Epidemiologic Transmission-Dynamic Modeling of Highly Pathogenic SARS-CoV-2 in Rural Robeson County, North Carolina

University of North Carolina at Pembroke

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Contents

EPIDEMIOLOGIC TRANSMISSION-DYNAMIC MODELING OF HIGHLY PATHOGENIC SARS-COV-2 IN RURAL ROBESON COUNTY, NORTH CAROLINA

February 2021

OVERVIEW

Project Background

The COVID-19 pandemic has rapidly caused a significant impact on global and local health and economies. In the US, the impact has resulted in over 27.8 million people infected, over 488,000 deaths as of February 16, 2021, as well as the collapse of national and local economies. While metro counties have significantly higher cases and deaths per capita, rural counties are experiencing faster growth rates signaling an increase in concern about the impact of the pandemic in rural America. As of February 16, 2021, North Carolina has experienced 826,340 cases and 10,582 deaths while Robeson County has experienced 14,167 cases and 186 deaths. To the extent that rural areas face an increasing impact, they could experience particular challenges with population health interventions due to the existing disparities in healthcare and community resources.

PROJECT GOALS

Epidemiologic Transmission-Dynamic Modeling of Highly Pathogenic SARS-CoV-2 in Rural Robeson County, North Carolina

University of North Carolina at Pembroke

<u>Project Goals</u>: (1) Conduct serology surveillance of SARS-CoV2 at two different time points in a rural population to determine infection prevalence and understand changes in prevalence and conversion rates over a 3-month period;

(2) Correlate demographic data and profile characteristics [behavior, attitudes, beliefs] from survey and focus group data with serology testing results for SARS-CoV-2;

(3) Use the laboratory and survey/focus group data to develop effective mitigation efforts and vaccine compliance that are culturally appropriate and acceptable to a rural, majority-minority population.

(4) Promote healthy habits to open schools. Work with Public Schools of Robeson County (PSRC) to install all school buildings with hands free temperature checks. Absent adequate screening and mitigation measures, parents and students won't feel safe to return to class and delays in the reopening process will likely cause further economic pain in a region which has already been severely affected by COVID-19.

(5) Enhance public health response. PSRC units would evaluate students, faculty and staff in the schools for COVID symptoms including temperature. The touchless units at school entrances would enhance public health as a check for all entering the building, identifying those with an increased temperature and reminding all to wear a face-mask.

RESULTS

SURVEILLANCE TESTING RESULTS

Process: (1) Conduct serology surveillance at each of 7 different sites located at the UNCP campus and randomly selected PSRC sites at 2 points in time 2 months apart.

- **A total of 1824 individual contacts with participants occurred over the 3-month data collection (September – November, 2021)**
- **Each individual was screened for COVID-19 symptoms and depression/anxiety at each contact**
- **398 individuals who were screened for COVID-19 symptoms had a positive profile and were referred to our community partner, the Robeson County Health Department, for antigen testing and excluded from this study**
- **Depression and anxiety related to COVID-19 were evaluated using brief, 2-item scales; 4 individuals were referred for follow-up evaluation of depression and/or anxiety due to extreme scores**
- **766 individuals participated in Round 1 only of the Serology testing component**
- **238 individuals participated in Round 2 only of the Serology testing component**
- **422 individuals participated in both Round 1 and Round 2 of the Serology testing components**
- **145 individuals had positive COVID-19 serology results; this represents 9.92% of 1462 individuals tested**

Outcomes: A total of 1824 discrete individual contacts occurred over the 3-month period of time. All participants were screened for COVID-19 symptoms or recent known exposure to determine eligibility. 398 individuals had a positive COVID-19 screen, were excluded from the study, and referred to the Robeson County Health Department for antigen testing. Of the remaining 1462 individuals, 145 (9.92%) had positive COVID-19 serology results. 368 individuals, randomly selected from first round participants, completed the 5C Scale of Psychological Antecedents of Vaccination and Perceptions of the Efficacy of COVID-19 Mitigation Efforts Scale. Predominantly positive scores were exhibited by the group on both scales.

