dd

Attachment F
Covid-19 Grant Outcomes and Accomplishments Final Report

To finalize this award, you are required to provide to the Agency with a narrative of the outcomes and accomplishments related to the funds spent for the specific purpose as stated in the grant contract. You can use the secure link provided below to upload images, brochures, and other information to illustrate your outcomes and accomplishments.
https://ncosbm.sharefile.com/r-rc7f2ca49d574af2a

1. Organization:	
Organization Name:	23-01-04 North Carolina Policy Collaboratory at the University of North Carolina at Chapel Hill

Outcomes and Accomplishments of Research:

23-01-Attachment C-2 Reimbursement Request NCA&T

December Supporting Documentation

NC POLICY COLLABORATORY AWARD FUNDING

Summary Dec 1, 2020 through Dec 30, 2020

Project	Fund	Original Funding	November Ending Balance	December MTD Actuals	December MTD Commitments	Remaining Available Balance
1	110107	71,428.00	55,098.15	16,252.35		38,845.80
2	110106	298,137.00	50,593.16	81,616.80	-45,307.40	14,283.76
3	110104	247,920.00	144,880.79	42,389.14	26,142.05	76,349.60
4	110103	200,000.00	58,363.18	44,165.54	17,898.93	-3,701.29
5	110108	48,000.00	16,217.20	5,779.18	8,000.00	2,438.02
6	110105	130,400.00	53,313.44	15,285.81	31,342.53	6,685.10
7	110113			344,889.82	0	-344,889.82
	Total	**995,885.00**	**378,465.92**	**550,378.64**	**38,076.11**	**-209,988.83**

Note:

NC A&T, in an effort to align its efforts with other HMSI institutions, established a seventh project. This project was approved by Dr. Jeff Warren at the NC Collaboratory Office and directly address the intent of the implementing legislation. NC A&T has identified those charges and applied them to the project. The costs incurred of $344,889.82 are on the fund 110113, previously reported as 170017, above for this project. However, due to the short turnaround, we were unable to set up a separate fund. A separate fund will be created and the costs incurred will be transferred. We have included the associated back-up for the initial costs. The final transfer along with documentation will be submitted, in NC A&T's final reports.

As of December 30, 2020, the NC Policy Collaboratory funds show a negative available balance of $209,988.83. This is due to including the outstanding purchase commitments of $206,098.41. If the outstanding commitments of $206,098.41 are fulfilled, the budget will be over-expended by $209,988.83. A portion of the COVID testing expenditures transfer can be reversed to offset excess expenditures.

Project 1

Lead PI. Stephanie Tiexera-Poit:

Project Title. Predictors of and Strategies to Mitigate COVID-19 Cases and Death Among Older Adults in Nursing Homes and Residential Care Facilities

Our research objective was to examine policy, community, and facility determinants of long-term care facilities having COVID-19 cases and deaths. Community members in long-term care facilities have been disproportionately impacted by high COVID-19 cases and deaths across the United States. This population is particularly vulnerable to the effects of COVID-19 due to existing health conditions and social determinants of health including policies, exposure within the community, built environment, quality of health care, and socioeconomic conditions.

Using a multi-layered approach, this project examined North and South Carolina policy, community, and facility data to understand some of the root causes of this health inequity. Our research questions were: What policy-, community-, and facility-level factors predict whether or not long-term care facilities have COVID-19 cases and deaths? What are actionable strategies that can be implemented to mitigate COVID-19 cases and deaths in long-term care facilities? To answer these questions, we conducted bivariate analyses and multivariate regression analyses using data compiled from existing federal, state, and mobility secondary data sources. Policy-level variables included stay-at-home orders, mask orders, gatherings, and nursing home visitation. Community-level variables included community spread of COVID-19, community adherence to COVID-19 policies and best practices, community demographics, community political climate, and community resiliency. Facility-level variables included the service profile of facilities and quality of care in facilities.

Findings show that North Carolina had a smaller percentage of long-term care facilities with COVID-19 cases and deaths than South Carolina. Forty-nine percent of long-term care facilities in North Carolina had any COVID-19 cases compared to 60 percent of long-term care facilities in South Carolina. North Carolina and South Carolina responded to the pandemic in different ways, including policies regarding stay-at-home orders, whether masks were required or suggested in different settings, limitations on community mass gatherings, limitations on visitations with residents in facilities, and recommendations on resident and staff travel for holidays. Additional community- and facility-level factors that impacted facilities having COVID-19 cases and deaths included having more vulnerable residents in the facilities (e.g., poorer, multiple comorbidities), understaffing facilities, and being in communities that fail to social distancing.

Following a community-based participatory research approach, a Stakeholder Advisory Board provided feedback on findings, outlined points of advocacy for their constituents, and helped developed recommendations to mitigate COVID-19 cases and deaths. Discussions of findings emphasize the need for a multi-prong policy approach to mitigate the impact of these factors on COVID-19 cases and deaths. Policy-level recommendations include: (1) deploying resources to the most vulnerable groups and facilities; (2) providing universal mandates modeled by leadership at all levels of government; and (3) providing consistent messaging and recommendation may help build community trust and foster adherence. Community-level recommendations include: (1) encouraging social distancing for staff on and off work sites; (2) standardizing testing and contract policies; and (3) creating strong staff incentives for job retention, hazard exposures, and staying home when ill. Facility-level recommendations include (1) targeting mitigation strategies to address deficiencies in facilities; (2) prioritizing staff vaccination along with resident vaccination (along with supporting state and facility policies); and (3) engaging in campaigns and providing incentive programs for staff to get COVID-19 vaccinations, engage in social distancing, wear masks, and hand wash.

Our dissemination strategy involves creating deliverables in multiple formats for multiple audiences:

- We collaborated with the university to develop a news release on our project. The news release was featured on the home page of the NC A&T State University website.
- We submitted abstracts to present our work at two academic conferences. To reach scholars and clinical practitioners focusing on the interventions to improve health outcomes, we submitted an abstract to present at the annual meeting of AcademyHealth. To reach scholars focusing on social determinants of health within the State of North Carolina, we also submitted an abstract to present at the annual meeting of the North Carolina Sociological Association.
- We are also working to transform the content of our final report for the NC Policy Collaboratory into scholarly journal articles. One of the target journals will be the *Journals of Gerontology,* which is organizing a special issue on "COVID-19 and Aging 2.0".
- The Stakeholder Advisory Board (SAB) recommended that we develop an issue brief that could be electronically disseminated to key stakeholders throughout the state, including facility administrators and staff, advocates for older adults, and decision-makers. We developed an issue brief, reviewed the issue brief with SAB members to obtain feedback, and then revised the issue brief content and format to address feedback received. Several SAB members have offered to help us disseminate the issue brief within their professional networks. In our last SAB meeting, SAB members recommended that we offer a webinar highlighting key findings. We will advertise the webinar through similar methods as the issue brief.

See the attached report for full details in Appendix C.

Project 2

Lead PI: Raymond Tesiero

Project Title: COVID-19 Research Proposals: AFFORDABLE IR FEVER DETECTION SYSTEMS for K-12, and Higher Education Facilities

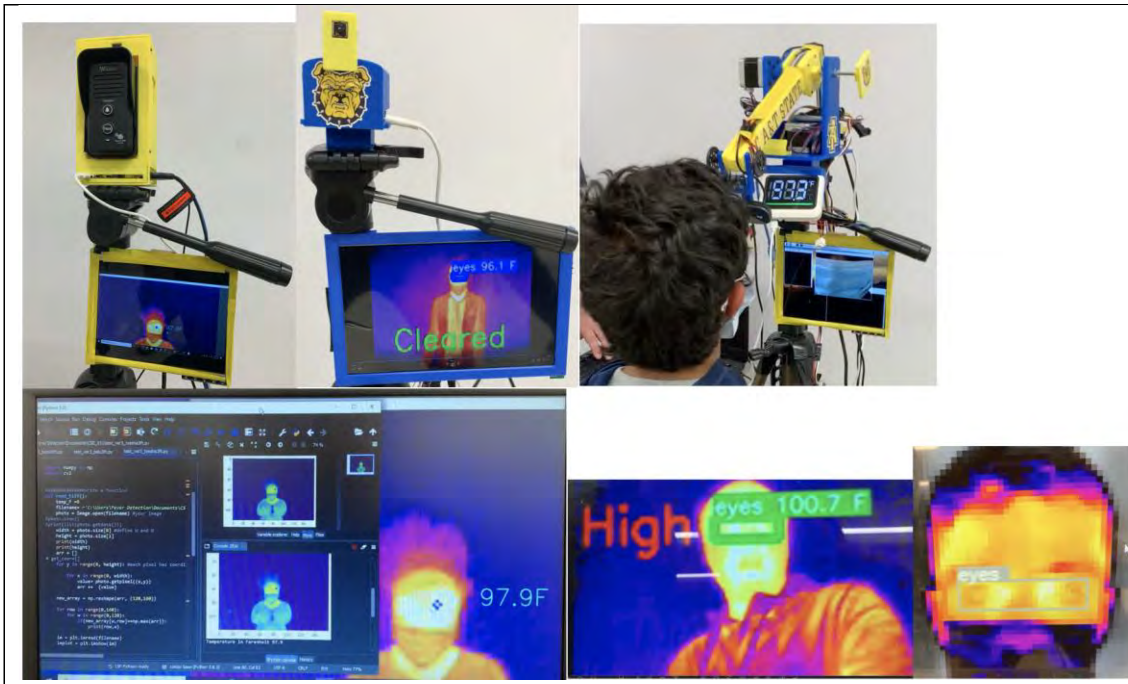
The main goal of this research was to evaluate, design, develop and build 3 new affordable (within a price range of $1000-$2000) IR fever detection system prototypes: (1) packaged system that will be wired to an existing computer station (front desk/administrator), (2) mobile station, and (3) retrofit system that would merge with an existing K-12 electronic intercom system, for an administrator to then be comfortable to open the front door or residential home alarm monitoring systems. These health safety systems could capture the thermal profile or elevated temperature information of human face, from a front door IR camera sensor to an administrator's desk or existing alarm monitor panel. The image processing algorithms will detect the inner body fever by focusing on elevated temperature around the inner canthus of the eye.

System 1 (Aggie Eye or Aggie Arm): this system would be a fixed mounted indoor packaged system that would be wired to the administrator's front desk existing computer station in departments, colleges, and universities or K-12 main offices. We would use the existing computer at the administrator's desk and supply the IR camera, mounting, wiring, conduit, and image processing software. Aggie Eye Prototypes total cost was under $380.00, Aggie Arm Prototypes total cost was under $260.00, and they both exceeded our expectations and were significantly under the $2,000 goal. System 2 (Aggie Eye with Tripod or Aggie Arm with Tripod and optional laptop and display): this system would be a complete packaged mobile station (you can pick it up and move it anywhere), it would incorporate a tripod, with a mounted IR camera, a computer, a display, and a fever detection system. Aggie Eye Prototypes 1 & 2 total cost with laptop and LCD display was under $922, Aggie Arm Prototypes 1 & 2 total cost under $802.00, and they both exceeded our expectations and were significantly under the $2,000 goal. System 3 (Aggie Intercom): this system would involve retrofitting existing front door security stations with IR Fever Detection capabilities (existing video doorbell, or audio doorbell, allowing administrators to feel comfortable to open the front door security release systems). Our Aggie Intercom System Prototypes 1 & 2 total cost were under $450.00, and they both exceeded our expectations and were significantly under the $2,000 goal. If systems 1 and 3 required the options to add a 10" LCD Display screen to each prototype, we would add an additional $145.00 to each total cost, and if a computer was also needed, we would include a Dell Latitude 3310 for an additional cost of $397.00. The reason system 2 was higher than systems 1 & 3 is because it included these additional options as part of a complete packaged system. All prototypes were significantly under our $2,000 cap.

A YOLOv5 model to detect eyes of a human in thermal images with high accuracy and efficiency has been developed. Yolov5 is selected for the detection of the human eyes because it can be used for real time applications, extremely easy to use, trains quickly, inferences quickly and also performs well. These AI programs will automatically detect the temperature from tear ducts, which gives more accurate inner core body temperature than forehead readings. A sensor equation is used to convert intensity pixel values of the tear duct to temperature. In addition, a warning is displayed if temperature exceeds set threshold value. Research has established that the temperature around the tear duct strongly correlates to the core body temperature (Pejman et al.and Teunissen et. al.).

1. Best practices for standardized performance testing of infrared thermography intended for fever screening. Pejman Ghassemi,T. Joshua Pfefer, Jon P. Casamento, Rob Simpson, Quanzeng Wang. September 19, 2018 https://doi.org/10.1371/journal.pone
2. Infrared thermal imaging of the inner canthus of the eye as an estimator of body core temperature. Teunissen, L. P. J., & Daanen, H. A. M. (2011). Journal of Medical Engineering & Technology.. https://doi.org/10.3109/03091902.201

As we mentioned previously we were interviewed by three different stations/networks Fox News Greensboro, local Spectrum News and Atlanta news which went national, we were featured several times on those channels with our first two prototypes. We are assuming the current high cost of FDS are associated with the manufacturer's proprietary programming, high definition infrared cameras and displays, and other expensive components and extra features in the programming that manufacturers are using to mark-up the overall costs. We addressed this research with the idea that the main objective was to accurately identify individual's temperatures via tear-duct or forehead temperature readings. No other extra features or high definition cameras and displays are needed to accurately measure temperature. The month of December was short due to the holidays and the PI's focused on administrative duties, addressing errors in the accounting and tracking down invoices from vendors and matching debits against the budget. Our final costs associated with each prototype were below $1000, we exceeded expectations and were much lower than the $2000 goal.



Project 3
Lead PI: Radiah Minor

Project Title: Food Animal SARS-CoV2 Testing

We were unable to spend down the entire budget of this grant. There are several reasons for this. 1) some of the supplies we priced we were able to find cheaper when the time came to purchase. 2) Because of some delays in getting started we did not need the summer salaries as budgeted, further we were unable to hire students to participate on the project because there were none available and because of social distancing guidelines, Further, although we contacted some farms and extension agents, they all declined to participate and thus salary that was earmarked (extension agents) was unspent. 3) We experienced some delays and issues with payroll paperwork being completed and processed on time, these issues were unable to be rectified, thus some of the personnel's salary on this project did not get paid as intended.
(4) Because of the change in scope and the time delays on collecting samples, we also did not travel farther than 1.5 hours, and travel was done using a state vehicle, so no travel costs were charged. (5) Finally, we experienced some delays in shipment of supplies and reagents. Some of the issues were due to the limited availability of the supplies and delays in shipping, and thus pushed to a later date. We are still awaiting the shipment of some supplies. Other items we purchased were canceled because the items were no longer available to researchers and instead made a priority to healthcare workers, notification of this to us by the company was made too late for us to replace the items and therefore not charged to the grant.

The objective of the project titled "Food Animal SARS-CoV2 Testing" was to perform SARS-CoV2 testing on food animals (swine, cattle, and chicken) across NC. At the time this proposal was written, there was limited scientific evidence for the potential of SARS-CoV2 infection in animals. The evidence that existed was that a tiger and two dogs, (one in Hong Kong, another in Chapel Hill, NC) had tested positive for the virus and that SARS- CoV2 was reported to infect cells that expressed the angiotensin converting-enzyme II receptor of animal (bats, civets, and swine) origin. Moreover, two related coronaviruses (MERS-CoV and SARS-CoV), have been detected in pigs. This led to our hypothesis that food animals may harbor the SARS-CoV2 and should be included in the NC SARS-CoV2 community testing initiatives.

The intended goal of this project was to test samples from live farm animals from 6-10 counties across NC. While we were unable to do that because producers were hesitant to allow us access to their farms, we were able to collect tissues to sample from animals being processed at slaughterhouses. We collected respiratory tracts, heart, and blood from 30 swine from four slaughterhouses located in Alamance, Stokes, Wilkes, and Guilford counties. It is noteworthy, that these facilities typically service farms from surrounding counties, so there is the potential to sample to test animals from several counties without traveling to them. The serum blood samples were tested for the presence of SARS-CoV2-specific antibodies and the trachea (upper respiratory) the heart and lungs were tested for the presence of viral genetic material by RT-PCR. To date only 19 of the 30 samples have been tested and we preliminarily report that while pig serum was negative for SARS-CoV2-specific antibodies, 9 of 19 (47%) of the tracheal swabs were swine found to be positive for SARS-CoV2 genetic material using primers to the gene that codes for the nucleocapsid.

Suggesting that 47% of the swine we tested were carrying the virus that causes COVID-19. More animal/sample collection and testing are occurring along with confirmation of these results.

In the time since the initiation of this project, a few studies investigating whether food animals, specifically pigs and chickens can be infected and spread SARS-CoV2 have been published. The results from these studies are varied. Several studies published in May, July, and October of 2020 report that the virus could not detected in either pigs or chickens, days after experimental infection with SARS-CoV2. However, another study published in September of 2020, reported that experimental infection of pigs did result in low levels of SARS-CoV2 infection, although this infection was not transmissible it did not result in respiratory distress, and only a few of the infected animals had an antibody response to the virus.

There is enough still unknown about impact of this virus on food animals such as pigs and chickens; that more statewide or national effort is needed. If food animals are found to carry the virus, animal-specific standard operating procedures for sampling, testing and herd management will be key and importantly, the people working with these animals on farm or in processing plants should be educated and aware of the need to wear proper personal protective equipment to limit exposure. This grant has allowed us to build capacity in this area and we will continue to collect and test samples in the weeks and months to come. Our research has been featured on a few outlets internal to the University and the Association of Research Directors. We look forward to sharing our data with the scientific and lay communities.

Project 4

Lead PI: Liefang Zhang

Project Title: Portable Sensing Platform for Rapid Detection of SARS-CoV-2 Virus in Air Through Nanoengineered Surface Enhanced Raman Scattering

The overall objective of this research project is to design and prepare flexible polymer nanofibrous capture net with porosity and hierarchical nanostructure engineered for SARS-CoV-2 virus detection in air using surface enhanced Raman scattering. The fund was used to carry out the proposed research tasks.

Task I. Development of electro-spinning-netting technique to acquire efficient nanofibrous capture material for SARS-CoV-2 virus

Electro-spinning is a straightforward and universal technique to acquire fibers with diameters generally in the submicrometer range for a wide range of applications, particularly air filtration [1,2]. According to the ~125 nm size of SARS-CoV-2 virus, which caused the outbreak of COVID-19, the conventional nonwoven nanofibrous mat with fiber sizes in the range of a few hundreds of nanometers from electro-spinning process cannot effectively capture the virus. Therefore we modified the conventional electrospinning technique and developed an electro-spinning-netting technique to acquired a novel material that has 2D nano-net structure (fiber diameters < 100 nm) inside the conventional electrospun nanofibrous mat with the anticipation that the formation of these nano-net structures can facilitate viral capture and localization at the surface of the capture substrate, which is critical to effective detection. The electro-spinning-netting setup is shown in Figure 1.

We observed nano-net structure from electro-spinning-netting nylon 6 by screening different polymers (Figure 2). The electrospinning solution was prepared by dissolving nylon 6 pellets in formic acid at concentration of 20 wt.%. The prepared solution was then loaded into a 10 ml syringe with 18 g metal needle and pumped at a flow rate of 0.4 ml/h. A constant voltage of 28 kV was then applied to create a continuous solution jet that traveled toward a metal collector (a grounded Al drum covered with Al foil) 15 cm away. With the evaporation of solvent, the solidified fibers were deposited onto the collector. The formation of nano-net is probably attributed to the instability of Taylor cone, which was formed as a result of reduced surface tension at the tip of the nylon polymer solution jet [3]. The fiber diameter was around 120 to 140 nm, close to the size of SARS-CoV-2 virus. 3

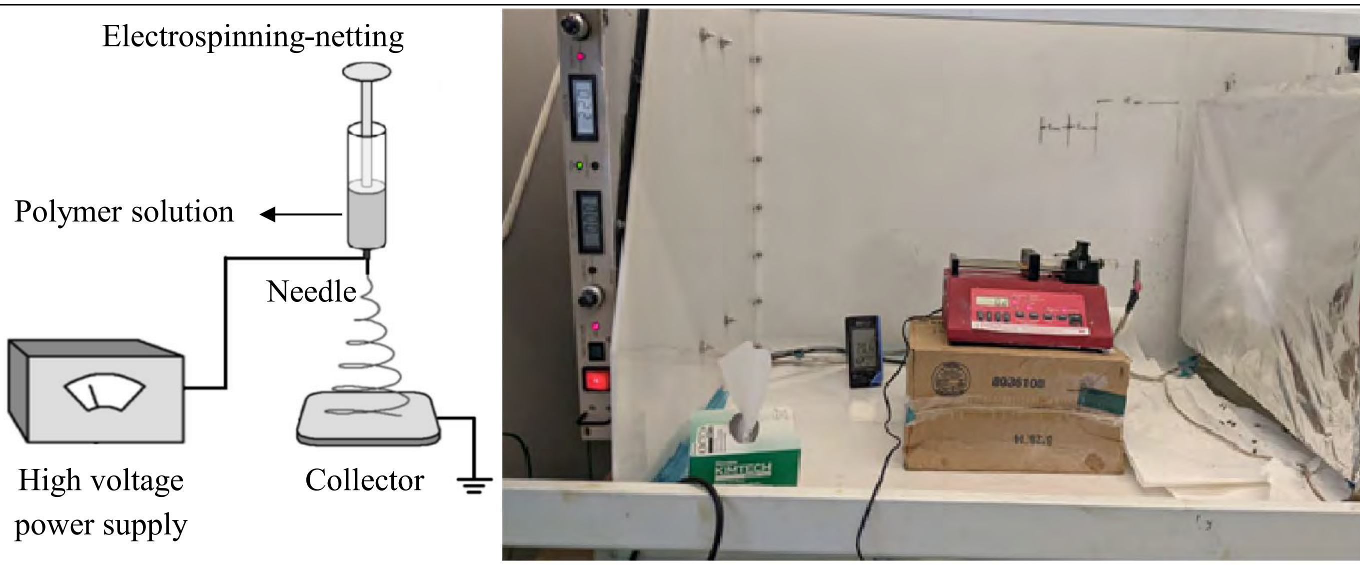


Figure 1. Electro-spinning-netting setup: (left) schematic diagram; (right) benchtop setup

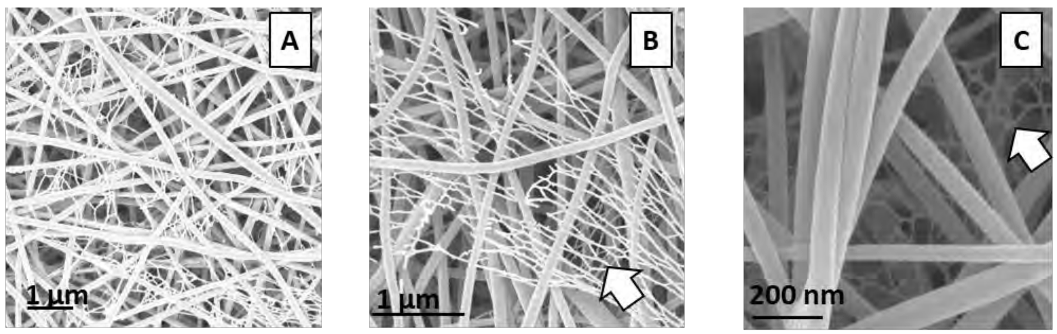


Figure 2. SEM images of nylon 6 nanofibrous mat with nano-net structure at three magnifications (A-C). White arrows highlight the nanonet structures.

However, the coverage of the nano-net structure in the electrospun nanofiber mat was limited and scattered, likely due to incomplete charge separation of polymer and solvent. Thus we investigated how to increase the nano-net structure by varying the solution system and adjusting the electro-spinning-netting operating parameters. We studied the solution systems by changing the polymer from nylon to amidoxime surface-modified polyacrylonitrile (ASFPAN) [3], changing the solvent from formic acid to 4:1 formic acid and acetic acid (weight), adding 1 wt.% chitosan with respect to nylon 6. It is observed that adding chitosan could increase the nano-net structure (Figure 3). The morphology changed from smooth and uniform fibers to bigger and non-uniform fibers with much more nano-net structure. The polycationic nature of chitosan may increase electroconductivity of polymer solution, induce more electrostatic charges in solution, and create more repulsive forces in spinning process and result in more instability zones which would enable more nano-net structure. There is additional advantage for using chitosan. The positive charge from chitosan may provide additional electrostatic attractive force to capture the virus.

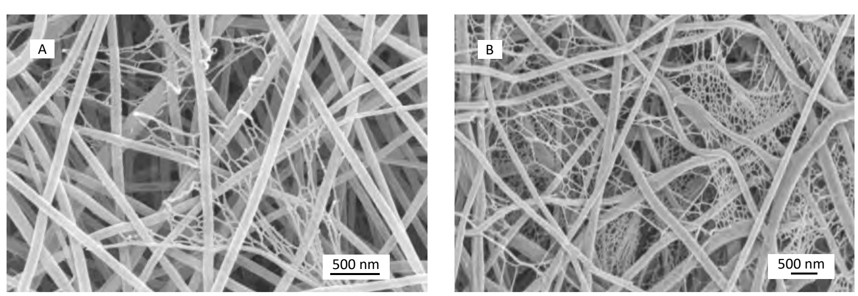


Figure 3. SEM images of nylon 6 nano-net structure with nanofibrous mat from electro-spinning-netting from 20 wt.% nylon 6 solution with a mixture solvent (formic acid:acetic acid = 4:1) (A) without chitosan; (B) with chitosan (1wt.% with respect to nylon 6).

By studying the electrospinning parameters, we optimized spinning condition that could generate so far the best nano-net structures (Figure 4). This nano-net structure was generated by electrospinning 20 wt.% nylon 6 from a mixture solvent of formic acid and acetic acid at a ratio of 4:1 with 1 wt.% of chitosan with respect to nylon 6. The spinning solution was loaded to a 10 ml syringe attached with a 18g blunt end needle and the solution was pumped out at a flow rate of 0.2 ml/h under an applied voltage of 22.2 kV with 12 cm from tip of the needle to collector. The fibers that formed the nano-net structure were approximately in the order of 1/10 of regular nanofibers. This spinning condition can effectively and consistently generate nano-net structures.

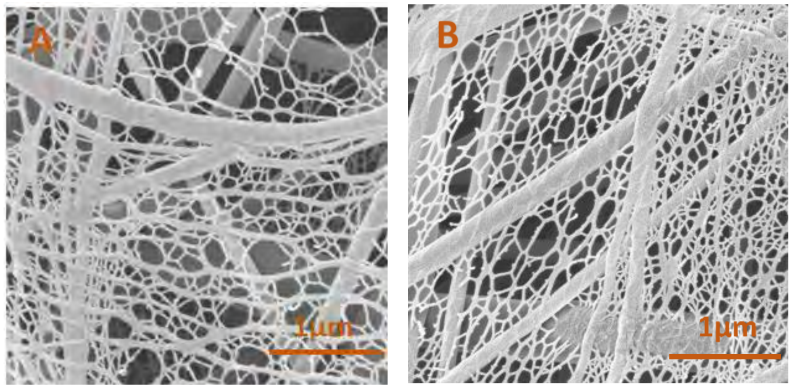


Figure 4. SEM images of the improved nylon 6 nano-net structure within nanofibrous mat from electro-spinning-netting technique.

Task II. Growth of silver nanoparticles (Ag NPs) on the nanofibrous virus capture net for the substrate of Surface-Enhanced Raman Scattering (SERS)

The preparation of SERS substrate was carried out by growing/dispersing AgNPs on the obtained nanofibrous mat especially on the nano-net structure. AgNP growth was done through redox reaction with AgNO3 as Ag precursor. Investigations on redox reaction systems and conditions were conducted to get AgNPs with desired shape, size and density.

We started with a sodium borohydride system: $AgNO_3$/ $NaBH_4$/citrate ($Na_3C_6H_5O_7$). We carried out the synthesis in two steps. First, Ag NPs were synthesized by a reduction reaction where sodium borohydride ($NaBH_4$) was used in the presence of sodium citrate dihydrate ($Na_3C_6H_5O_7$) and silver nitrate ($AgNO_3$). In the second step, the Ag NPs were dispersed onto the nanofibers. This was carried out by immersing the nanofibers into a pH-controlled environment of Ag NPs, which was maintained at pH 5 for 30 min - 1 h with slow stirring. Ag NPs were successfully deposited on the prepared nanofiber surface. There was no significant change in the diameter of the nylon 6 nanofibers upon Ag NPs coating and the nano-net remained intact (Figure 5). EDX analysis confirmed the Ag formation (Figure 6).

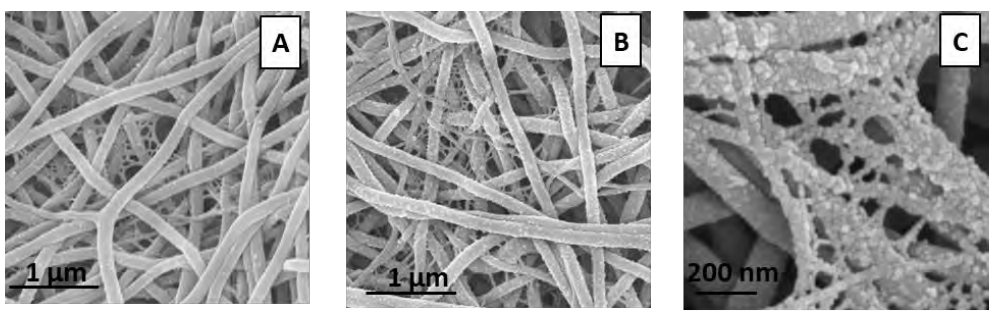


Figure 5. SEM images of nylon 6 nanofibers with Ag NPs at three magnifications (A-C) from $AgNO_3/Na_3C_6H_5O_7/NaBH_4$ = 1:1:5 (molar ratio) with immersion time of 1 h.

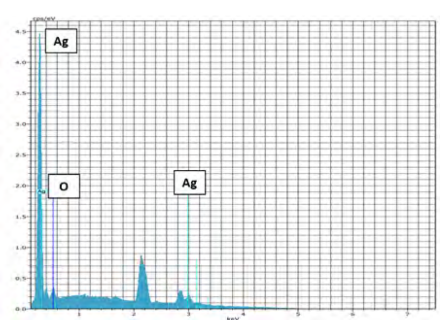


Figure 6. EDX of nylon 6 nanofibers with Ag NPs

Synthesis conditions were studied to get appropriate AgNP size and density while reduce agglomeration of AgNPs. We next introduced activation step and a new reducing reagent - dextrose. We performed activation prior to Ag NP growth: As-spun nylon nanofibers were immersed in solution 1 consisted of 3 mM $SnCl_2$ solution for about 30 min (step 1) followed by being immersed in solution 2 consisted of 3 mM $PdCl_2$ solution for about 10 min (step 2). The fibers which are water-washed in between the two steps are named as washed fibers and the one which are not water-washed in between the two steps are named as unwashed fibers. The Ag NP growth was then carried out by immersing the nanofibrous material in mixture of freshly prepared tollens reagent ($AgNO_3 + NH_3$) and dextrose solution for about 2 mins. At this step, we also compared the ASFPAN nanofibers with the nylon nanofibers for AgNP growth. As shown in Figure 7, the ASFPAN nanofibers led to AgNPs with smaller average size and uniform distribution. The water-wash in activation reduced nanoparticle agglomeration.

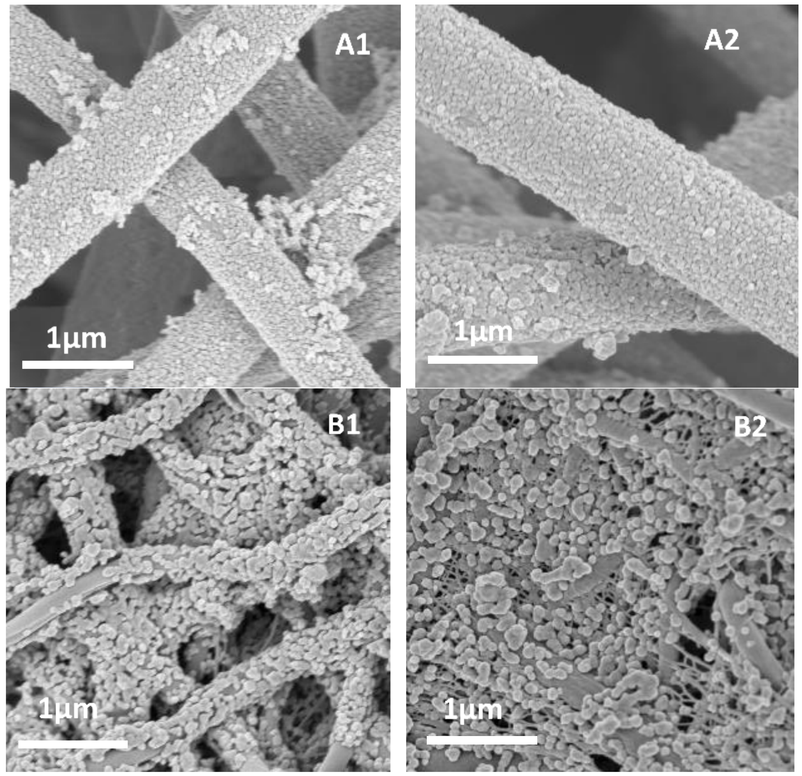


Figure 7. SEM images of nanofibers with AgNPs loaded. A: ASFPAN nanofibers; B: Nylon nanofibers; 1 & 2 represents fibers unwashed and washed samples as mentioned.

However, ASFPAN does not form nano-net structure. Therefore we have to further adjust the AgNP growth condition on Nylon 6 nanofibers to get something like we got from ASFPAN nanofibers for better AgNP size, density and less agglomeration. We modified the system by reducing concentrations. Concentrations of $SnCl_2$ and $PdCl_2$ seeding solutions were reduced to 1/3, and the concentrations of all components in Tollens reagent was reduced to 1/10. The Nylon nanofibers were washed thoroughly after each activation steps. It was observed that both the regular nanofibers and nano-net structure are covered with Ag nanoparticles (Figure 8). The sizes of these Ag nanoparticles are in the range of 30-85 nm. Fewer Ag nanoparticles were present as compared to Figure 7 probably due to the concentration reduction of all the chemical reagents.

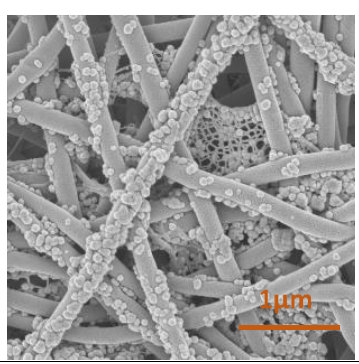


Figure 8. SEM images of nanofibers with AgNPs loaded through surface activation and growth using Tollens ($AgNO_3/NH_3$)/dextrose system.

To further adjust the Ag NP size and density on the electrospun Nylon nanofibrous mat with nanonet structure, we adjusted the reaction system by keeping the activation step but changing the Ag redox reaction system back to $AgNO_3/NaBH_4/Na_3C_6H_5O_7$ at concentrations of 0.01M, 0.05M and 0.01M, respectively. The Nylon nanofibrous mat was washed thoroughly after each activation steps. Compared to Figure 8, this new Ag nanoparticle synthesis system could produce Ag nanoparticles with smaller average size and larger density on nanofiber surface (Figure 9). This synthesis condition can generate AgNPs with close-to-desired size and density [4].

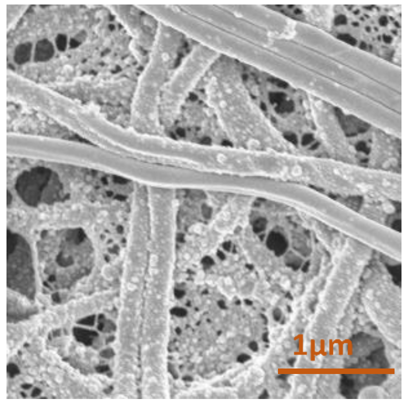


Figure 9. SEM images of nanofibers with AgNPs loaded through surface activation and growth using $AgNO_3/NaBH_4/Na_3C_6H_5O_7$ system.

Task III. Surface-Enhanced Raman Scattering (SERS) test on the nanofibrous virus capture net with surface-attached Ag NPs (SERS nanofiber/substrate)

We studied the Raman spectra of the SERS substrate using a confocal Raman spectrometer XploRA (Horiba Instrument Incorporated) at the Joint School of Nanoscience and Nanoengineering (JSNN) at North Carolina A&T State University during the project time while we wait for the portable Raman spectrometer.

To test the SERS enhancement efficiency of the SERS nanofibers/substrate, we used a model compound as a surrogate for the virus. This approach is intended help us optimize the nanofiber/nanoparticle system and provide us with the best enhancement, which can then be used to test viral samples. The model compound we selected was crystal violet (CV), given that it has a well-known Raman spectrum. To accomplish this task, we prepared two concentrations of CV at 10^{-2} and 10^{-6} M and drop casted 5 µL of each solution onto three nanofiber samples for the first round: (1) raw nanofiber, with no Ag nanoparticles; (2) SERS nanofiber with a low density of Ag nanoparticles; and (3) SERS nanofiber with a high density of nanoparticles. The relative low/high nanoparticle concentrations were determined by the color of the nanofibers with higher levels of discoloration associated with higher levels of nanoparticles. The Raman band at 1175 cm^{-1} is representative of CV, thus it was selected to perform the enhancement factor calculations. Table 1 shows the average intensity at 1175 cm^{-1} taken from 3 spots on a given nanofiber sample.

Table 1. Average Raman intensities of crystal violet on SERS nanofibers

CV Concentration (M)	Raw nanofiber intensity (a.u.)	Low-density SERS nanofiber intensity (a.u.)	High-density SERS nanofiber intensity (a.u.)
10^{-2}	128.62	1298.34	2604.50
10^{-6}	41.36	384.84	377.00

To calculate the average enhancement factor (AEF), we utilized Equation 1.

$$AEF = \left(\frac{I_{SERS}}{I_{Raman}}\right) * \left(\frac{C_{RS}}{C_{SERS}}\right) \quad (1)$$

Where I_{SERS}= Intensity of a 1175 cm^{-1} vibration mode CV on Ag-nanofibers
I_{Raman}= Intensity of a 1175 cm^{-1} vibration mode CV on raw nanofibers
C_{RS}= Concentration of CV on raw nanofibers
C_{SERS}= Concentration of CV on SERS nanofiber

Table 2 presents the enhancement factors calculated for low- and high-density nanofibers. Results showed an enhancement of around 10 for the low-density fibers, while the high-density fibers provided an even higher enhancement reaching a factor of 20 compared to the raw fiber alone in the 10^{-2} M samples. The numbers were in line and even higher compared to studies published recently in the field [5].

Table 2. Average Enhancement Factors for Crystal Violet on SERS Nanofibers

CV Concentration (M)	Low-density SERS nanofiber average enhancement factors	High-density SERS nanofiber average enhancement factors
10^{-2}	10.09	20.25
10^{-6}	9.30	9.13

Finally, representative data collected for these experiments using 10^{-2} M CV are shown in Figure 10.

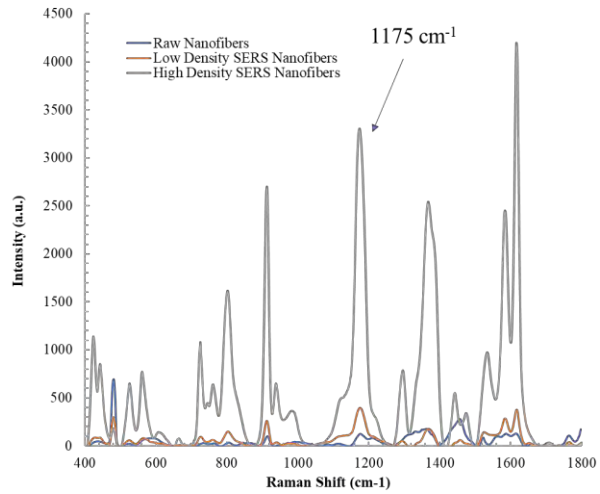


Figure 10. Raman spectrum of nanofiber samples at 10^{-2} M CV concentration

In the second round, we tested 6 nanofiber samples: (1) raw nylon 6 nanofibers; (2) nylon 6 nanofibers with Ag nanoparticles (washed in activation); (3) nylon 6 nanofibers with Ag nanoparticles (unwashed in activation); (4) Raw ASFPAN nanofibers; (5) ASFPAN nanofibers with Ag nanoparticles (washed in activation); and (6) ASFPAN nanofibers with Ag nanoparticles (unwashed in activation). Spectra were collected with a 10X objective to focus the 532 nm laser with a power of 3mW onto the sample. A Peltier-cooled CCD camera was used as the detector and the system was calibrated with silicon at 520 cm^{-1} prior to each characterization study. Integration times was set at 5 s, and all spectra and intensity data are represented as an average of 3 acquisitions.

