions to the statistical literature; however, in addition to his exceptional research record, he has also had extraordinary impact as a mentor which was recognized in 2007 with the SPH Larsh Award for Mentorship. After more than 40 years of legendary mentoring, the Koch “student family” of former graduate students reaches around the world.

Gillings was recruited in 1971 for his contributions in Health Services Research. Together with Koch and the students of “Trailer 39,” Gillings consulted on the design and analysis of clinical trials for pharmaceutical companies and developed statistical methods for drug development. The consulting work that began in the cramped environment of the trailer led to the creation of Quintiles, which was incorporated in 1982. Gillings left the faculty in 1988 to lead Quintiles full-time. Quintiles Transnational is currently the world’s largest contract research organization with an annual revenue in excess of \$2 billion and more than 20,000 employees worldwide.



**Fig. 2** UNC-CH Department of Biostatistics, 1980s. (left to right) Marjolein Smith, Paul Stewart, Michael Symons, Dick Bilsborrow, Ed Davis, Dick Shachtman, Larry Kupper, Gary Koch, Pranab Sen, Dennis Gillings, Muhammed Habib, Bill Kalsbeek, David Kleinbaum, Kinh Troung, Shrikant Bangdiwala, Jim Knoke, Elizabeth Coulter, Jim Abernathy, Jim Grizzle, Chirayath Suchindran, Jim Hosking, Joe Janis, David Christiansen

Internationally recognized genetics expert, Dr. Robert Elston served on the faculty from 1960 to 1979. Known for the Elston–Stewart algorithm, he has coauthored several books on genetic epidemiology and biostatistics as well as trained many of the present-day leading statistical geneticists. Elston proceeded to become the chairman at Louisiana State University and then Case Western Reserve University. His departure left a void in the department’s genetics program not addressed for nearly 20 years.

Dr. Lawrence Kupper, Alumni Distinguished Professor of Biostatistics, coauthored several books including *Applied Regression Analysis and Other Multivariable Methods* which has been adopted for use by approximately 100 universities. In addition to serving as the Director of the Environmental Training grant, the largest and most successful training program of its kind in the world, his many contributions included authoring or coauthoring more than 160 peer-reviewed articles. His research included statistical applications in epidemiology, environmental, occupational, and women’s health. Kupper earned many awards for teaching and mentoring including two university-wide awards: the UNC-CH Distinguished Teaching Award for Post-Baccalaureate Instruction (1996) and the UNC-CH Mentor Award for Lifetime Achievement in Teaching and Mentoring (2007).

Other faculty members hired in this period included Drs. Clarence (Ed) Davis, Chirayath Suchindran, Richard Bilsborrow, Richard Shachtman, O. Dale Williams,

William Kalsbeek, Shrikant Bangdiwala, James Hosking, Lloyd (Woody) Chambliss, Keith Muller, Paul Stewart, and Young Kinh-Nhue Truong (Fig. 2).

This period saw the beginning of the annual back-to-school picnics held at the Grizzle farm that are fondly remembered for good food, hayrides, music, and volleyball games. These social events, attended each year by approximately 150 students, faculty, staff and their families, continued for the 15 years that Grizzle served as chair.

## **Margolin Years (1987–1997)**

After leading the statistical methodology section at the National Institute of Environment Health Sciences, Dr. Barry Margolin was hired as professor and chair in 1987. Margolin also served as the Director of the biostatistics facility of the UNC-CH Lineberger Cancer Center beginning in 1989. Margolin was an energetic student advocate, successfully lobbying for more office space, and better computing resources for the biostatistics graduate students. He placed a high priority on student funding for promising graduate students, strengthening the funding structure. Margolin was also a strong faculty advocate, successfully nominating several faculty members for ASA Fellow awards.

The Survey Research Unit (SRU) was established in 1990 under the direction of Dr. William Kalsbeek with the primary emphasis on specialized sampling plans and data collection. Since its inception, the SRU has been involved in approximately 300 projects ranging from the evaluation of triage procedures in emergency rooms to the investigation of teen dating behaviors. Kalsbeek has led the unit in applying state-of-the-art principles in conducting population-based research and in training students in the design, data collection, and analysis of survey studies.

Linear models research was strengthened during Dr. Keith Muller's more than 25 years of service to the department. He made valuable contributions in multiple areas including first authorship of two books, *Regression and ANOVA: An Integrated Approach using SAS Software* (Muller and Fetterman 2002) and *Linear Model Theory: Univariate, Multivariate and Mixed Models* (Muller and Stewart 2006). A respected mentor and teacher, much of his research focused on linear and nonlinear repeated measures models, medical imaging, and the development of software for power analysis.

