Rachel Carroll, Ph.D.
CURRICULUM VITAE

Address:
Osprey Hall
601 S. College Rd.
Wilmington, NC 28403

Office: Osprey 2012D
Phone: 910-962-7654
E-mail: carrollr@uncw.edu
ORCID: 0000-0001-5895-0031
Webpage

Education

Medical University of South Carolina (MUSC) - Charleston, South Carolina
Ph.D. in Biomedical Sciences - Biostatistics, December 2015
PI: Andrew B. Lawson, Ph.D.
Dissertation: *Model Selection for Hierarchical Poisson Modeling in Disease Mapping.*

Charleston Southern University (CSU) - Charleston, South Carolina
Bachelor of Science - Mathematics, Minor: Biology, *Cum Laude*, May 2011

Research Experience

Department of Mathematics and Statistics, University of North Carolina at Wilmington (UNCW)

Assistant Professor	Aug 2018 - Present	

Biostatistics and Computational Biology Branch, National Institute of Environmental Health Sciences (NIEHS)

Guest Researcher	Aug 2018 - Present	
Research Fellow	Sept 2016 - Aug 2018	Shanshan Zhao, Ph.D.

Department of Public Health Sciences, MUSC

Postdoctoral Scholar	Jan 2016 - Aug 2016	Andrew B. Lawson, Ph.D.
Graduate Research Assistant	Aug 2011 - Dec 2015	Andrew B. Lawson, Ph.D.

Professional Memberships and Services

- UNCW Data Science Program Board of Directors
  Member (April 2019-present)
- UNCW Department of Mathematics and Statistics - Statistics Interest Group
  Member (Aug 2018-present), Chair (2019-2020)
- UNCW Department of Mathematics and Statistics - Outreach Committee
  Member (Aug 2018-present)

- NIEHS Trainees' Assembly Steering Committee
  Branch Representative (October 2016-July 2018)
- International Biometric Society
  Member - Eastern North American Region
- American Statistical Association
  Member - Biometrics and Bayesian Statistical Science Sections
- NIEHS Career Symposium Planning Committee
  Committee member (October 2017-May 2018)
- 2019, 2020 NIH Fellows Award for Research Excellence competition - Judge

Reviewer (publons.com/a/1246451/)
Statistics in Medicine, Statistical Methods in Medical Research, Annals of Epidemiology, Spatial and Spatio-temporal Epidemiology, Environmetrics, Stochastic Environmental Research and Risk Assessment, Journal of the Royal Statistical Society – Interface, International Journal of Health Geographics, Public Health, Computational and Mathematical Methods in Medicine, Biometrics, Environmental Health Perspectives

Awards/Honors

2020	Co-Investigator on Corbett Grant for "Do Fitbits® Encourage Health Tracking and Lower Blood Pressure in Barbershop Initiatives? A Feasibility Study" (Total award: $6,709)
2019	ETEAL Pedagogy Initiative for "Transformative learning through statistics capstone projects" ($3498 stipend, co-PI along with Y. Wang and I. Ghosh)
2019	International Travel Grant, UNCW ($1200 for use on international travel in fiscal year 2019)
2018	Applied Learning Recovery Grant, UNCW ($500 stipend for a Fall, 2018 class project)
2017	2018 Fellows Award for Research Excellence (FARE), NIH ($1000 travel award to be used in 2018)
2011	Honor graduate, Charleston Southern University
2011	Cross Country All Academic Award, CSU
2010	Named captain of the Cross Country team, CSU
2010	Accepted to the Summer Undergraduate Research Program, MUSC ($4000 summer stipend)
2007-11	Academic Dean's List, CSU
2008, 2011	Cross Country Sportsmanship Award, CSU
2007	Board of Trustees Scholar for Florence School District One

Teaching Experience

Courses taught, UNCW

DSC551	Spatial-temporal analysis Fall '19
STT210	Introduction to Statistics with Applications in the Health Sciences Fall '18, Spring '19. Fall '19, Spring '20
STT420/520	Biostatistical Analysis Fall '18
STT350	Survey Sampling Spring '19, Spring '20

Workshops and Short Courses

[Tutor] Bayesian Disease Mapping
March 14-18, 2016, Department of Public Health Sciences, MUSC, Charleston, SC
Five-day workshop consisting of introductory and advanced Bayesian disease mapping with `WinBUGS` and `R-INLA`.