The Raman band at 1175 cm^{-1} is representative of CV, thus it was selected to perform the enhancement factor calculations. Table 3 shows the average intensity at 1175 cm^{-1} taken from 3 spots on a given nanofiber sample for nylon 6 nanofibers while Table 2 shows the average intensity at 1175 cm^{-1} taken from 3 spots on a given nanofiber sample for ASFPAN nanofibers.

Table 3. Average Raman intensities of crystal violet on SERS Nylon 6 nanofibers

Concentration	Average intensity of Raw Nylon 6	Average intensity of washed Nylon 6	Average intensity of unwashed Nylon 6
10^{-2}	74.93	3791.99	2393.01
10^{-6}	6.19	723.87	288.77

Table 4. Average Raman intensities of crystal violet on SERS ASFPAN nanofibers

Concentration	Average intensity of Raw ASFPAN	Average intensity of washed ASFPAN	Average intensity of unwashed ASFPAN
10^{-2}	89.4	234.83	675.89
10^{-6}	33.23	125.85	148.13

Table 5 and 6 present the enhancement factors calculated for nylon 6 and ASFPAN nanofibers. Results showed an AEF of around upwards of 50 and 116 for washed nylon 6 at 10^{-2} and 10^{-6} M concentrations of CV, respectively. The performance of the ASFPAN samples was much lower in comparison.

Table 5. Average Enhancement Factors for Crystal Violet on Nylon SERS Nanofibers

CV Concentration (M)	Washed Nylon 6 AEF	Unwashed Nylon 6 AEF
10^{-2}	50.61	31.94
10^{-6}	116.94	46.65

Table 1. Raman peak intensities and possible band assignments

Raman Shift (cm^{-1})	SERS Nanofibers + SARS-CoV-2 Intensity (a.u.)	SERS Nanofibers Alone (a.u.)	Possible Band Assignment
1348	2123 ± 172	146 ± 129	G (RNA/DNA)
1600	2626 ±1797	232 ± 174	Tyrosine, pheylalanine, cytosine
1774	3494 ± 679	215 ± 115	Esters. C=0 stretching (viral lipid)

Due to the delivery and training delay of the ordered portable Raman spectrometer, we were not able to test the virus sample on the portable Raman spectrometer.

Conclusion

We successfully designed and prepared nylon nanofibrous mat with nano-net structure engineered for the SAS-CoV-2 virus capture through the development of electro-spinning-netting technique. Silver (Ag) nanoparticle have been successfully attached to the nanofiber surface through a controlled redox reaction after surface activation. The resultant nanofibrous mat (SERS nanofiber) was tested with a Confocal Raman Spectrometer at JSNN. Raman signal enhancement was observed from the SERS nanofiber with a model compound, crystal violet, as well as the heat-inactivated SAS-CoV-2 virus from ATCC (Manassas, VA). Due to the challenge from COVID-19 during the 6-month project period such as delayed delivery of the PPE and portable Raman spectrometer, JSNN limited opening and instrument service, and limited virus resources, only limited Raman results have been achieved. Our results indicated that the SERS nanofiber developed from this research project could serve as a promising platform for testing SAS-CoV-2 virus in air. The research team sincerely appreciates the financial support from the North Carolina Policy Collaboratory and will continue working on this project based on what we have.

References

[1] S. Sundarrajan, K. L. Tan, S. H. Lim, S. Ramakrishna. Electrospun nanofibers for air filtration applications. Procedia Engineering, 2014, 75, 159-163.
[2] M. Zhu, J. Han, F. Wang, W. Shao, R. Xiong, Q. Zhang, H. Pan, Y. Yang, S. K. Samal, F. Zhang, C. Huang. Electrospun nanofibers membranes for effective air filtration. Macromolecular Materials and Engineering, 2017, 302, 1600353.
[3] N. Sirelkhatim, D. Lajeunesse, A. D. Kelkar, L. Zhang. Antifungal activity of amidoxime surface functionalized electrospun polyacrylonitrile nanofibers. Materials Letters, 2015, 141, 217-220.
[4] L. Zhang, X. Gong, Y. Bao, Y. Zhao, M. Xu, C. Jiang, H. Fong. Electrospun nanofibrous membranes surface-decorated with silver nanoparticles as flexible and active/sensitive substrates for surface-enhanced Raman scattering. Langmuir, 2012, 28, 14433-14440.
[5] J. H. Roque-Ruiz, H. Martínez-Máynez, M. A. Zalapa-Garibay, A. Arizmendi-Moraquecho, R. Farias, S. Y. Reyes-López. Surface enhanced Raman spectroscopy in nanofibers mats of SiO_2-TiO_2-Ag. Results in physics, 2017, 7, 2520-2527.
[6] N. N. Durmanov, R. R. Guliev, A. V. Eremenko, I. A. Boginskaya, I. A. Ryzhikov, E. A. Trifonova, et al. Non-labeled selective virus detection with novel SERS-active porous silver nanofilms fabricated by Electron Beam Physical Vapor Deposition. Sensors and Actuators B: Chemical, 2018, 257, 37-47.

Project 5

Lead PI: Cephas Naanwaab

Project Title: The Economic Impact of COVID-19 in the Piedmont Triad Region

See attached report for full details in Appendix B.

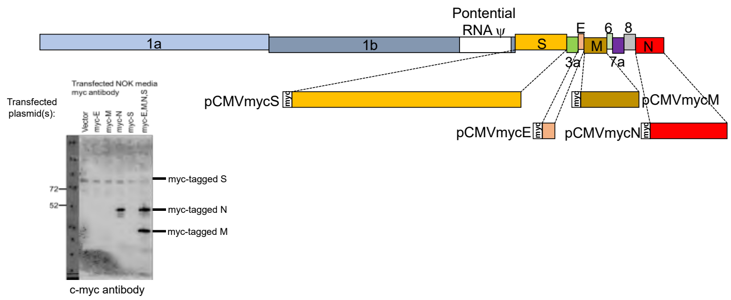
Project 6

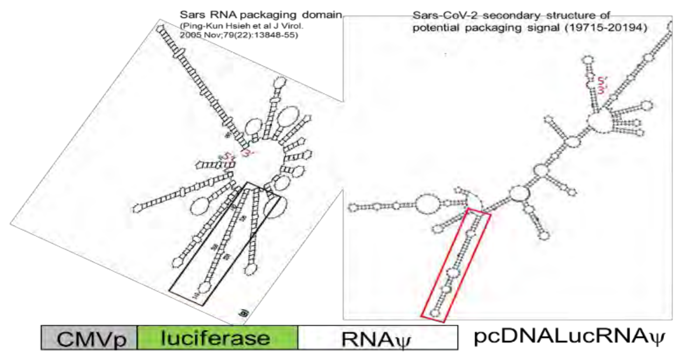
Lead PI: Lisel Jeffers-Francis

Project Title: Designing an Anti-Viral Nanoparticle Against SARS-CoV2

Figure 2. Detection of myc-tagged viral structural proteins in media from oral keratinocytes transfected with SARS-CoV-2 expression plasmids

Figure 3. Predicted secondary structure of SARS-CoV-2 region homologous to SARS RNA packaging domain cloned next to the luciferase gene.





Outcome 3. Metabolic activity of three cell types (human acinar salivary gland cells, human ductal salivary gland cells and telomerase-immortalized human normal oral keratinocytes (NOK)) in increasing concentrations of copper nanoparticles were investigated (figure 4.). The data show that high levels of copper nanoparticle results in lower metabolic activity of human cells. Future studies will be performed to determine the optimal concentration of copper nanoparticles that will bind to and inhibit SARS-CoV-2 as well as the optimal concentration of copper that does not harm human host cells.

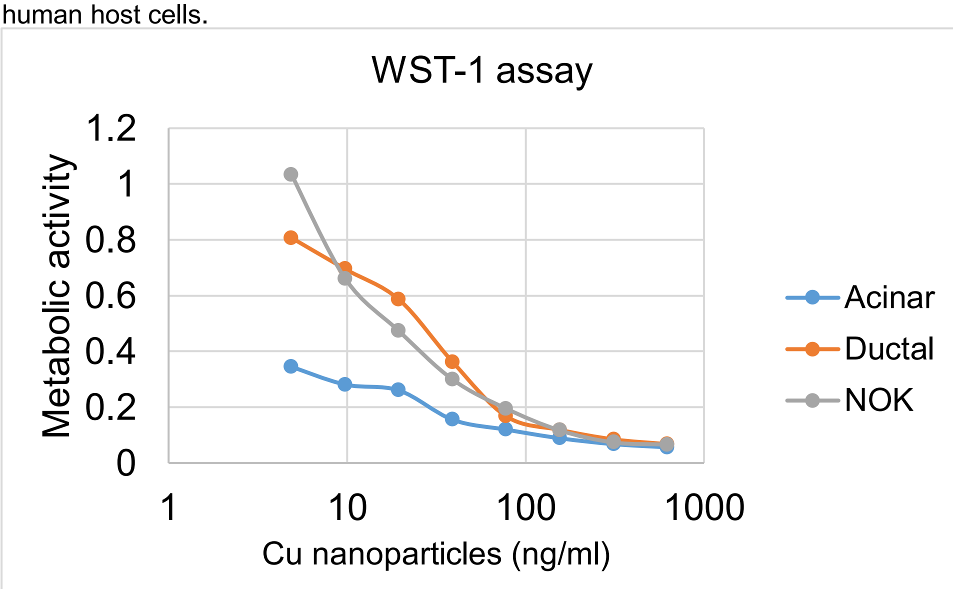


Figure 4. Metabolic activity of human cells with increasing concentration of copper nanoparticles.

See the attached report for full details in Appendix C.

Project 7

Lead PI: Dr. Padonda Webb – Interim Executive Director, NC A&T Student Health

Project Title: NC A&T COVID-19 Testing Initiative

Led by Dr. Padonda Webb, NC A&T provides on-campus testing services through its Student Health Service Center. From August 1, 2020 through December 30, 2020 NC A&T performed 10,601 Rapid Antigens (BinaxNOW), 8,316 Quest PCRs, 1000 Broad PCR, and 459 Omingene PCR (saliva) tests. From these tests, there were 655 positives, which includes faculty, staff, and students.

Appendix A

Final Research Report

Predictors of and Strategies to Mitigate COVID-19 Cases and Death Among Older Adults in Nursing Homes and Residential Care Facilities

Submitted By

Stephanie Teixeira-Poit, PhD, MS
Vannessa Gharbi, MSW, LCSW
Amy Crews, BS
Jessie Cockerham, BSW
Tasha Furr, BSW
Elijah Bell
Bobby Gorham McCrary

Submitted To

North Carolina Policy Collaboratory

Table of Contents

Section **Page**

Table of Contents

Section Page

1. Introduction

1.1 Significance of the Problem

Community members in long-term care facilities have been disproportionately impacted by high COVID-19 cases and deaths across the United States and globally. This population is particularly vulnerable to the deleterious effects of COVID-19 due to numerous factors existing both inside and outside their facility settings. Older adults residing in congregate settings typically have physical, emotional, and functional ability challenges that make them particularly vulnerable to higher rates of infection and death (Campbell-Enns et al. 2020; D'Adamo et al. 2020). Residents in long-term care settings may experience multiple chronic health conditions along with progressive diseases that impact symptomatology and complicate the ability to discern how COVID-19 presents differently in this population (D'Adamo et al. 2020; McMichael et al. 2020).

1.2 Literature Review

1.2.1 Risk and Protective Factors for Older Adults

Research has begun globally and within the United States to better understand the risks and protective factors for infection and mortality risk related to COVID-19. Based on this research, older adults face risk and protective factors, which can be unique to this demographic. Age has itself been identified as a serious risk factor demonstrated consistently through research and is shown in COVID-19 infection and mortality metrics (Bernabeu-Wittel et al. 2020; Li et al. 2020; Rozenfield et al. 2020; Sun et al. 2020). Researchers have noted that clear and transparent communication is critical to understanding and implementing effective protective measures (Sun et al. 2020). One study identified that women are more likely to respond to and understand risks and safety measures related to COVID-19 while men tend to be more resistant to protective measures (Sun et al. 2020).

When combined with age, certain underlying medical conditions, such as diabetes and chronic kidney disease, increase the mortality risk for those older adults who contract COVID-19 (Bernabeu-Wittel et al. 2020; Rozenfield et al. 2020). Research suggests that, in the general population, older adults perceiving a high risk of infection (e.g., those with 10 or more prescription medications; those with multiple comorbidities) was associated with lower risk for infection, presumably because these individuals engaged in more protective measures (Rozenfield et al. 2020). One gap in the research is whether this information holds true for community members in skilled nursing facilities or other long-term care settings.

The level of self-care, along with sex and age, was found to be influential in the level of understanding related to COVID-19 risk factors and preventive measures (Sun et al. 2020). When looking at this from a long-term care perspective, this could be a significant risk factor for older adults in a long-term care facility due to the reduced level of self-care experienced by the residents of such facilities. Another long-term risk factor identified through research is that those older adults who do participate in strict social and physical distancing preventive measures face a higher risk of decreased mental health (Gustavsson and Beckman 2020). There has been extensive anecdotal evidence of this mental health concern; more research will be needed to ascertain the impact on mental health for community members in long-term care facilities.

1.2.2 Risk and Protective Factors of Adult Long-Term Care Facilities

In a facility protective factors meta-analysis, Rios et al. (2020) found that, to reduce the spread of infectious diseases such as COVID-19, facilities must establish surveillance, monitoring, and evaluation. For surveillance and monitoring, the digital contact tracing system outperformed any other method of tracking the spread of COVID-19 (Wilmink et al. 2020). Symptom-based screening was the least effective method of preventing the spread (Callahan et al. 2020; Kimball et al. 2020; Wilmink et al. 2020). The digital contact tracing system method tracks staff by using a digital monitor, and all workers and staff would have to wear the device. However, manual contact tracing was second most effective. Yet, due to human error, it was not as reliable as digital contact tracing. The digital tracking was an electronic simulation and still needs to be implemented. With monitoring, Hatfield et al. (2020), suggested that facility-wide testing of both staff and residents after the first case of COVID-19 was proven to reduce the spread. Timing is important and must be done after the first positive case. Facility-wide testing helps identify unrecognized cases by 79 percent compared to other methods (Hatfield et al. 2020).

Rios et al. (2020), found through meta-analysis that there were several infection prevention and control recommendations that were most helpful in preventing the spread of COVID-19. These recommendations included:

> *"the use of PPE [personal protective equipment], employing physical distancing/isolation or cohorting measures among residents of a facility, disinfecting surfaces, promoting hand hygiene, promoting*

respiratory hygiene/cough etiquette, implementing policies regarding staff sick leave or restricting staff movement, establishing clear communication means and consulting with or notifying relevant healthcare authorities and ensuring appropriate action is taken, educating staff and/or residents on infection control and hygiene, ensuring adequate supplies for facilities, mandating droplet precautions, and policies restricting visitors to long-term care." (Rios et al. 2020:6)

However, Houghton et al. (2020) found that health care workers' adherence to these policies were not effective due to many variables. Most health care workers felt they could not keep up with the local guidelines as they changed over time. Additionally, the added cleaning and work created by policies caused the workers to feel overwhelmed and fatigued. Workers also stated that there was a lack of support from management in strategies in isolating, finding space, and having effective PPE on hand at all times. Houghton et al. (2020) found that workers were more likely to adhere to policies when they understood the value of policies, felt educated in the policies, and had a supportive culture at their job.

One risk factor for facilities was outpatient visits. Bigelow et al. (2020) studied a facility in Maryland where there was a spike in COVID-19 among patients who had to seek dialysis services outside of the facility. Bigelow et al. (2020) stated that more research would need to be conducted on outpatient visits. This could be a risk factor due to the facility being unable to control how other outpatient services are implementing preventive measures. Specifically, it would be best practice for facilities and outpatient services to communicate about safety and COVID-19 adherence or outbreaks (Bigelow et al. 2020).

Staffing conditions and foot traffic within a facility, particularly in areas with high community infection rates, also impact the potential for COVID-19 spread within long-term care facilities (McMichael et al. 2020). Research points to high movement of staff and visitors in and out of facilities where high rates of COVID-19 are found in the surrounding communities as a factor in high rates of COVID-19 in long-term care facilities (McMichael et al. 2020). A recent study indicated that about 60 percent of staff working in long-term care facilities also have additional caregiving roles in their homes and communities, while roughly 70 percent of those surveyed felt pressured to work even when they were ill (Van Houtven et al. 2020). Additionally, in facilities where nurses were working long hours, higher rates of infection were likely; however, they also found that as nurse aid hours increased, the likelihood of infection decreased indicating the important role that optimal staffing levels play in infection mitigation efforts (Gorges and Konetzka 2020).

1.2.3 Community Adherence to COVID-19 Policies and Procedures

Throughout the COVID-19 pandemic, the consistent message has been that community adherence to social distancing guidelines and other safety measures was and is critical to reducing the impact of the pandemic, and research has proven this to be true (Bargain and Aminjonov 2020; Hsiehchen, Espinoza, and Slovic 2020; Miguel et al. 2020). Further studies during the COVID-19 pandemic have found that there are several factors that relate to whether communities and individuals comply with government-imposed measures. These factors range from trust in government to political partisanship.

In a study of European countries during the COVID-19 pandemic, researchers found that where there is a high level of trust in government there has been a corresponding, higher level of compliance with public health guidelines (Bargain and Aminjonov 2020). For example, one study found that "the decline in mobility around mid-March 2020 is significantly stronger in high-trust regions" (Bargain and Aminjonov 2020: 2). Considering the political unrest and public discourse surrounding the lack of faith in government in the United States, this could be an important factor in assessing community adherence to public health guidelines and directly impact the infection and mortality rates in the United States. In turn, this may impact outbreaks in long-term care facilities.

On a similar note, political affiliation was also found to have an impact on compliance with public health guidelines in a study in the United States (Hsiehchen, Espinoza, and Slovic 2020). Mobility data was used as a means to assess a link between political affiliation and compliance with social distancing guidelines (Hsiehchen et al. 2020). This study found that "for every 10% increase in the proportion of Republicans in a state, NPI (non-pharmaceutical interventions) compliance declines 8%" (Hsiehchen et al. 2020: 112). As a connection to public trust in government, one of the conclusions from this study was that the results could help inform the content of public health policies and by what methods public health policies are disseminated (Hsiehchen et al. 2020).

2. Study Methodology

2.1 Multi-Level Explanatory Factors

As demonstrated in the literature review, multiple levels of factors impact COVID-19 cases and deaths. Our project examines multiple levels of factors that perpetuated or mitigated long-term care facilities having COVID-19 cases and deaths in North Carolina and South Carolina. This includes factors at the state-level, community-level, and facility-level. State-level policies impact community-level response. Community-level factors are important because facility staff reside in the community and are carriers bringing COVID-19 into facilities. Facility-level factors include quality of care in facilities as well as the service profile of facilities.

2.2 Overall Approach to Research Questions

Our research questions include:

- **RQ1:** What policy-, community-, and facility-level factors predict whether or not long-term care facilities have COVID-19 cases and deaths?
- **RQ2:** What are actionable strategies that can be implemented to mitigate COVID-19 cases and deaths in long-term care facilities?

To answer the first research question, we compiled data from existing secondary data sources. We then conducted bivariate and multivariate statistical analyses of these data sources (see ***Section 2.3*** for additional details). To answer the second research question, we convened a Stakeholder Advisory Board with six key stakeholders. The purpose of the Board was to provide feedback on the approach and analysis interpretation and help develop actionable recommendations for strategies that can be implemented to mitigate COVID-19 cases and deaths in long-term care facilities. The Board also provided feedback on deliverable formats that can best meet the needs of our local community partners, their constituents, policymakers, and decision makers, so that our research can be translated to inform practice (see ***Section 2.4*** for additional details). A study logic model is illustrated in ***Figure 1*** and the study's institutional review board approval is provided in ***Appendix A***.

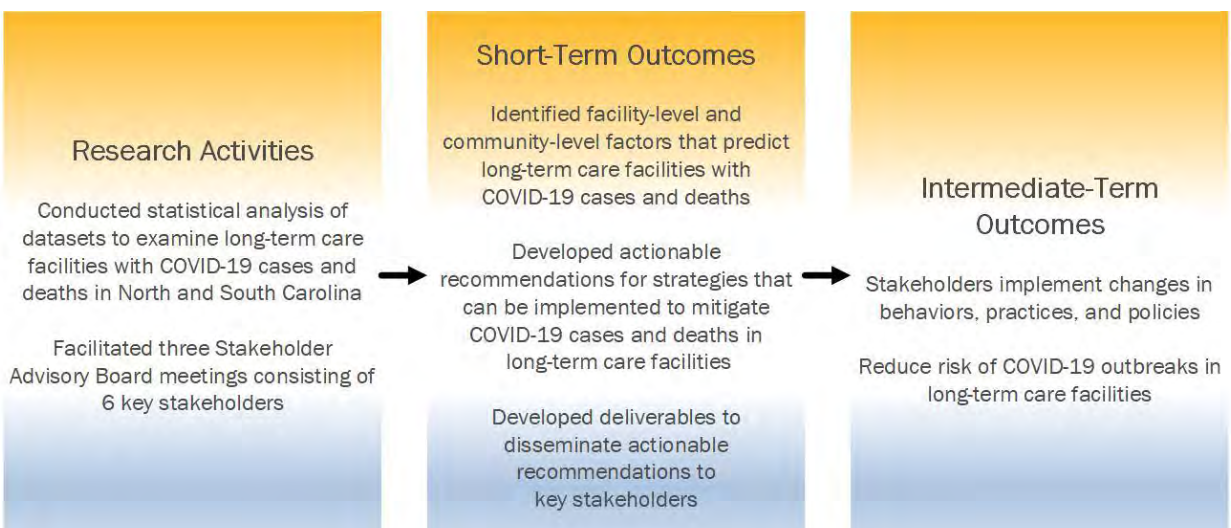


Figure 1. Study Logic Model

2.3 Methodology for Quantitative Analyses

2.3.1 Dependent Variables

The dependent variables examined whether or not long-term care facilities had COVID-19 cases and deaths. Among the 1,411 long-term care facilities included in the analyses, 59 percent were skilled nursing facilities, 17 percent were home health, 11 percent were hospice, 6 percent were assisted living, 3 percent were residential care facilities, and the remainder were other or non-specified types of long-term care facilities (see *Figure 2*).

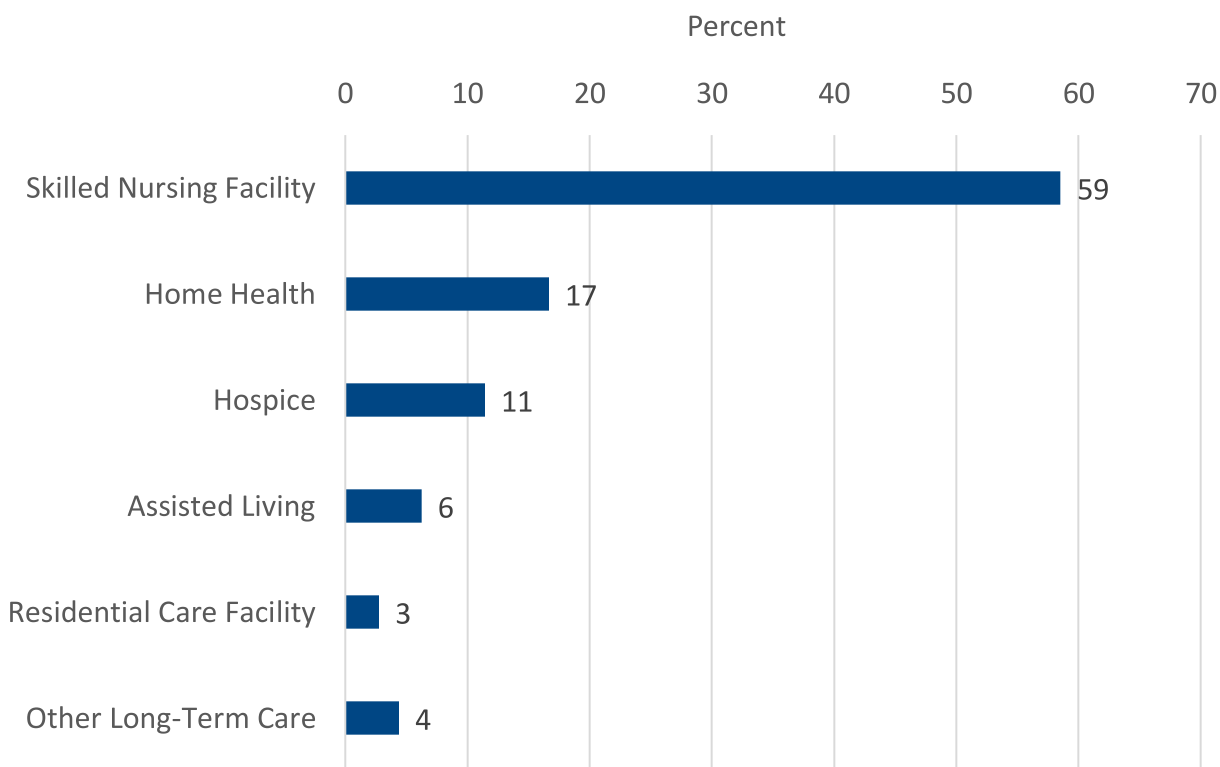


Figure 2. Types of Facilities Included in Analyses

We measured whether or not facilities had COVID-19 cases or deaths. For COVID-19 cases, we separately explored whether or not facilities had any COVID-19 cases, staff cases, or resident cases. For COVID-19 deaths, we separately examined whether or not facilities had any COVID-19 deaths, staff deaths, or resident deaths. ***Appendix B*** provides detailed information about how these data were compiled.

Among the 1,411 long-term care facilities included in the analyses, more than half had COVID-19 cases in their facilities by September 2020 (see *Figure 3*). Forty-nine percent of facilities had staff cases, and 44 percent had resident cases. Additionally, 25 percent of facilities had any COVID-19 deaths. Two percent of facilities had staff deaths, and one-quarter of facilities had resident deaths.

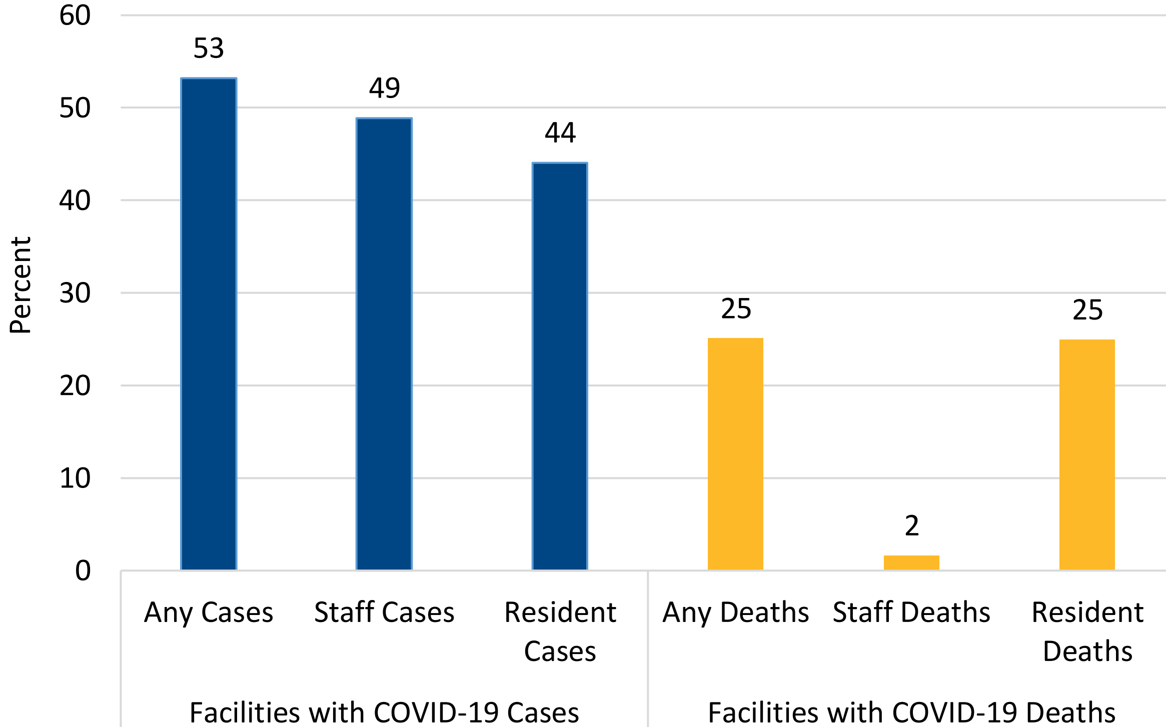


Figure 3. Percent of Facilities in North and South Carolina with COVID-19 Cases and Deaths By September 2020

2.3.2 Independent Variables

At the state-level, we compiled state policy context on stay-at-home orders, mask orders, gatherings, and nursing home visitation. At the community-level, we examined community spread of COVID-19, community adherence to COVID-19 policies and best practices, community demographics, community political climate, and community resiliency. At the facility-level, we explored the service profile of facilities as well as the quality of care in facilities. (see *Table 1* for detailed information on the independent variables).

2.3.3 Data Sources

This study examines state-, community-, and facility-level factors that may have an impact on COVID-19 cases and deaths in long-term care facilities. Throughout the study, we gathered data from state and federal agencies such as the North Carolina Department of Health and Human Services, the South Carolina Department of Health and Environmental Control, the U.S. Centers on Medicare and Medicaid Services, the U.S. Department of Agriculture, and the U.S. Census Bureau. Data were also compiled from other organizations, such as Unacast (see *Table 1* for a list of data sources).

Table 1. Data Sources

Concept	Data Source	Description	Variables	Data Month/Year
Dependent Variables				
Facilities with COVID-19 cases and deaths	North Carolina Department of Health and Human Services COVID-19 Weekly Dashboard	Information compiled weekly from report entitled "COVID-19 Ongoing Outbreaks in Congregate Living Settings"	➢ Facilities with any COVID-19 cases ➢ Facilities with any COVID-19 deaths ➢ Facilities with staff cases ➢ Facilities with staff deaths ➢ Facilities with resident cases ➢ Facilities with resident deaths	Data from March 2020 to September 2020
	South Carolina Department of Health and Environmental Control COVID-19 Weekly Dashboard	Information compiled weekly from report entitled "Cumulative COVID-19 in Long Term Care Facilities Year to Date"		
State-Level Factors				
State policy context	COVID-19 U.S. State Policy Database (see here)	State-level policies across numerous domains affecting movement, healthcare, and community well-being during the pandemic	➢ Stay-at-home orders ➢ Mask orders ➢ Gatherings ➢ Nursing home visitation	Data began in March 2020 and continues to be updated regularly with new state-by-state policies as new orders are issued
Community-Level Factors				
Community spread of COVID-19	North Carolina Department of Health and Human Services COVID-19 Statistics Dashboard (see here)	Dashboards that provide updates, policies, and guidelines on the status of COVID-19 throughout North Carolina	➢ COVID-19 cases per 10,000 population in the county	September 2020
	South Carolina Department of Health and Environmental Control COVID-19 Statistics Dashboard (see here)	Dashboards that provide updates, policies, and guidelines on the status of COVID-19 throughout South Carolina	➢ COVID-19 cases per 100,000 population in the county (team converted to per 10,000 population for comparability with NC)	

(continued)

Table 1. Data Sources (continued)

Concept	Data Source	Description	Variables	Data Month/Year
Community-Level Factors				
Community adherence to COVID-19 policies and best practices	Unacast Social Distancing Scoreboard (see here)	Social distancing is a CDC recommended practice for slowing the spread of COVID-19. Also referred to as "physical distancing" by the CDC, social distancing refers to staying at least 6 feet away from people, both indoors and outdoors, with whom you do not share a household	➢ Social distancing grade ➢ Grade for reduction in average mobility ➢ Grade for reduction in non-essential visitation ➢ Grade for decrease in human encounters	September 2020
Community demographics	U.S. Department of Agriculture Rural-Urban Continuum Codes (see here)	Codes that distinguish metropolitan counties by the population size of their metro area, and nonmetropolitan counties by degree of urbanization and adjacency to a metro area	➢ Rural/urban status	2013
Community political climate	Politico (see here for NC and here for SC)	Information on the percent of county residents who voted for candidates from particular political parties in the last Presidential election	➢ Percent who voted for the Republican candidate ➢ Percent who voted for the Democratic candidate	November 2020
Community resiliency	United States Census Bureau (see here)	Information on the ability of communities across the nation to recover from the impact of community disasters, including pandemics, as a measure of variation in individual and household vulnerabilities	➢ Percent of residents in county with 0 risk factors ➢ Percent of residents in county with 1-2 risk factors ➢ Percent of residents in county with 3+ risk factors	Initial release date of data was June 22, 2020

(continued)

Table 1. Data Sources (continued)

Concept	Data Source	Description	Variables	Data Month/Year
Facility-Level Factors				
Service profile of facilities	U.S. Centers for Medicare and Medicaid Services (CMS) Post-Acute Care and Hospice Provider Utilization and Payment Public Use Files (see PAC-PUF here)	Information on services provided to Medicare beneficiaries by home health agencies, hospices, skilled nursing facilities, inpatient rehabilitation facilities, and long-term care hospitals	➢ Percent dual beneficiaries ➢ Percent Black beneficiaries ➢ Average Hierarchical Condition Category (HCC) risk score ➢ Average number of chronic conditions of residents	October 2019
Quality of care in facilities	U.S. CMS Nursing Home Provider Information (see here)	Information compiled from Care Compare from sources (1) CMS's health inspection database (2) Payroll-Based Journal system (3) The Minimum Data Set national database (4) Medicare claims data	➢ Overall five-star quality rating ➢ Health inspection rating ➢ Quality measure rating ➢ Long-stay quality measure rating ➢ Short-stay quality measure rating ➢ Staffing rating ➢ Registered Nurse staffing rating ➢ Number of fines ➢ Total number of penalties ➢ Number of substantiated complaints ➢ Reported licensed staffing hours ➢ Reported total nurse staffing hours	Data reported for FY 2020 with baseline period (FY 2016) and performance period (FY 2018)

2.3.4 Analytic Technique

We ran univariate analyses of each variable in *Table 1*. Then we conducted bivariate analyses to examine the state-, community-, and facility-level factors associated with COVID-19 cases and deaths. Bivariate analyses included chi-square tests (or Fisher's exact tests because of low cell sizes) for independent variables that were categorical and simple logistic regression models for independent variables that were continuous. All independent variables that were statistically ($p<0.05$) or marginally significant ($0.05<p<0.10$) were considered for inclusion in multivariate models. Independent variables were assessed for multicollinearity (variance inflation factor > 2.50; correlation>0.60) before making the final decision of inclusion in multivariate models. We estimated mixed-effects logistic regression models to examine the relationship of state-, community-, and facility-level factors with each of the following outcomes: (1) facilities having staff cases, (2) facilities having resident cases, and (3) facilities having resident deaths. All models were three-level models with random intercepts for counties and states; in other words, the facilities were nested in community contexts (measured as counties) nested in state policy contexts (measures as states).

2.4 Methodology for Stakeholder Advisory Board

2.4.1 Identifying Stakeholder Regions

We examined various maps to identify a method for dividing the State of North Carolina into regions to ensure that members of the Stakeholder Advisory Board optimally represented the State. Map foci included data monitoring, geographic boundaries, health response, and trauma planning. With its emphasis on preparation and response to public health emergencies, we used the four North Carolina Public Health Preparedness Regions consisting of western, central, eastern, and the cities readiness initiative region (see ***Figure 4***). These regions would serve as the boundaries for determining representation across the areas.

Figure 4. North Carolina Public Health Preparedness Regions
(Source: North Carolina Department of Health and Human Services 2020c)

2.4.2 Identifying Stakeholders within Regions

Each region was assessed for county rurality and urbanicity. To achieve a balance among rural and urban areas, we examined numerous sources to identify a mix of counties for inclusion. Though overlap exists among sources that define urban and rural regions, we used the Office of Management and Budget definition to select at least one urban and one rural county for each region. Counties were also reviewed for outbreak status to identify a balance between those that were experiencing a high level of outbreak, or a hotspot, and those that were not experiencing a high outbreak level.

Once the balance of high/low outbreak and rural/urban county characteristics were achieved, we searched the internet and the Division of Health and Human Services licensed nursing home listings to identify a list of prospective contacts to invite to participate in the Stakeholder Advisory Board. The search included facilities identified as nursing homes, congregate facilities with memory care units, all-inclusive programs for older adults who meet criteria for nursing home admissions and maintain onsite congregate services, hospice, skilled nursing, and ombudsman programs who advocate on behalf of residents in long-term care facilities.

With a goal of 6 to 8 members for the Stakeholders Advisory Board (SAB), which is in line with research on optimal focus group sizing (Kreuger and Casey 2015), we conducted an internet search of counties within the regions of interest to develop a list of prospective contacts that would give us a mix of diverse professional backgrounds, agency settings, income levels, and socio-demographic characteristics. Prospective members were contacted by email with IRB approved templates and invited for participation over Zoom informational meetings. An initial contact list was compiled based on inclusion criteria and subsequent lists followed over the beginning phase of the project. A large portion of potential agencies were screened out for insufficient contact information that would meet IRB communication requirements. A first cycle of email contact went out with a follow up contact for non-responses (see ***Appendix C*** for the initial contact email script). This process continued for three additional cycles over a three-month period. A total of six contacts agreed to participate on the SAB.

2.4.3 Facilitating Onboarding Meetings with Stakeholders

After each community member responded to our initial invitation to participate on the Stakeholder Advisory Board, we invited them to participate in a virtual onboarding meeting with the study co-PIs based on their preferred availability. We developed a brief presentation for use during informational meetings with prospective stakeholders (see ***Appendix D***). We started with brief introductions and proceeded to discuss information about study parameters, scope of the problem, goals, and purpose of the SAB. Each member was invited to ask clarifying questions and confirm their interest during the onboarding session. We convened six informational meetings with prospective stakeholders who responded to the project email invitation to participate, and all agreed to participate in the SAB.

Members of the Stakeholder Advisory Board are a diverse set of professionals from across the state of North Carolina who are committed to safe, high quality care for residents of long-term care facilities (see ***Figure 5***):

- Carol Hallisey is a Nurse and Director of Onslow County Hospice and Home Health who concentrates her efforts on the outpatient side of client care by addressing problems in organizing care for clients and issues in home health services that arise.
- Kashima Jones is an Assistant Professor of Clinical Adult Health at NC A&T School of Nursing and a Nurse who provides care for adult clients in community settings and educates the next generation of nurses in best practices for safe and competent adult nursing care.
- Aimee Kepler is the Regional Long Term Care Ombudsman with the Triad J Council of Governments with a background in Human Relations and Gerontology and who has served and advocated for the well-being of residents in congregate facilities for 18 years.
- Sandy Nasbaum is the retired Chair for the Moore County Nursing/Adult Care Home Advisory Committee which is responsible for overseeing the work of volunteer members of the community in advocating for people residing in long term care facilities.
- Larry Alan Reeves is a social worker with experience working in long-term care facilities and as an Alzheimer's Disease caregiver whose current role as Regional LTC Ombudsman with the Area Agency on Aging focuses on advocating for the needs of residents in nursing and adult care homes living in a seven-county region of western North Carolina and among the Eastern Band of Cherokee Indians.
- Ursula Robinson is the Executive Director for Pace of the Triad whose breadth of experience spans 30 years within the field of Aging services including nursing homes, hospice, and other community-based settings.

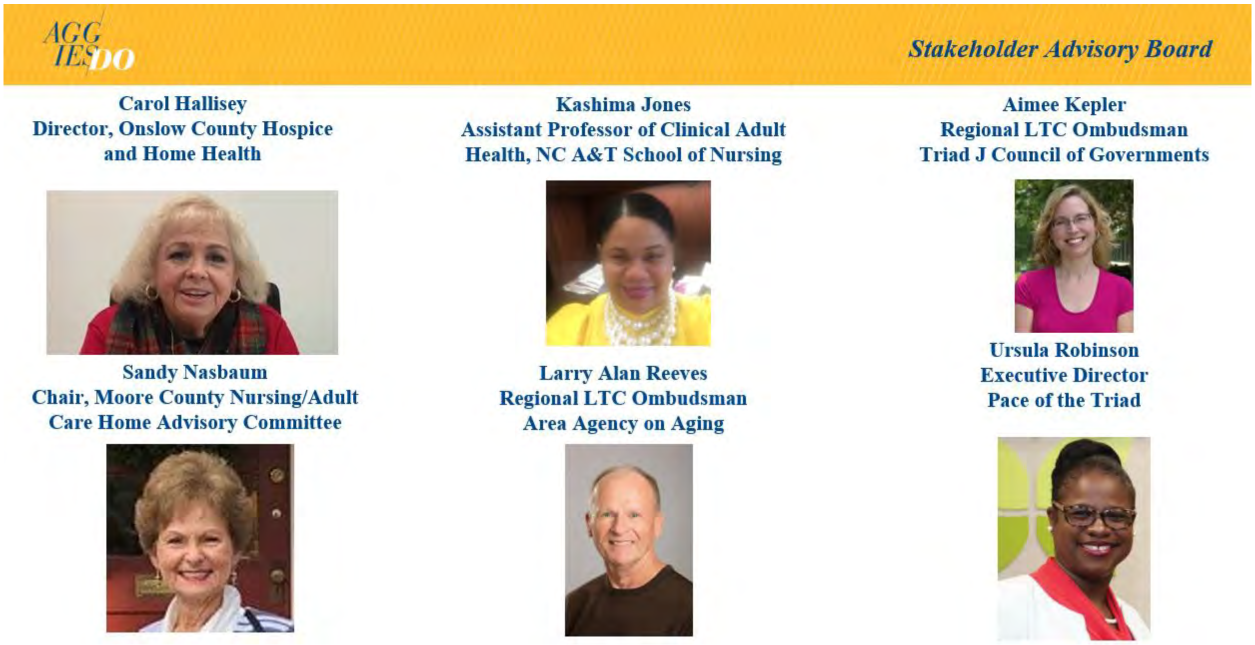


Figure 5. Stakeholder Board Members

2.4.4 Facilitating Stakeholder Board Meetings

Once the group of six members for the SAB was established, we proposed three team meetings and distributed a Doodle poll to all team members to identify their availability. There were several scheduling challenges to overcome, but the SAB members were able to reach consensus for our first meeting.

