PENNSTATE

1855

Annual Productivity Report

The Methodology Center

PENN STATE | 2011-12

Our Mission

The mission of the Methodology Center is to advance public health by improving experimental design and data analysis in the social, behavioral, and health sciences.

We serve as a national resource in the development and dissemination of innovative research methods for preventing and treating health problems, especially HIV, alcohol abuse, tobacco use, and other drug abuse.

The Methodology Center

Director's Statement

Welcome to the first annual report issued by the Methodology Center at Penn State.

As a National Institute on Drug Abuse (NIDA) P50 Center of Excellence, we serve as a national resource on cutting-edge applied statistical methods for the behavioral, social, and health sciences. Our team comprises scientists with a wide variety of backgrounds, including statistics, biostatistics, engineering, human development, psychology, and epidemiology. Using our knowledge of the field and our collaborations with applied researchers, we keep pace with the methodological needs of behavioral science to identify important emerging methodological issues. Our original research draws from and integrates many disciplinary perspectives to develop new approaches to meet these needs, thereby enhancing the quality of prevention and treatment research worldwide.

An important part of our mission is to place innovative quantitative methods in the hands of behavioral scientists through a variety of outlets, including publications in many types of journals; workshops, seminars, and graduate courses; technical reports and other documents; and free, user-friendly software. Our website, methodology.psu.edu, is an important part of our outreach. By making it straightforward for researchers to use the approaches we develop, we hasten the rate at which cutting-edge methods are adopted. The result is better behavioral research on the determinants, correlates, and consequences of public health problems.

Here is an example of our work in action: Nearly ten years ago we recognized that electronic devices and the Internet were making it more and more feasible to collect intensive longitudinal data, such as ecological momentary assessments (EMA) data. These data inspired new, complex, and nuanced research questions, but there were few statistical modeling approaches that enabled scientists to use these data to address their research questions effectively. The center produced a book, *Models for Intensive Longitudinal Data* (Walls & Schafer, 2006), that is, to our knowledge, the first edited volume on statistical methods for analyzing intensive longitudinal data. Since then, center scientists, led by Dr. Runze Li, have actively researched methods for modeling intensive longitudinal data. Pages 10 and 11 of this report summarize our recent work in this rapidly evolving area.

It has been a great year for the center. We continue to work on the goals of our P50. In addition, center scientists have received four new grants, described on page 6. We have reached a yearly budget of approximately $3 million, provide partial or full support for more than 20 Ph.D.-level investigators, and offer mentoring to more than a dozen graduate students. I am proud to share this report with you, and I hope you enjoy reading it as much as we have enjoyed doing the work described in it.

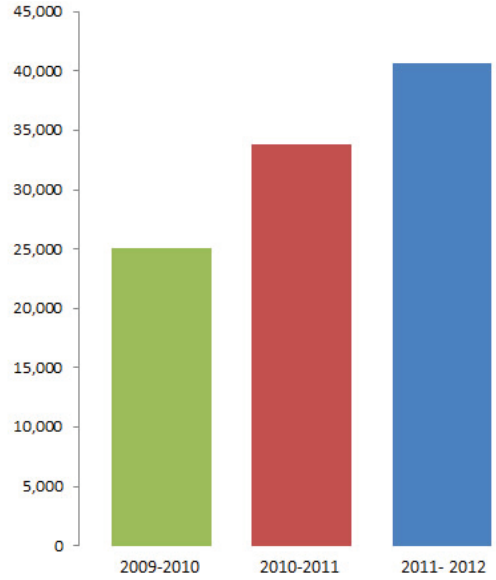
Linda Collins
Director, The Methodology Center
Professor, Department of Human Development and Family Studies
Professor, Department of Statistics

To learn more, visit **methodology.psu.edu**

2011-12 Productivity

Publications

Website Visits



INNOVATION AND DISSEMINATION

- Articles, books, chapters
- Presentations, posters, workshops

AVAILABLE ONLINE RESOURCES

- Free research software
- Training materials and tutorials
- Introductions to new methods
- Podcasts

2011-12 Productivity

The Methodology Center at a Glance

1 National Institute on Drug Abuse Center of Excellence

14 collaborating faculty

10 research associates and postdocs

From **11** different disciplines

157 publications and presentations in 2011-12 grant year

Software

methodology.psu.edu/downloads

Enables researchers to use methods we develop

5,000+ downloads this year

10 new releases

in SAS, R, or Java

Awards

Dr. Linda Collins
2011 Evan G. and Helen G. Pattishall Outstanding Research Achievement Award