The department has long endeavored to hire and graduate underrepresented minority biostatisticians. One of the first African-American female biostatistics faculty members, Mildred Francis, was hired in the early 1970s. Successful summer programs for minorities were instituted in late 1970s and early 1980s. Notable African-American graduates of the department include Delton Atkinson, George Bonney, Dubois Bowman, Randy Davis, Lloyd Edwards, Alula Hadgu, and Jean Orelie.

In 1990, Dr. Lloyd Edwards joined the department and made contributions in mixed model theory and applications, longitudinal data analysis, and clinical trials.

Dr. Bahjat Qaqish also joined the faculty in 1990, strengthening the department's research areas of generalized linear models and statistical computing. Increased emphasis on environmental statistics was accomplished in recruiting Dr. Haibo Zhou in 1997. With research contributions in missing data, respiratory diseases, and fertility modeling, Zhou serves as the Director of the Biostatistics Core for the Center for Environmental Medicine, Asthma and Lung Biology at UNC-CH and is a five-term associate editor for *Biometrics*.

By recruiting Dr. Jianwen Cai in 1992, the department's emphasis on survival analysis research was enhanced. A prolific researcher in multivariate failure time and recurrent event data, she has served as associate editor for *Biometrics*, *Lifetime Data Analysis*, and *Statistics in Biosciences*. Cai has been recognized not only for her research and service, but also for teaching through the 2004 McGavran Award for Excellence in Teaching. In 2006, Cai served as interim chair of the department and currently serves as Associate Chair.

### **Davis Years (1997–2005)**

Dr. Clarence (Ed) Davis had been recruited to the department in 1972 by Grizzle. Davis became well known for research in clinical trials and cardiovascular disease epidemiology. He taught courses in clinical trials and public health research in more than 15 countries including an 11-year collaboration between the SPH and the University of Chile at Santiago. He served as the Director of the CSCC from 1991 to 1997 before being named the fourth chair of the department in 1997.

Under the direction of Davis, the faculty research productivity increased dramatically, including significant growth in the number of publications in the most prestigious methodological, as well as collaborative journals. Davis was also instrumental in recruiting talented women faculty members, increasing the number of female faculty from two to nine.

Recruiting several talented genetics faculty during this period reestablished the department's position in statistical genetics. Dr. Fred Wright joined the department in 2002 and directs the Carolina Environmental Bioinformatics Center. His research focus includes gene expression and controlling errors in multiple testing. In 2001, the department recruited Dr. Fei Zou, an accomplished researcher in statistical genetics with expertise in linkage analysis and genomics.

Davis was successful in procuring the department's first endowed chair and recruited Dr. Danyu Lin as the first Dennis Gillings Distinguished Professor of Biostatistics in 2001. The position was endowed by former faculty member, Dr. Dennis Gillings. With more than 120 peer-reviewed publications, Lin is an internationally recognized expert in survival analysis as well as statistical methods and software for genetic studies. Lin was the 1999 recipient of the Spiegelman Gold Medal. Some of his methods are used in several commercially available statistical software packages including SAS, S-Plus, and Stata. Lin has served as an associate

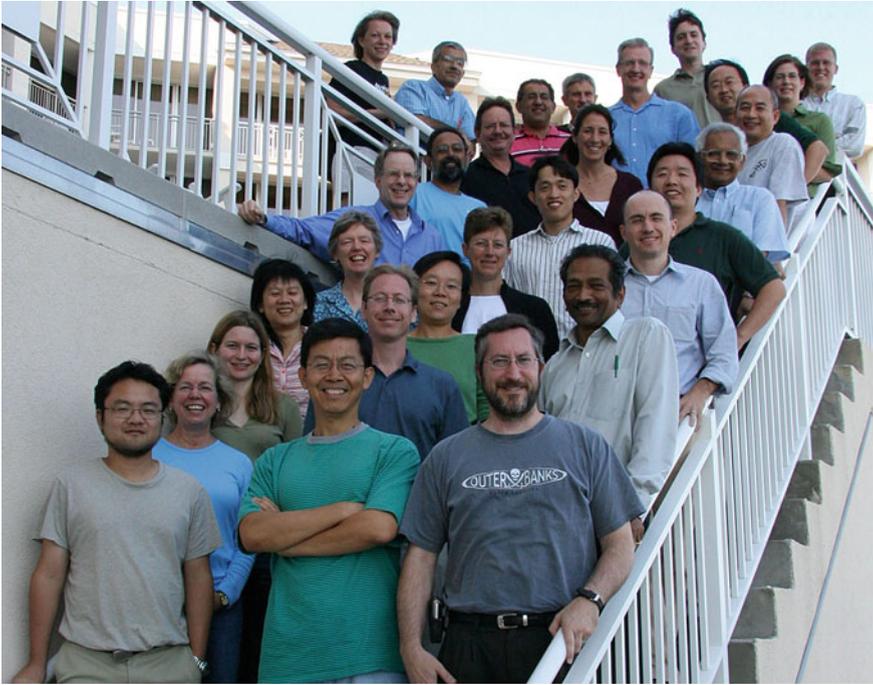
editor of *Biometrika* since 1999 and been named in the Thomson ISI (Institute for Scientific Information) list of Highly Cited Researchers in Mathematics.