The initial SAB meeting focused on icebreaker questions, team building, role clarification, and input from the SAB on their thoughts on potential project variables, their experience with COVID-19 in their facilities and surrounding communities, trends they are seeing, and what they feel are the most important targets to consider. Subsequent meetings focused on reviewing preliminary results from data analyses and brainstorming interpretation of results, suggestions for additional analyses, actionable recommendations, and deliverable formats for data dissemination.

We conducted a debriefing session among the research team after each SAB meeting. We also compiled notes outlining key takeaways after each meeting. After the first SAB meeting was held, key takeaways that emerged included themes of community spread, patient advocacy, testing, infection control, staffing, communication/messaging, what's working, and funding and economic factors. Preliminary results were introduced to the SAB members at the second meeting for discussion and feedback and the key themes that emerged from that meeting included reactions to the results, possible explanations for the findings, staffing related challenges and preferred formats for deliverables. The third, and final, SAB meeting concluded with a discussion of additional findings and thoughts on results, current and desired deliverables, review and feedback for design and content, and recommendations for connecting with additional community stakeholders for data dissemination (see ***Section 4*** for additional details on the content and results of the SAB meetings). Members were invited to follow up as new developments emerged or ongoing interest in project activities were expressed.

3. Results of Quantitative Analysis

3.1 Trends Across States

We used chi-square tests to examine differences between North Carolina versus South Carolina in facilities having any COVID-19 cases, any deaths, staff cases, staff death, resident cases, and resident deaths. North Carolina had a statistically significantly lower percent of facilities with any COVID-19 cases or any deaths than South Carolina (see ***Figure 6*** and ***Table 2***). Forty-nine percent of facilities in North Carolina had any COVID-19 cases compared to 60 percent of facilities in South Carolina (X^2 (1, N = 1411) = 16.58, p = <0.001). Additionally, one-fifth of facilities in North Carolina had any COVID-19 deaths compared to one-third of facilities in South Carolina (X^2 (1, N = 1411) = 31.632, p = <0.001). A similar, statistically significant pattern followed when examining facilities with COVID-19 staff deaths, resident cases, and resident deaths. The relationship between state and facilities with staff cases was also marginally significant ($0.05 < p < 0.10$).

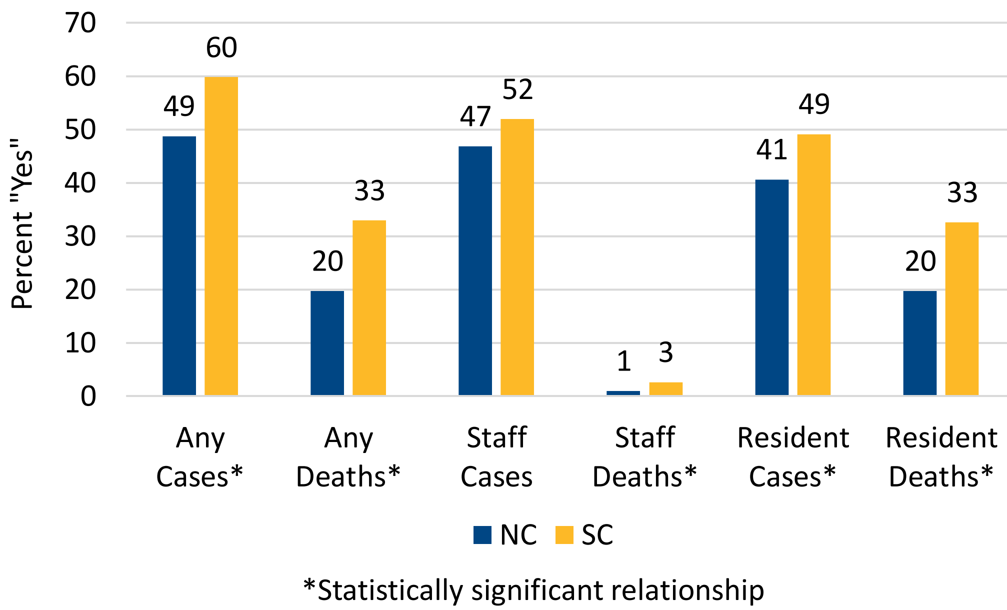


Figure 6. Percent of Facilities with COVID-19 Cases and Deaths by State

Table 2. Facilities with COVID-19 Cases and Deaths by State

State	Bivariate Analyses				p-value
	No	Yes	No	Yes	
	N	N	Row Percent		
Facilities with Any Cases					
NC	429	408	51.25	48.75	<0.001
SC	231	343	40.24	59.76	
Facilities with Any Deaths					
NC	672	165	80.29	19.71	<0.001
SC	385	189	67.07	32.93	
Facilities with Staff Cases					
NC	445	392	53.17	46.83	0.061
SC	276	298	48.08	51.92	
Facilities with Staff Deaths					
NC	829	8	99.04	0.96	0.016
SC	559	15	97.39	2.61	
Facilities with Resident Cases					
NC	497	340	59.38	40.62	0.002
SC	292	282	50.87	49.13	
Facilities with Resident Deaths					
NC	672	165	80.29	19.71	<0.001
SC	387	187	67.42	32.58	

3.2 State-Level Factors

One explanation for the differences in facilities with COVID-19 cases and deaths across North Carolina and South Carolina may be state-level contextual factors. We compared and contrasted policies related to COVID-19 for North Carolina and South Carolina. North Carolina and South Carolina responded to the pandemic in different ways, including policies regarding stay-at-home orders, whether masks were required or suggested in different settings, limitations on community mass gatherings, limitations on visitations with residents in facilities, and recommendations on resident and staff travel for holidays (see *Figure 7* for a comparison of policies across North Carolina and South Carolina).

	Stay-at-home Orders	Mask Orders	Gatherings	Nursing Home Visitation
NC	• Issued March 2020 ended May 2020, ongoing modified restrictions, current order until January 2021	• Statewide - required in all public indoor settings, businesses over 15,000 sq.ft. post worder to enforce	• No mass gatherings, no more than 10 indoors/50 outdoor, 25 max at amusement parks, museums, aquariums	• Outdoor visits as deemed safe by facility, compassionate care indoors, Resident and Staff travel for holidays NOT recommended
SC	• Issued April 2020 ended May 2020, November 2020 no plans for new restrictions	• "Suggested" - only required in state government, restaurants, large crowds/gatherings, counties decide	• 50% occupancy limit or 250 people indoors, whichever is less, October 2020- restaurants 100% occupancy	• Facility driven visitation, must allow, can resume visits if less than 3 COVID-19 cases, recommends leave of absence policy for travel

Figure 7. Comparison of Policies Between North Carolina and South Carolina

The North Carolina Department of Health and Human Services issued a series of protocols and informational tools to enhance the safety and well-being of residents in long-term care facilities. They maintain a comprehensive website with various dashboards that provide updates on the status of COVID-19 throughout the state and for populations residing in these facilities (NCDHHS 2020a). The "COVID-19 Outbreak Toolkit for Long-Term Care Settings" was issued to provide guidance on ways to address various needs that may arise in these facilities and to increase the use of recommended measures to reduce virus exposure and spread (NCDHHS 2020b). Policies reflected current Centers for Disease Control and local Public Health guidelines for reporting, triaging, testing, staff shortage mitigation, return-to-work procedures, and visitation to long-term care facilities.

South Carolina's Department of Health and Environmental Control also maintains a website that provides similar information for community members and impacted staff to assist with precautionary measures and decision making in controlling the spread of COVID-19 across the state and within congregate settings (SCDHEC 2020a). Policy and executive order amendments and additions are continuously updated to meet the needs of an evolving pandemic environment. Extensive county-level and facility data is provided on their new dashboard, which went live on August 11, 2020 (SCDHEC 2020b). Guidelines and information for testing, vaccination, community resources, quarantine, travel, and high-risk groups are also included among the various resources provided on these sites.

The response to the pandemic has differed in several ways for these two states. At the start of the pandemic, the two states followed a similar nationwide pattern of closures and stay-at-home orders that were issued across states nationally, with both states also closing schools for the remainder of the spring semester (State of North Carolina 2020; South Carolina Office of the Governor 2020). However, the emphasis in reopening has seen different approaches to recommendations for businesses and individuals. North Carolina has maintained tighter restrictions for gatherings, while South Carolina has maintained language in many guidelines that are “recommended”, “encouraged”, or “urged” (South Carolina Emergency Management Division 2020; South Carolina Office of the Governor 2020). While North Carolina still maintains limitations on restaurant occupancy with concurrent CDC recommended practices for indoor dining (State of NC 2020), South Carolina allowed restaurants to operate at 100% capacity in October 2020, contrary to CDC recommendations that indicated this presents the “highest risk” for COVID-19 transmission (CDC 2020).

One of the most notable differences between North and South Carolina is their approach to face coverings. North Carolina’s Governor, Roy Cooper, laid out a mask mandate in June 2020 (State of North Carolina 2020) while South Carolina’s Governor, Henry McMaster, has yet to order a mandate for universal face coverings across the state. In fact, South Carolina’s Executive Order 2020-63 only requires face coverings in state government or office buildings, restaurants, and in large crowds or gatherings (South Carolina Office of the Governor 2020). South Carolina’s leadership leaves it up to local counties and municipalities to create their own policies. As it stands, South Carolina currently has 10 counties and 56 municipalities with mask ordinances ranging from “required” to “suggested use” (South Carolina County and Municipality Mask Ordinances 2020). Conversely, Governor Cooper has tightened penalties for violating mask orders and issued another modified stay-at-home order that will be in effect until the beginning of 2021 (State of North Carolina 2020).

3.3 Community-Level Factors

We explored community-level factors to determine whether they were associated with facilities having any COVID-19 cases, any deaths, staff cases, staff death, resident cases, and resident deaths. Community-level factors were all measured at the county-level; factors included: rural/urban status, overall social distancing, reduction in average mobility, reduction in non-essential visitation, decrease in human encounters, community spread of COVID-19, political climate of the county, and community resiliency.

3.3.1 Rural/Urban Status

Rural/urban status of the county was measured using the USDA Beale rural-urban continuum codes. The Beale codes classify counties on a scale from one to nine. Categories one through three were collapsed to create a category reflecting “metropolitan” counties. Categories four through seven were collapsed to create a category reflecting “nonmetropolitan urban” counties. Categories eight and nine were collapsed to create a category reflecting “nonmetropolitan rural” counties. We used chi-square tests to examine whether metropolitan, nonmetropolitan urban, and nonmetropolitan rural counties had differences in the percent of facilities with any COVID-19 cases, any deaths, staff cases, staff death, resident cases, and resident deaths.

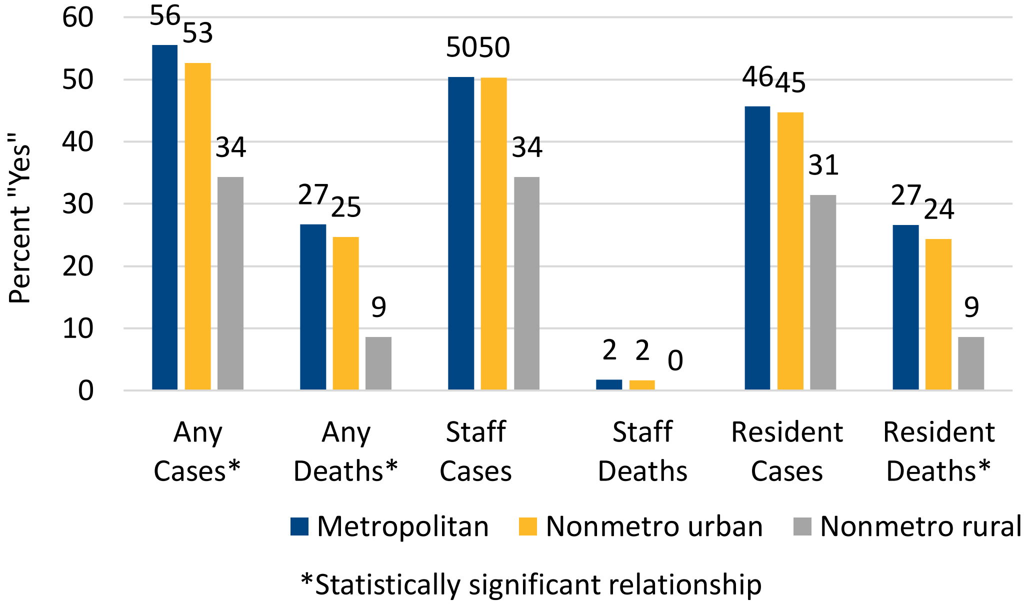


Figure 8. Percent of Facilities with COVID-19 Cases and Deaths by Rural/Urban Status

Nonmetropolitan rural counties had a significantly lower percent of facilities with any COVID-19 cases and deaths compared to metropolitan and nonmetropolitan urban counties (see ***Figure 8*** and ***Table 3***). Thirty-four percent of facilities in nonmetropolitan rural counties had any COVID-19 cases compared to more than half of facilities in metropolitan and nonmetropolitan urban counties (X^2 (2, N = 1369) = 6.58, p = 0.037). Additionally, nine percent of facilities in nonmetropolitan rural counties had any COVID-19 deaths compared to more than one-quarter of facilities in metropolitan and nonmetropolitan urban counties (X^2 (2, N = 1369) = 6.06, p = 0.048).

The relationships between rural/urban status and staff cases, staff deaths, and resident cases were not statistically significant. Yet, the relationship between rural/urban status and resident deaths was statistically significant. Nonmetropolitan rural counties had a significantly lower percent of facilities with resident deaths than metropolitan and nonmetropolitan urban counties, respectively. Nine percent of facilities in nonmetropolitan counties had resident deaths compared to more than one-quarter of facilities in metropolitan and nonmetropolitan urban counties (X^2 (2, N = 1369) = 6.11, p = 0.047).

Table 3. **Facilities with COVID-19 Cases and Deaths by Rural/Urban Status**

Rural/Urban Status	Bivariate Analyses				
	No N	Yes N	No Row Percent	Yes Row Percent	p-value
Facilities with Any Cases					
Metropolitan	460	574	44.49	55.51	0.037
Nonmetro urban	142	158	47.33	52.67	
Nonmetro rural	23	12	65.71	34.29	
Facilities with Any Deaths*					
Metropolitan	758	276	73.31	26.69	0.048
Nonmetro urban	226	74	75.33	24.67	
Nonmetro rural	32	3	91.43	8.57	
Facilities with Staff Cases					
Metropolitan	513	521	49.61	50.39	0.171
Nonmetro urban	149	151	49.67	50.33	
Nonmetro rural	23	12	65.71	34.29	
Facilities with Staff Deaths					
Metropolitan	1016	18	98.26	1.74	1.000
Nonmetro urban	295	5	98.33	1.67	
Nonmetro rural	35	0	100.00	0.00	
Facilities with Resident Cases					
Metropolitan	562	472	54.35	45.65	0.248
Nonmetro urban	166	134	55.33	44.67	
Nonmetro rural	24	11	68.57	31.43	
Facilities with Resident Deaths*					
Metropolitan	759	275	73.40	26.60	0.037
Nonmetro urban	227	73	75.67	24.33	
Nonmetro rural	32	3	91.43	8.57	

*Fisher's exact tests were used instead of chi-square tests due to low cell sizes.

3.3.2 Social Distancing

Social distancing was measured using data compiled from Unacast's social distancing scoreboard. Social distancing is measured as an overall grade that averages grades from three measures: (1) percent change in average distance traveled; (2) percent change in non-essential visitation; and (3) decrease in human encounters compared to a national baseline. We used chi-square tests to explore whether counties with a failing grade versus passing grade for social distancing had differences in the percent of facilities with any COVID-19 cases, any deaths, staff cases, staff death, resident cases, and resident deaths.

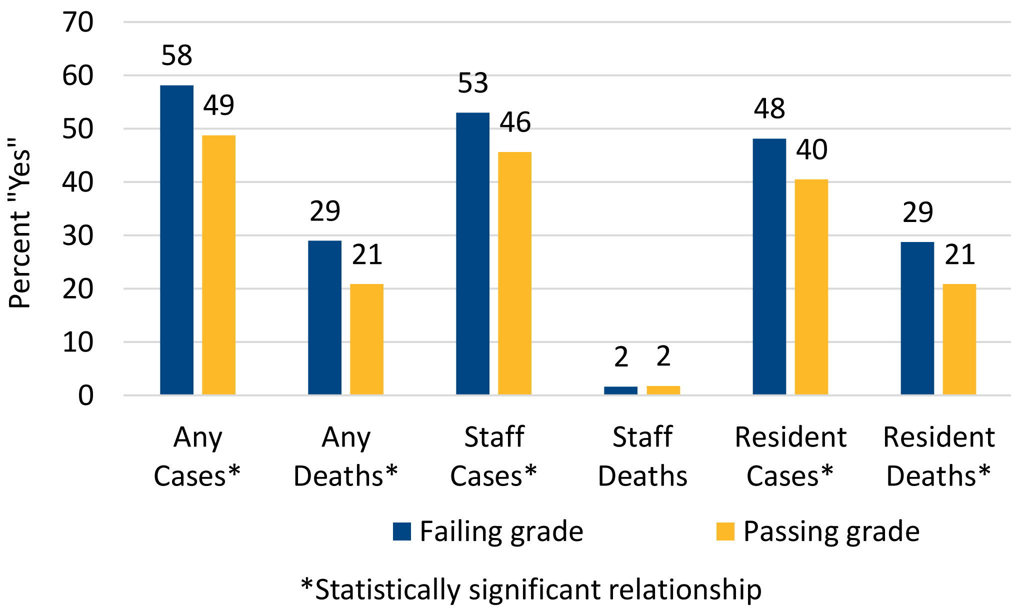


Figure 9. Percent of Facilities with COVID-19 Cases and Deaths by Social Distancing Grade

Counties with failing social distancing grades had a significantly higher percent of facilities with any COVID-19 cases and deaths compared to counties with passing social distancing grades (see ***Figure 9*** and ***Table 4***). Fifty-eight percent of facilities in counties with failing social distancing grades had any COVID-19 cases compared to 49 percent of facilities in counties with passing social distancing grades (X^2 (1, N = 1357) = 11.48, p = 0.001). Additionally, 29 percent of facilities in counties with failing social distancing grades had any COVID-19 deaths compared to 21 percent of counties with passing social distancing grades (X^2 (1, N = 1357) = 10.88, p = 0.001). A similar, statistically significant pattern followed when examining facilities with COVID-19 staff cases, resident cases, and resident deaths.

Table 4. Facilities with COVID-19 Cases and Deaths by Social Distancing Grade

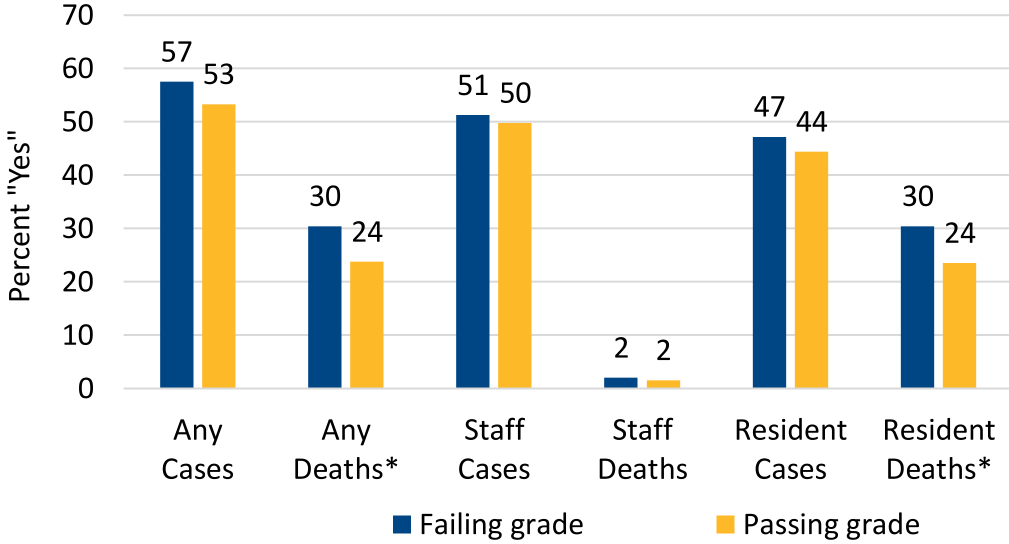
Social Distancing Grade	Bivariate Analyses No N	Yes N	No Row Percent	Yes Row Percent	p-value
Facilities with Any Cases					
Failing grade	357	496	41.85	58.15	0.001
Passing grade	258	246	51.19	48.81	
Facilities with Any Deaths					
Failing grade	606	247	71.04	28.96	0.001
Passing grade	399	105	79.17	20.83	
Facilities with Staff Cases					
Failing grade	401	452	47.01	52.99	0.009
Passing grade	274	230	54.37	45.63	
Facilities with Staff Deaths					
Failing grade	839	14	98.36	1.64	0.842
Passing grade	495	9	98.21	1.79	
Facilities with Resident Cases					
Failing grade	442	411	51.82	48.18	0.006
Passing grade	300	204	59.52	40.48	
Facilities with Resident Deaths					
Failing grade	608	245	71.28	28.72	0.001
Passing grade	399	105	79.17	20.83	

3.3.3 Reduction in Average Mobility

Reduction in average mobility in the county was measured using data compiled from Unacast's social distancing scoreboard. Reduction in average mobility was measured using the percent change in average distance traveled, where grades corresponded to the following percent decreases:

- A: >70% decrease
- B: 55-70% decrease
- C: 40-55% decrease
- D: 25-40% decrease
- F: <25% decrease or increase

We collapsed these categories and used chi-square tests to explore whether counties with failing grades versus passing grades for reduction in average mobility had differences in the percent of facilities with any COVID-19 cases, any deaths, staff cases, staff death, resident cases, and resident deaths.



*Statistically significant relationship

Figure 10. Percent of Facilities with COVID-19 Cases and Deaths by Grade for Reduction in Average Mobility

Counties with failing grades for reduction in average mobility had a significantly higher percent of facilities with any COVID-19 deaths and resident deaths (see *Figure 10* and *Table 5*). Thirty percent of facilities in counties with failing grades had any COVID-19 deaths compared to 24 percent of facilities in counties passing grades (X^2 (1, N = 1357) = 6.98, p = 0.008). A similar, statistically significant pattern was found for the relationship between reduction in average mobility and facilities with resident deaths (X^2 (1, N = 1357) = 7.47, p = 0.006).

Table 5. Facilities with COVID-19 Cases and Deaths by Grade for Reduction in Average Mobility

Grade for Reduction in Average Mobility	Bivariate Analyses				
	No N	Yes N	No Row Percent	Yes Row Percent	p-value
Facilities with Any Cases					
Failing grade	190	257	42.51	57.49	0.144
Passing grade	425	485	46.70	53.30	
Facilities with Any Deaths					
Failing grade	311	136	69.57	30.43	0.008
Passing grade	694	216	76.26	23.74	
Facilities with Staff Cases					
Failing grade	218	229	48.77	51.23	0.616
Passing grade	457	453	50.22	49.78	
Facilities with Staff Deaths					
Failing grade	438	9	97.99	2.01	0.524
Passing grade	896	14	98.46	1.54	
Facilities with Resident Cases					
Failing grade	236	211	52.80	47.20	0.329
Passing grade	506	404	55.60	44.40	
Facilities with Resident Deaths					
Failing grade	311	136	69.57	30.43	0.006
Passing grade	696	214	76.48	23.52	

3.3.4 Reduction in Non-Essential Visitation

There was little variation in reduction in non-essential visitation among counties in our dataset; nearly 97 percent of counties had a failing grade for reduction in non-essential visitation (data not shown). Because of this limited variation, we did not further explore reduction in non-essential visitation.

3.3.5 Decrease in Human Encounters

Decrease in human encounters in the county was measured using data compiled from Unacast's social distancing scoreboard. Decrease in human encounters was measured as decrease in human encounters compared to a national baseline, where grades corresponded to the following percent:

- **A:** >94%
- **B:** 82%-94%
- **C:** 74%-82%
- **D:** 40%-74%
- **F:** <40%

We collapsed these categories and used chi-square tests to explore whether counties with failing grades versus passing grades for decrease in human encounters had differences in the percent of facilities with any COVID-19 cases, any deaths, staff cases, staff death, resident cases, and resident deaths.

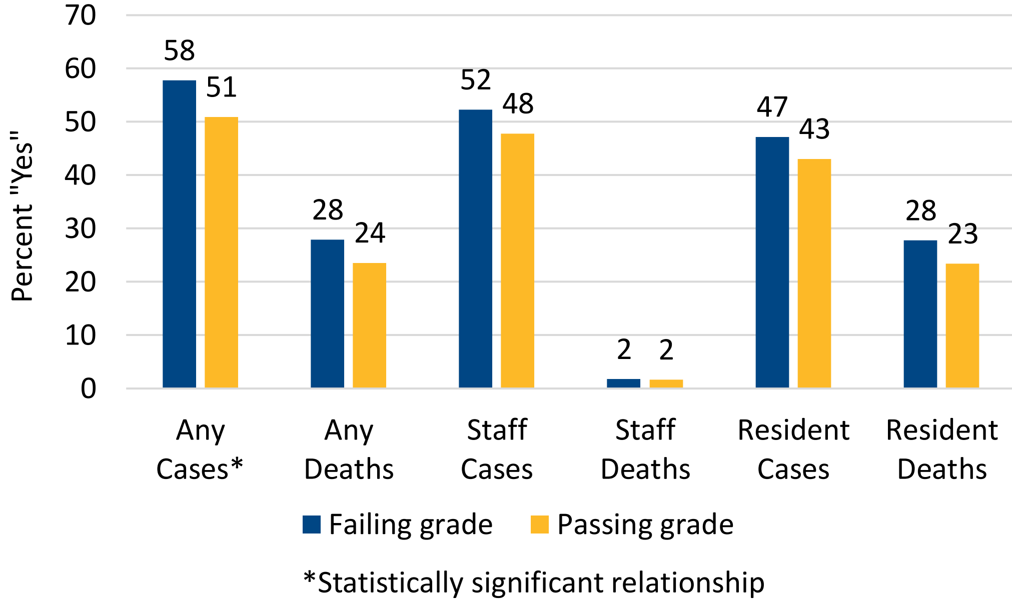


Figure 11. Percent of Facilities with COVID-19 Cases and Deaths by Grade for Decrease in Human Encounters

Counties with failing grades for decreases in human encounters had a significantly higher percent of facilities with any COVID-19 cases than counties with passing grades for decreases in human encounters (see ***Figure 11*** and ***Table 6***). Fifty-eight percent of facilities in counties with failing grades for decreases in human encounters had any COVID-19 cases compared to 51 percent of facilities in counties with passing grades (X^2 (1, N = 1357) = 6.41 p = 0.011). The relationships between grades for decreases in human encounters and facilities with any COVID-19 deaths and resident deaths were also marginally significant ($0.05 < p < 0.10$).

Table 6. Facilities with COVID-19 Cases and Deaths by Grade for Decrease in Human Encounters

Grade for Decrease in Human Encounters	Bivariate Analyses				
	No N	Yes N	No Row Percent	Yes Row Percent	p-value
Facilities with Any Cases					
Failing grade	315	431	42.23	57.77	0.011
Passing grade	300	311	49.10	50.90	
Facilities with Any Deaths					
Failing grade	538	208	72.12	27.88	0.071
Passing grade	467	144	76.43	23.57	
Facilities with Staff Cases					
Failing grade	356	390	47.72	52.28	0.100
Passing grade	319	292	52.21	47.79	
Facilities with Staff Deaths					
Failing grade	733	13	98.26	1.74	0.880
Passing grade	601	10	98.36	1.64	
Facilities with Resident Cases					
Failing grade	394	352	52.82	47.18	0.127
Passing grade	348	263	56.96	43.04	
Facilities with Resident Deaths					
Failing grade	539	207	72.25	27.75	0.069
Passing grade	468	143	76.60	23.40	

3.3.6 Community Spread of COVID-19

Community spread of COVID-19 was measured using COVID-19 cases per 10,000 population in the county. Simple logistic regression models were performed to examine the relationship between the extent of community spread and facilities having any COVID-19 cases, any deaths, staff cases, staff death, resident cases, and resident deaths. Facilities in counties with greater community spread had higher odds of having any COVID-19 cases, any COVID-19 deaths, staff cases, resident cases, and resident deaths ($p<0.05$). However, there was no relationship between community spread and facilities having staff deaths.

3.3.7 Political Climate of the County

Political climate of the county was measured using a proxy of the percent of county residents who voted for the Republican candidate versus the Democratic candidate in the last Presidential election. Simple logistic regression models were performed to examine the relationship between the political climate in the county and facilities having any COVID-19 cases, any deaths, staff cases, staff death, resident cases, and resident deaths. None of these relationships were statistically or marginally significant (data not shown).

3.3.8 Community Resiliency

Community resiliency relied on measures developed by the United States Census Bureau to assess the ability of communities to recover from the impact of community disasters, including pandemics. These measures capture variations in individual and household vulnerabilities at the county-level. The three measures examined include: (1) percent of residents in county with zero risk factors; (2) percent of residents in county with one to two risk factors; and (3) percent of residents in county with three or more risk factors. Simple logistic regression models were performed to examine the relationship between these three measures of community resiliency and facilities having any COVID-19 cases, any deaths, staff cases, staff death, resident cases, and resident deaths, respectively. Facilities in communities with higher percent of residents with three or more risk factors had lower odds of having any COVID-19 cases, staff cases, resident cases, and resident deaths ($p<0.05$). One explanation is that facilities in communities with more risk factors were more also likely to be located in rural areas with greater ability to decrease human encounters and prevent COVID-19 (see evidence below).

3.4 Facility-Level Factors

We explored facility-level factors to determine whether they were associated with facilities having any COVID-19 cases, any deaths, staff cases, staff death, resident cases, and resident deaths. Facility-level factors included measures of the service profile of the facility as well as the quality of care in the facility.

3.4.1 Service Profile

The service profile of the facility was measured using variables from the U.S. Centers for Medicare and Medicaid Services' Post-Acute Care and Hospice Provider Utilization and Payment Public Use Files. Measures of the service profile included the percent dual beneficiaries (i.e., Medicare and Medicaid) in the facility, the percent Black beneficiaries in the facility, the average Hierarchical Condition Category (HCC) risk score in the facility, and the average number of chronic conditions of facilities residents. Service profile data were available for a subset of facilities in our overall sample, which represented about 77 percent of the facilities in North Carolina and about 54 percent of facilities in South Carolina. The availability of data represents a limitation of the study.

3.4.1.1 *Percent Dual Beneficiaries*

The percent of dual beneficiaries in the facility is measured as the "percent of Medicare beneficiaries qualified to receive Medicare and Medicaid benefits. Beneficiaries are classified as Medicare and Medicaid entitlement if in any month in the given calendar year they were receiving full or partial Medicaid benefits." We used simple logistic regression models to explore the relationship between percent of dual beneficiaries in facilities and facilities having any COVID-19 cases, any COVID-19 deaths, staff cases, staff deaths, resident cases, and resident deaths. Facilities with higher percent dual beneficiaries had higher odds of having any COVID-19 cases, any COVID-19 deaths, staff cases, resident cases, and resident deaths ($p<0.05$). However, there was no relationship between percent dual beneficiaries in facilities and facilities having staff deaths.

3.4.1.2 *Percent Black Beneficiaries*

Percent Black beneficiaries in the facility is measured as "percent of beneficiaries who are non-Hispanic Black or African American." We used simple logistic regression models to explore the relationship between percent Black beneficiaries in facilities and facilities having any COVID-19 cases, any COVID-19 deaths, staff cases, staff deaths, resident cases, and resident deaths. Facilities with higher percent Black beneficiaries had higher odds of having any COVID-19 cases, any COVID-19 deaths, staff cases, staff deaths, resident cases, and resident deaths ($p<0.05$).

3.4.1.3 *Average Hierarchical Condition Category (HCC) Risk Score*

Hierarchical Condition Category (HCC) coding is a risk adjustment model designed by the U.S. Centers for Medicare and Medicaid Services to estimate health care costs for patients. The model uses ICD-10 coding to assign risk scores to patients; higher risk scores typically represent patients who have more complex health conditions and higher expected health care costs. We used simple logistic regression models to explore the relationship between average HCC risk scores and facilities having any COVID-19 cases, any COVID-19 deaths, staff cases, staff deaths, resident cases, and resident deaths. Facilities with residents with higher average HCC risk scores had higher odds of having any COVID-19 cases, any COVID-19 deaths, staff cases, resident cases, and resident deaths ($p<0.05$). However, there was no relationship between average HCC risk score among residents and facilities having staff deaths.

3.4.1.4 *Average Number of Chronic Conditions*

Average number of chronic conditions of residents was measured as the "average number of chronic conditions as determined by the 16 Chronic Conditions Data Warehouse (CCW) chronic conditions: atrial fibrillation, Alzheimer's, asthma, cancer (Includes breast cancer, colorectal cancer, lung cancer and prostate cancer), CHF, chronic kidney disease, COPD, depression, diabetes, hyperlipidemia, hypertension, IHD, osteoporosis, RA/OA, schizophrenia, and stroke". We used simple logistic regression models to explore the relationship between average number of chronic conditions and facilities having any COVID-19 cases, any COVID-19 deaths, staff cases, staff deaths, resident cases, and resident deaths. Facilities with higher average number of chronic conditions had higher odds of having any COVID-19 cases, any COVID-19 deaths, staff cases, resident cases, and resident deaths ($p<0.05$). However, there was no relationship between average number of chronic conditions among residents and facilities having staff deaths.

3.4.2 Quality of Care

The quality of care in the facility was measured using variables from the U.S. Centers for Medicare and Medicaid Services' Nursing Home Provider Information dataset. Measures of the quality of care in the facility explored included the overall five-star quality rating, health inspection rating, quality measure rating, long-stay quality measure rating, short-stay quality measure rating, staffing rating, Registered Nurse staffing rating, number of fines, total number of penalties, number of substantiated complaints, reported licensed staffing hours, reported total nurse staffing hours. Quality of care data were only available for skilled nursing facilities. Out of these types of facilities in our overall sample, the quality of care data represented about 97 percent of the facilities in North Carolina and about 46 of facilities in South Carolina. The availability of data in South Carolina represents a limitation of the study.

We ran simple logistic regressions to explore whether the quality of care in facilities was associated with facilities having any COVID-19 cases, any deaths, staff cases, staff death, resident cases, and resident deaths. Several measures of quality of care were not statistically or marginally significantly related to facilities having COVID-19 cases or deaths, overall, among staff, or among residents; these included: overall five-star quality rating, health inspection rating, short-stay quality measure rating, staffing rating, Registered Nurse staffing rating, number of fines, and total number of penalties. Thus, these measures were not further explored. Overall quality measure rating, total long-stay quality measure rating, number of substantiated complaints, reported licensed staffing hours, and reported total nurse staffing hours were associated with one or more of our outcome measures; these measures are presented below.

3.4.2.1 *Overall Quality Measure Rating*

Overall quality is measured using a five-star scale where 1 represents the lowest quality and 5 represents the highest quality; this measure is a summation of the total long-stay quality measure rating and the total adjusted short-stay quality measure rating (U.S. Centers for Medicare and Medicaid Services, 2021). In simple logistic regression models, facilities with higher quality measure ratings had lower odds of having any COVID-19 deaths and resident deaths than facilities with lower quality measure ratings ($p<0.05$). More than half of facilities with an overall quality measure rating of one had any COVID-19 deaths and resident deaths compared to less than 40 percent of facilities with overall quality measure ratings of two or more (see ***Figure 12***).

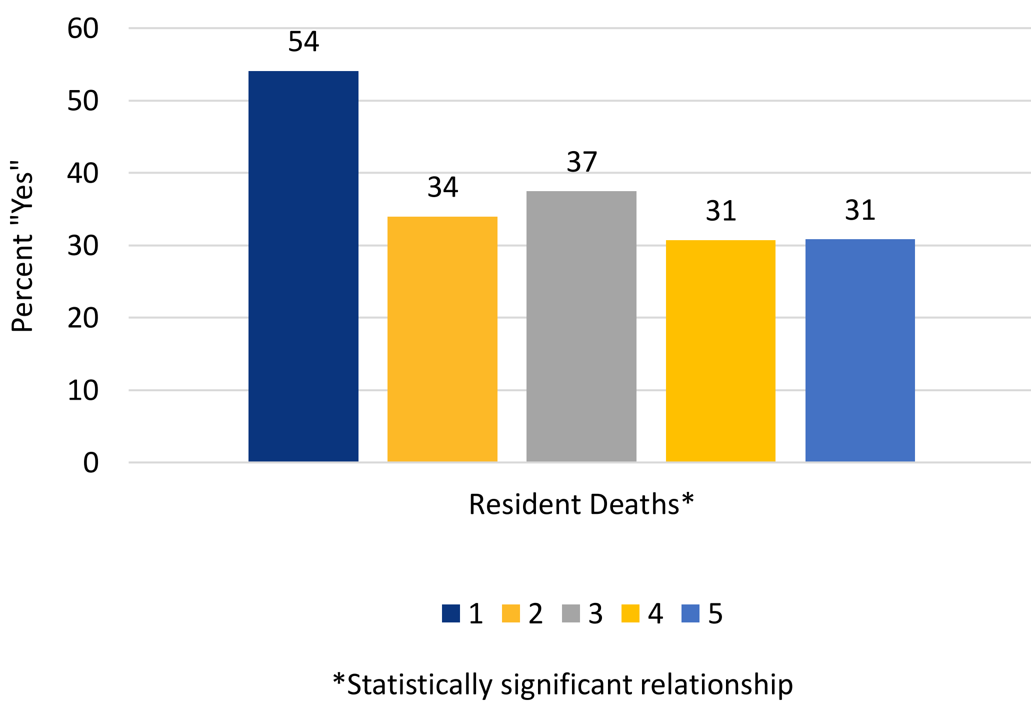


Figure 12. Percent of Facilities with COVID-19 Resident Deaths

by the Overall Quality Measure Rating

3.4.2.2 *Total Long-Stay Quality Measure Rating*

Long-stay is defined as "residents who are in the nursing home for greater than 100 days" (U.S. Centers for Medicare and Medicaid Services, 2021: 12). Long-stay quality is measured using a five-star scale where 1 represents the lowest quality and 5 represents the highest quality. In simple logistic regression models, facilities higher in long-stay quality measure ratings had higher odds of having staff deaths (statistically significant; $p<0.05$). Possible interpretations of these findings may be that staff are less compliant with safety protocols because (a) these facilities are understaffed, or (b) perhaps staff in these facilities get complacent because they have increased comfort after having long-term exposure to the same residents over time.

3.4.2.3 *Number of Substantiated Complaints*

Number of substantiated complaints is measured as the number of "substantiated findings from the most recent 36 months of complaint investigations" (U.S. Centers for Medicare and Medicaid Services, 2021: 1). In simple logistic regression models, facilities with higher number of substantiated complaints had statistically significantly lower odds of resident deaths ($p<0.05$). One interpretation of this finding is that facilities with substantiated complaints had recently experienced oversight in order to substantiate the complaints; therefore, they may have had stronger quality assurance procedures in place following the incidents.

3.4.2.4 *Licensed Staffing Hours*

Licensed staffing hours is reported per resident per day. In simple logistic regression models, facilities with higher reported licensed staffing hours had statistically significantly lower odds of having resident cases ($p<0.05$).