Interpretation: The positivity rate on antibody testing mirrored the community antigen testing positivity rate at the time of the study. This suggests that a 'hidden' population of individuals exposed to the virus represents a dramatically larger infected group than previously surveilled. Future surveillance efforts should include a serology antibody component to get a truer picture of infection rates. The generally positive scores on the surveys suggest a low rate of vaccine hesitancy and a high rate of compliance with mitigation efforts. The social and cultural congruence between providers and consumers, and the culturally appropriate messaging that ensues, may be one explanation for this outcome.

ATTITUDES TOWARDS VACCINATION & MITTIGATION EFFORTS SURVEY RESULTS

Process: (2) Conduct surveys with a randomly selected group of participants during the first round of serology surveillance.

The *5C Scale of Psychological Antecedents of Vaccination* is a survey tool that explores the impact of intrinsic psychological factors that affect an individual's willingness to participate in vaccination efforts.

Typically, reasoning for failure to participate in vaccination efforts focuses on vaccine availability and ease of access. The 5C scale looks at more personal, relevant factors that may affect vaccine hesitancy. These include:

- **Confidence: trust in (i) the effectiveness and safety of vaccines, (ii) the system that delivers them, including the reliability and competence of the health services and health professionals, and (iii) the motivations of policy-makers who decide on the need of vaccines.**
- **Complacency: when perceived risks of vaccine-preventable diseases are low and vaccination is not deemed a necessary preventive action.**

- **Constraints: when physical availability, affordability and willingness-to-pay, geographic accessibility, ability to understand (language and health literacy) and appeal of immunization service affect uptake.**
- **Calculation: refers to individuals' engagement in extensive information searching.**
- **Collective Responsibility: the willingness to protect others by one's own vaccination by means of herd immunity.**

The *Perceptions of the Efficacy of COVID-19 Mitigation Efforts Scale* is a survey tool that evaluates compliance with COVID-19 mitigation efforts recommended by the Centers for Disease Control and Prevention.

Samples of the tools with outcome data for the sample evaluated in this study are below.

5C Scale of Psychological Antecedents of Vaccination

Please evaluate how much you disagree or agree with the following statements:
(1=Strongly Disagree; 2=Moderately Disagree; 3=Slightly Disagree; 4=Neutral, 5=Slightly Agree; 6=Moderately Agree; 7=Strongly Agree)

1. I am completely confident that vaccines are safe.
2. Vaccinations are effective.
3. Regarding vaccines, I am confident that public authorities decide in the best interest of the community.
4. Vaccination is unnecessary because vaccine-preventable diseases are not common anymore.
5. My immune system is so strong, it also protects me against diseases.
6. Vaccine-preventable diseases are not so severe that I should get vaccinated.
7. Everyday stress prevents me from getting vaccinated.
8. For me, it is inconvenient to receive vaccinations.
9. Visiting the doctor's makes me feel uncomfortable, this keeps me from getting vaccinated.
10. When I think about getting vaccinated, I weigh benefits and risk to make the best decision possible.
11. For each and every vaccination, I closely consider whether it is useful for me.
12. It is important for me to fully understand the topic of vaccination, before I get vaccinated.
13. When everyone is vaccinated, I don't have to get vaccinated, too (reverse score)
14. I get vaccinated because I can also protect people with a weaker immune system.
15. Vaccination is a collective action to prevent the spread of disease.