Research emphasis in Bayesian statistics within the department was significantly strengthened with the recruitment of Dr. Joseph Ibrahim, in 2002. Ibrahim, Alumni Distinguished Professor of Biostatistics, has authored or co-authored two books, *Bayesian Survival Analysis* and *Monte Carlo Methods in Bayesian Computation*, and more than 160 peer-reviewed articles, most in the premier statistical journals. In addition to interests in Bayesian statistics, he has also expanded the department's focus on genomics and missing data. He directs the Biostatistics and Data Management Core at UNC'S Lineberger Comprehensive Cancer Center and has served as the Director of Graduate Studies since 2003.

Many faculty additions (including Drs. Anastasia Ivanova (1999), Amy Herring (2000), Donglin Zeng (2001), and Lisa LaVange (2005)) during this period have impacted the direction of the department. Clinical trials research was expanded by Ivanova, whose particular focus is on adaptive and dose-finding designs. She has worked with researchers at the UNC-CH Lineberger Comprehensive Cancer Center to improve efficiency of oncology clinical trials. Herring has made research contributions in longitudinal analysis, missing data, and Bayesian methods as well as in collaborative areas of environmental and reproductive health. She was the 2011 President of the Eastern North American Region of the International Biometric Society (ENAR), following in the footsteps of Grizzle (1973), Koch (1979), and LaVange (2007). Zeng's research contributions include semiparametric inference for censored data, medical imaging, and empirical processes. In 2008, Zeng was awarded the American Statistical Association's Noether Young Scholar Award presented for contributions in nonparametric statistics to an accomplished statistician under age 35. LaVange joined the department as the first Professor of the Practice of Biostatistics. With more than 25 years' experience, she previously held leadership positions in several nonprofit and pharmaceutical industries, including serving as Vice President of Biostatistics at Quintiles. Additional faculty members hired in this period included Drs. Diane Catellier, David Couper, John Preisser, Todd Schwartz, Jane Monaco, and Michael Hudgens.

### **Kosorok Years (2006–Present)**

Dr. Michael Kosorok joined the department as professor and chair in 2006. Prior to joining the department, Kosorok was a faculty member at the University of Wisconsin–Madison. He established a new research area within the department in theoretical and applied methods in empirical processes. He is the author of *Introduction to Empirical Processes and Semiparametric Inference* with other research endeavors in semiparametric methods with applications to clinical trials, personalized medicine, cystic fibrosis, and cancer. He was a coauthor on a publication (Farrell et al., 1997) which was instrumental in changing public health policy that resulted in neonatal screening for cystic fibrosis in all 50 states.



**Fig. 3** UNC-CH Department of Biostatistics, Wrightsville Beach Retreat 2008. *Left column:* Hongtu Zhu, Lisa LaVange, Amy Herring, Jianwen Cai, Kathy Roggenkamp, Richard Bilsborrow, Shrikant Bangdiwala, Paul Stewart, Joseph Ibrahim, David Couper. *Center column:* Haibo Zhou, Fred Wright, Fei Zou, Rosalie Dominik, Wei Sun, Diane Catellier, William Kalsbeek, Jason Fine. *Right column:* Michael Kosorok, Chirayath Suchindran, Michael Hudgens, Haitao Chu, Pranab Sen, Kinh Truong, Danyu Lin, Jane Monaco, Todd Schwartz. *On the Rail:* Anastasia Ivanova, Bahjat Qaqish

Expansion of the genomics, statistical genetics, and imaging research areas has continued under Kosorok's leadership with the hiring of multiple tenured and tenure-track faculty members, including Drs. Jason Fine, Wei Sun, Hongtu Zhu, and Michael Wu. Fine and Zhu both have over 100 publications and have made internationally recognized contributions in biostatistics. Fine's contributions are in areas of survival analysis, diagnostic imaging, and epidemiological methods; Zhu's contributions are in brain imaging and other biostatistical methods (Fig. 3).