3.4.2.5 *Total Nurse Staffing Hours*

Total nursing staffing hours is measured as the reported "sum of RN, licensed practical nurse (LPN), and nurse aide hours per resident per day" (U.S. Centers for Medicare and Medicaid Services, 2021: 1). In simple logistic regression models, facilities with higher reported total nurse staffing hours had marginally lower odds of having resident cases ($0.05<p<0.10$).

3.5 Analysis of Multi-Level Factors Predicting Facilities with COVID-19 Cases and Deaths

The previous sections examined multi-level factors associated with facilities having any COVID-19 cases, any COVID-19 deaths, staff cases, staff deaths, resident cases, and resident deaths. Community- and facility-level factors that were associated with one or more of the outcome measures were considered for inclusion in multivariate models (see ***Table 7***).

Table 7. Factors Associated with Outcomes in Bivariate Analyses

Level	Concept	Variables
Community-Level Factors	Community spread of COVID-19	➢ COVID-19 cases per 10,000 population in the county
	Community adherence to COVID-19 policies and best practices	➢ Social distancing ➢ Reduction in average mobility ➢ Decrease in human encounters
	Community demographics	➢ Rural/urban status
	Community resiliency	➢ Percent of residents in the county with 3+ risk factors
Facility-Level Factors	Service profile of facilities	➢ Percent dual beneficiaries ➢ Percent Black beneficiaries ➢ Average Hierarchical Condition Category (HCC) risk score ➢ Average number of chronic conditions of residents
	Quality of care in facilities	➢ Overall quality measure rating ➢ Total long-stay quality measure rating ➢ Number of substantiated complaints ➢ Licensed staffing hours ➢ Total nurse staffing hours

We performed collinearity diagnostics to assess for multicollinearity between the independent variables (variance inflation factor > 2.50; correlation > 0.60) before making the final decision of which independent variables to retain in multivariate models. In the multicollinearity analyses, we identified a strong, positive correlation between average HCC risk score and percent dual beneficiaries. We also found a strong, positive correlation of score on the rural-urban continuum code with (a) decrease in human encounters, and (b) percent of residents in the county with three or more risk factors. Specifically, rural communities had greater ability to decrease human encounters, but less resiliency to recover from the impact of community disasters. We found that licensed staffing hours had a strong, positive relationship with total nurse staffing hours. Finally, we found a strong, positive relationship between overall quality measure rating and total long-stay quality measure rating. To address multicollinearity, we removed average HCC risk score, total nurse staffing hours, total long-stay quality measure rating, rural/urban location, and community resiliency from subsequent analyses.

We estimated mixed-effects logistic regression models to examine the relationship of the remaining factors in ***Table 7*** with each of the following outcomes: (1) facilities having staff cases, (2) facilities having resident cases, and

(3) facilities having resident deaths.[1] All models were three-level models with random intercepts for counties and states; in other words, the facilities were nested in community contexts (measured as counties) nested in state policy contexts (measures as states).

3.5.1 Regression Models with Community and Service Profile Factors

In the first set of models, we sought to include as many facilities as possible. Models included service profiles of the facilities and community-level factors because data were available for multiple types of facilities (N=661 facilities). Service profile variables included the percent dual beneficiaries, percent Black beneficiaries, and the average number of chronic conditions. Community-level variables included a measure of social distancing as well as a measure of community spread of COVID-19.

Factors that predicted whether or long-term care facilities had COVID-19 staff cases included: the percent dual beneficiaries, average number of chronic conditions, and social distancing (see ***Table 8***). Facilities with a higher percent of dual beneficiaries and residents with a higher average number of chronic conditions had higher odds of having staff with COVID-19 than facilities with lower percent of dual beneficiaries and residents with lower average number of chronic conditions – respectively. Although community spread of COVID-19 is statistically significant, it is not practically significant; the odds ratio of near 1 suggests that the effect is small when controlling for the other factors in the model. Facilities in communities with passing grades for decreasing human encounters had lower odds of having staff with COVID-19 than facilities in communities with failing grades.

Two takeaways are key here. First, an interpretation of the service profile findings is that staff caring for the most vulnerable individuals (i.e., those who are poor and have multiple comorbidities) are the ones most likely to bring COVID-19 into facilities. This is concerning because these are the populations which theoretically need most protection from COVID-19. Policy implications are to deploy resources to the most vulnerable groups and facilities and the need for targeted mitigation strategies to address deficiencies in facilitates.

Second, an interpretation of the community-level findings is that staff practicing social distancing outside of work is important for reducing the likelihood of bringing COVID-19 into facilities. Taken together, it is pivotal to encourage staff to engage in preventive measures both at work and in the community. This includes engaging in campaigns and providing incentive programs for staff to get COVID-19 vaccinations, engage in social distancing, wear masks, and hand wash. This also highlights the importance of state policymaking to prioritize staff vaccination along with resident vaccination.

[1] We did not run regression models examining facilities having staff deaths because of the low N.

Table 8. **Factors Associated with Long-Term Care Facilities Having COVID-19 Staff Cases**

Variables	Odds Ratio	Std. Error	p-value	95% Confidence Interval		
Service Profile						
Percent dual beneficiaries	7.638	5.623	0.006***	1.804	-	32.335
Percent Black beneficiaries	0.202	0.170	0.057	0.039	-	1.049
Average number of chronic conditions	7.205	1.606	<0.001***	4.654	-	11.152
Community Factors						
Passing grade for decrease in human encounters (Reference category=failing grade)	0.608	0.146	0.038***	0.380	-	0.972
COVID-19 cases per 10,000 population in the county	1.004	0.001	0.005***	1.001	-	1.007

*p<0.10 **p<0.05 *** p<0.01

Factors that predicted whether or long-term care facilities had COVID-19 resident cases and deaths included: the percent dual beneficiaries, average number of chronic conditions, and social distancing (see ***Tables 9 and 10***). As in the previous model, facilities with a higher percent of dual beneficiaries and residents with a higher average number of chronic conditions had higher odds of having resident cases and deaths. Note that community spread of COVID-19 was not significant in either of these models. Yet, facilities in communities with passing grades for decreasing human encounters had lower odds of having resident cases and deaths. We also ran models that included the same variables as in ***Tables 9 and 10***, but also added in staff cases (data not shown); in the model predicting resident deaths, staff cases and social distancing were the only predictors of resident deaths. Facilities with staff cases had higher odds of having resident deaths, and facilities in communities practicing social distancing had lower odds of having resident deaths.

Table 9. **Factors Associated with Long-Term Care Facilities Having COVID-19 Resident Cases**

Variables	Odds Ratio	Std. Error	p-value	95% Confidence Interval		
Service Profile						
Percent dual beneficiaries	11.637	8.346	0.001***	2.853	-	47.458
Percent Black beneficiaries	0.484	0.387	0.364	0.101	-	2.315
Average number of chronic conditions	5.169	1.089	<0.001***	3.420	-	7.812
Community Factors						
Passing grade for decrease in human encounters (Reference category=failing grade)	0.604	0.134	0.023***	0.391	-	0.933
COVID-19 cases per 10,000 population in the county	1.000	0.002	0.821	0.997	-	1.004

*p<0.10 **p<0.05 *** p<0.01

Table 10. **Factors Associated with Long-Term Care Facilities Having COVID-19 Resident Deaths**

Variables	Odds Ratio	Std. Error	p-value	95% Confidence Interval		
Service Profile						
Percent dual beneficiaries	7.459	5.436	0.006***	1.788	-	31.121
Percent Black beneficiaries	0.814	0.669	0.802	0.162	-	4.077
Average number of chronic conditions	3.353	0.735	<0.001***	2.183	-	5.152
Community Factors						

Passing grade for decrease in human encounters (Reference category=failing grade)	0.526	0.118	0.004***	0.339	-	0.817
COVID-19 cases per 10,000 population in the county	1.001	0.002	0.510	0.998	-	1.005

*p<0.10 **p<0.05 *** p<0.01

3.5.2 Regression Models with Community, Service Profile, and Quality of Care Factors

In the second set of models, we included quality of care of the facilities, service profiles of the facilities, and community-level factors as predictors. Since quality of care data were only available for skilled nursing facilities, the number of facilities in the second set of models is smaller than the number of facilities in the first set of models (N=387). Quality of care variables included overall quality measure rating and licensed staffing hours. Service profile variables included the percent dual beneficiaries, percent Black beneficiaries, and the average number of chronic conditions. Community-level variables included a measure of social distancing as well as a measure of community spread of COVID-19.

In the models in the previous section, factors that predicted whether or long-term care facilities had COVID-19 staff cases included: percent dual beneficiaries, average number of chronic conditions, and social distancing (see ***Table 8***). Yet, when we control for the quality of care of the facilities, percent dual beneficiaries, average number of chronic conditions, and social distancing are no longer statistically significant (see ***Table 11***). Community spread of COVID-19 remains statistically significant but is not practically significant; the odds ratio of near 1 suggests that the effect is small when controlling for the other factors in the model. When controlling for the quality of care in the facility, licensed staffing hours is marginally significantly associated with skilled nursing facilities having staff cases. Skilled nursing facilities that have higher licensed staffing hours per resident per day have lower odds of having staff cases. One interpretation is that understaffing may lead to staff rushing and taking unnecessary risks, including regarding preventive and safety measures for COVID-19. This emphasizes the importance of remaining appropriate staffing levels and avoiding understaffing during biological threats. A policy implication is to create strong staff incentives for job retention, hazard exposures, and staying home when ill.

Table 11. Factors Associated with Skilled Nursing Facilities Having COVID-19 Staff Cases

Variables	Odds Ratio	Std. Error	p-value	95% Confidence Interval		
Quality of Care of Facilities						
Overall quality measure rating	1.081	0.121	0.484	0.869	-	1.346
Licensed staffing hours	0.534	0.179	0.061*	0.277	-	1.030
Service Profile						
Percent dual beneficiaries	0.385	0.372	0.323	0.058	-	2.557
Percent Black beneficiaries	1.578	1.609	0.655	0.214	-	11.651
Average number of chronic conditions	1.527	0.474	0.173	0.831	-	2.807
Community Factors						
Passing grade for decrease in human encounters (Reference category=failing grade)	0.761	0.223	0.351	0.429	-	1.351
COVID-19 cases per 10,000 population in the county	1.005	0.002	0.004***	1.002	-	1.009

*p<0.10 **p<0.05 *** p<0.01

In the model in the previous section, factors that predicted whether or long-term care facilities had COVID-19 resident cases included: the percent dual beneficiaries, average number of chronic conditions, and social distancing (see ***Table 9***). When controlling for quality of care of facilities, these factors are no longer statistically significant, yet licensed staffing hours is marginally significantly associated with facilities having resident cases. Skilled nursing facilities that have higher licensed staffing hours per resident per day have lower odds of having resident cases (see ***Table 12***). This finding is not surprising because staffing cases drive resident cases, and understaffing was a main predictor in the model predicting staffing cases.

Table 12. Factors Associated with Skilled Nursing Facilities Having COVID-19 Resident Cases

Variables	Odds Ratio	Std. Error	p-value	95% Confidence Interval		
Quality of Care of Facilities						
Overall quality measure rating	0.957	0.100	0.676	0.780	-	1.175
Licensed staffing hours	0.552	0.177	0.063*	0.294	-	1.034
Service Profile						
Percent dual beneficiaries	0.620	0.556	0.594	0.107	-	3.600
Percent Black beneficiaries	3.055	2.880	0.236	0.481	-	19.388
Average number of chronic conditions	1.373	0.392	0.267	0.785	-	2.402
Community Factors						
Passing grade for decrease in human encounters (Reference category=failing grade)	0.698	0.179	0.161	0.422	-	1.154
COVID-19 cases per 10,000 population in the county	1.001	0.002	0.580	0.997	-	1.005

*p<0.10 **p<0.05 *** p<0.01

In the models in the previous section, factors that predicted whether or long-term care facilities had COVID-19 resident deaths included: the percent dual beneficiaries, average number of chronic conditions, and social distancing (see ***Table 10***). When controlling for quality of care of facilities, percent dual beneficiary and average number of chronic conditions are no longer statistically significant, yet social distancing remains statistically significant. Skilled nursing facilities in communities with passing grades for decreasing human encounters had lower odds of having resident deaths (see ***Table 13***).

An interpretation of this finding has to do with the differences in policies and related outcomes in North and South Carolina. These states have a statistically significant difference in grade for decreasing human encounters; 66 percent of facilities in South Carolina are in communities with failing grades for decreasing human encounters compared to 48 percent of facilities in North Carolina (X^2 (1, N = 1,357) = 44.097, p = <0.001). The policies guiding COVID-19 preventive measures was different in these states, with North Carolina providing stricter policies limiting mass gatherings and guidance on outdoor nursing home visitation (see *Section 3.2*). Taken together with the regression findings, a recommendation is to provide universal mandates modeled by leadership at all levels of government. Consistent messaging and recommendation may help build community trust and foster adherence.

Table 13. Factors Associated with Skilled Nursing Facilities Having COVID-19 Resident Deaths

Variables	Odds Ratio	Std. Error	p-value	95% Confidence Interval
Quality of Care of Facilities				
Overall quality measure rating	0.861	0.090	0.152	0.702 - 1.057
Licensed staffing hours	0.704	0.232	0.288	0.369 - 1.344
Service Profile				
Percent dual beneficiaries	0.749	0.663	0.744	0.132 - 4.242
Percent Black beneficiaries	2.447	2.268	0.334	0.398 - 15.051
Average number of chronic conditions	1.003	0.290	0.991	0.570 - 1.768
Community Factors				
Passing grade for decrease in human encounters (Reference category=failing grade)	0.548	0.140	0.018***	0.333 - 0.904
COVID-19 cases per 10,000 population in the county	1.002	0.002	0.259	0.998 - 1.006

*p<0.10 **p<0.05 *** p<0.01

4. Results from Stakeholder Advisory Board

We scheduled three Stakeholder Advisory Board (SAB) meetings, one for November 2020 and two for December 2020. We developed slides and activities to guide discussion for all three SAB meetings.

4.1 Results from First Meeting

The purpose of the first SAB meeting was to introduce SAB members; provide an overview of the project and overall approach, datasets, and variables; and better understand the context that SAB members are experiencing within their communities and partner facilities. Discussion raised by SAB members centered around four key themes: community spread, patient advocacy, testing, and infection control (see *Table 14*). Results from the first SAB meeting included useful feedback that informed the expansion of our variables and datasets used. For example, the discussion of a lack of consistent cleaning led us to explore health inspection rating of the facilities in additional analyses.

Table 14. Key Takeaways from First Meeting

Community Spread:

- Concerns COVID-19 spreading in nursing homes via family members coming in
- Concerns staff are bringing COVID-19 into facilities
- Concerns about community "attitude", with some areas of the community not taking COVID-19 seriously and not observing CDC guidelines to reduce incidence of COVID-19 spread
- Inconsistency among houses of worship, with some having video service and some having full services with lack of attention to CDC recommended guidelines

Patient Advocacy:

- Community advocates for this population report challenges in getting into facilities and facilitating COVID-19 information with families
- Concerns about patient rights and quality of life issues regarding visitation and contact
- Questions about different methods to facilitate contact between residents and their families (e.g., tablets)
- Some residents with COVID-19 transferred to other facilities – leaving families, induces trauma
- Concerns that residents may not self-advocate to avoid "making waves"

Testing:

- Concern that people getting screened on "suspicion" of risk based on screening questions, which may miss asymptomatic and pre-symptomatic cases
- Concerns of no mandate for nursing home testing if there are no symptoms

Infection Control:

- Concerns about lack of consistent cleaning
- Concerns of consistent availability of personal protective equipment and supplies

4.2 Results from Second Meeting

The second SAB meeting focused on reviewing preliminary results; brainstorming the interpretation and implications of preliminary results; brainstorming additional analyses to complete; and brainstorming relevant audiences and the most helpful deliverable formats. For preliminary results, we discussed differences between the percent of facilities with COVID cases and deaths between NC and SC; the impact of quality of care / star ratings on facilities with COVID cases and deaths; the impact of the care setting / resident characteristics on facilities with COVID cases and deaths; and the impact of community spread and social distancing on facilities with COVID cases and deaths. Results from the second SAB meeting included useful feedback on the interpretation of the preliminary findings and additional variables to consider including in additional analyses; and feedback that an issue brief would be a useful deliverable format (see ***Table 15***). Based on these recommendations, we drafted an issue brief displaying key findings and preliminary recommendations for review during the third meeting of the SAB.

Table 15. **Key Takeaways from Second Meeting**

Interpretation of Analyses / Hypothesized Explanations of Results:

- Is COVID-19 politicized?
- Urban/rural differences?
- Smart tablets / technology availability
- Staff not wearing masks correctly-infection control issue
- Need more signs
- People are getting comfortable, letting their guard down
- Dual beneficiaries mirroring what's in community data

Staffing:

- Staffing very hard to manage - not sure how to limit staff activities outside of facilities
- Higher quality = higher incidence of deaths - size of facility, more staff?
- Staff with longer tenure, more comfortable, more time with residents, more time for virus exposure?

Recommended Deliverables:

- Issue Brief / pamphlet
- Infographics

4.3 Results from Third Meeting

The third SAB focused on presenting a draft issue brief for review and feedback; brainstorming additional actionable recommendations; and identifying additional methods of dissemination. Results of the third SAB meeting were useful feedback on the issue brief's organization, format, and content; feedback to disseminate the issue brief electronically to facility leadership and other key stakeholders; and feedback that a webinar would be another helpful deliverable format for facility leadership and other key stakeholders (see ***Table 16***). We discussed additional opportunities to develop a manuscript from the project and invited the SAB members to be co-authors on the manuscript.

Table 16. Key Takeaways from Third Meeting

Support for Policies:

- Inconsistent support locally and nationally - some support COVID-19 measures and others do not
- Public support for policies impact acceptance of policy measures and vaccine uptake
- Concern with lack of supportive services and leadership at various public health departments

Recommended Changes to Issue Brief Deliverable:

- Different layout/content options can be geared towards different audiences
- Balance of easy to read plus enough scientific data to build credibility
- Dissemination plan should include providers on the front lines and leaders in long-term and health and human services organizations
- Mix of interest for quick read with graphic representations to more text rich presentation
- Recommended page length varied from 2 to 4
- Emphasis on content and deliverables that are "functional, practical, and usable"
- Title should be short and to the point
- Call out boxes were suggested to balance content with recommendations

Additional Recommended Deliverable:

- Webinar

5. Dissemination of Results

5.1 Dissemination Strategy

Our dissemination strategy involves creating deliverables in multiple formats for multiple audiences. This strategy is outlined in ***Table 17*** and described in greater detail in the sections below.

Table 17. Dissemination Strategy

Deliverable Format	Primary Audience				
	Public	Academic Scholars	Health Policy Analysts / Decision-makers	Facility Admin./Staff	Advocates for Older Adults
➢ News release	✓				
➢ Conference presentations		✓	✓		
➢ Manuscripts		✓			
➢ Issue brief			✓	✓	✓
➢ Webinar			✓	✓	✓

5.2 Deliverable for the Public

We collaborated with the university to develop a news release on our project (see ***Appendix E*** for the news release). The news release was featured on the home page of the NC A&T State University website (see ***Figure 13*** for screenshot).

Figure 13. Screenshot of NC A&T University Website Home Page Featuring Study

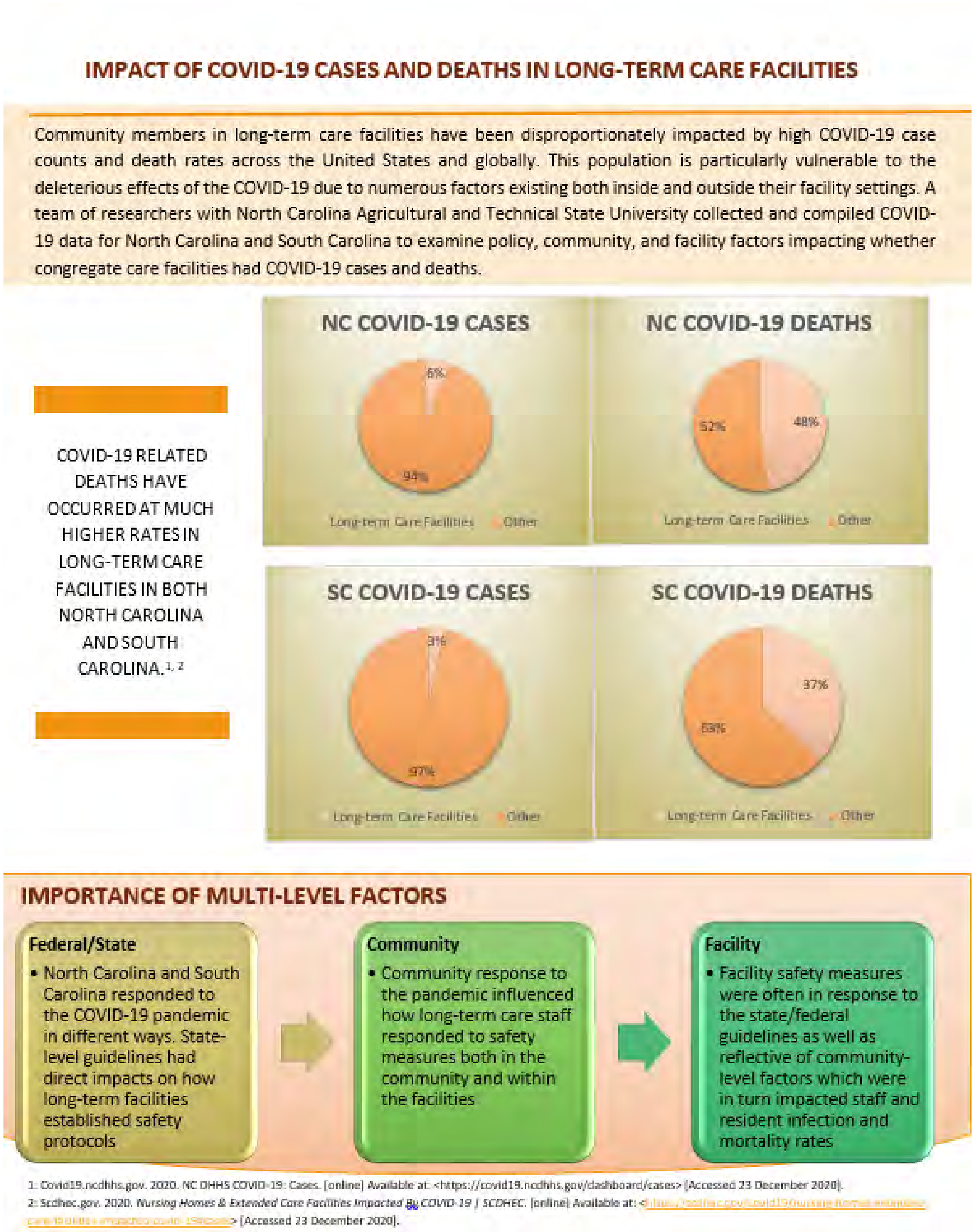
5.3 Deliverables for Academic Scholars and Health Policy Analysts

We submitted abstracts to present our work at two academic conferences. To reach scholars and clinical practitioners focusing on the interventions to improve health outcomes, we submitted an abstract to present at the annual meeting of AcademyHealth. To reach scholars focusing on social determinants of health within the State of North Carolina, we also submitted an abstract to present at the annual meeting of the North Carolina Sociological Association.

We are also working to transform the content of our final report for the NC Policy Collaboratory into scholarly journal articles. One of the target journals will be the *Journals of Gerontology,* which is organizing a special issue on “COVID-19 and Aging 2.0”.

5.4 Deliverables for Facility Administrators, Staff and Advocates for Older Adults, and Health Policy Decision-makers

The Stakeholder Advisory Board (SAB) recommended that we develop an issue brief that could be electronically disseminated to key stakeholders throughout the state, including facility administrators and staff, advocates for older adults, and decision-makers. We developed an issue brief, reviewed the issue brief with SAB members to obtain feedback, and then revised the issue brief content and format to address feedback received. *Figure 14* presents the working version of the issue brief. Several SAB members have offered to help us disseminate the issue brief within their professional networks. In our last SAB meeting, SAB members recommended that we offer a webinar highlighting key findings. We will advertise the webinar through similar methods as the issue brief.



IMPACT OF COVID-19 CASES AND DEATHS IN LONG-TERM CARE FACILITIES

Community members in long-term care facilities have been disproportionately impacted by high COVID-19 case counts and death rates across the United States and globally. This population is particularly vulnerable to the deleterious effects of the COVID-19 due to numerous factors existing both inside and outside their facility settings. A team of researchers with North Carolina Agricultural and Technical State University collected and compiled COVID-19 data for North Carolina and South Carolina to examine policy, community, and facility factors impacting whether congregate care facilities had COVID-19 cases and deaths.

COVID-19 RELATED DEATHS HAVE OCCURRED AT MUCH HIGHER RATES IN LONG-TERM CARE FACILITIES IN BOTH NORTH CAROLINA AND SOUTH CAROLINA.[1, 2]

IMPORTANCE OF MULTI-LEVEL FACTORS

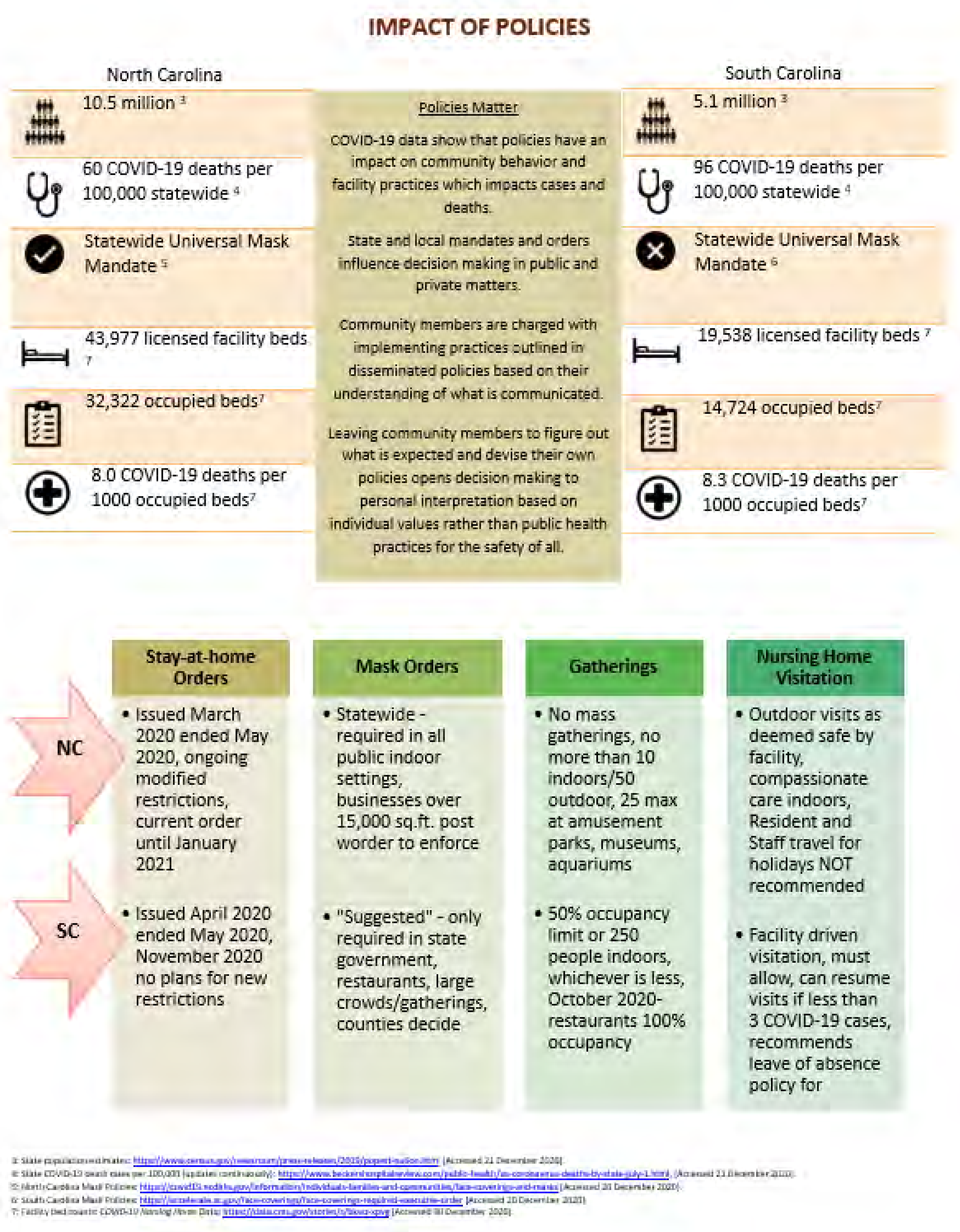
Federal/State
- North Carolina and South Carolina responded to the COVID-19 pandemic in different ways. State-level guidelines had direct impacts on how long-term facilities established safety protocols

Community
- Community response to the pandemic influenced how long-term care staff responded to safety measures both in the community and within the facilities

Facility
- Facility safety measures were often in response to the state/federal guidelines as well as reflective of community-level factors which were in turn impacted staff and resident infection and mortality rates

1: Covid19.ncdhhs.gov. 2020. *NC DHHS COVID-19: Cases*. [online] Available at: <https://covid19.ncdhhs.gov/dashboard/cases> [Accessed 23 December 2020].
2: Scdhec.gov. 2020. *Nursing Homes & Extended Care Facilities Impacted By COVID-19 | SCDHEC*. [online] Available at: <[illegible]> [Accessed 23 December 2020].

Figure 14. Issue Brief: Page 1



IMPACT OF POLICIES

North Carolina	South Carolina
10.5 million [3]	5.1 million [3]
60 COVID-19 deaths per 100,000 statewide [4]	96 COVID-19 deaths per 100,000 statewide [4]
Statewide Universal Mask Mandate [5] (yes)	Statewide Universal Mask Mandate [6] (no)
43,977 licensed facility beds [7]	19,538 licensed facility beds [7]
32,322 occupied beds[7]	14,724 occupied beds[7]
8.0 COVID-19 deaths per 1000 occupied beds[7]	8.3 COVID-19 deaths per 1000 occupied beds[7]

Policies Matter

COVID-19 data show that policies have an impact on community behavior and facility practices which impacts cases and deaths.

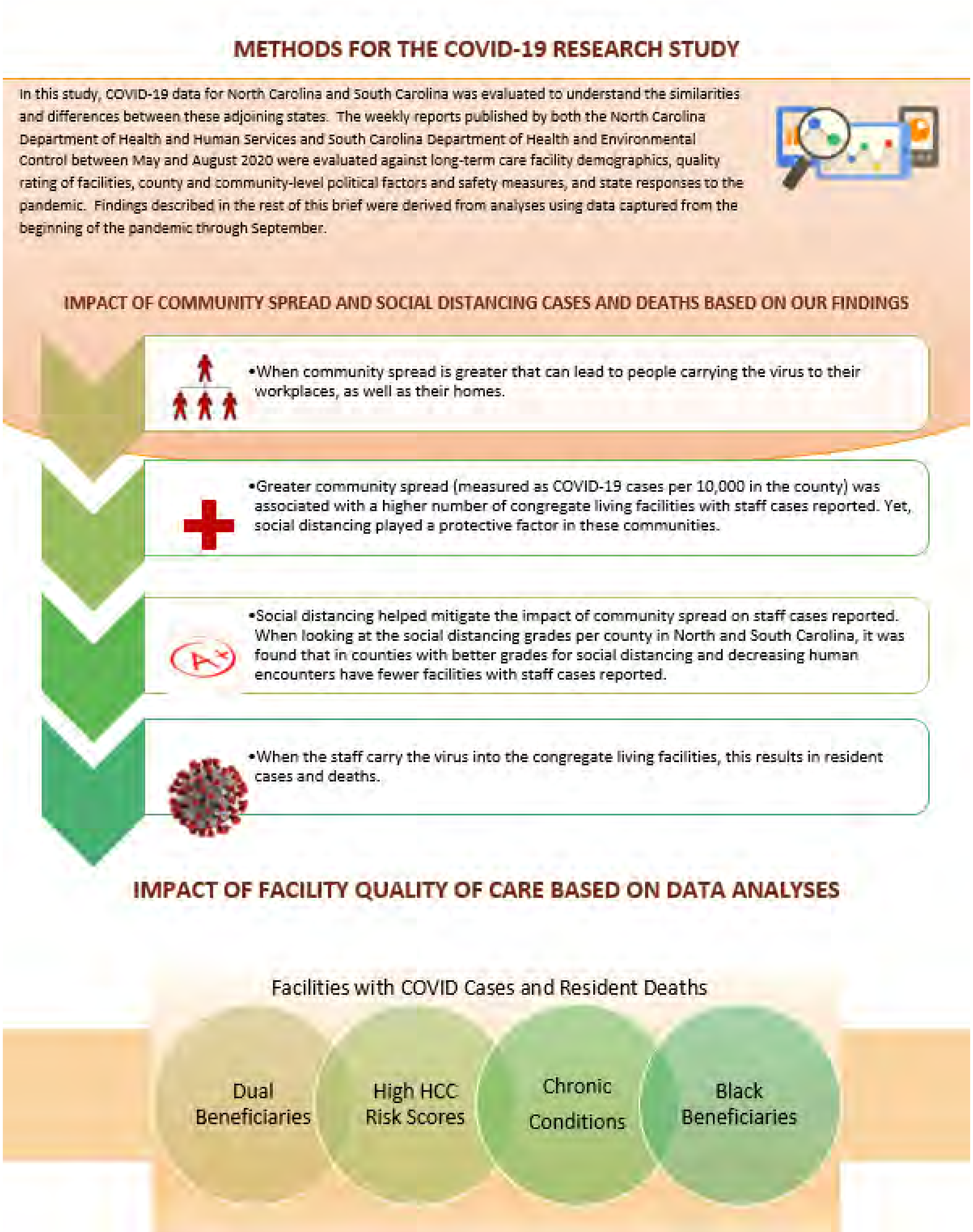
State and local mandates and orders influence decision making in public and private matters.

Community members are charged with implementing practices outlined in disseminated policies based on their understanding of what is communicated.

Leaving community members to figure out what is expected and devise their own policies opens decision making to personal interpretation based on individual values rather than public health practices for the safety of all.

	Stay-at-home Orders	Mask Orders	Gatherings	Nursing Home Visitation
NC	• Issued March 2020 ended May 2020, ongoing modified restrictions, current order until January 2021	• Statewide - required in all public indoor settings, businesses over 15,000 sq.ft. post worder to enforce	• No mass gatherings, no more than 10 indoors/50 outdoor, 25 max at amusement parks, museums, aquariums	• Outdoor visits as deemed safe by facility, compassionate care indoors, Resident and Staff travel for holidays NOT recommended
SC	• Issued April 2020 ended May 2020, November 2020 no plans for new restrictions	• "Suggested" - only required in state government, restaurants, large crowds/gatherings, counties decide	• 50% occupancy limit or 250 people indoors, whichever is less, October 2020- restaurants 100% occupancy	• Facility driven visitation, must allow, can resume visits if less than 3 COVID-19 cases, recommends leave of absence policy for

Figure 14. Issue Brief (continued): Page 2



METHODS FOR THE COVID-19 RESEARCH STUDY

In this study, COVID-19 data for North Carolina and South Carolina was evaluated to understand the similarities and differences between these adjoining states. The weekly reports published by both the North Carolina Department of Health and Human Services and South Carolina Department of Health and Environmental Control between May and August 2020 were evaluated against long-term care facility demographics, quality rating of facilities, county and community-level political factors and safety measures, and state responses to the pandemic. Findings described in the rest of this brief were derived from analyses using data captured from the beginning of the pandemic through September.

IMPACT OF COMMUNITY SPREAD AND SOCIAL DISTANCING CASES AND DEATHS BASED ON OUR FINDINGS

- When community spread is greater that can lead to people carrying the virus to their workplaces, as well as their homes.
- Greater community spread (measured as COVID-19 cases per 10,000 in the county) was associated with a higher number of congregate living facilities with staff cases reported. Yet, social distancing played a protective factor in these communities.
- Social distancing helped mitigate the impact of community spread on staff cases reported. When looking at the social distancing grades per county in North and South Carolina, it was found that in counties with better grades for social distancing and decreasing human encounters have fewer facilities with staff cases reported.
- When the staff carry the virus into the congregate living facilities, this results in resident cases and deaths.

IMPACT OF FACILITY QUALITY OF CARE BASED ON DATA ANALYSES

Facilities with COVID Cases and Resident Deaths

Dual Beneficiaries

High HCC Risk Scores

Chronic Conditions

Black Beneficiaries

Figure 14. Issue Brief (continued): Page 3

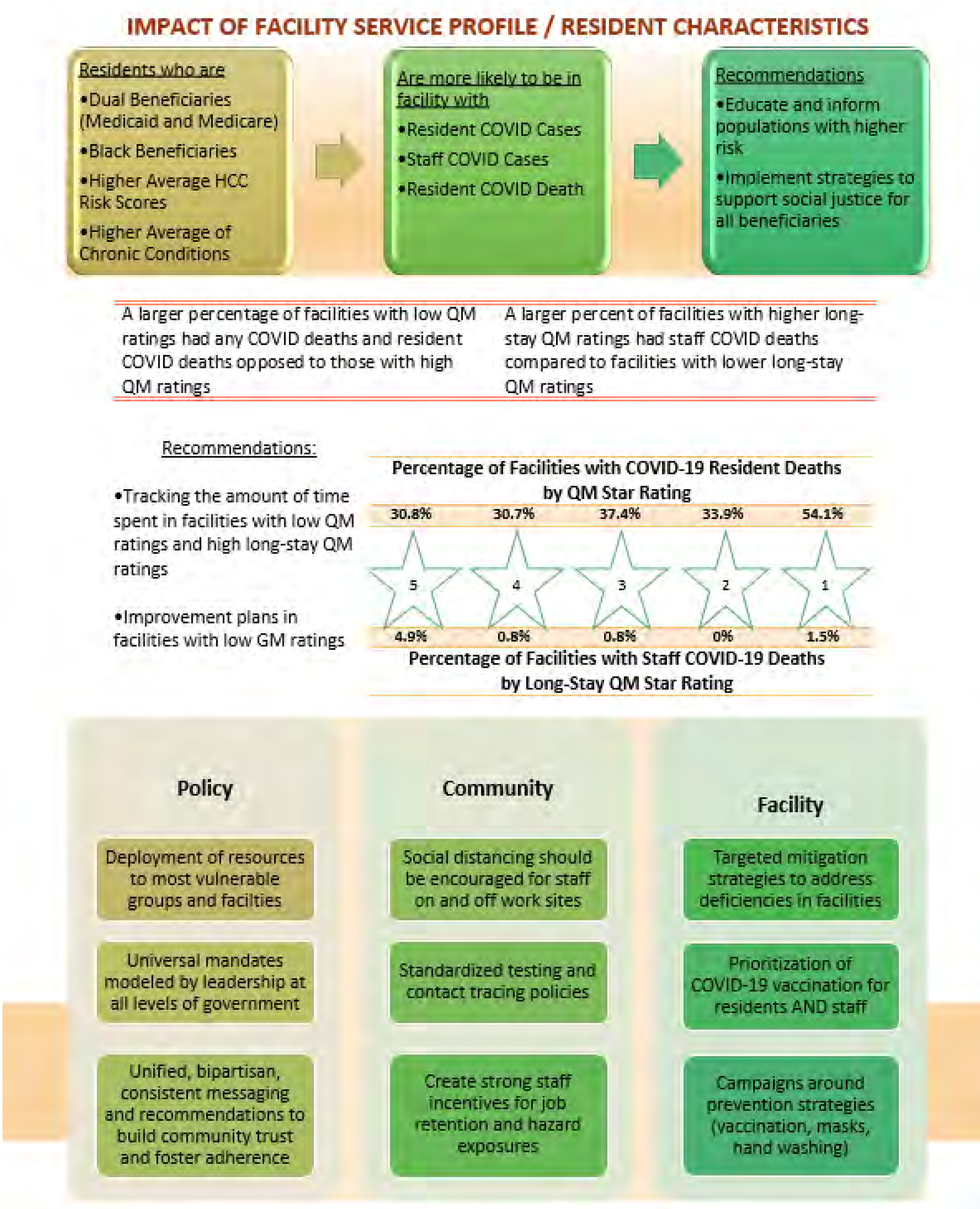


Figure 14. Issue Brief (continued): Page 4

6. Conclusion

Our research objective was to examine policy, community, and facility determinants of long-term care facilities having COVID-19 cases and deaths. Community members in long-term care facilities have been disproportionately impacted by high COVID-19 cases and deaths across the United States. This population is particularly vulnerable to the effects of COVID-19 due to existing health conditions and social determinants of health including policies, exposure within the community, built environment, quality of health care, and socioeconomic conditions.