Antecedents:
Confidence (1,2,3), Complacency (4,5,6), Constraints (7,8,9), Calculation (10,11,12), Collective Responsibility (13, 14,15)

Confidence = trust in (i) the effectiveness and safety of vaccines, (ii) the system that delivers them, including the reliability and competence of the health services and health professionals, and (iii) the motivations of policy-makers who decide on the need of vaccines.
Complacency = When perceived risks of vaccine-preventable diseases are low and vaccination is not deemed a necessary preventive action.
Constraints = When physical availability, affordability and willingness-to-pay, geographic accessibility, ability to understand (language and health literacy) and appeal of immunization service affect uptake.
Calculation = refers to individuals' engagement in extensive information searching.
Collective Responsibility = the willingness to protect others by one's own vaccination by means of heard immunity.

Source: Betsch, C., Schmid, P., Heinemeier, D., Korn, L., Holtmann, C., & Bohm, R. (2018). Beyond confidence: Development of a measure assessing the 5C psychological antecedents of vaccination. *PLoS ONE, 13*(12), e0208601. Retrieved 02/10/21 from: https://doi.org/10.1371/journal.pone.0208601

RESULTS

The mean overall scores for this sample was 61.66 +/- 7.9 (Total possible score = 95, Range for this group = 33-84) and mean antecedent scores [on a scale of 1 to 7] were: Confidence = 5.71, Complacency = 2.51, Constraints = 1.74, Calculation = 5.67, and Collective Responsibility = 6.38

Perceptions of the Efficacy of COVID-19 Mitigation Activities

In your opinion, how effective are the following actions for keeping you safe from COVID-19? (1=Not Effective At All, 2=Hardly Effective, 3=Somewhat Effective, 4=Effective, 5=Very Effective)

1. *Wearing a face mask*
2. *Praying*
3. *Washing your hands with soap or using hand sanitizer frequently*
4. *Seeing a health care provider if you feel sick*
5. *Seeing a health care provider if you feel healthy but worry that you were exposed*
6. *Avoiding public spaces, gatherings, and crowds*
7. *Avoiding contact with people who could be high-risk*
8. *Avoiding hospitals and clinics*
9. *Avoiding restaurants*
10. *Avoiding public transport*

Source: Adapted from Bennett, D., Bruine de Bruin, W., Darling, J., Jian, Q., Kapteyn, A., & Samek, A., (2020). Understanding America Study, UAS230, Retrieved February 11, 2021 from: https://www.nlm.nih.gov/dr2/JHU_COVID-19_Community_Response_Survey-v1.3.pdf

RESULTS

Mean overall score = 43.97 +/- 5.24, range 25-50

Item Ranking (on a scale of 1-5):

4.84 +/- 0.41	Wash your hands with soap or using hand sanitizer frequently
4.69 +/- 0.61	Seeing a health care provider if you feel sick
4.68 +/- 0.69	Avoiding contact with people who could be high-risk
4.48 +/- 0.83	Avoiding public spaces, gatherings, and crowds
4.38 +/- 0.86	Wearing a face mask
4.30 +/- 0.88	Avoiding public transport
4.27 +/- 0.99	Avoiding hospitals and clinics
4.22 +/- 0.99	Seeing a health care provider if you feel healthy but worry that you were exposed
4.14 +/- 1.33	Praying
3.97 +/- 1.05	Avoiding restaurants

