CLARKSON UNIVERSITY
David A. Walsh ‘67 Arts & Sciences
Mini - Conference 2024

Friday April 12, 2024 @ 8:00 am - 3:30 pm in Snell 241

USING DATA AND MATHEMATICAL MODELING TO UNDERSTAND THE COVID-19 DYNAMICS

Breakfast and Registration — **8:00 am - 9:00 am**

Morning session: Workshop

Rajesh Nandy	**Modeling and forecasting the spread of infectious disease using the statistical package R with COVID-19 as an example**	**9:00 am - 12:00 pm**

Lunch — **12:00 pm - 1:00 pm**

Afternoon session: Research Talks

Byron Erath	**The fluid dynamics of airflow expelled from the mouth during speech**	**1:00 pm - 1:20 pm**
Andrea R. Ferro	**Comparing respiratory aerosol emissions between children and adults during sustained phonation**	**1:25 pm - 1:45 pm**
Karabi Nandy	**Early impact of COVID-19 on mental health in adults with depression: Findings from a Texas study**	**1:50 pm - 2:10 pm**
Sumona Mondal	**COVID-19 in New York state: Effects of demographics and air quality on infection and fatality**	**2:15 pm - 2:35 pm**

Break — **2:40 pm - 3:00 pm**

James Greene	**Mathematical models and control strategies related to the COVID-19 pandemic and infectious diseases generally**	**3:00 pm - 3:30 pm**

For more information: Dr. Sumona Mondal (smondal@clarkson.edu), Dr. James Greene (jgreene@clarkson.edu), Dr. Shantanu Sur (ssur@clarkson.edu) .
Breakfast (8.00 am - 9.00am) and lunch (12.00pm - 1.00pm) will be provided

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WORKSHOP

Modeling and forecasting the spread of infectious disease using the statistical package R with COVID-19 as an example.

9:00 am - 12:00 pm

Abstract: For spread of infectious disease, mathematical modeling provides a flexible framework for exploring different scenarios related to disease spread and prevention strategies. It empowers public health officials to make data-driven choices during a pandemic. During COVID-19, forecasts based on mathematical modeling under different scenarios helped inform public health decision making by projecting the likely impact of COVID-19 in the next few weeks. In this workshop, we will learn the models and how to implement them on real data using the statistical package R. We will also look at real data from counties in the DFW metropolitan as examples. Participants of the workshop are expected to have the statistical package R and the free software R-studio installed in their laptops.

Associate Professor of Biostatistics and Interim Co-Chair
Department of Population & Community Health
School of Public Health
UNT Health Science Center

About the speaker

Dr. Rajesh Nandy is an Associate Professor of Biostatistics and interim Co-Chair in the Department of Population & Community Health at the School of Public Health in the UNT Health Science Center. He received his PhD in Mathematics from the University of Washington, specializing in the theory of stochastic processes. His research goal is to develop novel, intuitive, and practical statistical methods that can contribute to solving real life problems. He has applied his methods to a broad range of applications including clinical trials, neuroimaging, dose response, psychiatry, and signal processing using a wide array of statistical methods like Multivariate Statistical Analysis, Receiver Operating Characteristics (ROC) methods, Multiple Comparison, Resampling Methods, Machine Learning, Bayesian variable selection, Optimal Designs, and Spatial Statistics. He is currently involved in multiple NIH funded research projects.

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RESEARCH TALKS

The fluid dynamics of airflow expelled from the mouth during speech.

Byron Erath, Ph.D.