Dr. Runze Li
Fellow of the American Statistical Association
(named 2011)

Dr. Susan Murphy
Member of the International Statistical Institute
(elected 2011)

Dr. Debashis Ghosh
Fellow of the American Statistical Association
(named 2012)

2011-12 Grant Awards

Building an Effective and Efficient Pediatric Obesity Preventive Intervention

Penn State Clinical and Translational Science Institute KL2 Early Career Award

Investigator: Kari Kugler; Linda Collins, mentor

Aim: to build effective behavioral interventions to prevent pediatric obesity. Dr. Kugler will follow the multiphase optimization strategy (MOST; *see page 7*) to develop an intervention to encourage responsive infant-feeding practices among low-income mothers.

Discovering Tailoring Variables in Childhood Mental Health Treatment Research

National Institute of Mental Health R03

Investigator: Daniel Almirall

Aim: to develop a data analysis method for discovering how best to individualize treatment for children with mental health disorders. The method will enable scientists to identify which measures are most useful, and how to combine them, to make optimal, individualized treatment decisions.

Joint Modeling of the Effects of Substance Use on Changes in CD4 and on Survival Time of Women

National Institute on Drug Abuse Supplement to the Women's Interagency Health Study

Investigators: Stephanie Lanza, Runze Li, and Jingyun Yang

Aim: to advance understanding of the impact of tobacco, alcohol, and other drug use on the health and survival of women with HIV.

Advancing Tobacco Research by Integrating Systems Science and Mixture Models

National Cancer Institute R01

(See pages 10-11)

Investigators: Stephanie Lanza, Runze Li, and Jingyun Yang

Aim: to identify subgroups of smokers who experience nicotine withdrawal differently. The project will facilitate the development of interventions that adapt to meet individual smokers' needs during quit attempts.

Center Research Projects

The Methodology Center

has five highly collaborative research projects. Each project addresses a critical, unsolved problem in data analysis or experimental design. Also, to foster new collaborations, the Methodology Center funds small pilot projects by researchers from a variety of disciplines.

The multiphase optimization strategy (MOST) is a framework for engineering effective and efficient behavioral interventions. MOST emphasizes careful management of research resources to maximize the gain of scientific information. This framework can be used to develop new behavioral interventions, improve existing interventions, and promote Type I and Type II translation of research.

Dr. Linda Collins
Principal investigator

2011-12 highlights: large-scale trial in the field to develop clinic-based smoking cessation intervention, trial to develop drug abuse prevention intervention for NCAA athletes

Current applications: tobacco cessation, drug abuse prevention, childhood obesity prevention, adult weight management

EXAMPLE PUBLICATIONS

Baker, T. B., Mermelstein, R. J., Collins, L. M., Piper, M. E., Jorenby, D. E., Smith, S. S., ... Fiore, M. C. (2011). New methods for tobacco dependence treatment research. *Annals of Behavioral Medicine, 41,* 192-207. PMCID: PMC3073306

Collins, L. M., Baker, T. B., Mermelstein, R. J., Piper, M. E., Jorenby, D. E., Smith, S. S., ... Fiore, M. C. (2011). The multiphase optimization strategy for engineering effective tobacco use interventions. *Annals of Behavioral Medicine, 41,* 208-226. PMCID: PMC3053423

Center Research Projects

Causal inference research seeks to identify the impact of exposure to a particular treatment or condition. Much of the center's work on causal inference focuses on using propensity scores to infer cause in observational studies. This allows scientists to more accurately identify agents of change and thus develop more effective and efficient behavioral and/or medical interventions.

Dr. Donna Coffman
Principal investigator

2011-12 highlights: new collaborations with criminologists, obesity researchers, and AIDS researchers

Current applications: adolescent drug abuse, HIV prevention, childhood obesity, delinquency

EXAMPLE PUBLICATIONS

Coffman, D. L., & Kugler, K. C. (2012). Causal mediation of a human immunodeficiency virus preventive intervention. *Nursing Research, 61*(3), 224-230. PMCID: PMC3377683

Coffman, D. L., Caldwell, L. L., & Smith, E. A. (2012). Introducing the at-risk average causal effect with application to HealthWise South Africa. *Prevention Science, 13,* 437-447. PMCID: PMC3405190

Sequential, multiple assignment, randomized trial (SMART) experimental designs provide high-quality data for constructing and optimizing adaptive interventions. Adaptive interventions are treatments that are individually tailored to meet a participant's changing needs. Adaptive interventions can improve patient outcomes while decreasing cost and burden.