Using a multi-layered approach, this project examined North and South Carolina policy, community, and facility data to understand some of the root causes of this health inequity. Our research questions were: What policy-, community-, and facility-level factors predict whether or not long-term care facilities have COVID-19 cases and deaths? What are actionable strategies that can be implemented to mitigate COVID-19 cases and deaths in long-term care facilities? To answer these questions, we conducted bivariate analyses and multivariate regression analyses using data compiled from existing federal, state, and mobility secondary data sources. Policy-level variables included stay-at-home orders, mask orders, gatherings, and nursing home visitation. Community-level variables included community spread of COVID-19, community adherence to COVID-19 policies and best practices, community demographics, community political climate, and community resiliency. Facility-level variables included the service profile of facilities and quality of care in facilities.

Findings show that North Carolina had a smaller percentage of long-term care facilities with COVID-19 cases and deaths than South Carolina. Forty-nine percent of long-term care facilities in North Carolina had any COVID-19 cases compared to 60 percent of long-term care facilities in South Carolina. North Carolina and South Carolina responded to the pandemic in different ways, including policies regarding stay-at-home orders, whether masks were required or suggested in different settings, limitations on community mass gatherings, limitations on visitations with residents in facilities, and recommendations on resident and staff travel for holidays. Additional community- and facility-level factors that impacted facilities having COVID-19 cases and deaths included having more vulnerable residents in the facilities (e.g., poorer, multiple comorbidities), understaffing facilities, and being in communities that fail to social distancing.

Following a community-based participatory research approach, a Stakeholder Advisory Board provided feedback on findings, outlined points of advocacy for their constituents, and helped developed recommendations to mitigate COVID-19 cases and deaths. Discussions of findings emphasize the need for a multi-prong policy approach to mitigate the impact of these factors on COVID-19 cases and deaths. Policy-level recommendations include: (1) deploying resources to the most vulnerable groups and facilities; (2) providing universal mandates modeled by leadership at all levels of government; and (3) providing consistent messaging and recommendation to help build community trust and foster adherence. Community-level recommendations include: (1) encouraging social distancing for staff on and off work sites; (2) standardizing testing and contract policies; and (3) creating strong staff incentives for job retention, hazard exposures, and staying home when ill. Facility-level recommendations include (1) targeting mitigation strategies to address deficiencies in facilities; (2) prioritizing staff vaccination along with resident vaccination (along with supporting state and facility policies); and (3) engaging in campaigns and providing incentive programs for staff to get COVID-19 vaccinations, engage in social distancing, wear masks, and wash hands.

References

Bargain, Olivier and Ulugbek Aminjonov. 2020. “Trust and Compliance to Public Health Policies in Times of Covid-19.” *Journal of Public Economics* 192.

Bernabeu-Wittel M, J.E. Ternero-Vega, P. Díaz-Jiménez, C. Conde-Guzmán, M. D. Nieto-Martín, L. Moreno-Gaviño, J. Delgado-Cuesta, M. Rincón-Gómez, L. Giménez-Miranda, M.D. Navarro-Amuedo, M.M. Muñoz-García, S. Calzón-Fernández, and M. Ollero-Baturone. 2020. “Death Risk Stratification in Elderly Patients with Covid-19. a Comparative Cohort Study in Nursing Homes Outbreaks.” *Archives of Gerontology and Geriatrics* 91.

Bigelow, Benjamin F et al. 2020. “Transmission of SARS-CoV-2 Involving Residents Receiving Dialysis in a Nursing Home - Maryland, April 2020.” *MMWR. Morbidity and mortality weekly report.* 69 (32) 1089-1094. doi:10.15585/mmwr.mm6932e4

Bui, David P. et al. 2020. “Association Between CMS Quality Ratings and COVID-19 Outbreaks in Nursing Homes — West Virginia, March 17–June 11, 2020.” *Morbidity and Mortality Weekly Report*. 69 (37) 1300–1304. , doi:10.15585/mmwr.mm6937a5

Callahan, Alison, Ethan Steinberg, Jason A. Fries, Saurabh Gombar, Birju Patel, Conor K. Corgin, and Nigam H. Shal. 2020. “Estimating the Efficacy of Symptom-Based Screening for Covid-19.” Npj Digital Medicine 3:95–95.

Campbell-Enns, Heather J., Megan Campbell, Kendra L. Rieger, Genevieve N. Thompson, and Malcolm B. Doupe. 2020. “No Other Safe Care Option: Nursing Home Admission As a Last Resort Strategy.” *Gerontologist* 60(8):1504–14.

Centers for Disease Control 2020. “Considerations for Restaurant and Bar Operators.” Retrieved December 29, 2020 (https://www.cdc.gov/coronavirus/2019-ncov/community/organizations/business-employers/bars-restaurants.html).

D'Adamo, Heather, Thomas Yoshikawa, and Joseph G. Ouslander. 2020. “Coronavirus Disease 2019 in Geriatrics and Long-Term Care: The Abcds of Covid-19.” *Journal of the American Geriatrics Society* 68(5):912–17..

Gustavsson, Johanna and Linda Beckman. 2020. “Compliance to Recommendations and Mental Health Consequences among Elderly in Sweden during the Initial Phase of the Covid-19 Pandemic-A Cross Sectional Online Survey.” *International Journal of Environmental Research and Public Health* 17(15).

Hatfield, Kelly M. et al. 2020. “Facility-Wide Testing for SARS-CoV-2 in Nursing Homes — Seven U.S. Jurisdictions, March–June 2020.” *MMWR. Morbidity and Mortality Weekly Report* 69(32):1095–99.

Houghton, Catherine et al. 2020. “Barriers and Facilitators to Healthcare Workers’ Adherence with Infection Prevention and Control (IPC) Guidelines for Respiratory Infectious Diseases: a Rapid Qualitative Evidence Synthesis.” *Cochrane Database of Systematic Reviews.*

Hsiehchen D, M. Espinoza, and P. Slovic. 2020. “Political Partisanship and Mobility Restriction during the Covid-19 Pandemic.” *Public Health* 187:111–14.

Kimball A et al. 2020. “Asymptomatic and Presymptomatic Sars-Cov-2 Infections in Residents of a Long-Term Care Skilled Nursing Facility — King County, Washington, March 2020.” *Mmwr. Morbidity and Mortality Weekly Report* 69(13):377–81.

Krueger, Richard A. and Mary Anne Casey. 2015. *Focus Groups : A Practical Guide for Applied Research*. 5th ed. Thousand Oaks, California: SAGE.

Li, Ping, Lulu Chen, Zheming Liu, Jinghui Pan, Dingyi Zhou, Hui Wang, Hongyun Gong, Zhenmin Fu, Qibin Song, Qian Min, Shasha Ruan, Tangpeng Xu, Fan Cheng, and Ziangpan Li. 2020. “Clinical Features and Short-Term Outcomes of Elderly Patients with Covid-19.” *International Journal of Infectious Diseases* 97:245–50.

McMichael, Temet M. et al. 2020. "Epidemiology of Covid-19 in a Long-Term Care Facility in King County, Washington." *New England Journal of Medicine* 382(21):2008–11.

North Carolina Department of Health and Human Services. 2020a. "COVID-19 North Carolina Dashboard". Retrieved December 20, 2020 (https://covid19.ncdhhs.gov/dashboard).

North Carolina Department of Health and Human Services. 2020b. "COVID-19 Outbreak Toolkit for Long-Term Care Settings". Retrieved December 20, 2020 (https://files.nc.gov/covid/documents/guidance/healthcare/Long-Term-Care-Outbreak-Toolkit-Instructions.pdf).

North Carolina Department of Health and Human Services. 2020c. "Public Health Preparedness and Response." Retrieved December 20, 2020 (https://epi.dph.ncdhhs.gov/phpr/regions.html).

Rios, Patricia et al. 2020. "Preventing the transmission of COVID-19 and other coronaviruses in older adults aged 60 years and above living in long-term care: a rapid review." *Systematic Reviews* 9 (218). doi:10.1186/s13643-020-01486-4

Rozenfeld, Yelena, Jennifer Bearn, Haley Maier, Whitney Haggerson, Karen Boudreau, Jamie Carlson, and Rhonda Medows. 2020. "A Model of Disparities: Risk Factors Associated with Covid-19 Infection." International Journal for Equity in Health 19(1):126–26.

South Carolina Department of Health and Environmental Control 2020a. "Coronavirus Disease 2019 (COVID-19)". Retrieved December 20, 2020 (https://scdhec.gov/covid19).

South Carolina Department of Health and Environmental Control 2020b. "South Carolina County-Level Data for COVID-19". Retrieved December 20, 2020 (https://scdhec.gov/covid19/south-carolina-county-level-data-covid-19).

South Carolina Emergency Management Division 2020. "COVID-19 Resources: Local Mask Ordinances". Retrieved December 20, 2020 (https://scemd.maps.arcgis.com/apps/opsdashboard/index.html#/83d7888fef084a89b7677e76e35cf928).

South Carolina Office of the Governor 2020. "Executive Orders". Retrieved December 20, 2020 (https://governor.sc.gov/executive-branch/executive-orders).

State of North Carolina 2020. "COVID-19 Orders". Retrieved December 20, 2020 (https://www.nc.gov/covid-19/covid-19-orders).

Sun, Zhonggen, Bingqing Yang, Ruilian Zhang, and Xin Cheng. 2020. "Influencing Factors of Understanding Covid-19 Risks and Coping Behaviors among the Elderly Population." *International Journal of Environmental Research and Public Health* 17(16).

U.S. Centers for Medicare and Medicaid Services. 2021. *Design for care compare: Nursing home five-star quality rating system. Technical users' guide.* Retrieved January 15, 2021 from https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/CertificationandComplianc/downloads/usersguide.pdf

Wilmink, Gerald et al. 2020. "Real-Time Digital Contact Tracing: Development of a System to Control COVID-19 Outbreaks in Nursing Homes and Long-Term Care Facilities." *JMIR Public Health and Surveillance* 6(3).

Appendix A. IRB Determination

NC A&T DIVISION OF RESEARCH AND ECONOMIC DEVELOPMENT
1601 East Market Street
Greensboro, NC 27411
336-334-7995
Web site: http://www.ncat.edu/research/dored/irb.html
Federalwide Assurance (FWA) #00000013

To: Stephanie Teixeira Poit
Social Work and Sociology Department

From: IRB

Date: 8/05/2020

RE: Determination that Research or Research-Like Activity does not require IRB Approval
Study #: 21-0003
Study Title: Predictors of and Strategies to Mitigate COVID-19 Cases and Death Among Older Adults in Nursing Homes and Residential Care Facilities

This submission was reviewed by the above-referenced IRB. The IRB has determined that this submission does not constitute human subjects research as defined under federal regulations [45 CFR 46.102 (d or f) and 21 CFR 56.102(c)(e)(l)] and does not require IRB approval.

Study Description:

Older adults in congregate living facilities have higher rates of death from COVID-19 than the general population. In North Carolina, 18% of COVID-19 cases and 61% of COVID-19 deaths were in long-term care facilities; nationally, there is wide variability in state guidelines regarding visitation, screening staff, and PPE use in these facilities (Chidambaram, 2020). Our project examines which pre-COVID-19 quality of care measures predict COVID-19 cases and deaths in congregate living facilities. We also examine community-level factors that perpetuated or mitigated disparities in the number of COVID-19 cases and deaths among older adults in congregate living facilities. Community-level risk factors are important because care providers reside in the community and are carriers bringing COVID-19 into congregate living facilities. Our *research questions include*: What facility-level and community-level factors predict the number of COVID-19 cases and deaths in congregate living facilities? What are actionable strategies that can be implemented to mitigate COVID-19 cases and deaths in congregate living facilities? We will conduct secondary data analyses of existing data sources to examine facility-level and community-level factors that predict the number of COVID-19 cases and deaths in congregate living facilities. Following community-based participatory research, we will use Zoom to virtually convene a Stakeholder Advisory Board with 6-8 key stakeholders during the research process. The Board will provide feedback on the approach, analysis interpretation, and help **develop actionable recommendations** for strategies that can be implemented to mitigate COVID-19 cases and deaths in congregate living facilities. The Board will provide feedback on deliverable formats that can best meet the needs of our local community partners, their constituents, policymakers, and decision makers (e.g., issue briefs, reports, community presentations), so that research can be translated to inform practice. We will also develop manuscripts and conference presentations for academia.

If your study protocol changes in such a way that this determination will no longer apply, you should contact the above IRB before making the changes.

Appendix B. Detailed Methodology for Dependent Variables

COVID-19 DATA IN NORTH CAROLINA

The process utilized in identifying the infection and mortality rates for staff and residents within long-term care facilities in North Carolina incorporated data from the North Carolina Department of Health and Human Services (NC DHHS) COVID-19 weekly dashboard. The weekly report was titled "COVID-19 Ongoing Outbreaks in Congregate Living Settings", and these reports were downloaded weekly from the NC DHHS website, beginning with the report on 5.29.2020 until 9.8.2020, for a total of 14 reports. The data from these reports was exported to Excel beginning with the 9.8.2020 report. This information was then merged with a set of data titled "The U.S. Centers for Medicare and Medicaid Services' Post-Acute Care and Hospice Provider Utilization and Payment Public Use Files ('PAC PUF'), which included facility type, provider ID, name of facility, city, and zip code. After the reported data from the 9.8.2020 report was merged with the PAC PUF, the facilities at the end of each prior report, listed as "Previous Outbreaks", were then added in a receding timeline (beginning with 9.8.2020 and ending with 5.29.2020) so that the most recent data for each facility was included.

Two areas of concern were noted early in the process of merging this data. The first being that the facility names listed in the weekly reports often did not match the facility name in part or in whole of that in the PAC PUF. This required a tedious, one-by-one process where each facility name listed in the weekly report was searched independently for its match within PAC PUF. Occasionally, an internet search was required to verify the correct facility was being identified. For each instance where the facility names did not match, this discrepancy was documented. The second area of concern was that there were a number of facilities listed in the weekly report which were not in the PAC PUF. The additional facilities with their infection and mortality rates were added to the list of data; however, these entries were missing data such as provider ID, city, and zip code. To reconcile this, three tables were located and downloaded from the NC DHHS website, NC Division of Health Service Regulation, Licensed Facilities. The three tables included: Adult Care Home Listing, Hospice Listing, and Nursing Home Listing Alphabetical. The .txt file was exported to Excel for each of these three tables as this was the only file which included the provider/facility ID.

For each entry from the weekly report which did not have a corresponding set of data in PAC PUF, the NC Licensed Facilities tables (Adult Care Home Listing, Hospice Listing and Nursing Home Listing Alphabetical) were searched. When the matching facility name was found, the needed data of facility ID, city, and zip code were then added to the main table of facilities with their infection and mortality rates. One final step of compiling the data was to then search for any duplicate provider/facility ID numbers within the final list of data. This search returned a list of approximately 15 entries; in these cases the facility name in the PAC PUF was completely different from the facility name provided on the weekly report and the NC Licensed Facilities list; for each of these, the data were merged with the PAC PUF dataset and a note of the correct name added. In the final compilation of data, there were 35 entries from the weekly report data for which a corresponding facility ID was not located out of a total of 409 facilities with reported infection and/or mortality rates. To add the county names for each entry, an internet search provided a list of counties based on zip codes, and this information was then cross-referenced with the zip code data in the table and county names added as the final column.

For quality assurance purposes, a research team member compiling South Carolina data double checked every 34th data entry. The number 34 was randomly generated from a number generator from a number between 0 to 100. Two inconsistencies were found, one being a mis-keyed number and the other being a misnamed facility. Corrections were made to both entrees. After finding one raw data number mis-keyed, the original data collector for North Carolina then went back to check every 15th entry to ensure no other data had been mis-keyed. No other errors were identified.

COVID-19 DATA IN SOUTH CAROLINA

The process utilized in identifying the infection and mortality rates for staff and residents within long-term care facilities in South Carolina incorporated data from the South Carolina Department of Health and Environmental Control (SC DHEC) COVID-19 weekly dashboard. The weekly report was titled "Cumulative COVID-19 in Long Term Care Facilities Year to Date", and these reports were downloaded weekly from the SC DHEC website, beginning with the report on 7.7.2020 until 8.26.2020, for a total of 6 reports. It is important to note that, unlike North Carolina, reports from South Carolina provided year to date instead of weekly data. The data from these reports were exported to Excel beginning with the 8.26.2020 report. This information was then merged with "The U.S Centers for Medicare and Medicaid Services' Post-Acute Care and Hospice Provider Utilization and Payment Public Use Files ('PAC PUF')" which included facility type, provider ID, name of facility, city, and zip code. In a receding timeline (beginning with 8.26.2020 and ending with 7.7.2020) weekly reports were searched to ensure the 8.26.2020 report was not missing data. 1 facility out of the 6 data reports sheets had been excluded from the 8.26.2020 report. The missing facility was added to the comparable dataset.

Two issues that arose with the South Carolina data. The first issue was 214 facilities reported on the SC DHEC were not listed on the PAC PUFF dataset. The second issue was that 193 of the additional facilities did not have a provider ID. To address the issue, the 214 additional facilities reported on the SC DHEC reports were added to the bottom of the comparable dataset. These 214 facilities did not have provider ID at first. To find the needed information, SC DHEC was searched for long-term care facilities using Licensed S.C. Healthcare Facilities (Lists) and the subsection Facilities and Activities Listed by Type. Then the subcategories of Community Residential care facilities, Day care facilities for adults, Day Care Facilities for Adults, Hospital and Institutional General Infirmaries, Intermediate Care Facilities for Pearson with Intellectual Disability, Hospice, Nursing lists were searched. Correct information was found on the facility, but the provider ID was only found on 21 facilities. However, those without provider ID did have state licenses numbers. State licenses numbers were substituted for facilities without provider ID. New provider ID and state licenses were imputed into the PAC PUF. 12 of the 214 additional facilities were private establishments and no information was found on the SC DHEC website or the establishment websites regarding provider ID or state licenses numbers. To add the county names for each entry, an internet search provided a list of counties based on zip codes, and this information was then cross-referenced with the zip code data in the table and county names added as the final column.

For quality assurance purposes, a research team member compiling North Carolina data double checked every 23th data entry. The number 23 was randomly generated from a number generator from a number between 0 to 100. No inconsistencies were found in the data.

Appendix C. Initial Contact Script for Stakeholder Advisory Board

NORTH CAROLINA
AGRICULTURAL AND TECHNICAL
STATE UNIVERSITY

A LAND-GRANT UNIVERSITY and A CONSTITUENT INSTITUTION of THE UNIVERSITY of NORTH CAROLINA

(Prospective Board Member's Name and Address)

(Date)

Re: Invitation to Participate on Stakeholder Advisory Board

Dear (Board Member's Name),

We are writing to invite you or a representative from your organization to be a part of a Stakeholder Advisory Board - an exciting component of a new research project developed by faculty at North Carolina A&T State University and funded by the NC Policy Collaboratory. As part of this work, we are conducting a research project using large datasets to examine what facility-level and community-level factors predict the number of COVID-19 cases and deaths in congregate living facilities. We seek to develop actionable strategies that can be implemented to mitigate COVID-19 cases and deaths in congregate living facilities.

Because of your familiarity with care provided to older adults in these settings, we are inviting you or a representative from your organization to serve on a Stakeholder Advisory Board to provide feedback on our research. We anticipate your commitment will include approximately 3 meetings between July and December 2020. Because of COVID-19, all meetings will be held virtually via Zoom.

Being a member of the Stakeholder Advisory Board provides you with a unique opportunity to:

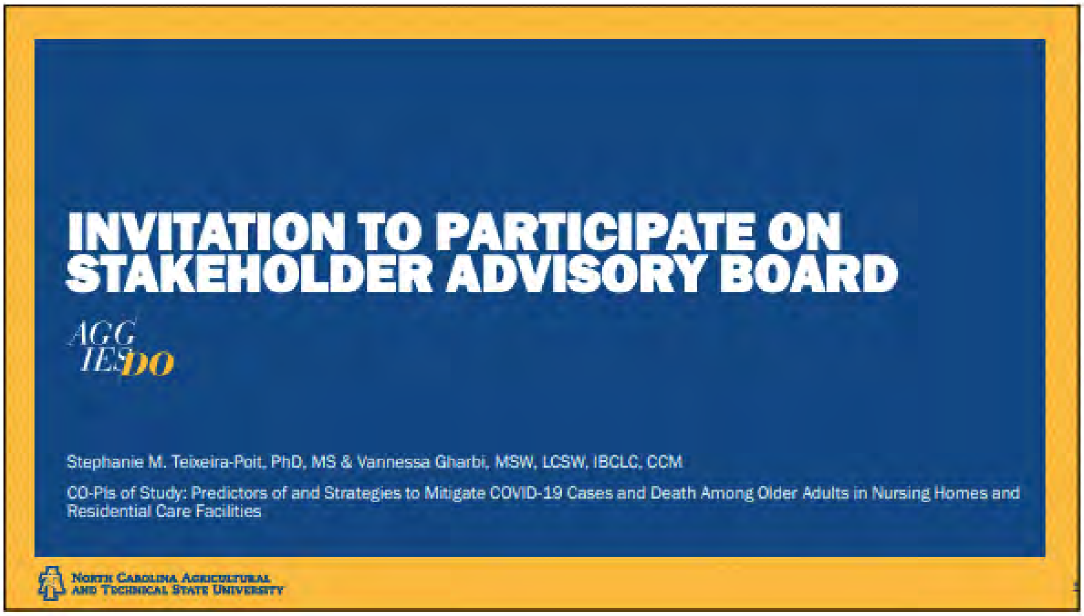
- Inform research questions and the overall approach to the problem
- Enhance interpretation of the analysis
- Provide feedback on actionable recommendations for strategies that can be implemented to mitigate COVID-19 cases and deaths in congregate living facilities
- Provide feedback on deliverable formats that can best meet the needs of key stakeholders
- Continue serving your community in meaningful ways that seek to improve quality of life
- Empower your organization with data to support its mission in serving your consumers
- Expand your network and meet people with similar interests

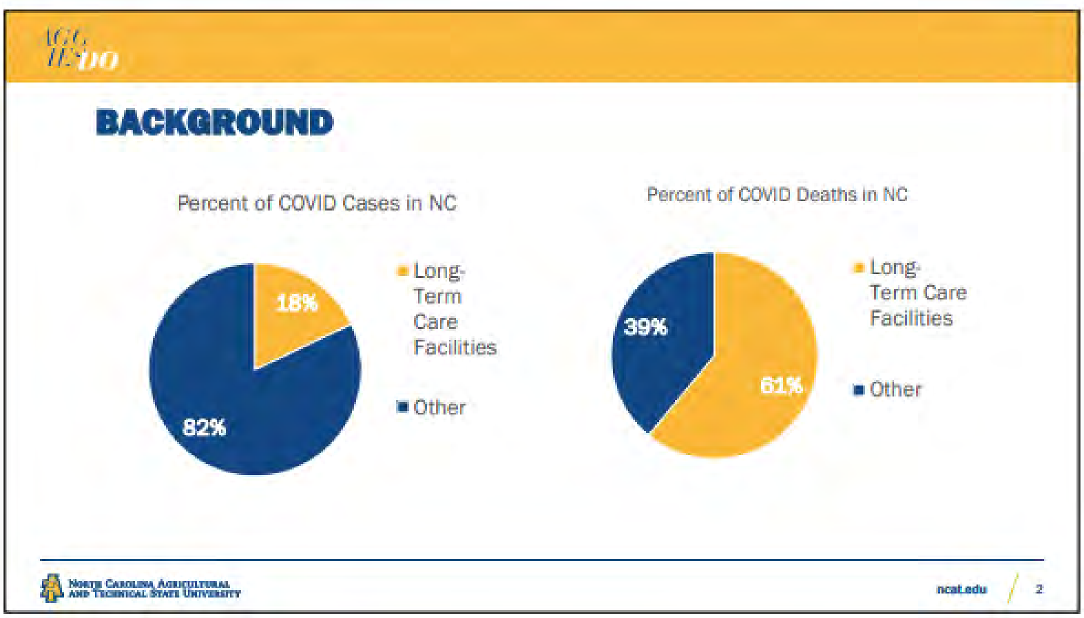
We would like to schedule a brief call with you to discuss your interest. Please let us know what time works best for you. We hope you will join us in this important work!

Thank you,

Stephanie M. Teixeira-Poit, PhD, MS & Vannessa Gharbi, MSW, LCSW, IBCLC, CCM
CO-PIs of Study: Predictors of and Strategies to Mitigate COVID-19 Cases and Death Among Older Adults in Nursing Homes and Residential Care Facilities

Appendix D. Onboarding Session Materials for Stakeholder Advisory Board





RESEARCH QUESTIONS

- RQ1: What facility-level and community-level factors predict the number of COVID-19 cases and deaths in congregate living facilities?
- RQ2: What are actionable strategies that can be implemented to mitigate COVID-19 cases and deaths in congregate living facilities?

APPROACH

- Data Analysis
  - > Uses large datasets to examine what facility-level and community-level factors predict the number of COVID-19 cases and deaths in congregate living facilities
- Stakeholder Advisory Board
  - > Follows model of community-based participatory research
  - > Includes 6-8 key stakeholders

ROLE OF STAKEHOLDER ADVISORY BOARD

- Inform research questions and the overall approach to the problem
- Enhance interpretation of the analysis
- Provide feedback on actionable recommendations for strategies that can be implemented to mitigate COVID-19 cases and deaths in congregate living facilities
- Provide feedback on deliverable formats that can best meet the needs of key stakeholders
- Continue serving your community in meaningful ways that seek to improve quality of life
- Empower your organization with data to support its mission in serving your consumers
- Expand your network and meet people with similar interests

North Carolina Agricultural and Technical State University   ncat.edu / 5

COMMITMENT OF STAKEHOLDER ADVISORY BOARD

- Participate in approximately 3 one-hour meetings
- Because of COVID-19, all meetings will be held virtually via Zoom
- Questions?

North Carolina Agricultural and Technical State University   ncat.edu / 6

CONTACT INFORMATION

Stephanie Teixeira-Poit, PhD, MS
NC A&T State University
steixeirapoit@ncat.edu

Vannessa Gharbi, MSW, LCSW, IBCLC, CCM
NC A&T State University
vcgharbi@ncat.edu

North Carolina Agricultural and Technical State University

ncat.edu

Appendix E. NC A&T Press Release

The following press release was featured on the NC A&T website:

N.C. A&T STUDY AIMS TO LOWER COVID-19 CASES, DEATHS IN RESIDENTIAL CARE FACILITIES

EAST GREENSBORO, N.C. (Dec. 18, 2020) – A study under way by researchers in North Carolina Agricultural and Technical State University's College of Health and Human Sciences aims to reduce the number of COVID-19 cases and deaths in residential care facilities, including nursing homes.

Data have established that older adults in congregate living facilities have higher COVID-19 mortality rates than the general population. In addition, guidelines regarding visitation, screening staff for the novel coronavirus, and the use of personal protective equipment (PPE) vary widely from state to state.

The N.C. A&T study examines which pre-COVID-19 quality of care measures predict COVID-19 cases and deaths in congregate living facilities, as well as community-level factors that perpetuated or mitigated disparities in the number of COVID-19 cases and deaths among older adults in these residences.

"Community-level risk factors are important because care providers reside in the community and are carriers bringing COVID-19 into congregate living facilities," said Stephanie Teixeira-Poit, Ph.D., an assistant professor of sociology in the CHHS and principal investigator (PI) of the study.

Earlier this month, the Centers for Disease Control and Prevention recommended that health care and nursing home workers be among the first to receive COVID-19 vaccines as soon as they become available.

Teixeira-Poit is leading the effort with co-PI Vannessa Gharbi, a student in the Joint Programs in Social Work of A&T and the University of North Carolina-Greensboro. Their team analyzed data from the N.C. Department of Health and Human Services COIVD-19 Ongoing Outbreaks in Congregate Living Settings Report, the U.S. Centers for Medicare and Medicaid Services Post-Acute Care and Hospice Provider Utilization and Payment Public Use Files, the U.S. Agency on Healthcare Research and Quality's Area Health Resources File, and county-level COVID-19 records.

As part of the study, researchers conducted community-based participatory research and convened a stakeholder advisory board (SAB). "To ensure the SAB could address the needs of a wide range of diverse constituents, we aimed to assemble a cohort of leaders in the field representing diverse geographical locations, professional backgrounds, agency settings, income levels, and socio-demographic characteristics," said Teixeira-Poit.

The SAB not only provided feedback on the approach and analysis interpretation, but also help develop actionable recommendations that can be implemented to reduce novel coronavirus cases and deaths in congregate living facilities.

"We will use this information to devise practical strategies that our local community partners, their constituents, policymakers and decision-makers can use to mitigate COVID-19 cases and deaths in these facilities," said Teixeira-Poit. "Our hope is that these strategies can be adapted and implemented in residential care facilities across North Carolina and in other states to slow and stop the spread of COVID-19 among these vulnerable adult populations."

The target completion date for the Predictors and Strategies to Mitigate COVID-19 Cases and Death Among Older Adults in Nursing Homes and Residential Care Facilities study, which received $75,428 in funding from the N.C. Policy Collaboratory, is Dec. 30.

Appendix B Contract Template for Use with Private Sector Contracts:

NC POLICY COLLABORATORY RESEARCH PROJECT

Authors*

Cephas Naanwaab, Principal Investigator
Associate Professor of Economics
North Carolina A&T State University

Alfredo Romero, Co-PI
Associate Professor of Economics
North Carolina A&T State University

Scott Simkins, Co-PI
Associate Professor and Chair, Economics Department
North Carolina A&T State University

*The authors gratefully acknowledge the research assistance of North Carolina A&T State University undergraduate Economics majors Avionna Burns and Mtende Roll.

DHHS

KEY FINDINGS

- COVID-19 has disproportionately impacted racial minorities and women in the Piedmont triad region. Minorities make up about 20% of the Piedmont Triad 12-county population but account for over 40% of initial unemployment claims, 38% of continuing claims, and over 32% of COVID-related unemployment. Women account for 56% of COVID-related unemployment claims.
- The unemployment rate in the Piedmont Triad region peaked in May 2020 at 13.3% with slight variations across counties. The Greensboro-High Point Metropolitan Statistical Area recorded the highest unemployment rate at 14.5% in May. Across the 12-county area, the unemployment rate has fallen to just under 6% in December.
- The most severely impacted industries include leisure and hospitality, food services and drinking bars, trade and transportation, educational and health services, and manufacturing.
- A survey of businesses and households in the Triad indicate 64% of businesses had moderate to large negative effects from COVID-19, and 60% will either temporarily or permanently shut down if there is another lockdown. 42% of households have lost employment income since March 2020 directly due to COVID-19. 41% report having difficulty paying their mortgage/rent, 49% have problems paying for utilities, and 50% have trouble paying for groceries.
- The conservative model estimates that the annual economic impacts of COVID-19 on the economy of the Piedmont Triad region will range from 55,960 lost jobs, $10.5 billion lost output, and $1.125 billion lost state and local tax revenues. The worst-case model estimates that these losses could top 157,220 jobs, $28 billion in output, and $2.55 billion in state and local tax revenues.
- Disruptions to North Carolina A&T State University operations could significantly impact the economy of the Piedmont Triad region. For instance, a hypothetical 50% reduction in enrollment and associated revenue would create economic impacts region-wide of up to $127 million lost output, 1,400 lost jobs and $33 million in federal, state, and local tax revenues.

INTRODUCTION

North Carolina recorded its first case of the Novel Coronavirus (COVID-19) infection on March 3, 2020 in Wake County. Within one month of the first reported case, there was a rapid increase in cases throughout the state and by the beginning of April, over 90% of counties in the state had recorded cases of the virus. In the Piedmont Triad, Forsyth County was the first to record a case on March 12. Figure 1.1 shows the disease progression statewide and within the Piedmont Triad Area. As seen in the figure, the first wave of COVID-19 cases peaked statewide and in the Piedmont Region around mid- to late-July. By July 18 - 30, the state was reporting an average of 2,100 cases per day while the Piedmont Triad area averaged 300 cases per day. The second wave of infections which started in October is still ongoing as of the beginning of December, with case counts continuing to increase rapidly statewide and in the Piedmont Triad. For example, the state reported an average of 2,065 confirmed new cases per day in October while in November the daily average of new cases increased sharply to 3,100 per day. In December, the average reported new cases statewide once again soared to over 5,600 per day (December 1 – 23).

As COVID-19 cases increased rapidly throughout the state in the early spring of 2020, North Carolina Governor, Roy Cooper, declared a state of emergency and imposed restrictions to curb the spread of the virus. By executive order, North Carolina began a statewide lockdown in mid-March, with most businesses—except for those offering essential services— and k-12 schools, closed until May 15. Phased easing of restrictions began on May 8: In phase 1, the statewide stay at home order which lasted from March 30 to April 29, was relaxed. On May 20, the state entered phase 2, transitioning from stay-at-home order to safer at home and encouraging stronger social distancing measures for individuals and businesses. In phase 3, which began September 30, additional COVID-19 restrictions on businesses were lifted.

The decision to impose statewide lockdowns was not a popular one. In the United States as a whole, lots of controversy surrounded the imposition of lockdowns to slow the spread of COVID-19, with some arguing that the "cure"—meaning the lockdown and its economic toll—should not be worse than the disease itself. Some research has shown that lockdowns could be effective in slowing the spread of the virus, especially if the timing is appropriate. A cross-country panel analysis of the effectiveness of COVID-19 lockdowns found that lockdowns were effective in reducing the number of COVID-19 cases in countries that implemented it compared with those that did not.[2] Lockdowns' impacts were generally felt beginning ten days after imposition and its efficacy continued to grow until twenty days after the implementation. As anecdotal evidence, three Nordic countries—Sweden, Finland, and Norway—are often cited as a classic contrast of how lockdowns can be effective in slowing down COVID-19 spread and reducing the number of deaths. Sweden, where the official policy to combat COVID-19 was predicated upon building herd immunity, did not impose lockdowns or severe social distancing restrictions, saw their cumulative cases soar to over 266,000 (27,000 cases per million people) with 6,972 deaths as of the beginning of December. Norway and Finland, on the other hand, which adopted more stringent COVID restrictions saw slow spread of the disease and total cases much lower than in Sweden. In Norway, total cases were just over 36,000 (or 7,000 per million people) and 334 deaths as of the beginning of December. In Finland, total cases were 24,900 (4,500 per million people) and 399 deaths as of beginning of December.

---

[2] Alfano, Vincenzo and Ercolano, Salvatore (2020). The Efficacy of Lockdown Against COVID-19: A Cross-Country Panel Analysis. *Applied Health Economics and Health Policy*, 18(4): 509-517. doi: 10.1007/s40258-020-00596-3.

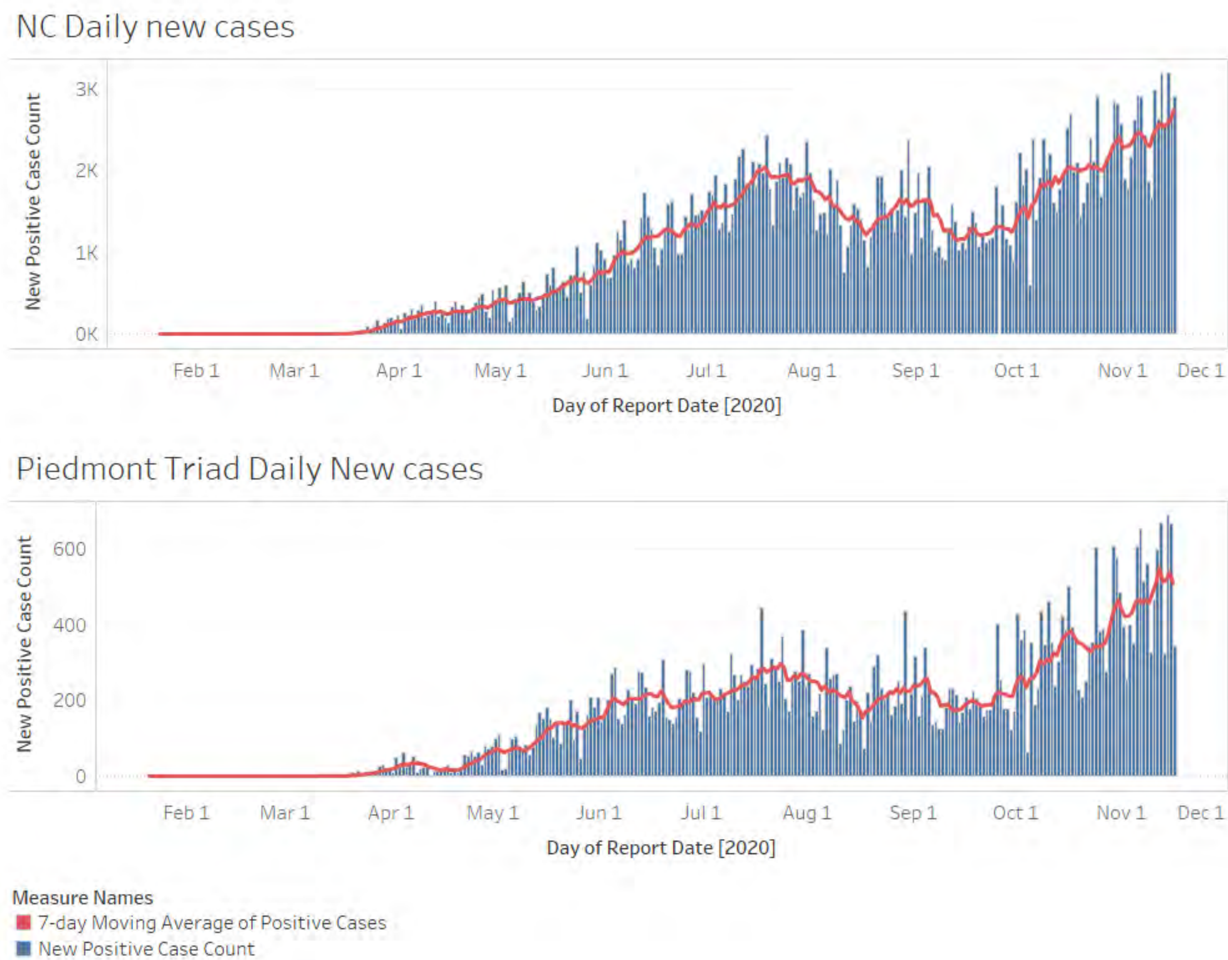


Figure 1.1: COVID-19 Cases in North Carolina and the Piedmont Triad

The Study Area

The study area is the Piedmont Triad region of central North Carolina, covering 12-counties (see map of study area in Appendix). The three major cities in the region, which form the Triad Area are Greensboro, Winston-Salem, and High Point. With an estimated population of over 1.75 million, the Piedmont Triad is the third largest combined statistical area in North Carolina. Five of the largest counties in the region (Guilford, Forsyth, Alamance, Davidson, and Randolph) account for 80% of the population. Table 1.1 shows the household income distribution of the Piedmont Triad region. About 30% of the Piedmont Triad's households are living at or below the federal poverty level in 2020 ($26,200 for a family of four). The labor force participation rate for the entire region was 58% (53% for females) pre-pandemic and median household incomes of just over $46,000 (see Table 1.2 for household income by county). The largest three counties, which are more cosmopolitan and diverse, have minority populations ranging from 26% in Alamance county, 33% in Forsyth county to 44% in Guilford county (Table 1.2). Considering the 12-county area, however, minorities make up just over 20% of the population. The economic output (regional gross domestic product) of the region is estimated at around $90.7 billion in 2019, with total employment of 994,765. Total business establishments are 134,000, of which 29,000 (or 22%) are minority-owned and 48,000 (or 36%) are women-owned.