[Instructor] Biostatistics I
January 9, 2017, NIEHS, Research Triangle Park, NC
3-hour short course offering an introduction to statistics and experimental design as well as minimal introduction to coding in `R`.

[Instructor] Biostatistics II
January 10, 2018, NIEHS, Research Triangle Park, NC
3-hour short course offering an introduction to hypothesis testing as well as minimal introduction to coding in `R`.

Guest Lectures

Statistical significance: The how to's. NIEHS Scholars Connect Series; 2017 June 6; Research Triangle Park, NC.
Case Studies in Spatial and Spatio-temporal Data Science. Series in UNCW DSC551; 2020; Wilmington, NC.

Thesis committee roles

Jasmine Gaston. Performance Analysis on Simultaneous Age, Gender, and Race Estimation using Canonical Correlation Analysis Based Methods and Feature Fusion. December 2019. Committee member.
Summerlin Thompson. Demographic Analysis on Simultaneous Age, Gender, and Race Estimation using Canonical Correlation Analysis Based Methods and Feature Fusion. July 2019. Committee member.

Students Mentored

Julia Castillo. Multivariate Spatio-temporal Accelerated Failure Time Model for Detecting Change Points in Cancer Survival. MAT595 UNCW, January 2020-May 2020.

Lesette Campbell, Jeremiah Carlson, and David Jackson. Data Mining and Analysis of North Carolina 2-1-1 Call Center Data. MAT495 UNCW, January 2020-May 2020.

Shelby Ferry, Hunter Wilkinson, and Griffin William. Disease Mapping of Breast Cancer Incidence and Mortality in North Carolina. STT490 UNCW, August 2019-December 2019.

Lauren Elwood. The college experience: Assessing several psychological outcomes with respect to academic success. UNCW undergraduate student, August 2018-present.

Elizabeth Huse. An analysis of event impact across multiple cancers: Accessing spatio-temporal variation in cancer-specific mortality for Louisiana SEER data. MAT596 UNCW, January 2019-May 2019.

Jordan Malone, Emma Ruesch, and Tara Sulak. An analysis of event impact across multiple cancers: Accessing spatio-temporal variation in cancer-specific mortality for Louisiana SEER data. MAT495 UNCW, January 2019-May 2019.

Kevin Day. Assessing the uses of Health Regions for NIEHS Sister Study; NIEHS Special Volunteer, June 2017-Aug 2018.

Data Science Pre-practicum Projects (DSC541)

- IBM PAIRS (August ’20-Present)
- Turtle nesting habitats (August ’19-May ‘20)
  ’19-’20 Kendall Lipsey and G. Steven Moore
- Socio-environmental analysis lab (March ’19-May ‘20)
  ’18-’19 Tyler Hefty and Matthew Yohe
  ’19-’20 Kayla Kirk and Tanner Miles
- Cape Fear Collective (January ’20-Present)
  ’19-’20 Lars Bajohr, Ivan Damien, Mukila Rajasekar, and Emma Ruesch

Major Research Interests

Biostatistics, Bayesian statistics, spatial epidemiology, spatio-temporal modeling, model uncertainty, model selection, mixture modeling, disease mapping, statistical methods in oncology, applications in public health, environmental data, survival analysis, multivariate analysis, statistical software development, statistical methods for environmental mixtures

Software Development

All available from GitHub, user: carrollrm

R packages

survsamp: This package offers several functions for performing estimation and sample size determination from Survey data. The sampling methods available include: simple, stratified, systematic, and cluster. The statistics for estimation include: mean, total, proportion, difference, and ratio. One of the functions also offers estimation of the population size using direct, inverse, or quadratic sampling methods. Variance estimated and confidence intervals are generated for all. R package version

0.0.0.9000.
fillmap: Create and assess maps with SpatialPolygons objects. R package version 0.0.0.9000.

