For the past few years, The Methodology Center has been moving into an exciting new research area. Mobile health, or mHealth, is the use of mobile devices such as smartphones to measure health characteristics and deliver health interventions. The promise of mHealth is the ability to deliver individually tailored interventions to large numbers of people at relatively low cost. mHealth studies generate huge amounts of complex data, calling for new methods to maximize the amount of scientific knowledge gained from this research.

We are developing methods for the analysis of data from mHealth studies and for the empirical design of mHealth interventions. We collaborate with many of the nation’s top researchers in fields such as smoking cessation, opioid-addiction recovery, autism, cardiovascular health, and HIV/AIDS. These collaborations produce important scientific advances that improve public health and serve as demonstration projects so that other researchers in the relevant fields can see the value of our methods.

For the past few years, The Methodology Center has been moving into an exciting new research area. Mobile health, or mHealth, is the use of mobile devices such as smartphones to measure health characteristics and deliver health interventions. The promise of mHealth is the ability to deliver individually tailored interventions to large numbers of people at relatively low cost. mHealth studies generate huge amounts of complex data, calling for new methods to maximize the amount of scientific knowledge gained from this research.

We are developing methods for the analysis of data from mHealth studies and for the empirical design of mHealth interventions. We collaborate with many of the nation’s top researchers in fields such as smoking cessation, opioid-addiction recovery, autism, cardiovascular health, and HIV/AIDS. These collaborations produce important scientific advances that improve public health and serve as demonstration projects so that other researchers in the relevant fields can see the value of our methods.

In this year’s Annual Report, we highlight a few of our most productive collaborations, and we introduce a few of our stellar trainees. As these demonstration projects and our former trainees spread out across the country, so do the reach and impact of the methods we develop.

I hope you enjoy learning about our work.

Linda M. Collins
Director, The Methodology Center
Distinguished Professor, Human Development and Family Studies
Professor, Statistics

From the Director

TO LEARN MORE ABOUT THE METHODOLOGY CENTER, VISIT methodology.psu.edu
Just-in-Time Adaptive Intervention (JITAI)
A JITAI determines when an intervention is needed based on data that are collected actively (like smartphone prompts that inquire about mood) or passively (like smartphone GPS data that indicate when a person is traveling in a vehicle). Principal Investigator Susan Murphy and her team are developing microrandomized trial designs and machine learning algorithms to create JITAI that are responsive to each person’s conditions and that learn over time what is effective or ineffective for each person.

2016 Highlight: Susan Murphy elected to the National Academy of Sciences

Sequential, Multiple Assignment, Randomized Trial (SMART)
SMART experimental designs provide high-quality data for constructing empirically validated adaptive interventions. Adaptive interventions are treatments that are individually tailored to meet a patient’s changing needs. A SMART can be used to create adaptive interventions that improve outcomes while decreasing patient burden.

Dozens of studies around the world are using SMART designs to address a wide range of health problems, including drug dependence, ADHD, alcoholism, and autism.

2015-16 Highlight: NIDA R01 grant funding five more years of research to develop SMART

Multiphase Optimization Strategy (MOST)
MOST is a framework for engineering effective and efficient behavioral and biobehavioral interventions. MOST is an iterative process with three phases: preparation, optimization, and evaluation. By following MOST, intervention designers can understand which aspects of an intervention are working. By emphasizing careful resource management, MOST can maximize the gain of scientific information.

2016 Highlight: Collaboration with Center for Drug Use and HIV/HCV Research at NYU on new grant to increase treatment engagement among minorities living with HIV

Latent Class Analysis (LCA)
LCA allows researchers to detect unobservable (latent) subgroups within a population. By expanding LCA models, we make it possible for intervention scientists to better target the subgroups who will benefit the most. Over twenty years, we have developed longitudinal extensions of LCA, methods for LCA with a distal outcome, and other extensions of LCA. Our LCA software for SAS and Stata has allowed thousands of researchers to perform LCA on their data.