Table 1.1: Household Income Characteristics of the Piedmont Triad Region

Income Range	Approximate Number of Households	Percent of Households
Less than 15k	98,208.58	13.97
15-30k	128,570.95	18.28
30-40k	80,353.45	11.43
40-50k	69,211.78	9.84
50-70k	103,517.62	14.72
70-100k	102,937.90	14.64
100-150k	73,403.94	10.44
150-200k	24,141.19	3.43
Greater Than 200k	22,863.30	3.25
Total	703,208.71	100.00

Source: IMPLAN 2019 data for model region (Piedmont Triad 12-County Region)

Table 1.2: Socio-demographic characteristics of the Piedmont Triad Region

County	Pop2019	Female (%)	Male (%)	White (%)	Black (%)	OtherRace (%)	MedianHHinc	Totalfirms	Minority_ownedfirms
Alamance	169509	52.5	47.5	73.6	20.9	5.5	$45,735	10,990	2,283
Caswell	22604	49.2	50.8	64.5	32.3	3.2	$43,961	1,106	279
Davidson	167609	51.1	48.9	85.6	10.1	4.3	$47,271	13,423	1,515
Davie	42846	51.2	48.8	90	6.5	3.5	$57,611	3,380	235
Forsyth	382295	52.7	47.3	66.6	27.5	5.9	$50,128	28,792	7,481
Guilford	537174	52.7	47.3	56	35.4	8.6	$51,072	45,746	14,168
Montgomery	27173	51.1	48.9	76.4	19	4.6	$42,346	1,890	330
Randolph	143667	50.7	49.3	88.8	6.6	4.6	$45,006	11,207	1,285
Rockingham	91010	51.7	48.3	77.5	19	3.5	$42,490	6,193	1,011
Stokes	45591	51	49	93.7	4.1	2.2	$46,169	2,843	158
Surry	71783	51.3	48.7	92.9	4.2	2.9	$41,068	5,681	397
Yadkin	37667	50.5	49.5	93.9	3.4	2.7	$42,876	3,022	118

Source: U.S. Census Bureau (American Community Survey and Survey of Business Owners)

~ Part I ~

Economic Trends

MINORITIES

20% of the Piedmont Triad population

32% of COVID-19 Unemployment

Key Economic Indicators

The Piedmont Triad region, like much of the country, took a direct hit from the COVID-induced economic meltdown in the spring. Businesses across the region shuttered as the state entered various phases of mandatory lockdowns from April to August 2020. Significant economic impacts began to be felt throughout the region as business closed, workers furloughed, and the economy came to a near-standstill in the spring. Data analysis shows the impacts of COVID-19 on job losses, initial and continuing claims for unemployment benefits, as well as the unemployment rate across the Piedmont Triad region (Figures 1.2, 1.3 & 1.4). In Figure 1.2, the number of people filing for first time unemployment benefits in the Piedmont Triad region reached a high of 91,553 in April, of which 74,475 were COVID-related. The unemployment rate increased from 3.7% (pre-COVID) to 13.3% in April-May (Figures 1.4 and 1.5). This implies that most of the jobs lost in the Piedmont Triad area were due to COVID-19. Both initial and continued claims have steadily fallen from their peaks in April-May—as of October, initial and continuing claims have receded to their pre-pandemic levels.

Disparities in Impacts of COVID-19

Analysis reveals a disproportionate economic impact of COVID-19 by gender, race, and type of industry. We have analyzed the impacts on unemployment rates, initial and continuing claims for unemployment insurance and found that initial and continuing claims for unemployment benefits are higher for females and minorities. Figure 1.3 shows the impacts of COVID-19 on unemployment claims by gender and race. Comparatively, the graphics show a disproportionate impact on racial minorities and women. Minorities make up about 20% of the Piedmont Triad 12-county population but account for over 40% of initial claims, 38% of continuing claims, and over 32% of COVID-related unemployment claims. Research has revealed that minorities are three times as likely to contract COVID-19 and two times as likely to die from it than whites.[3] A Federal Reserve Bank study showed that nearly 40% of people with household income under $40,000 lost their job due to COVID-19.[4] The same study found that 63% of workers with a bachelor's degree were able to work entirely from home during the COVID-19 lockdown, while only 20% of workers with a high school diploma or less could work at home. Additionally, 67% of workers with a high school diploma or less worked in jobs that could not, under any circumstance, be performed remotely. Minorities are overrepresented in these types of jobs that could not be performed remotely. Thus, it is not surprising that minorities have been more severely impacted.

FEMALES

51% of Piedmont Triad Population

56% of COVID-19 Unemployment

In terms of gender, females are over-represented in filings for continuing unemployment benefits due to COVID-19. Females make up 51% of the population of the region but account for nearly 56% of continuing claims for unemployment. Nationally, women have been hit hardest by the economic fall-out from COVID-19. Only 39% of females who were furloughed or laid off due to COVID-19 have gotten their jobs back compared with 58% for males.[5] Data from the Bureau of Labor Statistics show that women dropped out of the labor force at a higher rate than men. For

[3] The CDC (2020). COVID-19 case-level data reported by state and territorial jurisdictions. The Centers for Disease Control and Prevention, August 2020.

[4] The Federal Reserve Bank (2020). Report on the Economic Wellbeing of U.S. Households in 2019, Featuring Supplemental Data from April 2020. Board of Governors of the Federal Reserve System. May 2020.

[5] Kai, Ryssdal (Host): Marketplace Report, October 2, 2020

example, 865,000 women dropped out of the labor force between August and September alone, compared to 216,000 for men. Men's labor force participation rate dropped from 71.7% in February to 68.6% in April (3.1 percentage points drop) while women's participation rate dropped from 59.2% to 56.3% (2.9 percentage points drop). However, the recovery in participation rate has been unequal: As of September, male labor force participation rate has recovered back to 69.9% while women's' is 56.8%, meaning that women's participation rate is down 2.4 percentage points since the pandemic began compared with 1.8 percentage points for men.[6]

A recent study found that unlike in previous recessions, women's unemployment rate has risen significantly more than that of men in the COVID recession. Women's unemployment rate during the COVID-19 pandemic recession is 2.9 percentage points higher than that of men.[7] Two reasons account for this: firstly, women are the main providers of child-care in most households and have had to make the painful decision to exit the job market to take care of kids as schools closed. A survey of the American labor force between May and June found that one in four women lost their jobs during the COVID-19 pandemic because of lack of childcare.[8] Another survey conducted between February and September found that 2.2 million mothers of children aged 12 and under lost their jobs to the pandemic, compared with 870, 000 fathers in the same period.[9] Secondly, the occupations that have been hit hardest also happen to be where women are predominantly employed. Women predominate in essential jobs—jobs that can only be

---

[6] Bureau of Labor Statistics, U.S. Department of Labor, *The Economics Daily*, Labor force participation rate down, employment–population ratio little changed in September. Retrieved from https://www.bls.gov/opub/ted/2020/labor-force-participation-rate-down-employment-population-ratio-little-changed-in-september.htm (*December 17, 2020*).

[7] Alon, T., Doepke, M., Olmstead-Rumsey, J., and Tertilt, M. (2020). This Time It's Different: The Role of Women's Employment in a Pandemic Recession. August 2020. Working Paper

[8] Bateman, Nicole and Ross, Martha (2020). Why has COVID-19 been especially harmful for working women? Brookings Gender Equality Series, July 29, 2020. https://www.brookings.edu/essay/why-has-covid-19-been-especially-harmful-for-working-women/.

[9] Henderson, Tim (2020). Mothers are three times more likely than fathers to have lost jobs in the pandemic. Stateline Article. *Stateline, An Initiative of the Pew Charitable Trusts*. September 28, 2020. https://www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2020/09/28/mothers-are-3-times-more-likely-than-fathers-to-have-lost-jobs-in-pandemic.

performed in-person with no possibilities of telework, such as in hospitality, health care, retail and other personal services.

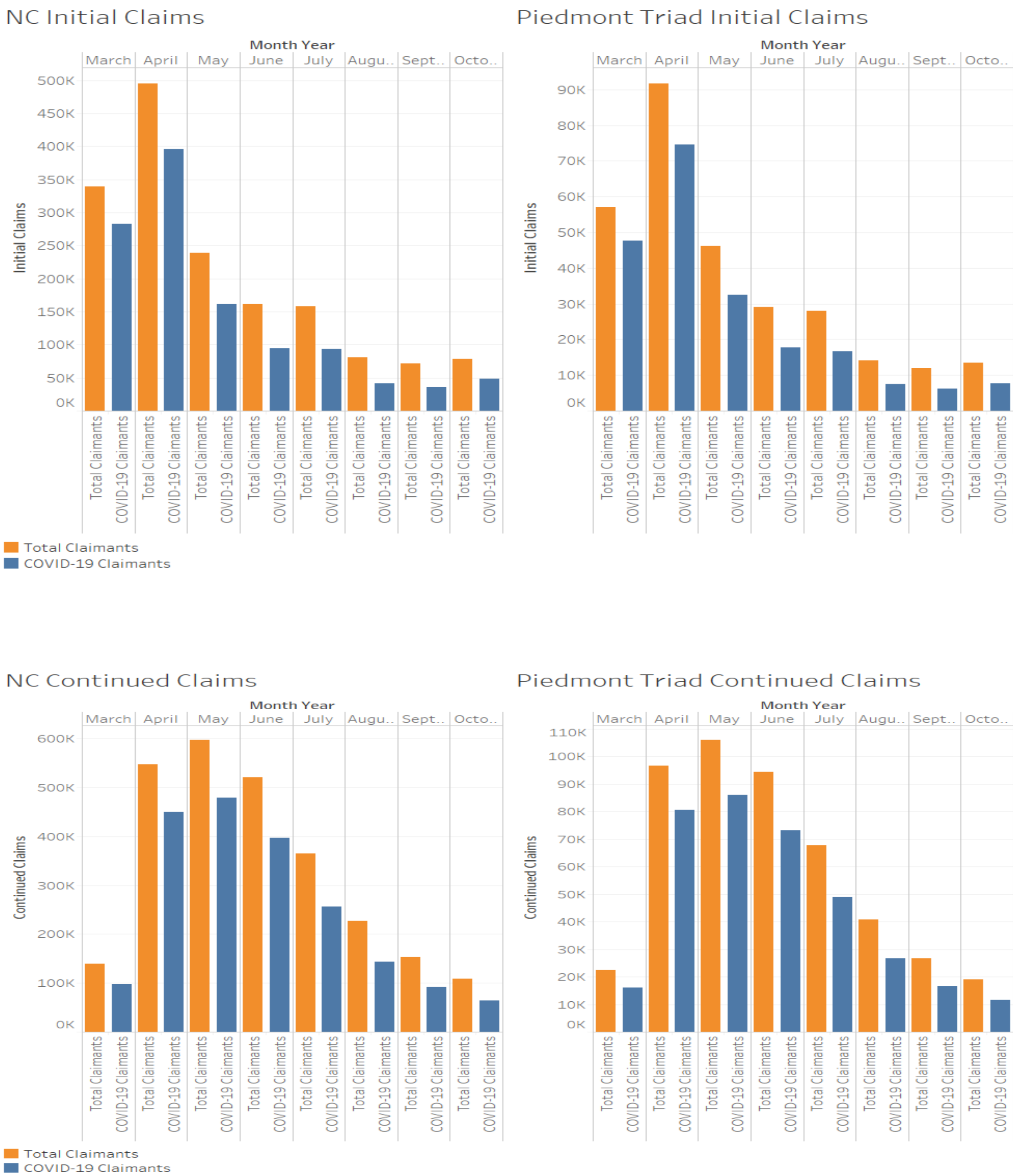


Figure 1.2: Initial and continuing claims for Unemployment Benefits

Figure 1.2 shows total versus COVID-19 initial claims for unemployment in the twelve-county region. Both the total and COVID-19 claims peaked in April and steadily declined in following months. At the peak in April, the Piedmont Triad region saw a total of 74,475 people filing for first time unemployment benefits because of COVID-19. Initial claims reached their lowest level in September and then increased in October. State total initial claims increased from 71,380 in September to 77,971 in October. COVID-related initial claims increased from 36,206 in September to 48,081 in October. In the Piedmont, total initial claims increased from 11,933 in September to 13,491 in October. Piedmont Triad COVID-related initial claims increased from 6,099 in September to 7,772 in October. Figure 1.2 also shows continued claims for unemployment Benefits (State versus Piedmont Triad Region). Total versus COVID-19 claims for unemployment in the twelve-county region. Both the total and COVID-19 continued claims peaked in May and have been steadily falling in the following months. At the peak in May, the Piedmont Triad region saw a total of 85,842 people receiving unemployment benefits because of COVID-19. Continued claims reached their lowest levels in October. State total continued claims hit a low of 108,221 in October. COVID-related continued claims hit a low of 63,489 in October. In the Piedmont, total continued claims hit a low of 19,097 in October. COVID-related continued claims reached a low of 11,666 in October.

COVID-19 IN THE PIEDMONT

December 21, 2020

81,256
Cases

992
Deaths

876
Hospitalizations

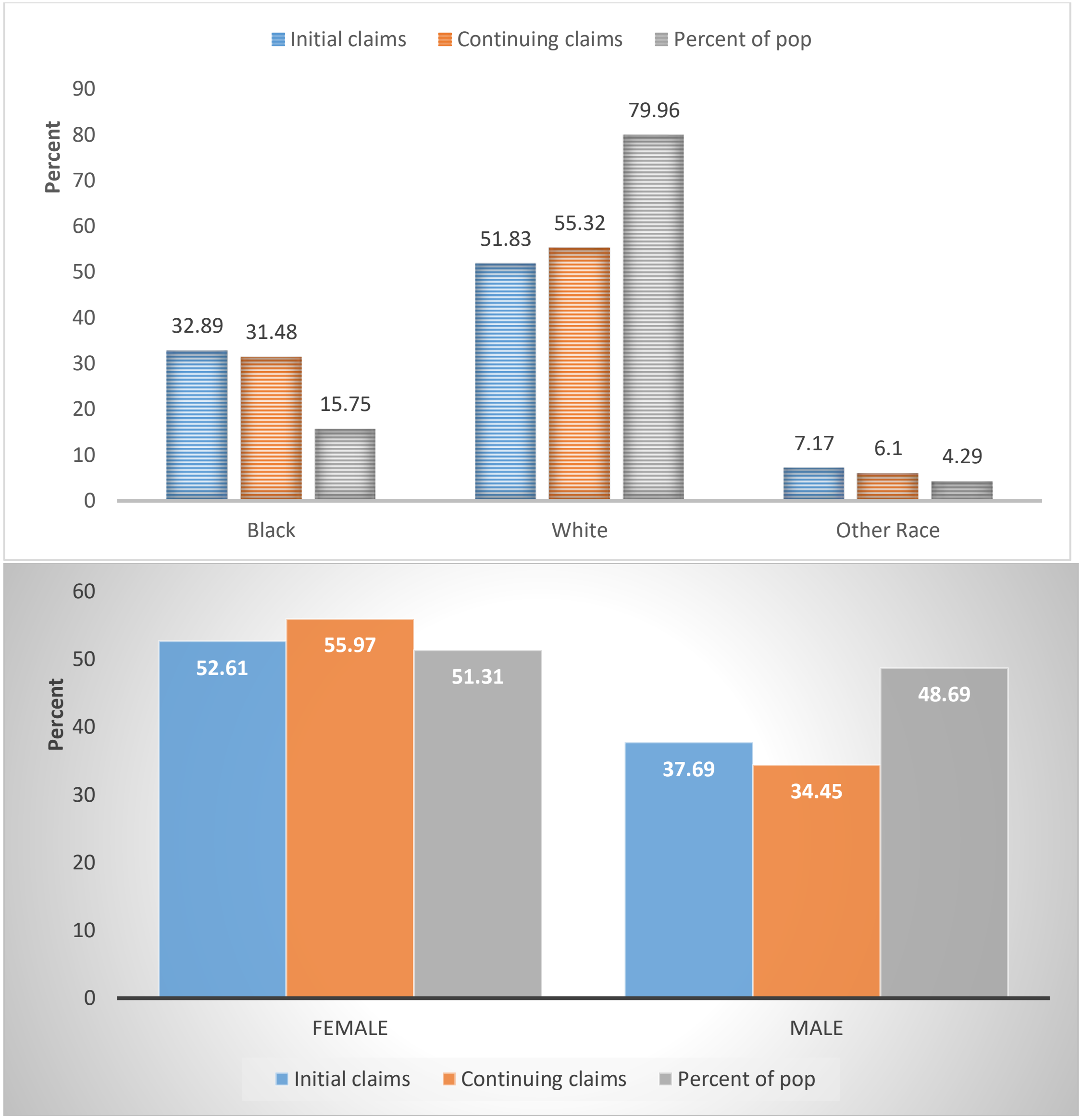


Figure 1.3: Racial and Gender Composition of COVID-Related claims for unemployment benefits

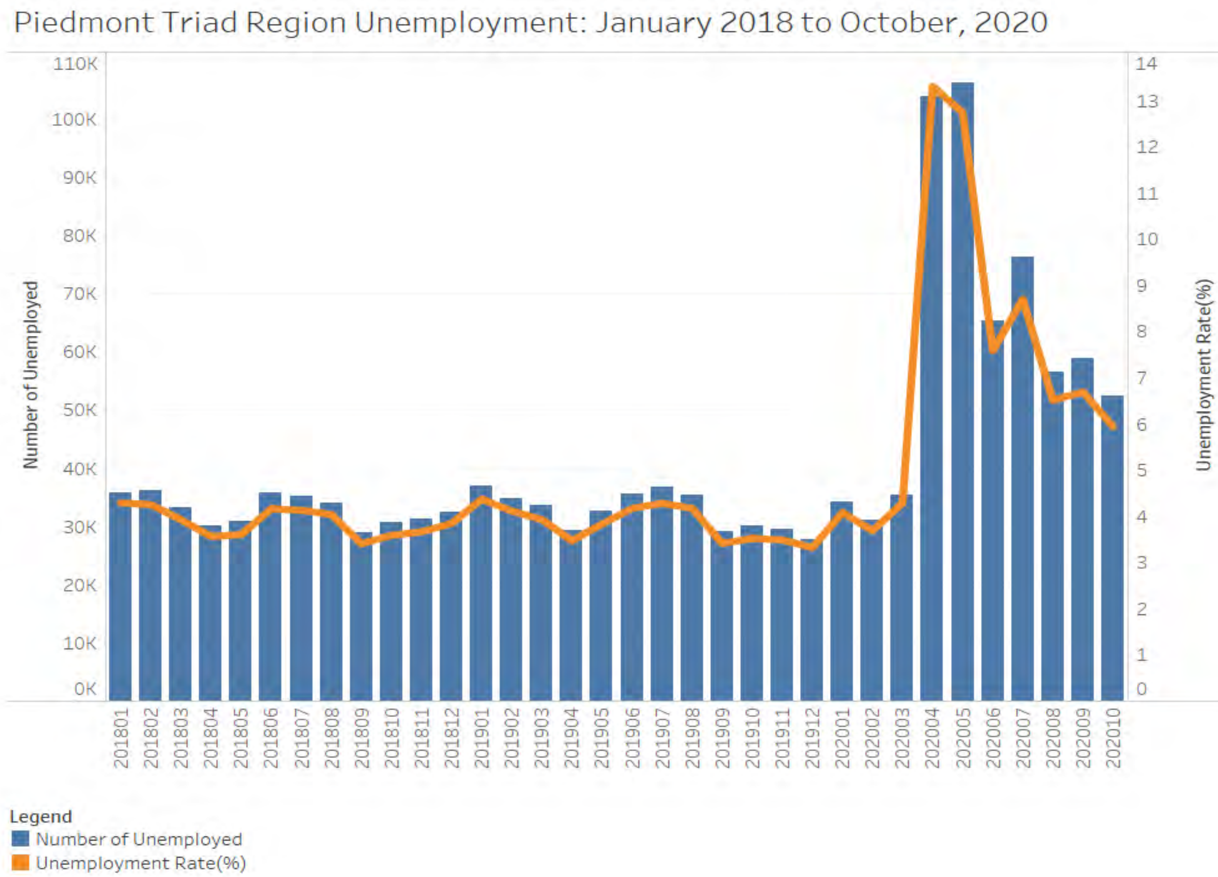


Figure 1.4: Region-wide Unemployment Trends

Figure 1.4 shows the unemployment trends for the Piedmont Triad 12-county area. In February, there was a total of 31,195 unemployed people with the unemployment rate at 3.7%. As COVID-19 spread through the area forcing businesses to close and furlough or lay-off workers, the number of unemployed jumped to 103,846 in April and 106,203 in May. The unemployment rate peaked at 13.3% between April and May. While it did fall considerably from the peak in May, the number of unemployed remains much elevated in October (52,428 people) compared to the pre-pandemic level. The unemployment rate in October standards at 5.6%.

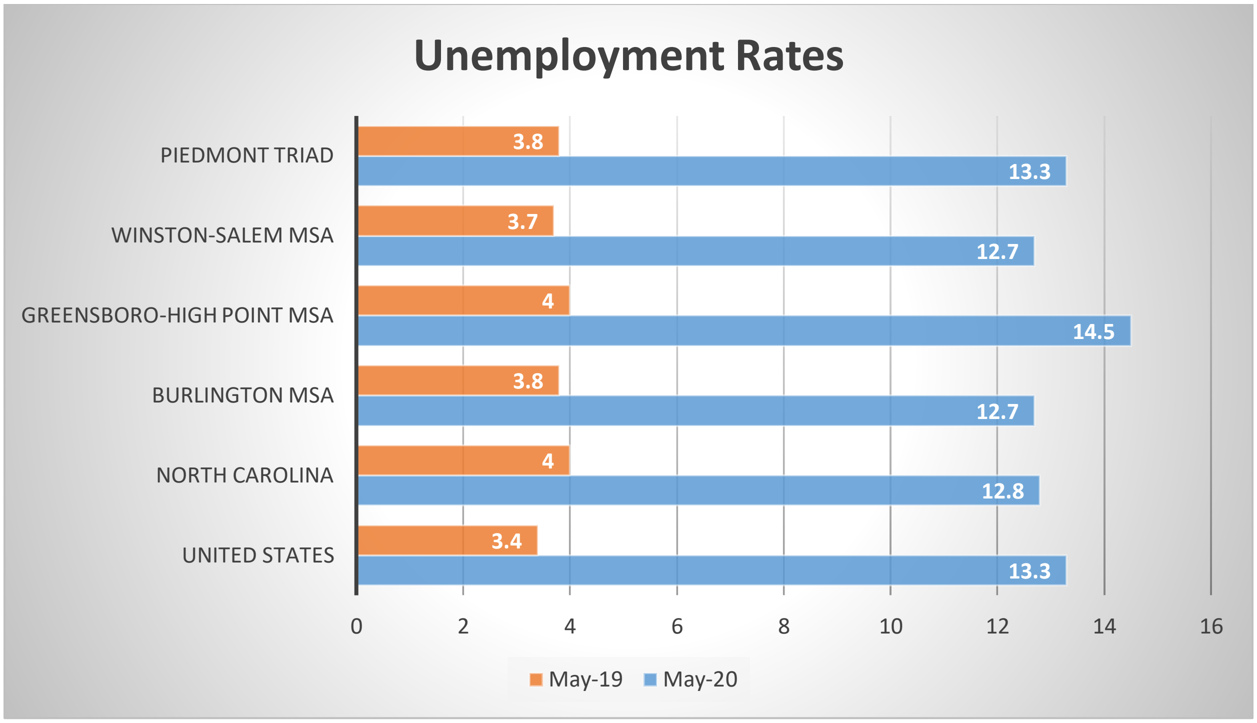


Figure 1.5: Unemployment Rate Comparisons by Region

The unemployment rate comparisions in Figure 1.5 shows that Greensboro-High Point MSA had the greatest unemployment impacts from the COVID-19 pandemic. The unemployment rate of 14.5 in May in Greensboro-High Point Metropolitan Statistical Area was higher than the Piedmont Triad region as a whole, North Carolina, and the United States.

Job Losses by Industry (Greensboro-High Point MSA versus Winston-Salem MSA)

Industries severely impacted include leisure and hospitality, food services and drinking bars, manufacturing, health care and social assistance services, and trade, transportation, and utilities. The following two graphs (Figure 1.6) compare job changes across 30 industries in the Greensboro-High Point and Winston-Salem Metropolitan Statistical Areas (MSA). From February to May 2020, all industries recorded negative job growth. Appendix Tables A1-A3 show that in April all major industries (except for federal sector) recorded negative job growth in the Greensboro-High Point, Winston-Salem, and Burlington MSAs. While there was recovery in the ensuing months (June – September), the pace slowed down and indeed some sectors reversed course into negative job growth as the second wave of COVID-19 infections gripped the area in October and November.

Greensboro-High Point MSA: the top three most impacted industries were leisure and hospitality (-15,300 jobs), food services and drinking bars (-15,200 jobs), and manufacturing (-12,700 jobs).

Winston-Salem MSA: the top three most impacted industries were food services and drinking bars (-10,000 jobs), leisure and hospitality (-10,000 jobs), and health care and social assistance services (-6,100 jobs).

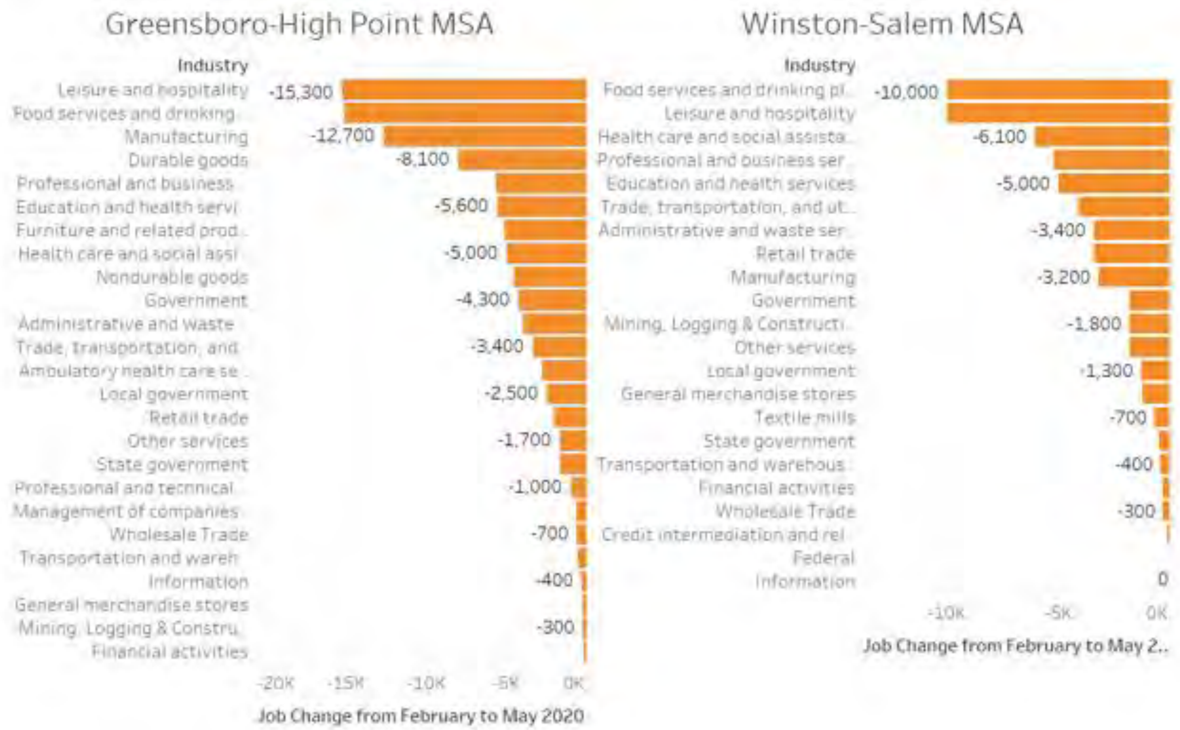


Figure 1.6: Job Change from February to May, 2020

~ Part II ~

Survey of COVID-19 Impacts on Businesses and Households in the Piedmont Triad

Survey of Piedmont Triad Businesses

A business survey was conducted between December 10, 2020 and January 20, 2021 to assess how business of the Piedmont Triad have been directly impacted by the pandemic. Respondents were sampled from across counties of the Piedmont Triad Region, representative of the size, industry, and economic importance of the business in the area. The survey instrument was administered online. Out of the total 50 surveys fielded, 50 were returned completed. Approximately 40% of the establishments had less than 20 employees, approximately 27% had between 20 and 499 employees, and the rest had more than 500 employees. Non-surprisingly, most of the businesses belong to the Professional, Scientific, and Technical Services and the Health Care and Social Assistance industries, both prominent industries in the area. Of particular interest was the representation of self-employed or sole proprietorship in the region. For this, half of the businesses belong to that category, followed by LLCs, representing a quarter of the businesses surveyed.

Minority or Female Owned Businesses

Approximately 40% of the business are owned by an underrepresented ethnic group. When the type of ownership is broken down by categories, almost 60% of the sole-proprietorship businesses are owned by an underrepresented group. Within this group, 63% of solo-proprietorship businesses owned by an underrepresented ethnic group also hire most of their employees from an underrepresented group.

Effects on COVID-19

Out of the universe of business surveyed that vast majority of sole-proprietor business reported to have suffered moderate to large negative effects from COVID-19. This is not surprising since it is being established that the pandemic has affected more severely underrepresented groups. In fact, if another lockdown was instituted, almost 40% of businesses owned by an underrepresented group will have to either temporarily shutdown or permanently shut down.

Expectations about the Short Run

Perhaps due to their experience with the Pandemic, most business owned by an underrepresented group are more pessimistic about the time it would take for things to go back to normal.
The below graphics summarize the results of the surveys.

Appendix B Contract Template for Use with Private Sector Contracts:

Figure 1: Industry Composition

Figure 2: Breakdown of Businesses by Type

Ownership	
Sole proprietor	50.00%
LLC	25.00%
9 S-Corp	10.42%
Non-profit	8.33%
Other	6.25%

Employees	
Less than 20	39.58%
20-499	27.08%
More than 500	33.33%

Figure 3: Businesses Ownership by Type of Employees

	Ownership / Employees Minority or Female									
	Sole proprietor		LLC		9 S-Corp		Non-profit		Other	
Owner Minority or Female	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
No	24.14%	10.34%	13.79%	13.79%	13.79%		10.34%	3.45%	6.90%	3.45%
Yes	10.53%	63.16%		21.05%		5.26%				

Appendix B Contract Template for Use with Private Sector Contracts:

Figure 4: Business Ownership by Type of Employees and Type of Owner

	Ownership				
Owner Minority or Female	Sole proprietor	LLC	9 S-Corp	Non-profit	Other
No	10	8	4	4	3
Yes	14	4	1		

Figure 5: Businesses' COVID-19 Impact Perception

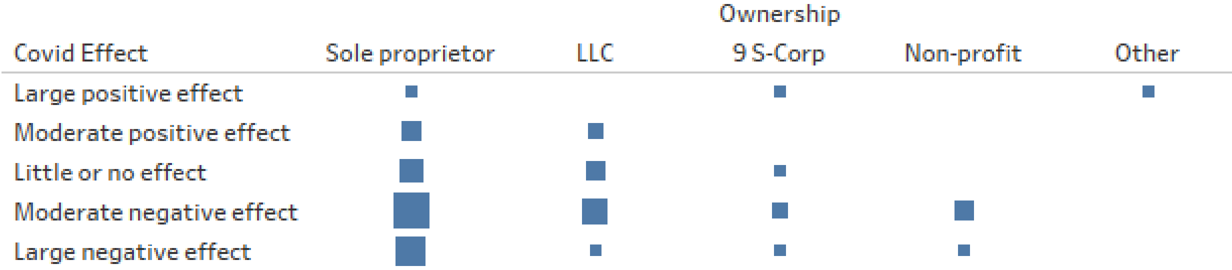


Figure 6: Businesses' COVID-19 Impact Expectation

	Employees Minority or Female	
If Lockdown	No	Yes
Permanently close a locat..	2	2
Temporarily close a locati..	8	14
None of the above	10	6

	Employees Minority or Female	
Expectations	No	Yes
There has been little or no..	4	1
This business has returne..	3	1
1 month or less	1	
2-3 months	2	4
4-6 months	4	4
More than 6 months	6	10
This business has perman..		1
I do not believe this busin..		1

Survey of Piedmont Triad Households

A household survey was conducted between December 10, 2020 and January 20, 2021 to assess how residents of the Piedmont Triad have been directly impacted by the pandemic. Respondents were sampled from across counties of the Piedmont Triad Region, representative of gender, socio-economic status, as well as racial and ethnic composition of the population. The survey instrument was administered online. Out of the total 800 surveys fielded, 639 were returned completed (nearly 80% response rate). The respondents consisted of 57% white, 34% Black/African American, and 9% other racial minorities.

Loss of employment

About 29% of respondents reported being temporarily out of work. Of those temporarily out of work, different reasons were given, including employer went out of business or temporarily closed due to the pandemic, laid-off due to the pandemic, sick from COVID-19, taking care of kids etc. Of those out of work, 43% said they were not working for reasons directly or indirectly tied to COVID-19.

Loss of employment income

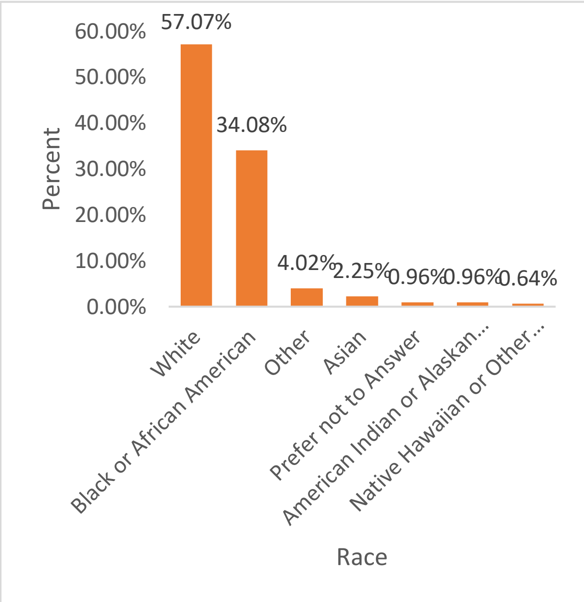
Forty-two percent of respondents reported that their household has lost employment income since March 2020 directly due to COVID-19. The specific reasons cited for loss of employment income range from reduced hours (34.5%) to laid-off (25.9%) to furloughed (9%).

Difficulty paying the bills

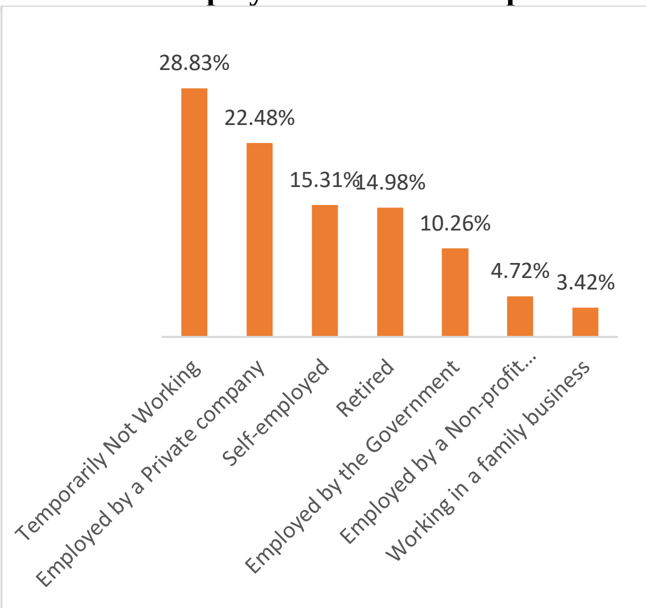
Forty-seven percent of Piedmont Triad residents reported that since the pandemic began, they have experienced a somewhat to very difficult circumstances paying their bills. Specifically, 41% report having difficulty paying their mortgage/rent, 49% have problems paying for utilities, and 50% have trouble paying for groceries.

The below graphics summarize the results of the surveys.

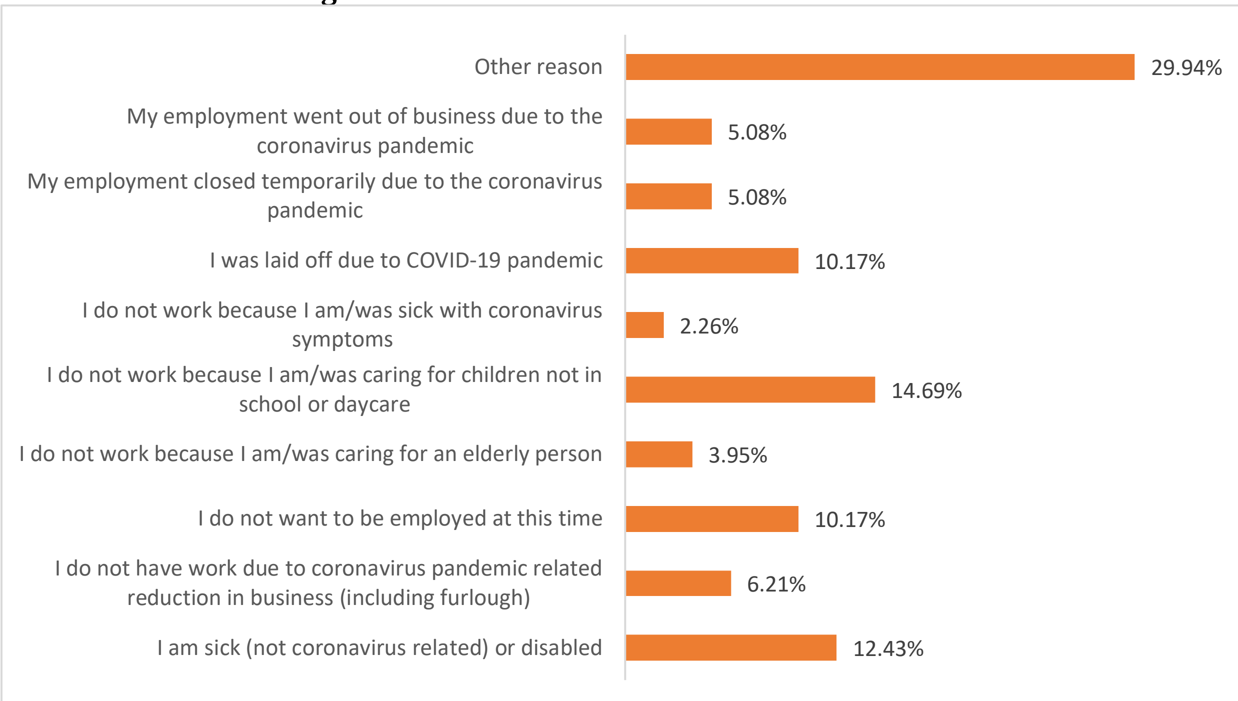
Racial composition of respondents



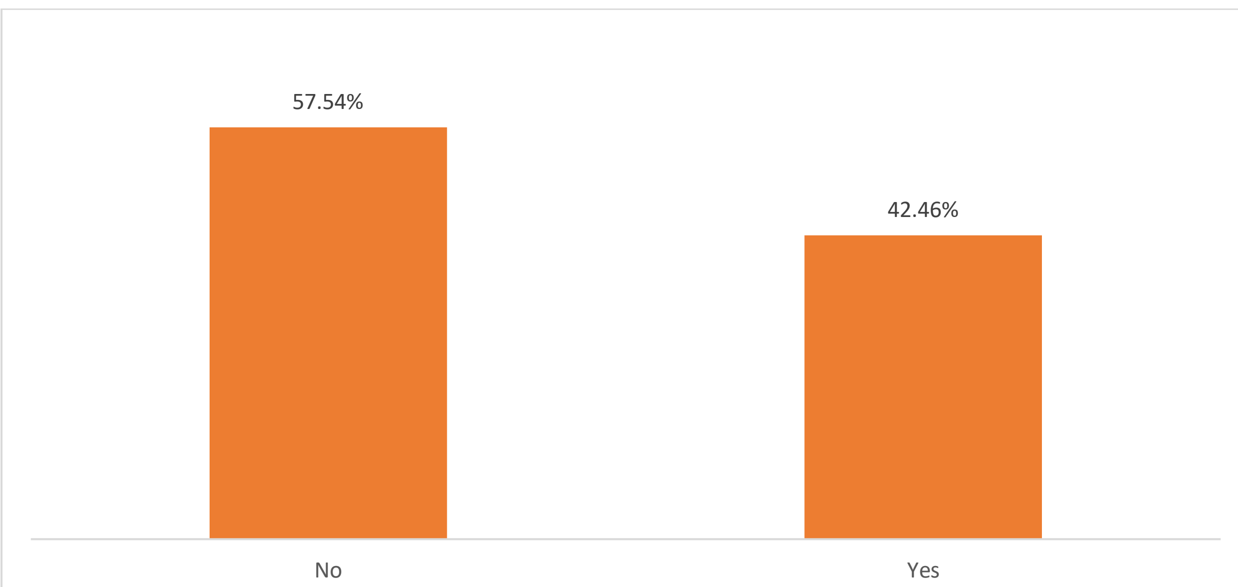
Employment status of respondents



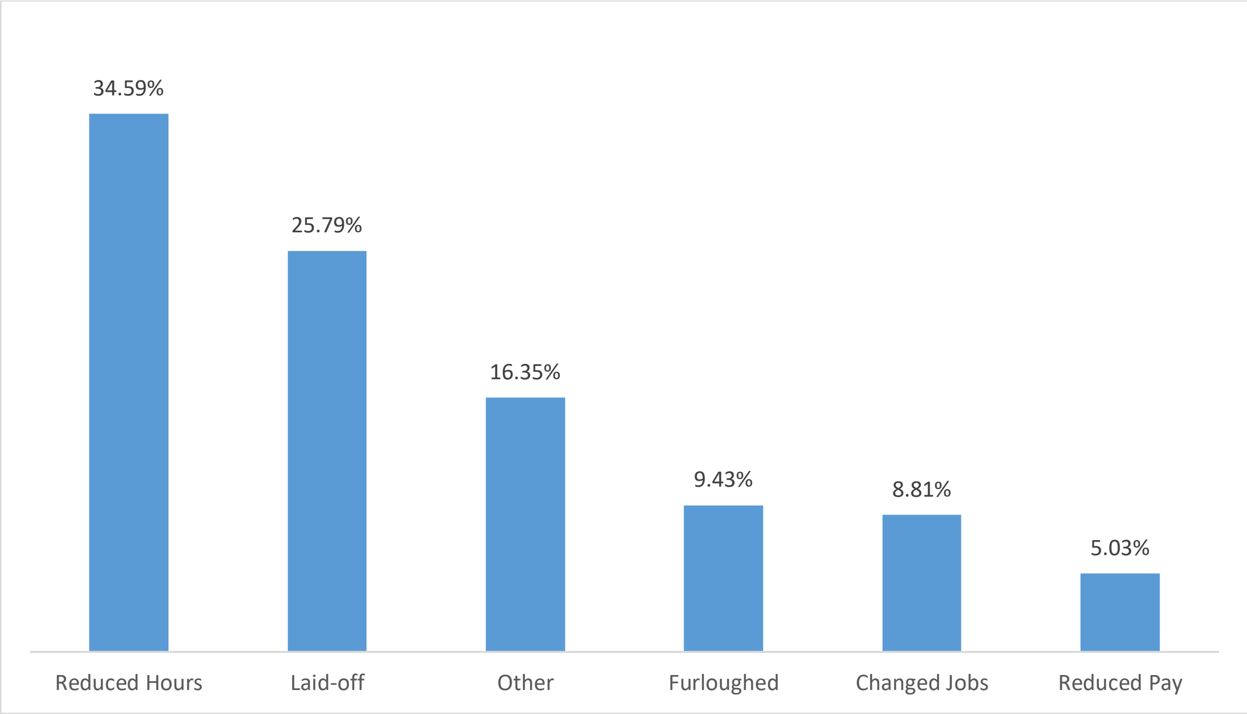
Reasons for not working



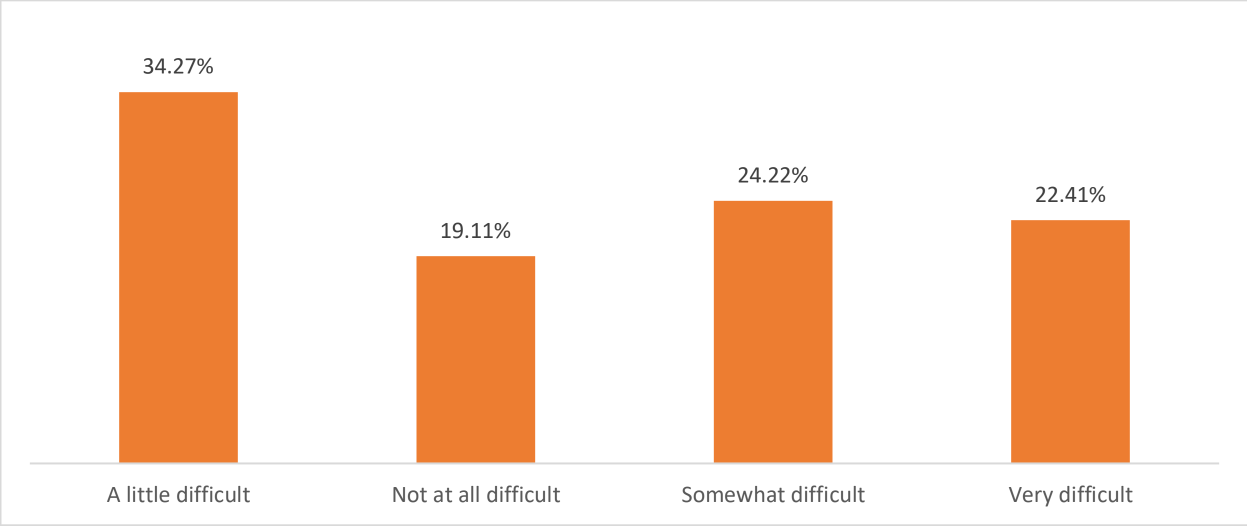
Did your household experience a loss of employment income since March 13, 2020 due to covid-19?