RMD tutorials
LCAmix: Latent class analysis applied to a simulated chemical mixtures example.

R shiny applications (some only available from shinyapps.oi)
WPDarrests: Spatio-temporal modeling and visualizations of Wilmington Police Department arrests
COVID19_US_NC_CF: Spatial-temporal COVID-19 visualizations dashboard
COVID19ts: International time series visualizations dashboard
COVIDmod: Spatio-temporal modeling of COVID19 dashboard
MixModShiny: Results using Melanoma cancer of the skin, Lung and Bronchus cancer, and Oral Cavity and Pharynx cancer data with the Bayesian spatio-temporal multivariate mixture models.
LAmortBrCaShiny: Produces survival curves and probabilities based on user spatial, demographic, and clinical related input.

Available code
Comparable `INLA/BUGS` code for Poisson spatial disease mapping models
Spatial Bayesian model selection for a Poisson likelihood `BUGS` code
Spatial Bayesian Model Averaging for a Poisson likelihood `BUGS` code
Spatio-temporal Bayesian model selection for a Poisson likelihood `BUGS` code
Spatio-temporal univariate and multivariate Bayesian mixture models for a Poisson likelihood `BUGS` code
Spatial Accelerated Failure Time model `BUGS` code
Spatio-temporal Accelerated Failure Time model `BUGS` code
Secondary random effect assessment `R` code (imbedded in fillmap)
Additive Spatial and Temporal Accelerated Failure Time model `BUGS` code with automation
COVID19 data processing and modeling, dashboard development

Available Data
US Health Regions shapefile
West Coast Health Regions shapefile
Southeast Coast Health Regions shapefile
Northeast Health Regions shapefile

Publications

*indicates students mentored

Submitted

1. Schroeder LH, Richardson EL, Carroll R. The quantitative examination of the relationship between job satisfaction and organization fit in athletic trainers.
2. Carroll R, Prentice CR, Brudney JL, Brennan JF. Nonprofit supply and citizen demand: A spatial analysis of the market for third sector services.
3. Carroll R, Prentice C. On stay at home orders: Using the power of data science for spatial and temporal modeling and visualization of COVID-19.
4. Bove LA, Carroll R. Comparing traditional blood pressure with a mobile health application.
5. Pickens BA, Carroll R, Taylor JC. Predicting the distribution of three Penaeid shrimp species reveals Linkages Between Estuarine and Marine Habitats.
6. Carroll R, Weinberg C, Sandler D, Zhao S. Understanding the impact of social and physical environment on breast cancer risk in the NIEHS Sister Study.
7. Aregay M, Lawson AB, Faes C, Kirby RS, Carroll R, Watjou K. Multiscale spatiotemporal models for aggregated small area health outcomes.