HEALTHY SCHOOOLS

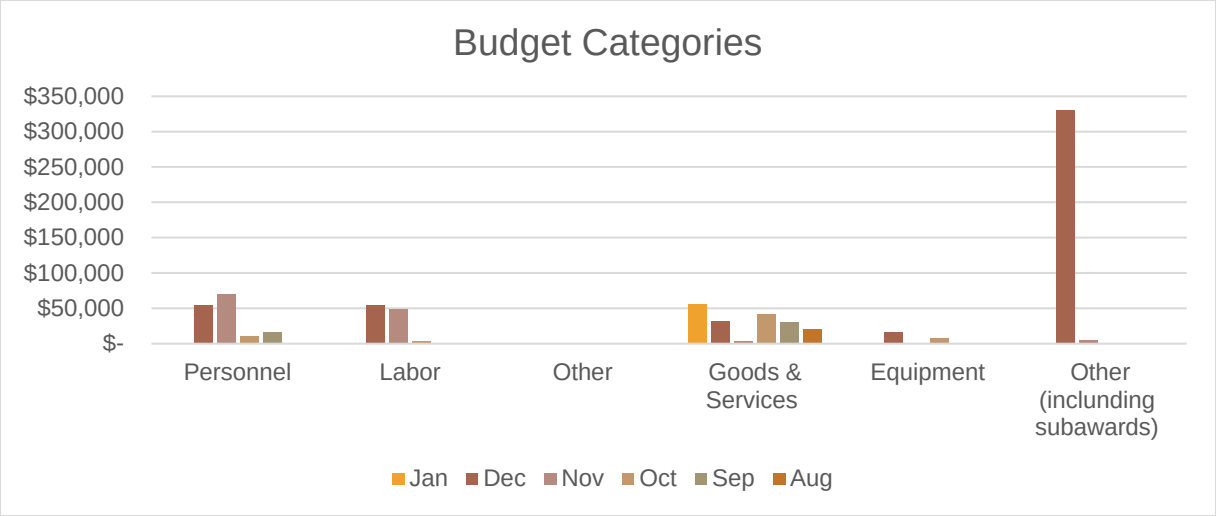
Process 3: Enhance public health response PSRC units would evaluate students, faculty and staff in the schools for COVID symptoms including temperature and face-mask protection, touchless units installed at school entrances.

In preparation for the return of students to 2021, UNCP was able to help them purchase and install free-standing temperature monitoring and hand-sanitizing stations at major entrances to all 36 schools in the system. In addition, we were able to help them purchase hand-held thermometers to be used by school personnel to 'spot check' students and for surveillance in larger schools with more than one entrance.

With a goal to promote healthy habits to open schools, these units will evaluate students, faculty and staff in the schools for COVID symptoms including temperature and face-mask protection, touchless units would be installed at school entrances. Enhancing public health as a check for all entering the building, identifying those with an increased temperature and reminding all to wear a face-mask.

USE OF FUNDS

- **The original budget of $987,176 was reduced to $818,018 due to a re-allocation of funds in December of 2020.**
- **$494,531 of the total remaining award, was spent in the surveillance testing and attitudes towards vaccination surveys and future vaccination efforts in Robeson county.**
- **$323,487 was directed to help the Public Schools of Robeson County secure the tools to open safely and mitigate the economic impacts of COVID-19.**