1:00 pm - 1:20 pm

Professor
Department of Mechanical and Aerospace Engineering
Clarkson University

Abstract: The COVID-19 pandemic highlighted the importance of airborne transmission of infectious diseases.particularly with regards to asymptomatic transmission, as occurs when speaking. Airborne infectious disease transmission occurs as respiratory particles, which can contain virions are expelled from the mouth and into the surroundings. The transport of respiratory particles is driven by the airflow that is expelled at the mouth. It is commonly assumed that when speaking, the flow exiting the mouth behaves as a steady, axi-symmetric round jet that exits straight out from the mouth. This work presents evidence that this assumption neglects important physics that govern the expiratory flow field. Emphasis is placed on quantifying how the trajectory of the expiratory jet varies for different intonations, and is influenced by the posturing of the oral cavity. Particle image velocimetry data of human expirations during running speech reveals a complex flow field is produced that is characterized by transient emissions that behave as both puffs and jets. Implications on modeling near and far field transport of infectious diseases are also discussed.

Comparing respiratory aerosol emissions between children and adults during sustained phonation.

Andrea R. Ferro, Ph.D.

1:25 pm - 1:45 pm

Professor / ISE Associate Director Research
Civil & Environmental Engineering , Center for Air and Aquatic Resources Engineering

Abstract: Respiratory activities such as coughing, breathing, singing, sneezing, and speaking release aerosols 0.1-100 µm in diameter, with a mean diameter of ~1 µm for vocalization activities.Several research groups have reported particle production rates for respiratory activities as a function of both loudness and frequency. Few studies, however, have included children, which has restricted understanding of exposure risk in environments occupied primarily by children, such as schools. Respiratory aerosols arise due to bronchial fluid film bursting within the pulmonary tract, vibration of the vocal folds during phonation, and articulation of the tongue/lips/teeth. We expect children's respiratory aerosol generation rates to be lower than adults' due to the smaller size of their laryngeal structure and reduced subglottal pressure created during speech. We recruited 50 participants from three age categories: children aged 6 − 11 years, children aged 12 − 18 years, and adults (> 18 years). We investigated particle emissions for vocalizations at 262 Hz (middle C, or C4, on a keyboard) for three different 5-second activities (normal sustained /a/, deep breath followed by sustained /a/, and /pa/ repeated at ~1Hz). All activities were repeated 6 times. The particle generation rate ranged from 0 to 488 particles/s. Children aged 6 − 11 years produced fewer particles (mean 12 ± SD 9 particles/s) than children aged 12 − 18 years (23 ± 19 particles/s) and adults (70 ± 73 particles/s). Taking a deep breath before vocalizing /a/ resulted in higher aerosol emission rates than the baseline case.Using the constrained inference approach, we realized good statistical power for the comparisons between groups even with the relatively small sample size. A relative importance analysis was performed using a regression model to further investigate the impact of the predictor variables, frequency, amplitude, and age, on particle emission rate. The results from the relative importance calculations indicate that the frequency and amplitude contributed 1% and 5%, respectively, to the overall particle emission rate, whereas the age contributed 94% to the particle emission rate.Superemitters (statistical outliers) were found in all groups.

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RESEARCH TALKS

Early impact of COVID-19 on mental health in adults with depression: Findings from a Texas study

1:50 pm - 2:10 pm

Karabi Nandy, Ph.D.

Associate Professor
Psychiatry Center for Depression Research and Clinical Care
Department of Psychiatry
UT Southwestern Medical Center

Abstract: Background: A decline in mental health was observed in the general population during theCOVID-19 pandemic. We observed a vulnerable population of depressed adults in a naturalistic setting and studied their depression, anxiety, and quality of life through the early months of the pandemic.Methods: Data regarding depression, anxiety, and quality of life in adult participants with a history of a depressive disorder (n=308) were collected before and during the COVID-19 pandemic. Mixed effects regression models were fit for these outcomes over the period May-August 2020, controlling for pre-pandemic depressive groups (none, mild, moderate-to-severe),demographics characteristics and early COVID-related experiences (disruptions in routines, mental health treatment and social supports).Results: In pre-to-early pandemic comparisons, the 3 pre-pandemic depressive categories varied significantly in anxiety (F df=2,197 = 7.93, p < 0.0005) and psychological QOL (F df=2,196 = 8.57, p =0.0003). The mildly depressed group (F df=1,201 = 6.01, p = 0.02) and moderate-to-severely depressed group (F df=1,201 = 38.51, p < 0.0001) had a significant reduction in anxiety. There were no changes among the groups in any outcome from May to August 2020. Early impact on mental health care access and disruption in routines predicted worse outcomes during this time.Limitations: Follow-up data were self-reported. Furthermore, the duration was a relatively short span into the pandemic.Conclusions: Symptoms of depression, anxiety, and quality of life were generally stable from 2019 throughout August 2020 in adults with a history of depression. Disruption in mental health care access and routines in May 2020 predicted worse symptom outcomes through August 2020.