Accepted

1. Richardson E, Strawn H, Conklin SL, Carroll R. Connecting the Dots - Tips for Innovatively Managing Competency Assessment in Healthcare Management Education. J Hlth Admin Educ. 2020. In print.
2. Johnson R, Matthews J, Diawara N, Carroll R. Prefrontal cortex activity across treatment duration in apraxia of speech: A single-case fNIRS feasibility study. Front Appl Math Stat. 2020. In print.
3. Wang M, Wasserman E, Geyer N, Carroll R, Zhao S, Zhang L, Hohl R, Lengerich EJ, McDonald AC. Spatial Patterns in Prostate Cancer-specific Mortality in Pennsylvania Using Pennsylvania Cancer Registry Data, 2004-2014. BMC Cancer. 2020. 2(1):394. doi: 10.1186/s12885-020-06902-5 .
4. Huse E*, Malone J*, Ruesch E*, Sulak T*, Carroll R. An analysis of hurricane impact across multiple cancers: Accessing spatio-temporal variation in cancer-specific survival with Hurricane Katrina and Louisiana SEER data. Health Place. 2020. 63(May):102326. doi: 10.1016/j.healthplace.2020.102326.
5. White AJ, Keller J, Zhao S, Carroll R, D Sandler. Air pollution, clustering of particulate matter components and breast cancer in a nationwide cohort of American women: The Sister Study. Environ Health Perspect. 2019; 127(10). doi: 10.1289/EHP5131.
6. Carroll R, White AJ, Keil AP, Meeker JD, McElrath TF, Zhao S, and Ferguson KK. Latent classes for meaningful chemical mixtures analyses in epidemiology: An

example using phthalate and phenol exposure biomarkers in pregnant women. J Expo Sci Env Epid. 2020; 30(1):149-159. doi: 10.1038/s41370-019-0181-y.

7. Day K*, Shanshan Z, Carroll R. Comparison of spatial resolutions in North Carolina. High School Journal of Mathematics. 2019; in print.
8. Watjou K, Faes C, Lawson AB, Kirby RS, Aregay M, Carroll R, Vandendijck Y. Spatial smoothing models to deal with the complex sampling design and nonresponse in the Florida BRFSS survey. Spat Spatiotemporal Epidemiol. 2019; 29(June):59-70. doi: 10.1016/j.sste.2019.03.001.
9. Carroll R, Lawson AB, Zhao S. A data-driven approach to estimate the change-points for and impact of major events on disease risk. Spat Spatiotemporal Epidemiol. 2019;29(2019):111-118. doi: 10.1016/j.sste.2018.08.005.
10. Kim SS, Meeker JD, Carroll R, Zhao S, Mourgas MJ, Richards MJ, Aung M, Cantonwine DE, McElrath TF, Ferguson KK. Urinary trace metals individually and in mixtures in association with preterm birth. Environ Int. 2018; 21(1):582-590. doi: 10.1016/j.envint.2018.09.052.
11. Carroll R, Shanshan Z. Trends in colorectal cancer incidence and survival in Iowa SEER data: The timing of it all. Clin Colorectal Cancer. 2018; pii: S1533-0028(18)30448-1. doi: 10.1016/j.clcc.2018.12.001. [Epub ahead of print].
12. Rosen EM, Brantsaeter AL, Carroll R, Haug L, Singer AB, Zhao S, Ferguson KK. Maternal Serum Levels of Perfluoroalkyl Substances and Breastfeeding Duration in the Norwegian Mother and Child Cohort. Environ Epi. 2018; 2(3):e027. doi: 10.1097/EE9.0000000000000027.
13. White AJ, O'Brien KM, Niehoff NM, Carroll R, Sandler DP. Hazardous Metallic Air Toxics and Breast Cancer Risk in a Nationwide Cohort Study. Epidemiology. 2018 Sep 6. doi: 10.1097/EDE.0000000000000917. PMID: 30198937; PMCID: 6269205.
14. Carroll R, Lawson AB, Zhao S. Temporally dependent accelerated failure time model for capturing the impact of events that alter survival in disease mapping. Biostatistics. 2018; in print. doi: 10.1093/biostatistics/kxy023. PMID: 29939209.
15. Carroll R, Zhao S. Gaining relevance from the random: Interpreting observed spatial heterogeneity. Spat Spatiotemporal Epidemiol. 2018;25:11-17. doi: 10.1016/j.sste.2018.01.002.
16. Carroll R, Lawson AB, Jackson C, Zhao S. Spatial assessment of breast cancer-specific mortality using Louisiana SEER data. Soc Sci Med. 2017;193(11):1-7. doi: 10.1016/j.socscimed.2017.09.045. PMID: 28985516; PMCID: 5659900.
17. Aregay M, Lawson AB, Faes C, Kirby RS, Carroll R, Watjou K. Zero inflated multiscale models for aggregated small area health data. Environmetrics. 2017;29(1):e2477. doi: 10.1002/env.2477. PMID: 27566773; PMCID: 5437596.
18. Lawson AB, Carroll R, Faes C, Kirby RS, Aregay M, Watjou K. Spatio-temporal multivariate mixture models for Bayesian model selection in disease mapping.

