

## Paul N Zivich

### Education

- 2016 – 2021 **Ph.D.**, *Department of Epidemiology*, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC  
Dissertation: Risk of influenza under realistic influenza vaccination interventions among university students
- 2014 – 2016 **M.P.H.**, *Department of Epidemiology*, College of Public Health, The Ohio State University, Columbus, OH
- 2011 – 2015 **B.S.P.H.**, College of Public Health, The Ohio State University  
Columbus, OH

### Experience

- 2023 – **Assistant Professor**, *Department of Epidemiology*, University of North Carolina at Chapel Hill, Chapel Hill, NC
- 2023 – **Participating Faculty**, *Biostatistics Core*, UNC Center for AIDS Research (CFAR), Chapel Hill, NC
- 2021 **Postdoctoral Research Associate**, *Causal Inference Research Laboratory*, University of North Carolina at Chapel Hill, Chapel Hill, NC

### Teaching

- 2024 – **Co-Instructor**, *Epidemiologic Analysis of Time-to-Event Data*, University of North Carolina at Chapel Hill
- 2023 – 2024 **Workshop Instructor**, *ABC's of M-estimation*, Society for Epidemiologic Research (SER) Annual Meeting
- 2019 **Graduate Teaching Assistant**, *Epidemiologic Analysis of Time-to-Event Data*, University of North Carolina at Chapel Hill

### Grants

Current

- 2023 – 2028 **K01-AI177102 NIH/NIAID (Zivich PN, PI)**, *Combining sources of information to improve HIV pre-exposure prophylaxis*, Principal Investigator  
Antiretroviral pre-exposure prophylaxis is an important tool for HIV prevention, with recent trials assessing new drug combinations. The limitations of clinical trials will increasingly require novel quantitative methods to reliably evaluate new interventions. The proposed study will use data from randomized trials, as well as novel methods, to address challenges in evaluation of new pre-exposure prophylaxis combinations.

## Completed

2021 – 2023 **T32-AI007001 NIH/NIAID (Adimora AA, PI), Training in Sexually Transmitted Diseases and HIV**, Postdoctoral Trainee

Provide training to doctoral students and postdoctoral fellows, including physicians, to create a cadre of young scientists with the skills in basic science, clinical medicine, epidemiology, and behavioral science to reduce the impact of sexually transmitted diseases, including HIV infection.

2018 – 2021 **T32-HD091058 NIH/NICHD (Aiello AE & Hummer RA, MPI), From Biological to Social Processes: Interdisciplinary Training in Life Course Research**, Predoctoral Trainee

Provide integrated social and biological/health sciences research training to junior scientists to better identify, understand, and produce new knowledge on the social and biological pathways to health across the life course, thereby identifying novel points of intervention to improve health and reduce health disparities.