Dr. Susan Murphy
Principal investigator

2011-12 highlights: multiple training workshops, many SMARTs in the field, release of SAS software

Current applications: drug abuse, depression, autism, ADHD, alcoholism, obesity, adherence to anti-retroviral treatment, smoking

EXAMPLE PUBLICATIONS

Lei, H., Nahum-Shani, I., Lynch, K., Oslin, D., & Murphy, S. A. (2012). A "SMART" design for building individualized treatment sequences. *Annual Review of Clinical Psychology, 8,* 21-48. PMC Journal—In progress

Nahum-Shani, I., Qian, M., Almiral, D., Pelham, W., Gnagy, B., Fabiano, G., ... Murphy, S. A. (in press). Experimental design and primary data analysis methods for comparing adaptive interventions. *Psychological Methods.*

Center Research Projects

Latent class analysis (LCA)

uncovers unobservable subgroups within a population. By expanding the available LCA models, we allow scientists to target interventions to the subgroups who will benefit most. Central to this project is the ongoing development of PROC LCA, SAS software for conducting LCA that has been downloaded thousands of times.

Dr. Stephanie Lanza
Principal investigator

2011-12 highlights: three software releases, causal inference in LCA, predicting distal outcomes from latent class membership

Current applications: drug abuse, alcohol abuse, HIV, youth risk exposure, smoking cessation, child health disparities

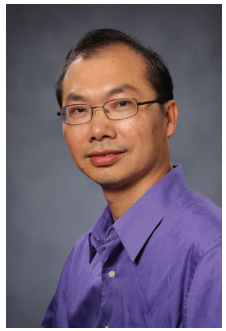
EXAMPLE PUBLICATIONS

Lanza, S. T., Tan, X., & Bray, B. C. (in press). Latent class analysis with distal outcomes: A flexible model-based approach. *Structural Equation Modeling.*

Lanza, S. T., & Rhoades, B. L. (2011). Latent class analysis: An alternative perspective on subgroup analysis in prevention and treatment. *Prevention Science.* doi: 10.1007/s11121-011-0201-1 PMCID: PMC3173585

Time-varying effect models (TVEMs)

enable researchers to answer new questions about data collected with mobile technology. TVEMs allow researchers to uncover changes in relationships between variables in a flexible way. *(See pages 10-11.)* Researchers are also exploring new ways to jointly model time-varying effects and time to an event.



Dr. Runze Li
Principal investigator

2011-12 highlights: grant on TVEM in smoking, grant on substance abuse in HIV disease course, workshop on new methods for smoking research

Current applications: smoking cessation, genetics, neuroimaging data analysis, HIV

EXAMPLE PUBLICATIONS

Tan, X., Shiyko, M. P., Li, R., Li, Y., & Dierker, L. (2012). Intensive longitudinal data and model with varying effects. *Psychological Methods, 17,* 61-77. PMCID: PMC3288551

Shiyko, M. P., Lanza, S. T., Tan, X., Li, R., & Shiffman, S. (2012). Using the time-varying effects model (TVEM) to examine dynamic associations between negative affect and self confidence on smoking urges: Differences between successful quitters and relapsers. *Prevention Science, 13,* 288-299. PMCID: PMC3372905

Featured Project: Time-Varying Effect Models

Fighting Nicotine Addiction With a Smartphone

The Unrealized Potential of EMA data

Methodology Center scientists have pioneered new methods for analyzing ecological momentary assessments (EMA) data. EMA are collected on many occasions as events unfold in subjects' natural environments. Hand-held computing devices, such as smartphones, have led to widespread collection of EMA.

EMA data have two clear advantages over traditional longitudinal data. First, subjects record their responses within a moment, rather than remembering and aggregating at a later time point. Asking someone, "What is your mood?" five times during a day will result in much more precise data than asking someone, "How did you feel on Tuesday?" Second, subjects in their natural environment provide better data than subjects in a laboratory. Studies have shown, for example, that a person's smoking behavior is much different in their own environment than in a lab. EMA allow scientists to study how people really behave on a day-to-day basis and to observe what locations and situations trigger problem behaviors for them.

"The collaboration enabled us to apply leading-edge analytic techniques to our dataset. This has generated new findings and insights from our data."

—Dr. Saul Shiffman, University of Pittsburgh

Despite the promise of EMA data, until recently, methods to realize their potential did not exist. For example, there are many complex, interrelated factors at work during a smoker's quit attempt, like the relationship between a smoker's craving and his/her mood. A strong negative or positive mood can drive the desire to smoke, or a strong craving can worsen one's mood. Traditional statistical models typically force scientists to assume the association between mood and craving is constant over time, even though there is no reason to believe that this is true. To really understand the data, new methods were needed.