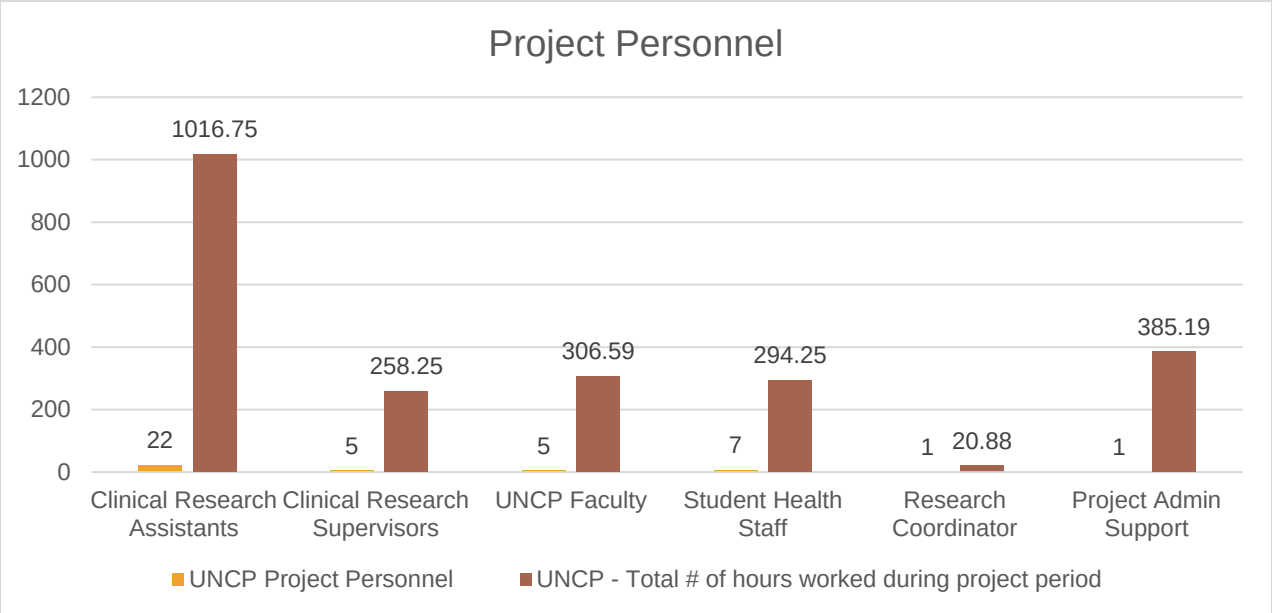
PROJECT PERSONNEL

Personnel

Name	*Title*	*Affiliation*
Cherry Beasley PhD, MS, FNP, RN, CNE, FAAN	**Anne R Belk Endowed Professor**	**UNCP College of Health Sciences, Department of Nursing**
Jennifer Jones-Locklear PhD, RN	**Associate Professor**	**UNCP College of Health Sciences Department of Nursing**
Lisa Mitchell PhD	**Associate Professor & Interim Associate Dean**	**UNCP School of Education**
Crystal Moore DNP, MSN, FNP-BC, WHNP	**Director, Student Health Services**	**UNCP Student Health Services**
William J Puentes PhD, RN, CNL, FAAN	**Brenda B Brooks Endowed Professor**	**UNCP College of Health Sciences, Department of Nursing**
Todd Telemeco PhD, DPT, PT	**Dean**	**UNCP College of Health Sciences**
Asa A Revels PhD	**Clinical Trials Research Coordinator**	**UNCP College of Health Sciences, Department of Nursing**

Cheryl Tschopp	**Administrative Assistant – Data Manager**	**UNCP College of Health Sciences, Department of Nursing**
Amir H. Barzin DO, MS	**Assistant Professor**	**UNC School of Medicine, Department of Family Medicine**
David B. Peden MD, MS	**Harry S. Andrews Professor Pediatrics**	**UNC School of Medicine, Division of Pediatric Allergy, Immunology, and Rheumatology**

Type	UNCP Project Personnel	UNCP - Total # of hours worked during project period
Clinical Research Assistants	**22**	**1016.75**
Clinical Research Supervisors	**5**	**258.25**
UNCP Faculty	**5**	**306.59**
Student Health Staff	**7**	**294.25**
Research Coordinator	**1**	**20.88**
Project Admin Support	**1**	**385.19**



- *In addition to the UNCP faculty, staff, and students who were paid to help carry out the serology study, nursing students from Robeson Community College (RCC) were also recruited to help do blood draws for the second round of serology testing. Fifteen RCC nursing students worked a total of 1005 hours (67 hours per student) for the second round of testing. These students were able to use this time to fulfill their required 126 clinical hours needed to complete their degree.*

PROJECT FINDINGS

Summary & Implications of Findings

The positivity rate for COVID-19 serology antibody testing in this sample was approximately 10%. This reflects the community positivity rate seen in COVID-19 antigen testing at the time this study was conducted. Inclusion criteria for this study included a negative screening for COVID-19 symptoms. With a few exceptions, most participants had never experienced symptoms of COVID-19 infection or identified known exposure.