## Peer-Reviewed Publications

1. **Zivich PN**, Shook-Sa BE. "Estimating marginal structural model parameters for time-fixed, binary actions with g-computation and estimating equations". *American Journal of Epidemiology* In-press 2024.
2. Edwards JK, Cole SR, **Zivich PN**, Hudgens MG, Breger TL, Shook-Sa BE. "Semiparametric g-computation for survival outcomes with time-fixed exposures: an illustration". *Annals of Epidemiology* In-press 2024.
3. **Zivich PN**, Cole SR, Edwards JK, Shook-Sa BE, Breskin A, Hudgens MG. "Bridged treatment comparisons: an illustrative application in HIV treatment". *American Journal of Epidemiology* In-press 2024.
4. Cole SR, Edwards JK, Breskin A, Rosin S, **Zivich PN**, Shook-Sa BE, Hudgens MG. "Rejoinder: Combining Information with Fusion Designs, and Roses by Other Names". *American Journal of Epidemiology* 2024; 193(5): 751-752.
5. Shi AX, **Zivich PN**, Chu HA. "Comprehensive Review and Tutorial on Confounding Adjustment Methods for Estimating Treatment Effects Using Observational Data". *Applied Sciences* 2024; 14, 3662.
6. Ross RK, **Zivich PN**, Stringer JSA, Cole SR. "M-estimation for common epidemiological measures: introduction and applied examples". *International Journal of Epidemiology* 2024; 53(2): dyae030.
7. **Zivich PN**, Cole SR, Edwards JK, Glidden DV, Das M, Shook-Sa BE, Shao Y, Mehrotra ML, Adimora AA, Eron JJ. "HIV prevention among men who have sex with men: tenofovir alafenamide combination preexposure prophylaxis versus placebo". *The Journal of Infectious Diseases* 2024; 229(4): 1123-1130.
8. Ross RK, Cole SR, Edwards JK, **Zivich PN**, Westreich D, Daniels JL, Price JT, Stringer JSA. "Leveraging external validation data: the challenges of transporting measurement error parameters". *Epidemiology* 2024; 35(2): 196-207.
9. Cole SR, Shook-Sa BE, **Zivich PN**, Edwards JK, Richardson DB, Hudgens MG. "Higher-order evidence". *European Journal of Epidemiology* 2024; 39(1): 1-11.
10. Shook-Sa BE, **Zivich PN**, Rosin SP, Edwards JK, Adimora AA, Hudgens MG, Cole SR. "Fusing Trial Data for Treatment Comparisons: Single versus Multi-Span Bridging". *Statistics in Medicine* 2023; 43(4): 793-815.
11. **Zivich PN**, Edwards JK, Lofgren ET, Cole SR, Shook-Sa BE, Lessler J. "Transportability without positivity: a synthesis of statistical and simulation modeling". *Epidemiology* 2024; 35(1): 23-31.
12. Martinez RM, Andrabi N, Goodwin AN, Wilbur RE, Smith NR, **Zivich PN**. "Conceptualization, operationalization, and utilization of race and ethnicity in major epidemiology journals 1995-2018:

- a systematic review". *American Journal of Epidemiology* 2023; 192(3): 483-496.
13. Cole SR, Edwards JK, **Zivich PN**, Shook-Sa BE, Hudgens MG, Stringer JSA. "Reducing Bias in Estimates of Per Protocol Treatment Effects: A Secondary Analysis of a Randomized Clinical Trial". *JAMA Network Open* 2023; 6(7): e2325907
  14. Cole SR, **Zivich PN**, Edwards JK, Shook-Sa BE, Hudgens MG. "Sensitivity Analyses for Means or Proportions with Missing Outcome Data". *Epidemiology* 2023; 34(5): 645-651.
  15. **Zivich PN**, Cole SR, Edwards JK, Mulholland GE, Shook-Sa BE, Tchetgen Tchetgen E. "Introducing Proximal Causal Inference in Epidemiology". *American Journal of Epidemiology* 2023; 192(7): 1224-1227.
  16. Renson A, Hudgen MG, Keil A, **Zivich PN**, Aiello AE. "Identifying and estimating effects of sustained interventions under parallel trends assumptions". *Biometrics* 2023; 79(4): 2998-3009.
  17. Cole SR, Edwards JK, Breskin A, Rosin S, **Zivich PN**, Shook-Sa BE, Hudgens MG. "Illustration of Two Simple Fusion Designs and Estimators". *American Journal of Epidemiology* 2023; 192(3): 467–474.
  18. Edwards JK, Cole SR, Shook-Sa BE, **Zivich PN**, Zhang N, Lesko CR. "When does differential outcome misclassification matter for estimating prevalence". *Epidemiology* 2023; 34(2):192-200.
  19. Martinez RAM, Smith NR, Wilbur RE, Andrabi N, Goodwin AN, **Zivich PN**. (2023). "Threats To Equity: Missing Methodological Details About Race And Ethnicity In Health Research". *Health Affairs Forefront*. March 13, 2023.
  20. Filiatreau LM, **Zivich PN**, Edwards JK, Mulholland GE, Max R, Westreich D. "Optimizing SARS-CoV-2 pooled testing strategies through differentiated pooling for distinct groups". *American Journal of Epidemiology* 2023; 192(2): 246-256.
  21. Cole SR, **Zivich PN**, Edwards JK, Ross RK, Shook-Sa BE, Price JT, Stringer JSA. "Missing Outcome Data in Epidemiologic Studies". *American Journal of Epidemiology* 2023; 192(1):6-10.
  22. **Zivich PN**, Hudgens MG, Brookhart MA, Moody J, Weber DJ, Aiello AE. "Targeted maximum likelihood estimation of causal effects with interference: a simulation study". *Statistics in Medicine* 2022; 41(23): 4554– 4577.
  23. **Zivich PN**, Shook-Sa BE, Edwards JK, Westreich D, Cole SR. "On the use of covariate supersets for identification conditions". *Epidemiology* 2022; 33(4):559-562.
  24. Noppert GA, Martin CL, **Zivich PN**, Aiello AE, Harris KM, O'Rand A. "Adolescent neighborhood disadvantage and memory performance in young adulthood" *Health & Place*. 2022; 75:102793
  25. Smith MJ, Maringe C, Rachet B, Mansournia MA, **Zivich PN**, Cole SR, Luque-Fernandez MA. "Tutorial: Introduction to computational causal inference using reproducible Stata, R and Python code". *Statistics in Medicine*. 2022; 41(2):407-432
  26. **Zivich PN**, Cole SR, Breskin A. "Twister plots for time-to-event studies". *American Journal of Epidemiology*. 2021; 190(12):2730–2731
  27. **Zivich PN**, Volfovsky A, Moody J, Aiello AE. "Assortativity and Bias in Epidemiologic Studies of Contagious Outcomes: A Simulated Example in the Context of Vaccination". *American Journal of Epidemiology*. 2021; 190(11):2442-2452
  28. Ciccone EJ, **Zivich PN**, Lodge EK, Zhu D, Law E, Taylor JL, Chung C, Xu J, Volfovsky A, Beatty C, Abernathy H, King E, Garrett HE, Markmann AJ, Rebuli ME, Sellers S, Weber DJ, Reyes R, Alvian N, Juliano JJ, Boyce RM, Aiello AE. "SARS-CoV-2 Infection in Healthcare Personnel and Their Household Contacts at a Tertiary Academic Medical Center: Protocol for a Longitudinal Cohort Study". *JMIR Research Protocols*. 2021; 10(4): e25410
  29. **Zivich PN**, Breskin A. "Machine learning for causal inference: on the use of cross-fit estimators". *Epidemiology* 2021; 32(3):393-401
  30. Hagaman A, LeMasters K, **Zivich PN**, Sikander S, Maselko J. "Longitudinal effects of perinatal social support on maternal depression: a marginal structural modeling approach". *J Epidemiol Community Health*. 2021; 75:936-943