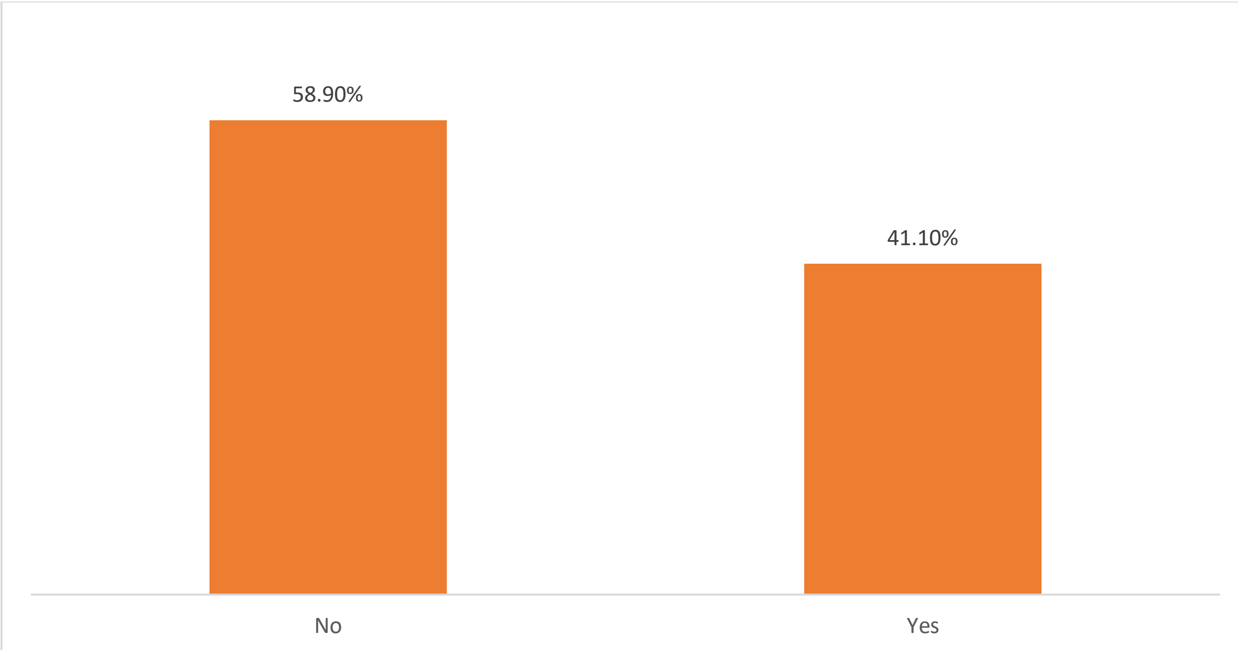
What is the main reason for the loss of employment income since March 13, 2020 due to covid-19?



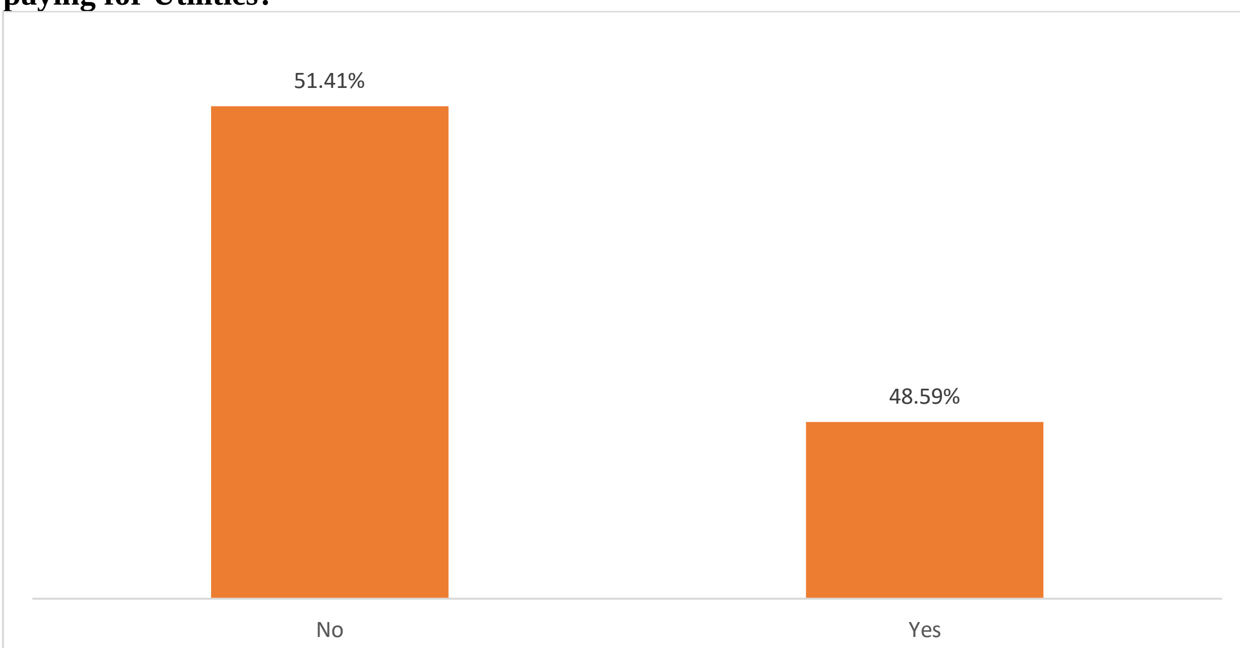
In the last 8 months, how difficult has it been for your household to pay for usual household expenses, including but not limited to food, rent or mortgage, car payments, medical expenses, student loans, and so on?



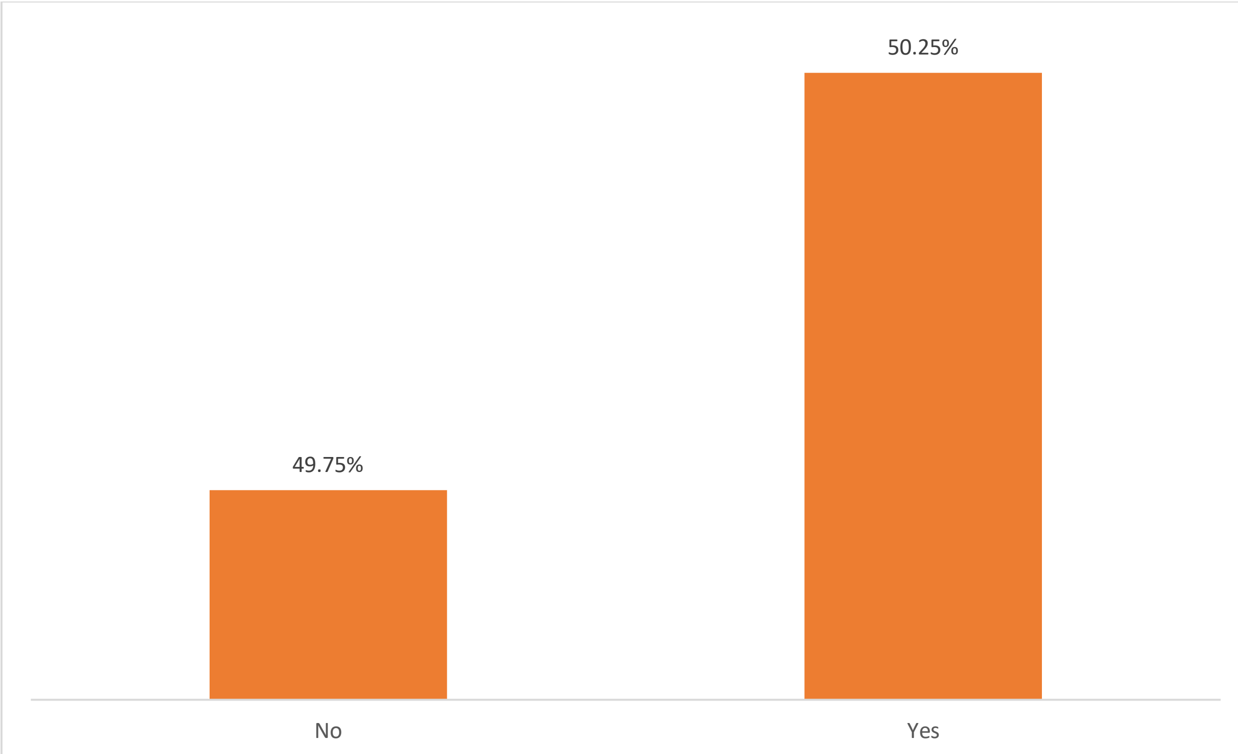
Thinking about your experience in the last 8 months, did your household have problems paying for Mortgage/Rent?



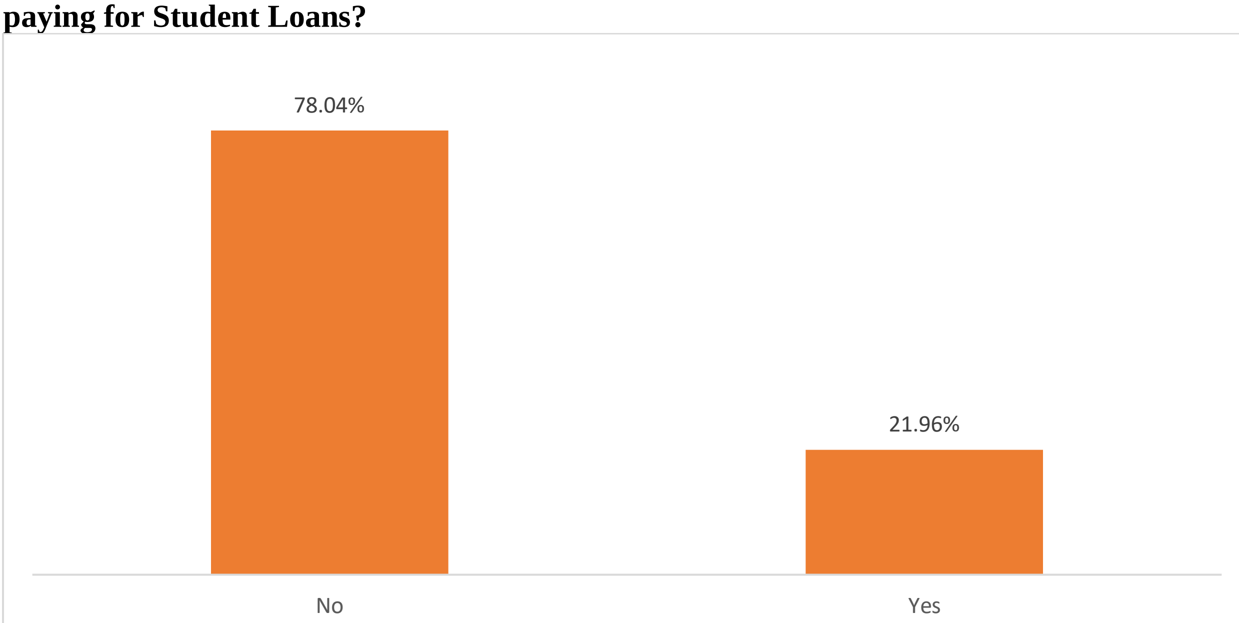
Thinking about your experience in the last 8 months, did your household have problems paying for Utilities?



Thinking about your experience in the last 8 months, did your household have problems paying for Groceries?



Thinking about your experience in the last 8 months, did your household have problems paying for Student Loans?



~ Part III ~

Estimating the Economic Impacts of COVID-19

In this section, we analyze the economic impact of COVID-induced disruptions to businesses, the resulting job losses, and how these create ripple effects to the entire economy of the region. We assess the negative impacts of job losses across all major industries, while also accounting for the positive impacts created by the Paycheck Protection Program (PPP).

Methodology:

The IMPLAN Model

The study used the IMPLAN modeling system which is an Input-Output model[10]. IMPLAN uses data from the U.S. Bureau of Economic Analysis to build trade flows between businesses, and between businesses and final consumers (The IMPLAN Group, LLC). The IMPLAN model is built with 546 industries of the North American Industrial Classification System (NAICS); thus, it captures the entire economy. We used the most recent database within the IMPLAN system for second quarter 2020 (annualized) to account for COVID-19. Within the IMPLAN program we built an economic model for the Piedmont Triad's 12-county region. This allows us to track the impacts of monetary transactions within the Piedmont Triad economy. Type SAM (Social Accounting Matrix) multipliers from the IMPLAN system were used to estimate the economic impacts associated with all scenarios.

To achieve the objective of modeling impacts by industry, it was necessary to aggregate the IMPLAN sectors. We used IMPLAN custom-aggregation scheme to aggregate sectors into two-digit NAICS industries (Table 2.1). Data on job losses by industry are calculated from county-level unemployment statistics and continuing claims for unemployment insurance during the first three months of the pandemic. Data sources are North Carolina Department of Commerce (Local

10 For more information on the IMPLAN modeling process, visit IMPLAN.com.

Area Unemployment Statistics) and the U.S. Department of Labor's Bureau of Labor Statistics (BLS).

Table 2.1: Job losses by industry for the Piedmont Triad During COVID-19 (April – June)

Aggregated Industry	Number of two-digit NAICS industries/sectors included	Number of jobs lost during the pandemic recession
Construction	13	2,134
Education and Health Services	13	15,601
Financial Activities	8	1,344
Information	16	555
Leisure and Hospitality	16	14,668
Manufacturing	329	19,070
Trade, Transportation, & Utilities	42	18,821
Natural Resources & Mining	38	91
Public Administration	8	558
Professional Services	8	12,307
Other support services	5	2,960

Paycheck Protection Program (PPP) loan recipients: We used data from the U.S. Small Business Administration (SBA) of PPP loan recipients by state. Since the data were stripped of identifying information except the addresses of the business, we had to cross-reference the recipient addresses in North Carolina, that is, geocoding the location of recipients (using their addresses) to determine the number of Piedmont Triad businesses that received PPP money. We then calculated the sum of PPP money that was received in the region and the number of jobs saved as a result. A total of 2,725 Piedmont Triad businesses received PPP loans totaling $1.13 billion. This is the equivalent of about 52,000 jobs saved.

Three Models of Economic Impacts

Model 1: The economic impact of job losses during the pandemic

In this model, we account for the economic impact of COVID-19- induced job losses. We take the job loss by all industries (Table 2.1) and run it within the IMPLAN model to calculate the direct, indirect, and induced effects in the region. This gives the total economic impact in terms of lost incomes, lost output, and lost tax revenues across the region.

Model 2: The net economic impact of job losses due to the pandemic and PPP loan payments

In this model we account for job losses across all industries (as in model 1) and then the amount of PPP money received by businesses within the region. This new money spent in the region creates positive economic impacts. Modeling both the impact of jobs lost due to COVID and the inflows of PPP money, we estimate the net impact within the economy of the region.

Model 3: The net economic impact of job losses due to the pandemic and PPP jobs saved

In this model we account for the effect of jobs lost during the pandemic, but rather than control for PPP money inflows as in model 2, we instead add jobs saved due to the PPP program. A major part of the PPP program requirements was for businesses receiving the loans to keep workers on payroll. We estimate that about 52,000 jobs were saved by the PPP money received by 2,725 businesses in the region, an average of 19 jobs saved per business receiving the PPP loans. This model calculates the net impact of these two opposing job changes within the region.

In addition to controlling for the PPP program effects in models 2 and 3, the analyses performed in all three models also account for the impacts of the $1,200 CARES Act (stimulus) payments to individuals and households. The IMPLAN database we used for the analysis already had the $1,200 stimulus payments and enhanced unemployment benefits built into it. Thus, it is reflected in household spending and saving behavior.[11]

Economic Impact Results

In discussing the results, it is important, first, to explain three types of economic impacts: direct, indirect, and induced effects. In economic impact studies, direct effects refer to the initial shock to an economy, which can take the form of a change in spending or employment within an economy. The initial change—positive or negative— is modeled in IMPLAN in terms of increase/decrease in spending or employment. Indirect and induced effects are the ripple effects to the economy resulting from the business to business and household to business transactions that result from the initial change in spending/employment. In all the results presented in the following tables and figures, the impacts are annualized, that is, we assume that the COVID-19 pandemic lasts for a full year. Thus, the initial (direct) impacts, and consequent indirect and induced effects, are calculated for a full calendar year. In other words, these would be the annual impacts on the economy of the region if COVID persisted for a year.

The analyses show negative impacts across the board. First, the direct effects are negative, indicating negative shock to employment, labor incomes, value added, and output due to COVID-19. This then creates additional negative indirect and induced effects as business-to-business spending dropped and households withheld spending. The total impact (sum of direct,

[11] Clouse, Candi. "Using the Evolving Economy- COVID 2020 Q2 Data." IMPLAN Support Site, The IMPLAN Group, LLC. October 7, 2020.

indirect, and induced) on regional employment, labor incomes, value added, and output is then calculated.

We now turn to discussing the results under each of the three models. The results presented in the following tables and figures, show that model 1 is an extreme (high) impact scenario, model 2 is a middle-ground scenario, and model 3 is an extreme low (conservative) impact scenario. A note of caution with these impacts, particularly the tax impacts, is that taxes on production and imports in the IMPLAN model are calculated net of government subsidies[12]. It is entirely possible that the large amount of subsidies granted to various industries under the CARES Act may skew the tax impacts. Also, the tax impact for each level of government is the sum of impact on all tax revenue sources (property tax, sales & excise tax, personal tax, corporate tax etc.)[13]

In model 1 (Tables 2.2 – 2.3 and Figures 2.1 – 2.2), the total impact on employment, if COVID-19 persisted for a year, is 157, 220 lost jobs, $8.5 billion lost labor incomes and $14 billion lost value added (contribution to gross regional product), and $28 billion lost output. Tax revenue losses are $384 million to sub-counties (municipalities), $668 million to counties, and $1.5 billion to state taxes. The top 5 most impacted industries under this scenario are trade, transportation & utilities; manufacturing; educational and health services; leisure & hospitality; and financial activities.

In model 2 (Tables 2.4 – 2.5 and Figures 2.3 – 2.4), the total impact on employment is 113, 448 lost jobs, $6.3 billion lost labor incomes and $10.5 billion lost value added (contribution to gross regional product), and $21 billion lost output. Tax revenue losses are $311 million to sub-counties (municipalities), $541 million to counties, and $1.18 billion in state taxes. The top 5 most impacted industries under this scenario are trade, transportation & utilities; manufacturing; educational and health services; leisure & hospitality; and financial activities.

In model 3 (Tables 2.6 – 2.7 and Figures 2.5 – 2.6), the total impact on employment is 55,960 lost jobs, $3 billion lost labor incomes and $5 billion lost value added (contribution to gross regional product), and $10.48 billion lost output. Tax revenue losses are $177 million to sub-counties (municipalities), $308 million to counties, and $640 million in state taxes. The top 5

---

[12] Taxes on production and income net of subsidies consist primarily of excise and sales taxes paid by individuals to businesses. These taxes occur during the normal operation of these businesses but do not include taxes on profit and income (IMPLAN Manual, 1996).

[13] Clouse, Candi. "Taxes: Where's the Tax?" IMPLAN Support Site, The IMPLAN Group, LLC. August 28, 2020.

most impacted industries under this scenario are trade, transportation & utilities; manufacturing; educational and health services; leisure & hospitality; and financial activities.

In a nutshell, the tax impact of a year-long COVID-19 pandemic would lead to the state losing anywhere from $640 million to $1.5 billion (or 6% of tax revenues). This estimate falls in line with the state official forecast of $1.64 billion tax revenue losses in FY2019-20 tax collections (6.6%) and $2.57 billion (9.9%) in FY2020-21.[14] Similarly, counties in the Piedmont Triad could lose combined tax revenues between $308 - $668 million (the equivalent of 3% of their annual revenues), and municipalities could lose $177 - $384 million. Other studies of COVID-19 impact on state and local tax revenues have shown losses much higher. The Tax Policy Center estimated that in May state sales tax receipts shrank 21% nationally, while in North Carolina, it shrank by 15.1%.[15] A survey recently found that cities have lost 21% of revenues since the pandemic started while expenditures have risen by 17% in the same period. As a result, municipalities are facing a budget gap of $90 billion for 2020 alone.[16]

PPP Program Multiplier

Comparing the impacts under model 1 and 3, we derive impact multipliers for the PPP program as follows. In terms of employment impact, total employment impact without the PPP (model 1) is -157, 220 and with the PPP job savings (Model 3) total employment impact is -55,960. On net, the difference is 101,260 jobs not lost, implying the PPP program had a

Employment multiplier

1.95

Output multiplier

15.88

PPP Program Tax multiplier

0.75

[14] Fiscal Research Division, North Carolina General Assembly (2020). North Carolina General Fund Revenue Consensus Forecast: May Revision. May 22, 2020.

[15] Dadayan, Lucy (2020). The COVID-19 Effect: State sales tax receipts shrank $6 billion in May. Retrieved from http://www.taxpolicycenter.org. July 14, 2020.

[16] National League of Cities (2020). The COVID-19 Recession: Without direct local aid, Americans will continue to fight this pandemic with both arms tied behind their backs. December 2, 2020.

multiplier of 1.95 (=101,260/52,000). This means that for every job saved by the PPP program, another 2 jobs were saved in the region.

To derive the PPP output multiplier, realize that output declines by $28,353,918,570 in model 1, and by $10,488,554,586 in model 3. The difference ($17,865,363,984) is the amount of output not lost which is attributed to the PPP program. Thus, given that the PPP payments received in the region was $1.13 billion, it implies that the PPP program created an output multiplier of 15.88. For every dollar of PPP loan money received in the region, $15.88 in output was saved. By similar calculations, the tax multiplier (State taxes) is 0.75, meaning that each dollar of PPP money saved $0.75 of state tax revenues that would otherwise have been lost without the PPP program.

Table 2.2: Employment and output impacts of COVID-19 in the Piedmont Triad (Model 1)

Impact	Employment	Labor Income	Value Added	Output
Direct	(88,105.89)	$(4,917,071,344.73)	$(8,305,194,671.91)	$(17,345,278,380.34)
Indirect	(42,871.53)	$(2,240,948,716.59)	$(3,362,946,870.43)	$(6,681,750,724.81)
Induced	(26,243.23)	$(1,349,778,560.86)	$(2,367,311,052.07)	$(4,326,889,464.93)
Total	**(157,220.66)**	**$(8,507,798,622.18)**	**$(14,035,452,594.40)**	**$(28,353,918,570.09)**

Table 2.3: Tax impacts of COVID-19 in the Piedmont Triad (Model 1)

Impact	Sub-County	County	State
Direct	$(245,839,055.93)	$(427,630,730.90)	$(927,691,387.89)
Indirect	$(65,476,363.53)	$(114,023,130.00)	$(294,627,770.39)
Induced	$(73,135,749.37)	$(127,202,289.21)	$(270,989,350.78)
Total	**$(384,451,168.83)**	**$(668,856,150.10)**	**$(1,493,308,509.05)**

Appendix B Contract Template for Use with Private Sector Contracts:

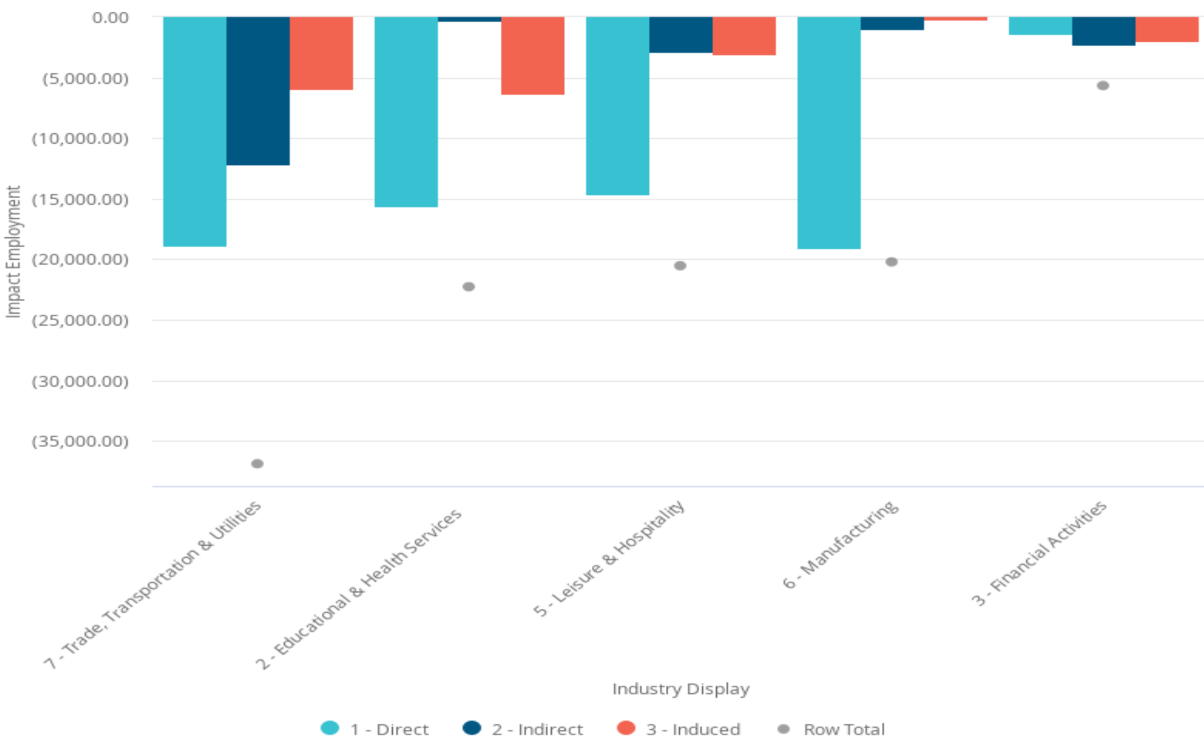


Figure 2.1: Top 5 Employment impact industries (Model 1)

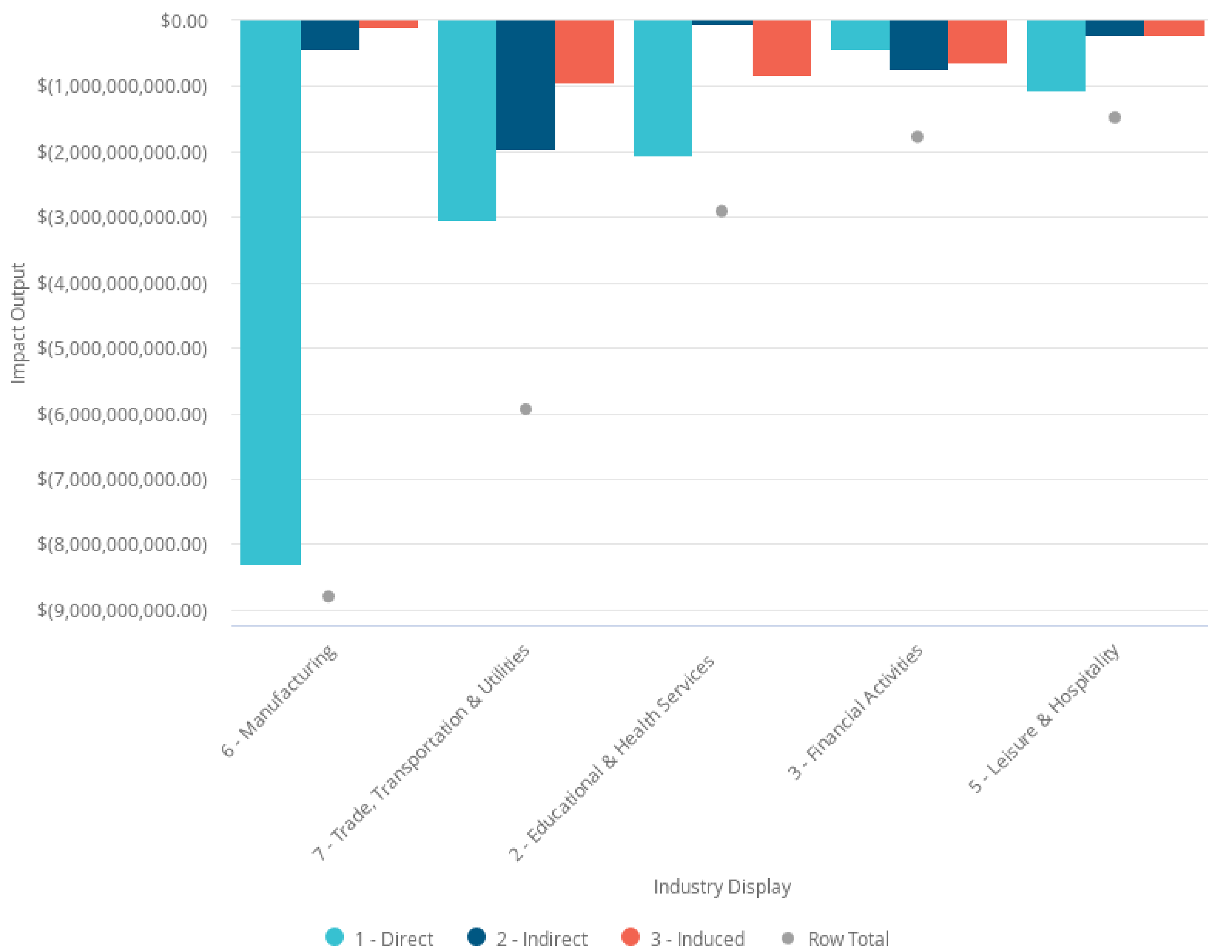


Figure 2.2: Top 5 Output impact industries (Model 1)

Table 2.4: Employment and output impacts of COVID-19 in the Piedmont Triad (Model 2)

Impact	Employment	Labor Income	Value Added	Output
Direct	(61,974.43)	$(3,623,851,171.29)	$(6,273,821,864.58)	$(13,195,490,328.83)
Indirect	(32,051.82)	$(1,678,126,830.59)	$(2,521,233,732.07)	$(5,012,094,539.98)
Induced	(19,422.48)	$(998,971,972.65)	$(1,752,057,739.06)	$(3,202,375,390.34)
Total	(113,448.73)	$(6,300,949,974.53)	$(10,547,113,335.70)	$(21,409,960,259.15)

Table 2.5: Tax impacts of COVID-19 in the Piedmont Triad (Model 2)

Impact	Sub-County	County	State
Direct	$(206,971,602.40)	$(359,950,573.47)	$(754,281,918.36)
Indirect	$(49,924,296.79)	$(86,935,929.00)	$(223,064,355.07)
Induced	$(54,138,690.47)	$(94,161,383.47)	$(200,589,104.18)

Total	$(311,034,589.67)	$(541,047,885.95)	$(1,177,935,377.61)

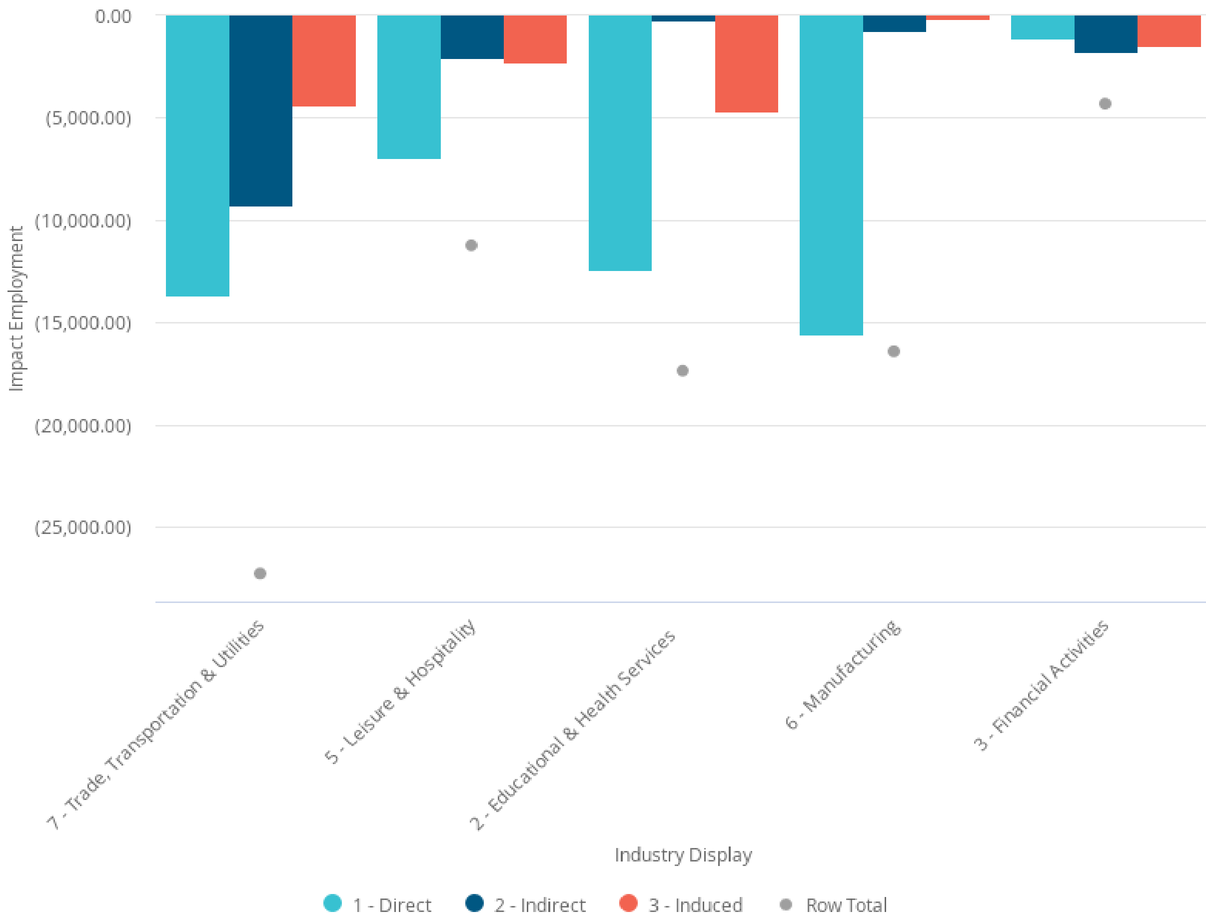


Figure 2.3: Top 5 Employment impact industries (Model 2)

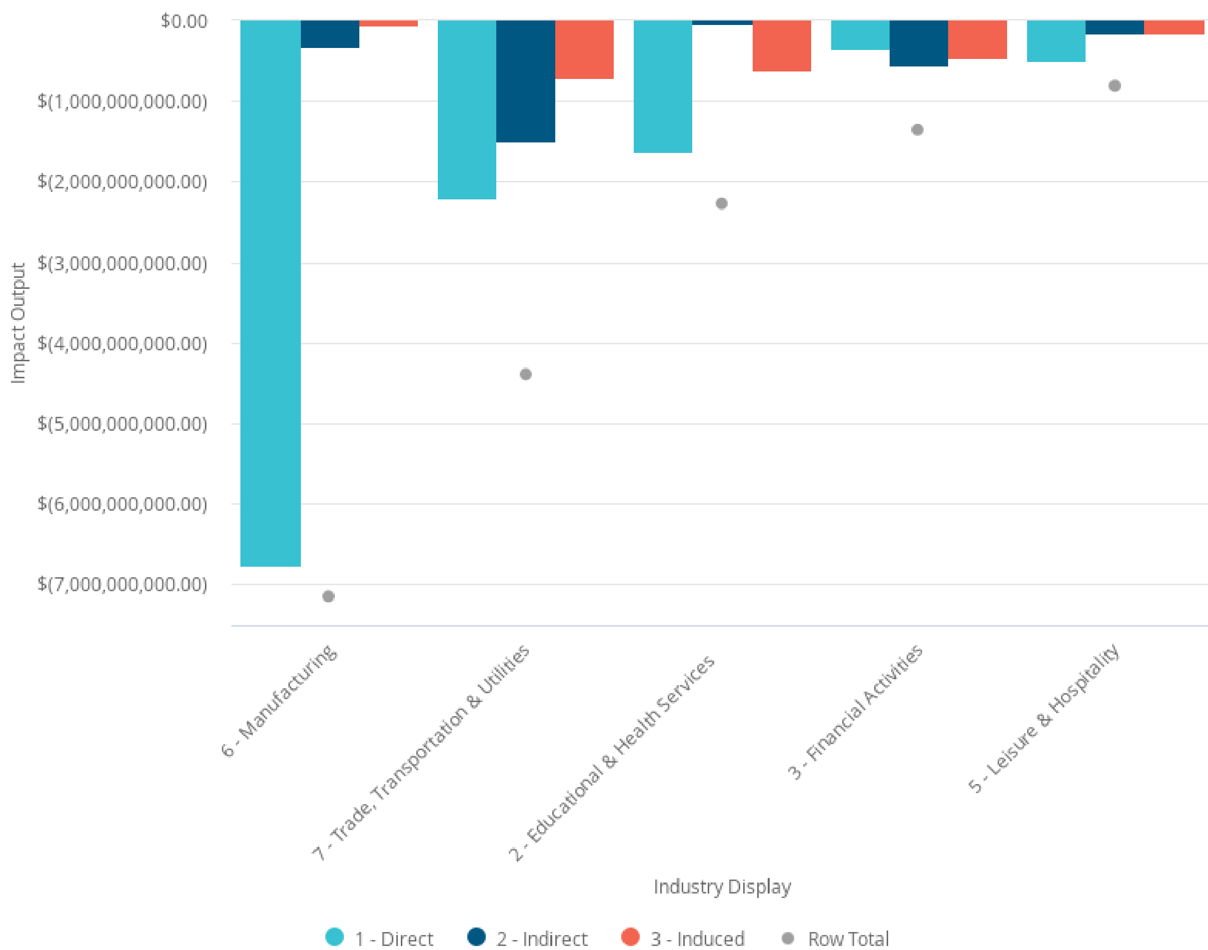


Figure 2.4: Top 5 Output impact industries (Model 2)