2015-16 Highlight: Release of Stata functions to perform bootstrap likelihood ratio test and to estimate the association between a latent class variable and a distal outcome

Time-Varying Effect Modeling (TVEM)
TVEM is a flexible tool that can answer questions about associations over time. It can be used with multiple data types, including intensive longitudinal data, panel data, and cross-sectional data. TVEM allows researchers to uncover changes in the relationships between variables. It enables researchers to model those relationships without assuming a parametric relationship between the variables.

2015-16 Highlight: A year of rapid growth for TVEM, capped by a standing-room-only session on TVEM at the Society for Prevention Research 2016 Annual Meeting

Variable Screening & Selection
In genetic studies there may be hundreds of subjects and hundreds of thousands of variables. Nearly all techniques for exploratory data analysis break down when the number of variables exceeds the sample size. High-dimensional variable-screening procedures allow researchers to narrow the subset of variables for analysis. We developed two SAS procedures that enable researchers to select relevant variables from large data sets.

2016 Highlight: Sixteen peer-reviewed articles published or accepted for publication
New data + new methods = new answers

Self-reported data on drinking.

Particular drink. Only recently has technology figured out the concentration of alcohol in a particular drink. Finally, it can be hard to know how much alcohol people exercise more, avoid drug use, stop smoking, and more.

Asking people in recovery who are on the verge of lapse

Susan Murphy is collaborating with Drs. Christy Scott and Michael Dennis of Chestnut Health Systems on improving an intervention for individuals with a history of substance use disorders. The intervention provides individuals recovering from a cardiac event. Researchers are developing a JITAI that encourages physical activity among people already exercising. By rating each prompt, participants help improve the quality of future suggestions for all participants.

Solving the mHealth Dropout Problem

One of the barriers to widespread use of mHealth apps is that dropout rates are famously high: Around 75 percent of mHealth apps are abandoned by the tenth day of use. One of the barriers to widespread use of mHealth apps is dropout rates are famously high: Around 75 percent of mHealth apps are abandoned by the tenth day of use. One of the barriers to widespread use of mHealth apps is dropout rates are famously high: Around 75 percent of mHealth apps are abandoned by the tenth day of use. One of the barriers to widespread use of mHealth apps is dropout rates are famously high: Around 75 percent of mHealth apps are abandoned by the tenth day of use. One of the barriers to widespread use of mHealth apps is dropout rates are famously high: Around 75 percent of mHealth apps are abandoned by the tenth day of use. One of the barriers to widespread use of mHealth apps is dropout rates are famously high: Around 75 percent of mHealth apps are abandoned by the tenth day of use. One of the barriers to widespread use of mHealth apps is dropout rates are famously high: Around 75 percent of mHealth apps are abandoned by the tenth day of use. One of the barriers to widespread use of mHealth apps is dropout rates are famously high: Around 75 percent of mHealth apps are abandoned by the tenth day of use. One of the barriers to widespread use of mHealth apps is dropout rates are famously high: Around 75 percent of mHealth apps are abandoned by the tenth day of use.

Answering a question in an mHealth app

Researchers are developing a JITAI that encourages physical activity among people recovering from a cardiac event. Researchers identified five times throughout the day when people are most likely to engage in physical activity. The HeartSteps app uses passively collected data to determine how to tailor to each person or not to provide tailored physical activity suggestions. The suggestions are based on the participant’s current location, time of day, quality of the weather, and day of the week. Also included in the next part of the project is to develop a full pilot phase, and following those it will run for a full year. During that time apps will deliver more than 300 suggestions to each participant. This means that scientists must reduce dropout by improving the quality, variety, and salience of the HeartSteps suggestions, relative to other apps. In initial pilot testing, some participants reported feeling like they had a relationship with the app when messages were encouraging and appropriate. When, however, they received the same message multiple times, they reported feeling betrayed.