31. LeMasters K, Bates LM, Chung EO, Gallis JA, Hagaman A, Scherer E, Sikander S, Staley BS, Zalla LC, **Zivich PN**, Maselko J. "Adverse Childhood Experiences and Depression Among Women in Rural Pakistan". *BMC Public Health*. 2021; 21(1):1-11
32. **Zivich PN**, Huang W, Eisenberg MC, Walsh A, Aiello AE. "Measuring office workplace interactions and hand hygiene behaviors through electronic sensors: a feasibility study". *PLoS One*. 2021; 16(1):e0243358
33. Smith NR, **Zivich PN**, Frerichs L, Moody J, Aiello AE. "A guide for choosing community detection algorithms in social network studies: the question-alignment approach". *American Journal of Preventative Medicine* 2021 Oct; 59(4):597-605
34. Agler RA, **Zivich PN**, Kawende B, Behets F, Yotebieng M. "Postpartum depressive symptoms following implementation of the 10 steps to successful breastfeeding program in Kinshasa, Democratic Republic of Congo: a cohort study". *PLoS Med*. 2021; 18(1):e1003465
35. **Zivich PN**, Eisenberg MC, Monto A, Uzicanin A, Baric RS, Sheahan T, Rainey J, Gao H, Aiello AE. "Transmission of viral pathogens in social network of university students: the eX-FLU study". *Epidemiology and Infection*. 2020; 148
36. Aiello AE, Renson A, **Zivich PN**. "Social media- and internet-based surveillance for public health". *Annual Reviews of Public Health*. 2020; 41
37. **Zivich PN**, Kiketa L, Kawende B, Lapika B, Behets F, Yotebieng M. "Effect of Family Planning Counseling After Delivery on Contraceptive Use at 24 Weeks Postpartum in Kinshasa, Democratic Republic of Congo". *Maternal and Child Health*. 2019 Apr; 23(4):530-537
38. **Zivich PN**, Grabenstein JD, Becker-Dreps SI, Weber DJ. "Streptococcus pneumoniae Outbreaks and Implications for Transmission and Control: A Systematic Review". *Pneumonia* 2018 Nov; 10(11)
39. **Zivich PN**, Yotebieng M, Lapika B, Behets F. "Implementation of Ten Steps to successful Breastfeeding and incidence of diarrhea, respiratory tract infection, and hospitalization among 0-6 month infants in Kinshasa, Democratic Republic of Congo: A randomized controlled trial". *Maternal and Child Health*. 2018 April; 22(5):762-771
40. **Zivich PN**, Gancz A, Aiello AE. "Effect of Hand Hygiene in the Office Workplace on Infectious Diseases: A Systematic Review" *American Journal of Infection Control*. 2018 April; 46(4):448-455
41. **Zivich PN**, Tatham L, Lung K, Tien J, Bollinger CE, Bower JK. "The association of influenza vaccine status and timing with outcomes among patients in Columbus, Ohio (2012-2015)". *Epidemiology and Infection*. 2017 Nov;145(15):3284-3293
42. **Zivich PN**, Kiketa L, Kawende B, Lapika B, Yotebieng M. "Vaccination coverage and timelines among children 0-6 months, Democratic Republic of Congo: a prospective cohort study". *Maternal and Child Health*. 2017 May;21(5):1055-1064