Preparing students for leadership positions in academia, private industry, and government continues to be a primary focus of the department. The department offers five degree programs: BSPH, MPH, MS, DrPH, and PhD. The Environmental Training Grant has been continuously funded for almost 40 years and is a crucial program in supporting students. The Genomics Training Grant provides support and training opportunities for highly qualified doctoral students in statistical genomics with an emphasis on cancer genomics. The Initiative for Maximizing

Student Diversity (IMSD) targets underrepresented students in an effort to increase diversity among doctoral level biostatisticians. As part of this initiative, Dr. Lloyd Edwards, co-principal investigator, mentors underrepresented PhD students and facilitates collaboration between biomedical and biostatistics graduate students.

The BSPH Program continues to be a unique, notable program which graduates a small number of highly qualified students. Dr. Jane Monaco has been the Director of the undergraduate program since 2006. A recent (2008) external departmental review noted, "...the BSPH is also a treasure in its own right.... both programs [BSPH and DrPH] are in fact small jewels in the Department's crown."

The Center for Innovative Clinical Trials (CICT) was established in 2007 as part of a gift by Joan and Dennis Gillings of \$50 million to the Gillings School of Global Public Health. The interdisciplinary focus of the center, directed by Dr. Joseph Ibrahim, provides a mechanism to accomplish methodological and applied research in the design and analysis of clinical trials for faculty in several departments at UNC-CH in addition to researchers from the industry. By providing predoctoral and postdoctoral support, students have opportunities to study and to advance statistical methods in clinical trials. The five components of the CICT are methodological research, applied interdisciplinary research, education, outreach to industry, and evaluation of clinical trials methods.

Important departmental units include the Biometric Consulting Lab (BCL), the Collaborative Studies Coordinating Center (CSCC), and the Survey Research Unit (SRU). The BCL continues to provide consultation to investigators while offering students training and funding opportunities. The CSCC currently coordinates more than a dozen large multicenter studies and employs approximately 90 faculty, staff, and students. With annual expenditures over \$12 million, the center serves as a valuable environment for research, teaching, and public service. The long-running ARIC (Atherosclerosis Risk in Communities Study) alone has produced more than 1,000 publications to date under the leadership of Dr. Chambless. The Hispanic Community Health Study, awarded in 2006 and recently completing enrollment of 16,000 US Hispanics/Latinos, is the largest study funded to date of this important and fast-growing minority population. Led by Dr. LaVange, this study seeks to evaluate risk factors and determine disease prevalence among US Hispanics/Latinos. The SRU uses state-of-art technology and methodology to conduct surveys at local, state, and national levels. Dozens of population-based studies are conducted each year at the SRU by survey specialists and student research assistants who contribute in the aspects of sampling design, data collection, and complex survey analysis.

Current and former faculty, students, staff, and administrators from across the world gathered to celebrate the sixtieth anniversary of the Department of Biostatistics in October, 2009. The 5-day celebration included a "Festschrift" in honor of Dr. Gary Koch and was attended by more than 300 people.

In 2009, the National Cancer Institute awarded a \$12.5 million, 5-year grant to design more effective clinical trials for cancer patients. Led by principal investigators, Kosorok, Dr. Marie Davidian at NCSU, and Dr. Stephen George at Duke University, "Statistical Methods for Cancer Clinical Trials" will develop new

techniques for improving design and analysis of clinical trials and discovering and evaluating personalized cancer therapies. This grant has been successful in increasing cooperation and goodwill among statistical and biostatistical researchers at UNC-CH, NCSU, and Duke.

In 2010, the department comprised 36 primary faculty members, 9 joint faculty, 15 adjunct faculty, 68 staff, and 177 students (24 BSPH, 11 MPH, 24 MS, 29 DrPH, and 89 PhD). *U.S. News & World Report* ranked the Department of Biostatistics tied at tenth among doctoral programs in statistics in 2010. Only three departments of biostatistics were ranked higher. Among the current primary faculty members, 15 have been elected ASA fellows, and 7 have been elected IMS fellows.