COVID-19 in New York state: Effects of demographics and air quality on infection and fatality

2:15 pm - 2:35 pm

Sumona Mondal, Ph.D.

Professor of Mathematics /
Co-Director of the MS Program in Applied Data Science
Clarkson University

Abstract:The coronavirus disease 2019 (COVID-19) has had a global impact that has been unevenly distributed among and even within countries. Multiple demographic and environmental factors have been associated with the risk of COVID-19 spread and fatality, including age, gender, ethnicity, poverty, and air quality among others. However, specific contributions of these factors are yet to be understood. Here, we attempted to explain the variability in infection, death, and fatality rates by understanding the contributions of a few selected factors. We compared the incidence of COVID-19 in New York State (NYS) counties during the first wave of infection and analyzed how different demographic and environmental variables associate with the variation observed across the counties. We observed that infection and death rates, two important COVID-19 metrics, to be highly correlated with both being highest in counties located near New York City, considered as one of the epicenters of the infection in the US. In contrast, disease fatality was found to be highest in a different set of counties despite registering a low infection rate. To investigate this apparent discrepancy, we divided the counties into three clusters based on COVID-19 infection, death, or fatality, and compared the differences in the demographic and environmental variables such as ethnicity, age, population density, poverty, temperature, and air quality in each of these clusters. Furthermore, a regression model built on this data reveals PM2.5 and distance from the epicenter are significant risk factors for infection, while disease fatality has a strong association with age and PM2.5. Our results demonstrate that for the NYS, demographic components distinctly associate with specific aspects of COVID-19 burden and also highlight the detrimental impact of poor air quality. These results could help design and direct location-specific control and mitigation strategies.

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RESEARCH TALKS

Mathematical models and control strategies related to the COVID-19 pandemic and infectious diseases generally

James Greene, Ph.D.

3:00 pm - 3:30 pm

Assistant Professor
Department of Mathematics
Clarkson University

Abstract: Since the onset of the COVID-19 pandemic, there has been much scientific interest in the ability of mathematical models to both predict disease dynamics, as well as their use in designing intervention strategies that can mitigate disease burden on medical infrastructure, reduce transmission, minimize negative economic and psychological impacts, etc. In this talk, we will present a number of recent modeling projects which address different questions of interest related to the COVID-19 pandemic and infectious diseases generally. Specifically, we will discuss early novel models of the spread of COVID-19, which capture both the effect of asymptomatic transmission and social distancing via explicit compartments. We will then discuss the role of non-pharmaceutical interventions in both reducing peak infection numbers ("flattening the curve") while simultaneously minimizing time spent in strict lockdowns; general optimal design strategies can be numerically seen to exist throughout a large class of epidemic models, which we show to be rigorously justified in the SIR model. Opening/closing strategies in schools/universities will also be studied, where we analyze robust feedback laws which maximize in-person instruction while keeping infections below a critical threshold. Furthermore, as mutations lead to new viral strains, such as the Omicron and Delta variants, important questions related to evolutionary fitness/competition exist, such as the effect of selection with respect to infectivity vs. disease severity. Again utilizing relatively simple mathematical models, we study the impact of selection on mutant variants, and characterize necessary parameter changes yielding a fitness advantage. We note that in almost all of the scientific questions of interest addressed here, transient disease dynamics are of fundamental importance, which will be a theme throughout this talk.