## Book Chapters

1. **Zivich PN**, Breskin A, Kennedy EH. "Machine learning and causal inference". *WileyStatsRef: Statistics Reference Online*. New York: Wiley & Sons.

## Letters, Commentaries, & Perspectives

1. Martinez RAM, Smith NR, Wilbur RE, Andrabi N, Goodwin AN, **Zivich PN**. "Not as we are, but as we could be: the role of agency and structure towards the improvement of race, ethnicity, and racism in epidemiology". *American Journal of Epidemiology* In-press 2024.
2. Li CX, **Zivich PN**. "Invited Commentary: Mixing multiple imputation and bootstrapping for variance estimation". *American Journal of Epidemiology* In-press 2024.
3. **Zivich PN**. "RE: 'Estimating the Effect of a Treatment When There Is Nonadherence in a Trial'". *American Journal of Epidemiology* In-press 2023.

4. Lu H, Howe CJ, **Zivich PN**, Gonsalves GS, Westreich D. "The Evolution of Selection Bias in the Recent Epidemiologic Literature – A Selective Overview". *American Journal of Epidemiology* In-press 2023.
5. Cole SR, **Zivich PN**, Edwards JK, Ross RK, Shook-Sa BE. "Five Authors Reply". *American Journal of Epidemiology* 2024; 193(3):562.
6. Martinez RAM, Smith NR, Wilbur RE, Andrabi N, Goodwin AN, **Zivich PN**. "Threats to Equity: Missing Methodological Details about Race and Ethnicity in Health Research". *Health Affairs Forefront* March 2023
7. **Zivich PN**, Ross RK. "RE: 'Using numerical methods to design simulations: revisiting the balancing intercept'". *American Journal of Epidemiology*. 2022 Sept; 191(10), 1833-1834.
8. Smith NR, **Zivich PN**, Frerichs L. "Social influences on obesity: current knowledge, emerging methods, and directions for future research and practice". *Current Nutrition Reports*. 2020 March; 9(1):31-41

## **Non-Peer-Reviewed Publications**

1. Shahn Z, **Zivich PN**, Renson A. "Structural Nested Mean Models Under Parallel Trends with Interference" *arXiv:2405.11781*
2. Shook-Sa BE, **Zivich PN**, Lee C, Xue K, Ross RK, Edwards JK, Stringer JSA, Cole SR. "Double Robust Variance Estimation". *arXiv:2404.16166*
3. **Zivich PN**, Edwards JK, Shook-Sa BE, Lofgren ET, Lessler J, Cole SR. (2023). "Synthesis estimators for positivity violations with a continuous covariate". *arXiv:2311.09388*
4. **Zivich PN**, Ross RK, Shook-Sa BE, Cole SR, Edwards JK. "Empirical sandwich variance estimator for iterated conditional expectation g-computation". *arXiv:2306.10976*
5. **Zivich PN**, Cole SR, Westreich D. "Positivity: Identifiability and Estimability". *arXiv:2207.05010*
6. **Zivich PN**, Klose M, Cole SR, Edwards JK, Shook-Sa BE. "Delicatessen: M-Estimation in Python". *arXiv:2203.11300*
7. Martinez RAM, Wilbur RE, Andrabi N, Goodwin AN, Smith NR, **Zivich PN**. "Conceptualization, operationalization, and utilization of race and ethnicity in major medical journals 1995-2018: a systematic review". *medRxiv:2022.03.07.22271661*