Table 2.6: Employment and output impacts of COVID-19 in the Piedmont Triad (Model 3)

Impact	Employment	Labor Income	Value Added	Output
Direct	(31,069.00)	$(1,704,140,636.65)	$(3,035,527,572.30)	$(6,487,518,805.77)
Indirect	(15,638.46)	$(823,816,876.18)	$(1,245,970,679.33)	$(2,475,313,614.50)
Induced	(9,253.35)	$(475,938,911.49)	$(834,734,745.50)	$(1,525,722,166.55)
Total	(55,960.81)	$(3,003,896,424.32)	$(5,116,232,997.14)	$(10,488,554,586.82)

Table 2.7: Tax impacts of COVID-19 in the Piedmont Triad (Model 3)

Impact	Sub-County	County	State
Direct	$(123,831,276.14)	$(215,294,769.25)	$(427,139,007.83)
Indirect	$(27,543,019.37)	$(47,948,101.41)	$(117,779,436.56)
Induced	$(25,798,085.99)	$(44,869,626.10)	$(95,579,683.67)

Total	$(177,172,381.50)	$(308,112,496.76)	$(640,498,128.06)

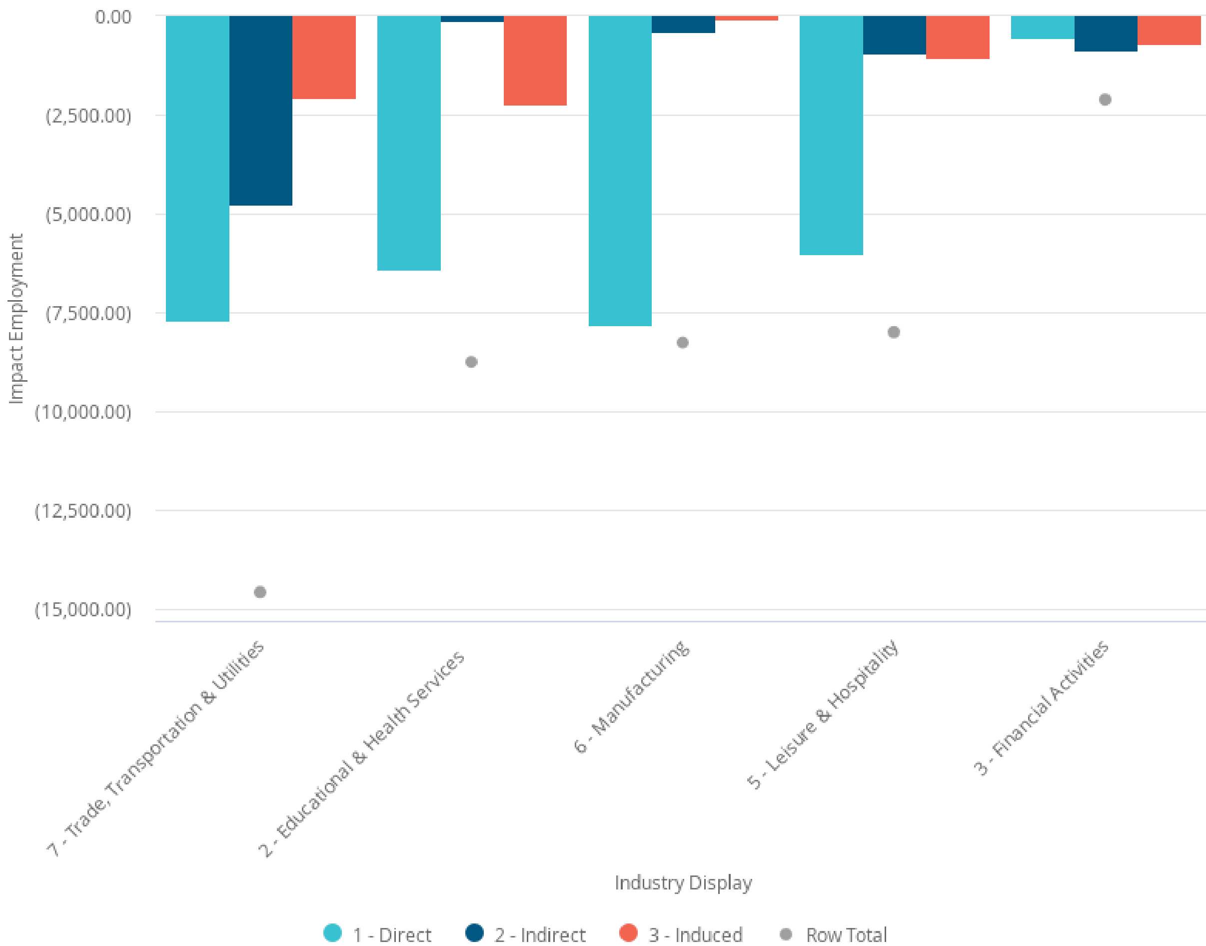


Figure 2.5: Top 5 Employment impact industries (Model 3)

Appendix B Contract Template for Use with Private Sector Contracts:

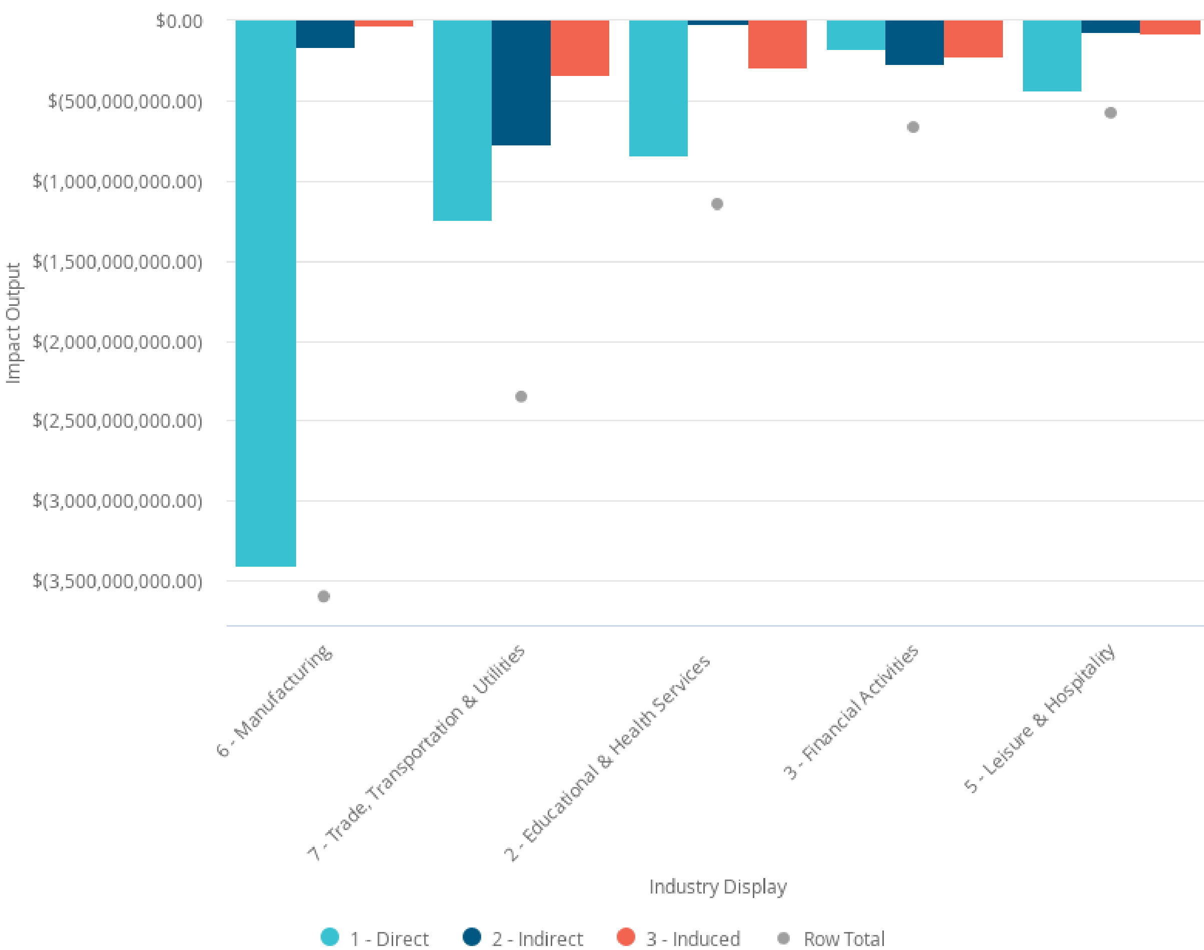


Figure 2.6: Top 5 Output impact industries (Model 3)

~ Part IV ~

Estimating the Economic Impacts of COVID-19

The Impact of COVID-19 on North Carolina A&T State University Operations

The outbreak of COVID-19 in the spring of 2020 forced many colleges in the UNC System, including North Carolina A&T, to move all classes online beginning in March and continuing into the summer and fall semesters. At the start of the fall semester the UNC System directed all campuses to prepare worst-case scenario-planning forecasts of how COVID-19 would impact their enrollment and budgets for the 2020 – 2021 academic year. North Carolina A&T State University presented seven scenarios (Table 3.1). These scenarios range from normal operations or status quo (Scenario A) to going completely online with 50% reduction in enrollment and consequent budget shortfalls (Scenario E). This study is an attempt to quantify the pandemic's impact on the operations of NC A&T State University, its enrollment and revenues, and the ripple effects that would create within the Piedmont Triad economy.

We assess the economic impact to the Piedmont Triad region of three of the hypothetical worst-case scenarios presented in Table 3.1 as well as the fall actual disruptions to NC A&T operations. These four worst-case and actual scenarios are compared in Table 3.2 below.

Table 3.1: North Carolina A&T scenario planning forecasts that would result under different states of closures due to the pandemic.

Appendix B Contract Template for Use with Private Sector Contracts:

Estimated Revenue Impact Scenario Planning for 2020-21		"New Normal" (status quo)	Social Distancing Only	Online Fall 2020 Enroll: -2% Δ + Mand. Fees	Online Fall 2020 Enroll: -5% Δ	Online Fall 2020 Enroll: -10% Δ	Online Fall 2020 Enroll: -25% Δ	Online Fall 2020 Enroll: -50% Δ
Revenue Source	Annual Budget	Scenario A	Scenario B	Scenario C1	Scenario C2	Scenario C3	Scenario D	Scenario E
Anticipated Revenue Impacts								
Enrollment (FTE)	11,766	-	-	(235)	(588)	(1,177)	(2,942)	(5,883)
State Appropriation	$ 95,000,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Tuition Revenue (net)	$ 50,000,000	$ -	$ -	$ (1,000,000)	$ (2,500,000)	$ (5,000,000)	$ (12,500,000)	$ (25,000,000)
Student Fees (net)	$ 24,000,000	$ -	$ -	$ (480,000)	$ (9,750,000)	$ (10,500,000)	$ (12,750,000)	$ (16,500,000)
Financial Aid (external)	$ 50,000,000	$ -	$ -	$ (1,000,000)	$ (2,500,000)	$ (5,000,000)	$ (12,500,000)	$ (25,000,000)
Athletics (less fees)	$ 3,000,000	$ -	$ (750,000)	$ (1,500,000)	$ (1,500,000)	$ (1,500,000)	$ (1,500,000)	$ (1,500,000)
Housing (net)	$ 10,000,000	$ -	$ -	$ (4,520,000)	$ (4,550,000)	$ (4,600,000)	$ (4,750,000)	$ (5,000,000)
Dining (net)	$ 13,000,000	$ -	$ (3,250,000)	$ (5,876,000)	$ (5,915,000)	$ (5,980,000)	$ (6,175,000)	$ (6,500,000)
Parking	$ 1,500,000	$ -	$ -	$ (678,000)	$ (682,500)	$ (690,000)	$ (712,500)	$ (750,000)
Sales, Services, & Other Aux.	$ 4,000,000	$ -	$ (600,000)	$ (1,200,000)	$ (1,200,000)	$ (1,200,000)	$ (1,200,000)	$ (1,200,000)
Patient Services	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Research & Grants	$ 35,000,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Gifts & Investments	$ 26,000,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenue	$ 311,500,000	$ -	$ (4,600,000)	$ (16,254,000)	$ (28,597,500)	$ (34,470,000)	$ (52,087,500)	$ (81,450,000)
Percent Change	100%	0.0%	-1.5%	-5.2%	-9.2%	-11.1%	-16.7%	-26.1%

Source: NC A&T State University, Office of the Vice Chancellor for Business and Finance

Table 3.2: Economic Impact Scenarios Analyzed

Scenario	Definition	Anticipated Revenue Change
Scenario A	All classes are in-person in fall 2020 with social distancing. No change in enrollment	-1.5% (-$4,600,000)
Scenario B	All classes are online in fall 2020. Enrollment decline by 25%	-16.7% (-$52,087,500)
Scenario C	All classes are online fall 2020. Enrollment decline by 50%	-26.1% (-$81,450,000)
Scenario D (Actual, Fall 2020)	4.13% of students taking all classes in-person, 34.38% all online, and 61.48% in hybrid/mixed classes.	-8.6% (-$26, 821,875)

Source: NC A&T State University, Office of the Vice Chancellor for Business and Finance

Assumptions underlying the economic impact analysis

In order to analyze the economic impacts of these scenarios of North Carolina A&T academic disruptions resulting from the COVID-19 pandemic, certain critical assumptions had to be made. One of these is that the university's operational spending occurs locally and that reductions in university revenues translate into reductions in spending. This assumption may not necessarily hold true if the revenue shortfalls have been offset (partially or wholly) by federal subsidies received under the CARES Act. For example, the university received about $42 million in CARES Act funding, of which $6 million was used to partially offset some of these revenue losses, and the remainder used to support student scholarships. The university, thus, had to make some operational budget cuts. Any such cuts in spending are expected to generate a negative economic impact in the region, through the multiplier process.

The second important assumption we make, as with all economic impact studies, is that every dollar spent in the local economy generates a multiplier effect which is equal to the sum of direct, indirect, and induced effects to the local economy. Direct effect refers to the initial spending change in the economy, whether positive or negative, and is modeled in terms of increase/decrease in spending. Indirect and induced effects are the ripple effects to the economy resulting from the initial (direct) spending change. Indirect effects are like "downstream" effects created by backward linkages of businesses along the supply chain of the economy, while induced effects result from transactions between households and businesses as households spend their incomes.

Economic Impact under different scenarios

We conducted economic impact analysis under the four scenarios presented in Table 3.2. In addition to the economic impacts of revenue shortfalls, we also model the economic impact of student spending or lack thereof. As a result of the pandemic, some students are taking all their classes virtually. Such students are not residing and spending within the region as would be the case without COVID-19. These lost expenditures are included in the analysis. Using the fall 2020 enrollment, we estimate that about 4,200 A&T students chose to take all their classes wholly online and therefore are not resident in Greensboro.

As shown in Table 3.3 below, 8,015 students have at least one main campus class in Fall 2020. Given fall 2020 total enrollment of 12,215, it means that 4,200 students are not resident in Greensboro due to COVID-19. The estimated lost expenditures of these students (such as spending in local restaurants, transportation/gas, recreation/amusements, etc) of about $15 million create direct, indirect and induced economic impact in the region.

Table 3.3: NC A&T Fall 2020 Headcount

Category	HEADCOUNT	Percentage
Main Campus Only	505	4.14%

Distance Learning Only	4200	34.38%
Mixed/Hybrid	7510	61.48%
Total	**12215**	**100%**

Source: NC A&T State University, Office of the Registrar, fall 2020

Economic Impact Results

We used the IMPLAN modeling program to analyze the economic impacts of the four NC A&T State University revenue scenarios resulting from the COVID-19 pandemic (Table 3.2). These worst-case scenarios of enrollment and budget cuts were modeled to determine how these cuts in spending would ripple across the region. The summary results of the economic impacts are shown in the Tables 3.4, 3.5, and 3.6 below.

Table 3.4: Employment Impacts of NC A&T Budget Reduction Scenarios

Impact Type	Scenario A	Scenario B	Scenario C	Scenario D (Fall 2020 Actual)
Direct	(56.80)	(643.17)	(1,005.73)	(331.19)
Indirect	(1.43)	(114.47)	(123.61)	(106.60)
Induced	(12.62)	(162.83)	(243.36)	(93.54)
Total	**(70.85)**	**(920.47)**	**(1,372.70)**	**(531.33)**

Notes: Scenario A: Normal university operations with minimal social distancing. Scenario B: Classes are virtual and 25% reduction in enrollment and budget. Scenario C: Classes are virtual and 50% reduction in enrollment and budget. Scenario D/Fall 2020 actual: 4.13% in-person, 34.38% virtual, and 61.48% hybrid/mixed Classes, $26.8 million revenue reduction

North Carolina A&T contributes to the economy of the Triad through its spending. Categories of spending by the university include payroll for faculty and staff, operational purchases, and spending by students. A recent economic impact study of the university showed that North Carolina A&T generates a $1.48 billion impact on the economy of the state.[17] Just as spending increases create positive economic impacts, any cuts in spending create a negative economic impact as well. In this analysis, the reduced spending under the four scenarios create negative

[17] Romero, Alfredo and Naanwaab, Cephas (2020). The Economic Impact of North Carolina A&T State University. https://www.ncat.edu/news/2020/08/ncat-2020-economic-impact.php

economic impacts on jobs, output, incomes, and tax revenues across the region. Table 3.4 shows that reduced spending would create direct job losses of 56.8 (Scenario A), 643 (Scenario B), 1,005 (scenario C), and 331.2 (Scenario D). In fall 2020, if the university were to cut spending by the amount of revenue fall ($26.8 million), then this would have resulted in 331.2 direct job losses. Presumably, the university would have had to eliminate some part-time and, possibly, full time positions to cope with these budget cuts had it not been for offsets like the CARES Act money that the university received. The indirect and induced effects are also negative. Thus, A&T direct spending cuts triggers a negative ripple effect on business and households, the impact of which is lost business and household spending leading to negative indirect and induced employment effects. Through the multiplier process, additional job losses would occur (indirect and induced effects). Thus, the total job losses under the four scenarios are much higher than the direct job losses (70.85 under Scenario A, 920.47 under Scenario B, 1,372.7 under Scenario C, and 531.33 under Scenario D/fall 2020 scenario). In total, the Scenario A—a mild case of COVID impact whereby the university can maintain all in-person classes with minimal social distancing— would yield a total impact of 70.85 jobs lost in the region. Comparatively, Scenario A has the least impact and Scenario C has the worst impact. The realized scenario (fall 2020) turned out to be much better than the worst worst-case scenario (Scenario C).

Table 3.5: Output Impacts of NC A&T Budget Reduction Scenarios

Impact Type	Scenario A	Scenario B	Scenario C	Scenario D (Fall 2020 Actual)
Direct	$(4,012,131.04)	$(45,430,842.56)	$(71,040,885.56)	$(23,394,103.77)
Indirect	$(224,428.23)	$(17,860,967.40)	$(19,293,526.92)	$(16,628,289.26)
Induced	$(1,931,691.85)	$(24,929,957.15)	$(37,260,240.17)	$(14,320,087.18)
Total	**$(6,168,251.12)**	**$(88,221,767.10)**	**$(127,594,652.65)**	**$(54,342,480.21)**

Notes: Scenario A: Normal university operations with minimal social distancing. Scenario B: Classes are virtual and 25% reduction in enrollment and budget. Scenario C: Classes are virtual and 50% reduction in enrollment and budget. Scenario D/Fall 2020 actual: 4.13% in-person, 34.38% virtual, and 61.48% hybrid/mixed Classes, $26.8 million revenue reduction

Table 3.5 shows negative output impacts that would result in losses to Gross Regional Product of the region. In all four scenarios, spending cuts create negative output in the region. The amount of direct output losses range from $4 million under Scenario A to $71 million under Scenario C. These initial output losses (direct impacts) then create ripple effects in the form of indirect and induced output losses. Total output losses range from $6.2 million in Scenario A to $127.6 million in Scenario C. Once again, the fall 2020 (actual) scenario turned out to be better than the worst-case Scenario C, but worse than would have been the case if the university had normal operations with minimal social distancing requirements (Scenario A). These results show that if covid-19 persists for a year and the university's normal operations (in-person classes) were disrupted, it could have significant economic impacts throughout the region. For instance, a 50% reduction in enrollment and associated revenue shortfalls would create economic impact ranging from $88 to $127 million lost output and close to 1,400 jobs lost in the Piedmont Triad.

The tax impacts of NC A&T budget reduction scenarios show that there would be significant tax revenue falls across all four scenarios (Table 3.6). Both state/local and federal tax revenues would significantly fall if NC A&T reduced its spending. Focusing only on the total tax impact (sum of direct, indirect, and induced impacts) Scenario A shows that the region would experience a decreased state and local tax revenue by $398,781 while federal tax revenue would decrease by $1,333,475. Under the worst-case Scenario C, state/local and federal taxes would fall by $8 million and $25.5 million, respectively. Under the fall 2020 scenario, state/local and federal tax revenues fall by $3.3 million and $9.7 million, respectively.

In summary, the COVID-19 pandemic has disrupted NC A&T normal operations as the Scenario D (actual fall 2020) shows. With the university having only 4.14% of classes in-person, 34.38% online, and 61.5% mixed/hybrid, has led to revenue losses of $26.7 million. Consequently, the economic impact to the Piedmont Triad region as a result of this disruption is projected to a total loss of 531 jobs, $54 million lost output, $3.3 million lost state/local tax revenues, and $9.7 million lost federal tax revenues. These estimates also account for lost student spending due to some students not staying in the area.

Table 3.6. Tax Impacts of NC A&T Budget Reduction Scenarios

	Scenario A		Scenario B		Scenario C		Scenario D (Fall 2020 Actual)	
Impact Type	State &Local	Federal	State & Local	Federal	State & Local	Federal	State & Local	Federal
Direct	$(170,185.29)	$(1,183,030.50)	$(1,927,070.90)	$(13,395,891.57)	$(3,013,389.49)	$(20,947,355.28)	$(992,323.59)	$(6,898,064.39)
Indirect	$(11,250.53)	$(23,449.18)	$(739,393.40)	$(1,945,246.30)	$(811,207.24)	$(2,094,925.97)	$(677,599.56)	$(1,816,451.05)
Induced	$(217,345.87)	$(126,995.66)	$(2,804,023.12)	$(1,639,772.48)	$(4,191,374.89)	$(2,450,405.10)	$(1,610,245.02)	$(942,245.36)
Total	**$(398,781.69)**	**$(1,333,475.34)**	**$(5,470,487.42)**	**$(16,980,910.34)**	**$(8,015,971.61)**	**$(25,492,686.35)**	**$(3,280,168.17)**	**$(9,656,760.80)**

Notes: Scenario A: Normal university operations with minimal social distancing. Scenario B: Classes are virtual and 25% reduction in enrollment and budget. Scenario C: Classes are virtual and 50% reduction in enrollment and budget. Scenario D/Fall 2020 actual: 4.13% in-person, 34.38% virtual, and 61.48% hybrid/mixed Classes, $26.8 million revenue reduction

IMPLAN Disclaimer

IMPLAN is a regional economic analysis software application that is designed to estimate the impact or ripple effect (specifically backward linkages) of a given economic activity within a specific geographic area through the implementation of its Input-Output model. Studies, results, and reports that rely on IMPLAN data or applications are limited by the researcher’s assumptions concerning the subject or event being modeled. Studies such as this one is in no way endorsed or verified by IMPLAN Group, LLC unless otherwise stated by a representative of IMPLAN.

APPENDIX

Map of NC Piedmont Triad (12-County Area)

Table A1

Month-to-Month Job Change by Industry, 2020
Greensboro-High Point MSA

	Month										
Industry Title	01	02	03	04	05	06	07	08	09	10	11
Federal		0.0%	-2.4%	2.4%	-2.4%	0.0%	2.4%	7.1%	0.0%	-4.4%	-2.3%
Finance and insuran..		0.7%	0.0%	-0.7%	0.7%	0.0%	0.0%	0.0%	0.7%	0.0%	0.7%
Other services		0.8%	0.0%	-21.0%	9.2%	15.9%	0.0%	-1.6%	-0.8%	0.8%	0.0%
Specialty trade cont..		0.9%	0.9%	-4.6%	1.9%	0.9%	0.0%	0.0%	0.9%	0.0%	0.0%
Financial activities		0.5%	1.6%	-2.1%	-0.5%	1.1%	-0.5%	0.5%	0.0%	0.5%	0.0%
Transportation and ..		-0.5%	0.0%	-7.5%	4.8%	1.5%	0.0%	1.5%	2.0%	2.0%	1.4%
Retail trade		-0.8%	1.1%	-7.0%	0.3%	6.0%	0.0%	1.1%	-0.8%	1.3%	2.7%
Trade, transportatio..		-0.4%	0.5%	-6.2%	1.4%	3.3%	0.0%	1.1%	0.3%	1.0%	2.1%
Mining, Logging & C..		1.3%	1.3%	-3.8%	0.7%	3.3%	0.0%	0.6%	0.0%	0.0%	-1.3%
Credit intermediatio..		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.7%	0.0%	0.0%
Durable goods		0.7%	-0.7%	-37.0%	17.3%	20.1%	0.7%	-3.3%	-0.4%	-0.4%	-1.2%
Professional and tec..		1.4%	4.3%	-11.6%	0.8%	0.0%	0.0%	0.8%	0.8%	0.8%	2.2%
Wholesale Trade		0.5%	0.0%	-3.6%	0.0%	0.0%	0.0%	0.5%	0.5%	-0.5%	1.6%
Administrative and ..		0.0%	2.6%	-17.8%	0.9%	6.1%	0.0%	2.5%	0.8%	2.4%	-1.2%
Leisure and hospital..		1.1%	-3.5%	-48.2%	17.3%	35.0%	0.7%	-2.7%	5.2%	0.3%	-1.3%
Private service-prov..		0.2%	0.0%	-15.7%	3.3%	6.7%	0.3%	0.2%	0.8%	0.8%	0.5%
Professional and bu..		0.4%	2.8%	-15.2%	0.7%	3.9%	0.0%	1.6%	0.7%	1.6%	-0.2%
Local government		0.7%	0.4%	-6.0%	-3.4%	0.0%	-21.6%	28.0%	13.3%	2.4%	-0.3%
Total private		0.3%	-0.1%	-17.4%	3.9%	7.3%	0.2%	-0.1%	0.6%	0.6%	0.3%
Information		0.0%	-2.1%	-6.5%	0.0%	0.0%	0.0%	-2.3%	0.0%	2.4%	0.0%
General merchandis..		-2.5%	0.0%	-8.9%	5.6%	3.9%	-2.5%	3.9%	-3.8%	1.3%	6.4%
Service-providing		0.3%	0.0%	-14.0%	1.8%	4.6%	-1.9%	2.4%	2.4%	0.9%	0.4%
Education and healt..		-0.2%	-1.3%	-12.6%	3.6%	2.2%	1.1%	-0.2%	0.0%	0.0%	0.2%
Total nonfarm		0.2%	-0.3%	-16.1%	2.6%	5.9%	-0.5%	0.7%	1.8%	0.5%	0.0%
Goods-producing		0.6%	-0.4%	-23.5%	6.5%	9.9%	0.2%	-1.1%	0.0%	-0.2%	-0.7%
Management of com..		0.0%	0.0%	-11.9%	0.0%	3.8%	0.0%	0.0%	0.0%	0.0%	-1.9%
Furniture and relate..		0.0%	0.0%	-64.0%	15.6%	37.8%	2.0%	0.0%	-1.9%	0.0%	0.0%
Health care and soci..		-0.9%	-0.9%	-15.0%	5.9%	1.9%	0.2%	-0.2%	0.0%	0.5%	0.0%
Ambulatory health c..		0.0%	0.0%	-26.1%	14.7%	1.3%	0.0%	0.6%	-0.6%	1.3%	0.0%
Manufacturing		0.4%	-0.9%	-29.4%	8.8%	12.3%	0.2%	-1.8%	0.0%	-0.2%	-0.4%
Government		1.1%	0.2%	-4.7%	-5.4%	-6.5%	-15.1%	18.1%	12.2%	1.4%	-0.5%
Food services and dr..		-0.3%	-4.8%	-59.0%	22.8%	39.3%	3.1%	-2.0%	5.6%	1.4%	-1.4%
Nondurable goods		0.0%	-1.3%	-19.1%	0.0%	2.7%	-0.5%	0.5%	0.5%	0.0%	0.5%
State government		2.5%	0.8%	-4.0%	-10.8%	-24.3%	-3.7%	-1.3%	15.6%	1.1%	0.0%

% Difference in Employment broken down by Month vs. Industry Title. The data is filtered on Year and Area Name. The Year filter keeps 2020. The Area Name filter keeps Greensboro-High Point MSA.

Table A2

Month-to-Month Job Change by Industry, 2020
Winston-Salem MSA

	Month										
Industry Title	01	02	03	04	05	06	07	08	09	10	11
Federal		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	31.58%	-4.00%	-12.50%	-9.52%
Other services		1.11%	0.00%	-20.88%	1.39%	16.44%	0.00%	-1.18%	-1.19%	1.20%	0.00%
Financial activities		0.72%	0.00%	-2.88%	0.74%	0.74%	0.00%	0.00%	0.00%	0.73%	0.00%
Transportation and ..		-1.10%	0.00%	-8.89%	4.88%	1.16%	0.00%	1.15%	2.27%	6.67%	1.04%
Retail trade		-0.65%	-0.33%	-18.42%	9.27%	5.17%	0.00%	2.81%	0.68%	-0.68%	2.05%
Trade, transportatio..		-0.62%	-0.21%	-14.02%	6.57%	3.42%	0.00%	2.21%	0.86%	0.86%	1.49%
Mining, Logging & C..		1.72%	-0.85%	-10.26%	-4.76%	4.00%	1.92%	0.00%	-0.94%	0.95%	0.94%
Credit intermediatio..		1.64%	0.00%	-1.61%	0.00%	0.00%	-1.64%	-1.67%	3.39%	-1.64%	0.00%
Wholesale Trade		0.00%	0.00%	-3.57%	0.00%	0.00%	0.00%	1.23%	0.00%	0.00%	0.00%
Administrative and ..		2.79%	1.09%	-22.58%	4.17%	4.00%	1.28%	6.96%	1.78%	4.07%	-3.91%
Leisure and hospital..		0.69%	-4.11%	-37.50%	9.71%	16.15%	4.93%	-1.28%	0.00%	0.87%	-0.43%
Private service-prov..		0.16%	-0.57%	-16.21%	3.66%	4.31%	0.46%	2.28%	0.61%	1.39%	-0.05%
Professional and bu..		2.25%	-0.27%	-16.53%	2.97%	3.21%	0.00%	3.42%	2.70%	2.92%	-2.27%
Local government		0.83%	0.00%	-2.89%	-2.55%	0.00%	-18.34%	12.83%	11.85%	2.12%	0.41%
Total private		0.25%	-0.63%	-14.76%	2.52%	4.25%	0.37%	1.85%	0.59%	1.35%	0.09%
Information		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
General merchandis..		-1.64%	0.00%	-23.33%	4.35%	2.08%	-2.04%	6.25%	-3.92%	0.00%	6.12%
Service-providing		0.27%	-0.40%	-14.29%	2.49%	3.50%	-1.76%	3.39%	1.98%	1.32%	-0.09%
Education and healt..		-1.07%	0.54%	-10.25%	0.80%	0.60%	-0.59%	4.57%	-0.19%	1.33%	0.19%
Total nonfarm		0.18%	-0.55%	-13.41%	1.39%	3.61%	-0.45%	2.21%	1.54%	0.81%	0.23%
Goods-producing		0.67%	-0.89%	-8.52%	-1.96%	4.00%	0.00%	0.00%	0.48%	1.20%	0.71%
Health care and soci..		-1.04%	1.05%	-15.18%	1.72%	1.69%	-0.47%	4.76%	-1.36%	1.61%	-0.23%
Manufacturing		0.30%	-0.90%	-7.90%	-0.99%	4.00%	-0.64%	0.00%	0.97%	1.28%	0.63%
Government		0.95%	0.63%	-2.80%	-3.51%	-0.99%	-14.72%	10.98%	10.60%	0.96%	-0.32%
Food services and dr..		0.42%	-5.02%	-45.81%	13.01%	15.11%	1.88%	0.00%	-2.45%	0.63%	-0.63%
Textile mills		0.00%	0.00%	-25.00%	0.00%	4.76%	0.00%	0.00%	0.00%	0.00%	0.00%
State government		1.72%	3.39%	-3.28%	-8.47%	-5.56%	-3.92%	-4.08%	12.77%	1.89%	0.00%

% Difference in Employment broken down by Month vs. Industry Title. The data is filtered on Year and Area Name. The Year filter keeps 2020. The Area Name filter keeps Winston-Salem MSA.

Table A3

Month-to-Month Job Change by Industry, 2020
Burlington MSA

	Month										
Industry Title	01	02	03	04	05	06	07	08	09	10	11
Federal		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	-33.33%
Other services		4.55%	-4.35%	-18.18%	-5.56%	11.76%	5.26%	0.00%	0.00%	0.00%	0.00%
Financial activities		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	0.00%	0.00%	4.76%
Transportation and ..		0.00%	0.00%	-6.25%	0.00%	0.00%	6.67%	0.00%	0.00%	0.00%	6.25%
Retail trade		-3.37%	2.33%	-11.36%	1.28%	5.06%	0.00%	2.41%	0.00%	1.18%	5.81%
Trade, transportatio..		-1.55%	1.57%	-9.30%	0.00%	3.42%	0.83%	1.64%	-0.81%	1.63%	4.80%
Mining, Logging & C..		3.13%	0.00%	-9.09%	10.00%	3.03%	0.00%	0.00%	0.00%	2.94%	-2.86%
Wholesale Trade		4.17%	0.00%	-4.00%	-4.17%	0.00%	0.00%	0.00%	-4.35%	4.55%	0.00%
Leisure and hospital..		1.20%	3.57%	-48.28%	42.22%	15.63%	1.35%	1.33%	-6.58%	4.23%	-1.35%
Private service-prov..		0.68%	0.45%	-18.74%	9.17%	5.85%	0.24%	2.40%	-1.64%	1.67%	1.87%
Professional and bu..		1.96%	-1.92%	-17.65%	11.90%	4.26%	-2.04%	10.42%	-5.66%	2.00%	1.96%
Local government		1.69%	0.00%	-6.67%	0.00%	1.79%	-14.04%	10.20%	7.41%	1.72%	0.00%
Total private		0.71%	0.18%	-19.72%	8.99%	6.44%	0.57%	1.88%	-1.11%	1.49%	1.29%
Information		0.00%	0.00%	-25.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Service-providing		0.98%	0.58%	-16.86%	7.23%	5.22%	-1.65%	3.36%	-0.20%	1.63%	1.40%
Education and healt..		1.55%	-0.76%	-11.54%	8.70%	4.00%	-0.77%	0.78%	1.54%	0.76%	0.75%
Total nonfarm		0.47%	0.23%	-18.24%	7.24%	6.22%	-0.33%	2.02%	-0.25%	1.16%	0.82%
Goods-producing		0.80%	-0.79%	-23.20%	8.33%	8.65%	1.77%	0.00%	0.87%	0.86%	-0.85%
Manufacturing		0.00%	-1.08%	-28.26%	7.58%	11.27%	2.53%	0.00%	1.23%	0.00%	0.00%
Government		2.86%	1.39%	-5.48%	-2.90%	1.49%	-13.24%	10.17%	9.23%	1.41%	-1.39%
State government		11.11%	10.00%	0.00%	-18.18%	0.00%	-11.11%	0.00%	25.00%	0.00%	0.00%

% Difference in Employment broken down by Month vs. Industry Title. The data is filtered on Year and Area Name. The Year filter keeps 2020. The Area Name filter keeps Burlington MSA.

Appendix C
Collaboratory Covid-19 Research Summaries

Start of Block: Introductory Text

Start of Block: Contact Information

Q1 Name

Liesl Jeffers-Francis, Phd

Q2 Email Address

ljeffers@ncat.edu

Q3 Department

Biology

Q5 Primary Institution

O Appendix State University (1)

O Elizabeth City State University (2)

O Fayetteville State University (3)

X NC A&T University (4)

O NC Central University (5)

O NC State University (13)

O UNC Asheville (6)

O UNC Chapel Hill (7)

O UNC Charlotte (8)

O UNC Greensboro (9)

O UNC Pembroke (10)

O UNC Wilmington (14)

O Western Carolina University (11)

O Winston Salem State University (12)

End of Block: Contact Information

Start of Block: Research Project Information

*

Q6 Succinctly state your research question in 2-3 sentences (character limit 100).

Can metals and metallic nanoparticles bind to and inhibit the spike protein of SARS-CoV-2 from interacting with the cellular receptor on host cells?

Q7 Describe your research methods and activities in a short paragraph. Please use plain language and avoid technical terms unless necessary. (character limit 1,000).

To test the hypothesis that metals and metallic nanoparticles can bind to and inhibit the spike protein of SARS-CoV-2 from interacting with the cellular receptor on host cells. We proposed to complete the following activities: 1. Determine the optimal metallic nanoparticle (Ag, Al, Cu) that binds to SARS-CoV-2 spike protein using in-silico computational modelling techniques. 2. Confirm the in-silico model by combining the coronavirus spike protein with the metallic nanoparticle using

the in-silico model by combining the coronavirus spike protein with the metallic nanoparticle usin

Q8 Describe your research findings and conclusions in a short paragraph. Please use plain language and avoid technical terms unless necessary. (character limit 1,000).

We were able to simulate interactions between metal ions and metal nanoparticle (silver, copper, aluminum) with SARS-CoV-2 nucleocapsid protein. A SARS-CoV-2 virus-like particle has been created and is being tested for interaction with copper nanoparticles in-vitro. We have shown that increasing concentrations of copper on three human cell types results in increased cell death.

Q9 From your perspective as a researcher, explain any implications or policy recommendations resulting from your research (character limit 1,000).

It is possible that copper ion/nanoparticles can provide some protective qualities against coronavirus infection when embedded within a fabric, for example, filters, masks, protective clothing.

End of Block: Research Project Information

Start of Block: By the Numbers

Q11 How many members were a part of your research team? Include faculty, staff, postdoctoral researchers, graduate, and undergraduate students. If a type does not apply, please indicate with a numeric zero (0).

- Faculty (1) 2
- Staff, permanent (2) 0
- Staff, temporary (6) 0
- Postdoctoral researchers (3) 0
- Graduate students (4) 4
- Undergraduate students (5) 0

*

Q12 How many community members or participants did you engage in your research project? If not applicable, please indicate with a numeric zero (0).

0

Q20 How many University-external stakeholders or partners did you work with as part of your research project?
If not applicable, please indicate with a numeric zero (0).

1 - UNC Chapel Hill

Q18 Please detail any other interesting project-specific metrics (e.g. number of samples) that are relevant to your project below.

We observed that copper nanoparticles are toxic to three human cells types

human acinar salivary gland cells, human ductal salivary gland cells and

telomerase-immortalized human normal oral keratinocytes ,in a concentration dependent manner.

____

____

Q13 Were you able to leverage additional funding to continue the research funded by the NC General Assembly through the NC Policy Collaboratory?

- O Yes (1)
- O x No (2)

Display This Question:

If Were you able to leverage additional funding to continue the research funded by the NC General As... = Yes

Q15 Please detail the amount of leveraged funding and the funding agency or agencies below. If you received funding from more than 5 sources, please email Hope Thomson at thomson1@email.unc.edu .

	Funding Amount ($) (1)	Funding Agency (2)
Funding Source 1 (1)		
Funding Source 2 (2)		
Funding Source 3 (3)		
Funding Source 4 (4)		
Funding Source 5 (5)		

Q16 Do you have a grant in progress or plan to apply for additional funds to continue your work as funded by the Collaboratory? If so, please detail the grant amounts and funding agencies below to the best of your knowledge.

Yes, we plan to first publish the data that we received then use this data to appyly for NSF/NIH funding. We have not identified a specific RFA as of yet.

Q17 Please include below any links to news coverage, press releases, or other public-facing documentation of your Collaboratory-funded work:

Virtual presentation at North Carolina A&T State University annual Center of Excellence Research Symposium

End of Block: By the Numbers