The implications of this dynamic suggest that COVID-19 serology antibody testing is an essential component of understanding transmission dynamics of the illness. At the time of this study, the standard antigen testing was limited to individuals with symptoms or those who had a verified exposure to COVID-19. Serology antibody testing provides a mechanism for identifying the 'hidden' cases of the infection.

The survey data suggests that this rural population was amenable to vaccination efforts and compliant with recommended mitigation efforts. This contrasts sharply with reports of vaccine hesitancy and resistance to mitigation efforts in other populations. Anecdotal data suggests that the relationship between provider and consumer has a strong impact on positive behaviors. Participants expressed gratitude for UNCP's provision of the testing service and frequently remarked, "I'm happy to help. Anything for UNCP." UNCP has a long-standing relationship with the local community and there is a strong sense of ownership within the community of the university.

Strengths & Weaknesses of Assessment

Data collection for this study occurred on the campus of the University of North Carolina at Pembroke as well as at seven randomly selected public schools located throughout Robeson county. Participants at each site self-selected to participate

in the study. Self-selection may have had an impact on the characteristics of the study sample and study outcomes.

In addition to collecting serology samples to test for COVID-19 antibodies, this study evaluated factors that contribute to vaccine hesitancy and compliance with recommended mitigation efforts. This approach provides a more comprehensive view of the transmission patterns by providing a context for understanding factors that contribute to transmission.

Transportation and childcare issues may have negatively influenced who was able to participate in this study. Reimbursement for transportation and childcare expenses associated with participation may have somewhat mitigated this influence. Work patterns of the population of interest may also have negatively influenced availability to participate in the study.

The social and cultural congruence of the research team and participants contributed positively to the outcomes of this study.

Identified needs

This study supports the utility of COVID-19 antibody serology testing as an important component of a COVID-19 surveillance program. It is unclear at this point if a COVID-19 vaccine will affect the results of antibody test. Until such time that vaccination levels in communities reach 70% and higher, COVID-19 antibody serology testing is an additional tool that will help us identify the 'hidden cases' which will result in a more accurate description of the dynamic transmission of the virus.

Additional work needs to be done to better interpret the results of the surveys employed in this study. Focus groups with survey respondents will better help us understand the motivations underlying vaccination and mitigation effort use. Focus groups are planned for the time that the current surge allows small group meetings to safely occur.

As part of our goal of helping the community mitigate the economic impact of COVID-19, we requested an expansion of our scope of work. After receiving permission from the NC Policy Collaboratory, we worked with the Public Schools of Robeson County system office to enhance their ability to provide a safe environment for students, faculty and staff to return to face-to-face learning. We were able to help them purchase and install freestanding temperature monitors and hand-sanitizing stations at all major entrances to all 36 schools in the system. In addition, we were able to help them purchase hand-held thermometers to be used by school personnel to 'spot check' individuals in the school environment for

COVID-19 symptoms. A survey of faculty, staff and parents of students enrolled in the system is currently being circulated. The survey seeks feedback regarding the impact of these resources on individuals' comfort level related to returning to the in-person school environment.

Future Directions

We will continue to work with our community partners, particularly the Robeson County Health Department and the Healthy Robeson Task Force, to collaborate on initiatives focused on educating our community and developing the support services needed to address the bio-psycho-social needs associated with the COVID-19 pandemic as well as the overall health of the community.

The outcomes of the research discussed in this document provides a foundation to build on for further efforts to better understand the transmission dynamics of SARS-CoV2 and the community response to vaccination efforts and compliance with mitigation efforts. Serology antibody testing should be considered as an integral component of future surveillance efforts to make sure that 'hidden' cases are included in transmission models. Provider and consumer social and cultural congruence, both in terms of education/health messaging and service provision, should be relied upon whenever possible to achieve the most effective outcomes.

Acknowledgement

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This report would not have been possible without the participation and valuable input from the interviewees. We extend our sincere thanks to those who took the time to meet with us and answer our questions.

Robeson County Health Department, Robeson County Public Schools.