## **Invited Presentations**

1. **Zivich PN**. (2024) "Transportability Without Positivity: A Synthesis of Statistical and Simulation Modeling". Lilienfeld Postdoctoral Prize Paper Award at the 57th annual Society for Epidemiologic Research (SER). June 18-21, 2024. Austin, TX.
2. **Zivich PN** (2024) "Addressing nonpositivity using statistical and mathematical models". Oral Presentation at the 57th annual Society for Epidemiologic Research (SER). June 18-21, 2024. Austin, TX.
3. **Zivich PN**. (2024) "How certain should we be? Modern methods for sensitivity analysis". Session Chair at the American Causal Inference Conference (ACIC). May 15-17, 2024. Seattle, WA.
4. **Zivich PN**. (2024) "Transporting Average Causal Effects with Positivity Violations". Poster Presentation at the American Causal Inference Conference (ACIC). May 15-17, 2024. Seattle, WA.
5. **Zivich PN**. (2023) "Extending Inferences to a Target Population Without Positivity". Oral Presentation at Extending Inferences to a New Target Population hosted by The Institute for Computational and Experimental Research in Mathematics (ICERM) at Brown University. November 17-19, 2023. Providence, RI.
6. **Zivich PN**. (2023) "Principled comparisons of treatment arms from different randomized trials in HIV research". Oral Presentation at the Joint Statistical Meetings. August 5-10, 2023. Toronto, Ontario, CA.

7. **Zivich PN**, Naimi AI. (2023) "Does Machine Learning Work? Designing Better Simulation Studies for Inference". Session Co-Chair at the 56th annual Society for Epidemiologic Research (SER). June 13-16, 2023. Portland, OR.
8. **Zivich PN**, Edwards JK. (2023) "Answering questions by combining data sources". Session Co-Chair at the 56th annual Society for Epidemiologic Research (SER). June 13-16, 2023. Portland, OR.
9. **Zivich PN**. (2022) "Targeted maximum likelihood estimation with network-dependent data". Oral Presentation at the International Conference on Advances in Interdisciplinary Statistics and Combinatorics. October 7-9, 2022. Greensboro, NC.
10. **Zivich PN**. (2022) "M-estimation". Oral Presentation at Centre for Statistical Methodology at the London School of Hygiene and Tropical Medicine. October 5, 2022. Virtual.
11. **Zivich PN**. (2022) "Why I use Python". Oral Presentation at the 43rd Annual Conference of the International Society for Clinical Biostatistics. August 21-25, 2022. Newcastle upon Tyne, UK
12. **Zivich PN**. (2022) "M-estimation for fusion designs". Oral Presentation at the 55th annual Society for Epidemiologic Research (SER). June 14-17, 2022. Chicago, IL.
13. **Zivich PN**. (2022) "Realistic policies on influenza vaccination and risk of subsequent influenza among university students: application of targeted maximum likelihood estimation with interference". Oral Presentation at the 55th annual Society for Epidemiologic Research (SER). June 14-17, 2022. Chicago, IL.
14. **Zivich PN**. (2022) "Fusion to address systematic errors across data sources". Oral Presentation at the Emerging Challenges for Statistics and Data Sciences: Complex Data with Missingness, Measurement Errors, and High Dimensionality. May 23-27, 2022. University of British Columbia - Okanagan, Kelowna, British Columbia, Canada.
15. **Zivich PN**. (2022) "Targeted Maximum Likelihood Estimation for Causal Inference with Network Data". Oral Presentation at Duke Social Networks and Health Workshop. May 10-12, 2022. Durham, NC
16. **Zivich PN**. (2021) "Efficient machine learning for causal effects". Health Data Science for Impact Workshop at Singapore Institute for Clinical Sciences. March 16-18, 2021. Virtual.
17. **Zivich PN**, Hudgens MG, Moody J, Brookhart MA, Weber DJ, Aiello AE. (2020) "Examining the utility of targeted maximum likelihood estimation for network data". Oral Presentation at the 53rd annual Society for Epidemiologic Research (SER). December 15-18, 2020. Virtual.
18. **Zivich PN**, Volfovsky A, Moody J, Aiello AE. (2019) "Assortativity by Treatment in Social Networks and Bias in Population Health Studies". Oral Presentation at the Interdisciplinary Association of Population Health Scientists (IAPHS) Meeting. October 1-4, 2019. Seattle, WA.
19. **Zivich PN**, Edwards JK, Keil AP. (2019) "An Inverse Probability Weighting Approach to Correct for Left Truncation". Oral Presentation at the 52nd Annual Society for Epidemiologic Research (SER) Meeting. June 18-21, 2019. Minneapolis, MN.
20. **Zivich PN**, Volfovsky A, Moody J, Aiello AE. (2019) "Assortativity by Treatment in Social Networks and Bias". Poster Presentation at the Symposium on Biosocial Approaches to Population Health across the Life Course. May 13, 2019. Chapel Hill, NC.
21. **Zivich PN**. (2018) "Better understanding transmission: a social network approach". Invited oral presentation at University of North Carolina at Chapel Hill Social Epidemiology Seminar. September 26, 2018. Chapel Hill, NC.
22. **Zivich PN**, Volfovsky A, Moody J, Aiello AE. (2018) "Using Networks to better estimate Vaccine Effectiveness". Oral Presentation at Social Networks and Health. May 14, 2018. Durham, NC.
23. **Zivich PN**, Eisenberg MC, Walsh A, Aiello AE. (2017) "Smartphone as a Tool for Deep Epidemiologic Data on Social Networks". Oral Presentation in Infectious Disease session at the 50th Annual Society for Epidemiologic Research (SER) Meeting. June 20-23, 2017. Seattle, WA.