Environmetrics. 2017;28(8):e2465. doi: 10.1002/env.2465; PMID: 29230091; PMCID: 5722237.

19. Aregay M, Lawson AB, Faes C, Kirby RS, Carroll R, Watjou K. Comparing multilevel and multiscale convolution models for small area aggregated health data. Spat Spatiotemporal Epidemiol. 2017;22(9):39-49. doi: 10.1016/j.sste.2017.06.001. PMID: 28760266; PMCID: PMC Journal-In Process.
20. Watjou K, Faes C, Lawson AB, Kirby RS, Aregay M, Carroll R, Vandendijck Y. Spatial small area smoothing models for handling survey data with nonresponse. Stat Med. 2017;36(23):3708-3745. doi: 10.1002/sim.7369. PMID: 28670709; PMCID: 5585068.
21. Carroll R, Lawson AB, Faes C, Kirby RS, Aregay M, Watjou K. Extensions to multivariate space time mixture modeling of small area cancer data. Int J Envi Res Pub Heal. 2017;14(5):503. doi:10.3390/ijerph14050503. PMID: 28486417; PMCID: 5451954.
22. O'Connell NS, Dai L, Jiang Y, Speiser JL, Ward R, Wei W, Carroll R, Gebregziabher M. Methods for analysis of pre-post data in clinical research - a comparison of five common methods. J Biom Biostat. 2017;8:334. doi: 10.4172/2155-6180.1000334.
23. Carroll R, Lawson AB, Faes C, Kirby RS, Aregay M, Watjou K. Space-time variation of respiratory cancers in South Carolina: A flexible multivariate mixture modeling approach to risk estimation [Special Issue]. Ann Epidemiol. 2017;27(1):42-51. doi: 10.1016/j.annepidem.2016.08.014. PMID: 27653555; PMCID: 5272780.
24. Neyens T, Lawson AB, Kirby RS, Nuyts V, Watjou K, Aregay M, Carroll R, Nawrot TS, Faes C. Disease Mapping of Zero-excessive Mesothelioma Data in Flanders [Special Issue]. Ann Epidemiol. 2017;27(1):59-66. doi: 10.1016/j.annepidem.2016.10.006. PMID: 27908590; PMCID: 5272833.
25. Aregay M, Lawson AB, Faes C, Kirby RS, Carroll R, Watjou K. Multiscale modeling approach for hierarchical aligned aggregated small area health data [Special Issue]. SIGSPATIAL. 2016;8(1):12-19. doi: 10.1145/2961028.2961032.
26. Carroll R, Lawson AB, Faes C, Kirby RS, Aregay M, Watjou K. Spatiotemporal Bayesian model selection for disease mapping. Environmetrics. 2016;27(8):466-478. doi: 10.1002/env.2410. PMID: 28070156; PMCID: 5217709.
27. Aregay M, Lawson AB, Faes C, Kirby RS, Carroll R, Watjou K. Multiscale measurement error models for aggregated small area health data. Stat Methods Med Res. 2016;25(4):1201-23. doi: 10.1177/0962280216661094. PMID: 27566773; PMCID: 5437596.
28. Carroll R, Lawson AB, Faes C, Kirby RS, Aregay M, Watjou K. Spatially-dependent Bayesian model selection for disease mapping. Stat Methods Med Res. 2018;27(1):250-268. doi: 10.1177/0962280215627298. PMID: 28034176; PMCID: 5374035.