A New Way to View Associations

Dr. Runze Li leads Methodology Center work on the analysis of EMA data. He and his collaborators developed new time-varying effect models (TVEMs) to describe how relationships between different factors *change over time.* For example, TVEMs allow researchers to model how and when the relationship between negative mood and craving changes. Craving and mood may be more strongly associated right after quitting smoking, or the association may be stronger a few weeks after quitting. Understanding associations like this will allow scientists to design more effective interventions to help smokers quit.

Building Tools for All Scientists

Methodology Center software developers created free, easy-to-use software that allows any researcher to apply TVEMs to his or her data. Center scientists applied the software to examine the process of quitting smoking using EMA data collected by Dr. Saul Shiffman of the University of Pittsburgh. Dr. Shiffman said, "The collaboration enabled us to apply leading-edge analytic techniques to our dataset. This has generated new findings and insights from our data." Center scientists published an introduction to TVEMs for audiences in the psychological sciences (Tan, Shiyko, Li, Li, & Dierker, 2012) and an analysis of the smoking data (Shiyko, Lanza, Tan, Li, & Shiffman, 2012). Shiyko et al. explores how factors, including mood and craving, interact during a quit attempt and

indicates when quitters might be in danger of a relapse. Several other articles by center scientists and collaborators are currently in progress.

Researchers around the world are applying TVEMs to answer some of the most pressing problems in public health.

Putting TVEMs into Action

In order to fully realize the potential of TVEMs, center scientists turned their attention to dissemination. In March 2012, more than 90 leading smoking researchers and methodologists from around the country participated in the workshop, "New Methods for Advancing Research on Tobacco Dependence." The day-long session, sponsored by the National Cancer Institute, was part of the Society for Research on Nicotine and Tobacco (SRNT) Annual Meeting in Houston, Texas. The workshop focused on methods, especially TVEMs, for analyzing EMA data in smoking research.

The workshop led to a forthcoming special issue of the journal *Nicotine and Tobacco Research* on the same topic. Center Scientific Director Stephanie Lanza is co-editor of the special issue, which will be published in late 2013.

The Future of TVEMs

Three center scientists were recently awarded a grant from the National Cancer Institute: *Advancing Tobacco Research by Integrating Systems Science and Mixture Models.* This project will use TVEMs and latent class analysis to uncover subgroups of smokers who experience nicotine withdrawal differently. This will facilitate the development of time-varying interventions that meet the changing needs of individual smokers.

TVEMs could be valuable in studies of exercise, eating, alcohol, or any field with repeated measures.

The TVEM software was recently expanded to accommodate different types of outcomes, and the new version was released for public download. The macro has been downloaded by scientists in a wide variety of fields researching previously unanswerable questions. The potential of this approach is immense, and we have only scratched the surface in a single applied field. TVEMs could be valuable in studies of exercise, eating habits, alcohol consumption, or any field in which measurements occur repeatedly over time. In the coming years, center scientists will expand the potential of this new method by integrating TVEMs with other innovative models. Meanwhile, researchers around the world are applying TVEMs to answer some of the most pressing problems in public health.

PENNSTATE
1855

The Methodology Center

advancing methods, improving health

LEAD RESEARCHER CONTACTS

General Inquiries
204 E. Calder Way, Suite 400
State College, PA 16801
MChelpdesk@psu.edu
814-865-3253

Linda Collins
Center Director
Professor, Department of Human Development and Family Studies and Department of Statistics
lmcollins@psu.edu
814-865-3253

Stephanie Lanza
Scientific Director
Research Associate Professor, College of Health and Human Development
slanza@psu.edu
814-865-7095

Runze Li
Principal Investigator
Professor, Department of Statistics and Department of Public Health Sciences
rli@stat.psu.edu
814-863-9481

Donna Coffman
Principal Investigator
Research Assistant Professor, College of Health and Human Development
dcoffman@psu.edu
814-863-9724

Susan Murphy
Principal Investigator
H.E. Robbins Professor of Statistics
University of Michigan
samurphy@umich.edu
734-647-3684

U.Ed. HHD 13-120 MPC120318

FUNDING

Research at the Methodology Center is funded by grants from the National Institutes of Health, primarily the National Institute on Drug Abuse and the National Cancer Institute.

The Methodology Center also receives support from the College of Health and Human Development at Penn State.

methodology.psu.edu

SCAN THIS CODE with your smart phone to learn more about the Methodology Center or enter the web address in your browser.