## ■ Mentorship

### Member of Doctoral Committee

- Current Justin DeMonte, *Sequential trial emulation for observational vaccine effectiveness studies*, Chair: Michael Hudgens, Department: Biostatistics
- Current Tianhao Song, *Triggering-Effect Models for Multi-Type Recurrent Events*, Chair: Anastasia Ivanova, Department: Biostatistics

## ■ Editorial Responsibilities

- 2024 – *Epidemiologic Methods*, Associate Editor

## ■ Reviewer Contributions

American Journal of Epidemiology, Annals of Applied Statistics, Annals of Epidemiology, Biometrics, BMJ Open, Communications in Statistics – Case Studies and Data Analysis, Data Technologies & Applications, Epidemiology, Influenza and Other Respiratory Viruses, Informatics for Health and Social Care, International Journal of Environmental Research and Public Health, International Journal of Epidemiology, Journal of Causal Inference, Journal of Clinical Epidemiology, Journal of Infectious Diseases, Nature – Scientific Reports, PLoS Computational Biology, PLoS One, Public Health Reviews, Social Forces, Social Networks, Statistics in Medicine, Vaccine

## ■ Honors and Awards

- 2024 Society for Epidemiologic Research (SER), *Lilienfeld Postdoctoral Prize Paper Award*
- 2023 Research featured in ‘Early Career Researchers: A Joint Collection from the *American Journal of Epidemiology* and the *European Journal of Public Health*’
- Zivich PN et al. “Introducing Proximal Causal Inference in Epidemiology”. *American Journal of Epidemiology* 2023; 192(7): 1224-1227.
  - Filiatreau LM et al. “Optimizing SARS-CoV-2 pooled testing strategies through differentiated pooling for distinct groups”. *American Journal of Epidemiology* 2023; 192(2): 246-256.
- 2017 – 2019 Social Network and Health Fellow at Duke Network Analysis Center
- 2017 Member of Delta Omega, Honorary Society in Public Health
- 2015 Sigma Xi Scientific Research Society

## ■ Open-Source Software Contributions

- Python zEpid: creator, maintainer  
Delicatessen: creator, maintainer  
MossSpider: creator, maintainer  
Lifelines: contributor