29. Carroll R, Lawson AB, Faes C, Kirby RS, Aregay M, Watjou K. Bayesian model selection methods in modeling small area colon cancer incidence. Ann Epidemiol. 2016;26(1):43-9. doi: 10.1016/j.annepidem.2015.10.011. PMID: 26688281; PMCID: 4687023.
30. Aregay M, Lawson AB, Faes C, Kirby RS, Carroll R, Watjou K. Spatial mixture multiscale modeling for aggregated health data. Biometrical J. 2016;58(5):1091-112. doi: 10.1002/bimj.200800143. PMID: 26923178; PMCID: PMC Journal-In Process.
31. Carroll R, Lawson AB, Faes C, Kirby RS, Aregay M, Watjou K. Comparing INLA and OpenBUGS for hierarchical Poisson modeling in disease mapping. Spat Spatiotemporal Epidemiol. 2015;14-15:45-54. doi: 10.1016/j.sste.2015.08.001. PMID: 26530822; PMCID: 4633705.
32. Aregay M, Lawson AB, Faes C, Kirby RS, Carroll R, Watjou K. Impact of income on small area low birth weight incidence using multiscale models. AIMS Public Health. 2015;2(4):667-80. doi: 10.3934/publichealth.2015.4.667. PMID: 27398390; PMCID: 4936536.
33. Carroll R, Lawson AB, Voronca D, Rotejanaprasert C, Vena JE, Aelion CM, et al. Spatial environmental modeling of autoantibody outcomes among an African American population. Int J Envi Res Pub Heal. 2014;11(3):2764-79. doi: 10.3390/ijerph110302764. PMID: 24608900; PMCID: 3987002.
34. Lawson AB, Carroll R, Castro M. Joint spatial Bayesian modeling for studies combining longitudinal and cross-sectional data. Stat Methods Med Res. 2014;23(6):611-24. doi: 10.1177/0962280214527383. PMID: 24713159; PMCID: 5388557.
35. Lawson AB, Ellerbe C, Carroll R, Alia K, Coulon S, Wilson DK, et al. Bayesian latent structure modeling of walking behavior in a physical activity intervention. Stat Methods Med Res. 2014;25(6):2634-2649. doi: 10.1177/0962280214529932. PMID: 24741000; PMCID: 5388556.

Select Recent Presentations (* indicates invited)

*Carroll R, Castillo J. Multivariate spatio-temporal accelerated failure time model for detecting change points in cancer survival. JSM. 2020 August 2; Virtual due to COVID-19. (oral)

*Carroll R. Using the power of data science for real-time spatial and temporal visualization and modeling of COVID-19. Fields Institute of Toronto. Advancing knowledge about spatial modeling, infectious diseases, environment and health. 2020 June 8; Virtual due to COVID-19. (oral)

Carroll R, Huse E, Malone J, Reusch E, and Sulak T. An analysis of hurricane impact across multiple cancers: Accessing spatio-temporal (poster)

variation in cancer-specific mortality with Hurricane Katrina and Louisiana SEER data. GEOMED; 2019 August 27; Glasgow, Scotland.

*Carroll R, White A, Zhao Z. A Bayesian approach to weighted quantile sums with extension for time to event data. ASIC; 2018 October 6; Greensboro, NC. (oral)

Carroll R, Lawson AB, Zhao S. Temporally dependent accelerated failure time model for capturing the impact of events that alter survival in disease mapping. JSM; 2018 July 29; Vancouver, BC, Canada. (poster)

Carroll R, Lawson AB, Zhao S. A spatial accelerated failure time (AFT) model for analyzing mortality following breast cancer diagnosis in Louisiana SEER data. ENAR; 2017 March 12; Washington, DC. (poster)