Measuring Drinking From Moment to Moment

Historically, studies of heavy drinking have relied on self-reports, but there are several problems with people’s reports of their own drinking. First, heavy drinking disrupts the memory. Second, drinking games, which are often part of heavy drinking episodes among young adults, can obscure the amount of alcohol ingested. Finally, it can be hard to figure out the concentration of alcohol in a particular drink. Only recently has technology become available to measure the accuracy of self-reported data on drinking.

New data + new methods = new answers

A new study at the Methodology Center by Michael Russell combines ecological momentary assessment (EMA) of self-reported alcohol use with continuous data from ankle bracelets that measure blood alcohol content (BAC) through contact with the skin. By applying innovative methods to these two data types, Russell will investigate the accuracy of using EMA self-reports as a proxy for actual BAC. He will also seek to identify time points during a drinking episode when an intervention delivered via smartphone might curb heavy drinking and the associated negative health outcomes. Once this pilot project is complete, Russell intends to apply for a larger grant to extend the research and develop a JITAI.

Intervention in Your Pocket

In just-in-time, adaptive interventions (JTAs), continuously collected data from a mobile device and/or wearable sensor are combined with each participant’s preferences and characteristics to select an appropriate intervention whenever and wherever it is needed. Realistically, a clinician can only check in with participants at appointed times, but people generally carry their smartphones, and those phones contain a lot of information about when each person is or is not at risk. By leveraging these data, JTAs can help people exercise more, avoid drug use, stop smoking, and more.

mHealth: Always There When It’s Needed

Smartphones and mobile sensors (like Fitbits) can collect massive amounts of data, and these data can be used to help people change their behavior to achieve their long-term goals. Information, including location, mood, activity, and stress, can all be obtained unobtrusively or passively. Methodology Center researchers are working to expand and improve methods for mHealth studies and interventions so that mHealth can provide maximum benefit to the highest number of people.

mHealth: Always There When It’s Needed
The Future of Prevention and Methodology

Dr. Bediako’s research is focused on sexual and reproductive health issues for underserved populations, with a current emphasis on youth in South Africa. She has published ten peer-reviewed papers (seven first-authored) in journals such as the Journal of Racial and Ethnic Health and Outcomes Research Methodology, and Alcohol Dependence, Health Services Research Crime Research Fellow. He has published forty-three peer-reviewed papers focusing on criminal justice and drug abuse and HIV prevention science. The National Institute on Drug Abuse (NIDA) has funded PAMT continually since 2005. In 2016, NIDA awarded five more years of funding to the program. Over its first eleven years, fifty-three young prevention researchers and former trainees go on to research careers. Dr. Schuler’s research focuses on the development and consequences of adolescent and young adult risk behaviors, including drinking alcohol, drug use, and risky sexual behaviors. She works to improve the prevention of health risk behaviors, methodological issues for behavioral research, and evidence-based practice. She has published eighty-eight peer-reviewed papers (nineteen first-autorship) in journals such as Prevention Research, Journal of Communication, Prevention Science, and Journal of Research on Adolescents.

Melissa Lippold PAMT: 2006–2010 Assistant Professor of Health, University of North Carolina–Chapel Hill Dr. Lippold’s research examines sex differences in the prevention of health risk behaviors and criminal (risk) behavior through evidence-based resource investments in childhood and adolescence. In 2006, she was invited to become a National Institute of Economic Research Crime Research Fellow. He has published nineteen peer-reviewed papers (eight first-authorship) in journals such as Journal of Adolescent Health, Preventive Science, and Child Psychiatry.

Dr. Bediako has published two peer-reviewed papers and currently has two papers under review (both first-authorship) at journals such as Journal of Adolescent Health and Identity Health.