A particular strength of the department is its physical location near the Research Triangle Park (RTP) within several miles of NCSU and Duke University, numerous pharmaceutical companies, government agencies, nonprofit agencies, and contract research organizations. The roots of many of these units can be traced to early efforts by Cox (NCSU and RTI), Greenberg, and Hotelling (UNC-CH Statistics) and the collaborative relationships across the three respective departments. Examples of nonacademic organizations in RTP include SAS, Research Triangle Institute, GlaxoSmithKline, Quintiles, Rho, Research Triangle Institute, PPD, NIEHS, EPA, FHI, National Institute of Statistical Science (NISS), and the Statistical and Applied Mathematical Science Institute (SAMSI). This proximity provides abundant opportunities for collaborative efforts for faculty and employment potential for students.

The current direction of the department builds on the successes achieved during a rich history and intensifies the commitment to lead in research, teaching, and service. The department continues to emphasize the synergy of collaborative and methodological research. Areas of current strength are recognized in statistical genetics, clinical trials, Bayesian statistics, imaging, longitudinal data, epidemiological methods, survival analysis, high-dimensional data, and semiparametric modeling. Growth is anticipated in statistical computing, personalized medicine, high dimensional data analysis, and environmental and spatio-temporal modeling. The department embraces its role as a training ground for talented students with an expanded curriculum and plentiful compelling applied research questions and methodological problems. The department stands poised to expand its role as a world leader in high-impact biostatistics.

## **Selection of Frequently Cited Articles by UNC-CH Biostatistics Faculty**

(1984). The Lipid Research Clinic Coronary Primary Prevention Trial Results: I. Reduction of Incidence of Coronary Heart Disease. *Journal of the American Medical Association*, 251, 351–364.

- Cai, J. W., Prentice, R. L. (1995). Estimating equations for hazard ratio parameters based on correlated failure time data. *Biometrika*, 82, 151–164.
- Elston, R. C., Stewart, J. (1971). A general model for the genetic analysis of pedigree data. *Human Heredity*, 21(6), 523–542.
- Greenberg, B. G. (1959). Conduct of cooperative field and clinical trials. *American Statistician*, 13, 13–17.
- Grizzle, J. E., Starmer, C. F., Koch, G. G. (1969). Analysis of categorical data by linear models. *Biometrics*, 25 (3), 489–504.
- Ibrahim, J. G., Chen, M. H., Lipsitz, S. R., Herring, A. H. (2005). Missing-data methods for generalized linear models: A comparative review. *Journal of the American Statistical Association*, 100, 332–346.
- Landis, J. R., Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33, 159–174.
- Lin, D. Y., Zeng, D. (2006). Likelihood-based inference on haplotype effects in genetic association studies (with discussion). *Journal of the American Statistical Association*, 101, 89–104.
- Sen, P. K. (1968). Estimates of the regression coefficient based on Kendall's tau. *Journal of the American Statistical Association*, 63(324), 1379–1389.
- Truong, Y. K., Stone, C. J. (1992). Nonparametric function estimation involving time-series. *Annals of Statistics*, 20, 77–97.

## **Selection of Books by UNC-CH Biostatistics Faculty**

- Draper, N. R., Smith, H. (1998, 3rd edition). *Applied Regression Analysis* Wiley.
- Ghosh, B. K., Sen, P. K. (1991). *Handbook of Sequential Analysis* CRC.
- Ibrahim J. G., Chen M. H., Sinha, D. (2001). *Bayesian Survival Analysis* Springer-Verlag.
- Kleinbaum, D. G., Kupper, L. L., Muller, K. E. (2007, 4th edition). *Applied Regression Analysis and Other Multivariable Methods* Duxbury Pr.
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## Distinguished Graduates

Distinguished graduates of the department include: Ronald Forthofer, Carl Henley, Peter Imrey, Robert Woolson, George Williams, Dennis Tolley, Yosef Hochberg, Richard Landis, Kerry Lee, Frank Harrell, Elizabeth Delong, Eric (Rocky) Feuer, Lisa Lavange, A. John Bailer, Edward Stanek, Maura Stokes, George Howard, Lloyd Edwards, Alula Hadgu, F. DuBois Bowman, John Preisser, Stuart Gansky, Robert Lyles, Catherine Tangen, Limin Clegg, Diane Catellier, Christopher Coffey, Antonio Sanhueza, Douglas Taylor, Douglas Schaubel, Guosheng Yin, and Jean Orelie.

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