Jennifer Kam PAMT: 2007–2009 Assistant Professor of Department of Communication, University of California–Santa Barbara Dr. Kam’s research focuses on the use of social-behavioral frameworks to illuminate research conducted within the field of adolescent risky behavior and the role that parent-child characteristics influence variability in promoting behavior. She has published nineteen peer-reviewed papers (nineteen first-authorship) in journals such as Prevention Research, Journal of Communication, Prevention Science, and Journal of Research on Adolescents.

Michael Cleveland PAMT: 2005–2007 Assistant Professor of Epidemiology and Biostatistics, Temple University Dr. Cleveland’s research focuses on assessing and applying statistical learning methods to handle complex data to address cutting-edge research questions related to behavioral health behaviors. Thus his principal investigation of multiple NIH grants and project director in a substance use disorder treatment study. He has served as a co-investigator on many grants from the National Institute of Health. Dr. Cleveland also served as the Principal Investigator of a project to develop an introductory course in adolescent health. He has published forty-three peer-reviewed papers (ten first-authored) in journals such as Addiction, Alcoholism: Clinical and Experimental Research, and Preventive Science.

Donna Coffman PAMT: 2005–2007 Assistant Professor of the National Institutes of Health, University of Michigan Dr. Coffman’s current work focuses on advancing and applying statistical learning methods to address complex data to address cutting-edge research questions related to behavioral health behaviors. She has served as a co-investigator on many NIH grants and project director in studies assessing the use of electronic health records in the treatment of substance use disorder. She has served as a co-investigator on many grants from the National Institute of Health. Dr. Coffman also served as the Principal Investigator of a project to develop an introductory course in adolescent health. She has published forty-three peer-reviewed papers (ten first-authored) in journals such as Addiction, Alcoholism: Clinical and Experimental Research, and Preventive Science.

Megan Patrick PAMT: 2005–2007 Research Associate Professor, Institute for Social Research, University of Michigan Dr. Patrick’s research focuses on the development and consequences of adolescent and young adult risk behaviors, including drinking alcohol, drug use, and risky sexual behaviors. She works to improve the prevention of health risk behaviors, methodological issues for behavioral research, and evidence-based practice. She has published eighty-eight peer-reviewed papers (nineteen first-authorship) in journals such as Statistics in Medicine, Epidemiology, Childhood Obesity, Psychological Methods, and Preventive Science.
Each month, we gather for a meeting where we share our achievements over the past month. Each individual sets his or her own short and long term goals, and we track everyone's progress. This lets us share each other's successes and stay in touch with what is going on around The Methodology Center. And for fun, when we meet our goals, we get a fresh baked cookie!

**OUR FUNDING**

Research at the Methodology Center is funded by grants from the National Institutes of Health, primarily the National Institute on Drug Abuse, the National Cancer Institute, the National Institute of Diabetes and Digestive and Kidney Diseases, and the National Institute on Alcohol Abuse and Alcoholism. The Methodology Center also receives significant support from Penn State's College of Health and Human Development.

**TO LEARN MORE ABOUT THE METHODOLOGY CENTER, VISIT** methodology.psu.edu

This publication is available in alternative media on request. The University is committed to equal access to programs, facilities, admission, and employment for all persons. It is the policy of the University to maintain an environment free of harassment and free of discrimination against any person because of age, race, color, ancestry, national origin, religion, creed, service in the uniformed services (as defined in state and federal law), veteran status, sex, sexual orientation, marital or family status, pregnancy, pregnancy-related conditions, physical or mental disability, gender, perceived gender, gender identity, genetic information, or political ideas. Discriminatory conduct and harassment, as well as sexual misconduct and relationship violence, violates the dignity of individuals, impedes the realization of the University's educational mission, and will not be tolerated. Direct all inquiries regarding the nondiscrimination policy to Dr. Kenneth Lehrman III, Vice Provost for Affirmative Action, Affirmative Action Office, The Pennsylvania State University, 328 Boucke Building, University Park, PA 16802-5901; Email: klf2@psu.edu; Tel 814-863-0471; U.Ed. HHD 17-018 MPC139350