Research activities and findings

As of mid-February 2020, SARS-CoV-2 has infected more than 100 million people worldwide and caused almost 2.4 million deaths. There have been multiple reports of outbreaks, sometimes involving more than a thousand people, in meat packing plants, food processing facilities, and commercial farms in the US and other countries. As employees of these facilities are considered essential workers, they are expected to continue working despite the elevated risk. Workers also infect their household members, contributing to spread in surrounding communities. In addition to the adverse effects on human health, these localized outbreaks can overwhelm medical and public health institutions, especially in underserved rural communities where these industries are concentrated, and threaten the food supply due to worker absenteeism from illness. Furthermore, spread of SARS-CoV-2 in these industries contributes to health disparities. Racial and ethnic minorities have suffered a disproportionate burden of COVID-19 morbidity and mortality, and similar trends have been seen among food processing workers. Among agricultural workers in the United States, 87% of known COVID-19 cases have occurred in racial or ethnic minorities, particularly among Hispanic or Latinx communities.

Workers in the farming and food processing industries face an elevated risk of SARS-CoV-2 infection due to distinctive workplace, environmental, and community factors including physical proximity between workers; prolonged shifts; and shared work and living spaces, equipment, and transportation. Meat and food processing facilities may also provide favorable physical environments for SARS-CoV-2 due to cold temperatures, low humidity, and metallic surfaces. Despite the high susceptibility of meat packing and food processing workers to SARS-CoV-2 infections and outbreaks, our understanding of how to reduce viral transmission in this population is limited. Given the unique challenges and considerations for the prevention of COVID-19 transmission in the meat packing and food processing industry, a targeted approach is warranted to prevent future outbreaks among workers and their families.

To address these questions, we conducted a cohort study of adults aged 18 years and older who had worked for at least two weeks in a meat packing plant, food processing facility, or commercial farm and resident in North Carolina since February of 2020 (index workers). Household members of index workers at least 12 months of age were also eligible to participate. Participants were recruited by contacting patients identified as potential food processing workers at Piedmont Health Services, flyers, social media campaigns, and local community organizations. Participants were enrolled after providing informed consent in English or Spanish. Study visits took place at the study office or under a tent outside the participant's residence. The enrollment visit consisted of a questionnaire collecting data on demographic characteristics, medical history, workplace and household characteristics, and preventive behaviors. Participants were invited to complete monthly follow-up visits, where the same specimens were collected and a short follow up questionnaire was administered to update exposure and clinical data. Blood, saliva, and nasal turbinate swabs were collected at every visit. Participants were screened for COVID-19 symptoms or exposures with weekly phone calls, and if necessary, referred to local clinics for free diagnostic testing. This study was approved by the IRB at the University of North Carolina at Chapel Hill (IRB 20-2032). Antibodies

(IgG, IgM, and IgA) to SARS-CoV-2 were detected in serum using an in-house ELISA targeting the receptor-binding domain of the SARS-CoV-2 spike protein. Viral RNA was extracted from nasal swabs and saliva and detected using a RT-qPCR assay designed by the US CDC.

From September to December 2020, we enrolled 224 participants in 90 households. Enrollment blood samples were available for 218 participants in 89 households, including 118 index workers and 100 household members. The prevalence of SARS-CoV-2 antibodies in our study population was 50.0%, over five times the rate observed in most of the United States when we conducted this study in September 2020; prevalence was the same in index workers and household members. Prior COVID-19 infection was reported by 50 (22.9%) of participants. Among the 109 participants with positive SARS-CoV-2 serology, 44 (40.4%) reported known history of COVID-19; among the 109 participants with negative SARS-CoV-2 serology, 6 (5.5%) reported known history of COVID-19. Younger participants were more likely to have positive SARS-CoV-2 serology but lack of known COVID-19, consistent with the milder or even asymptomatic course of disease common in children.

Index workers were 61.0% female and 94.9% Latinx, with a mean age of 41.9 (SD 13.2) years. 61 (51.7%) worked at farms and 49 (41.5%) at meat packing facilities. Baseline seropositivity of SARS-CoV-2 was 50.0% among all index workers, with the highest prevalence among meat packing plant workers (64.6%). Regular mask wearing and eye protection at work were reported by 77.5% and 32.5% of participants, respectively. Workers reporting washing their hands at work several times per day (75.8%), one or two times per day (21.7%), or not all (2.5%). Over a third of participants reported being close enough to touch another worker while working (36.7%), particularly among meat packing plant workers (63.3%). No participants reported working despite failing a temperature or symptom check at work. Compared to workers who sometimes or never worked in loud environments, workers who always worked in loud environments had 1.70 times the risk of SARS-CoV-2 seropositivity, adjusted for industry (95% CI: 1.13-2.57). Workers who used shoe coverings or shields between workers also had higher risk of SARS-CoV-2 seropositivity (aRR: 1.76, 95% CI: 1.35-2.30 and aRR: 1.54, 95% CI: 1.03-2.29, respectively; adjusted for industry). Age, sex, race, and preferred language were not associated with risk of SARS-CoV-2 seropositivity.

Household members were 47.0% female and 94.0% Latinx, with a mean age of 21.4 (SD 17.9) years. Baseline seroprevalence of SARS-CoV-2 was 50.0% among household members. Of the 90 households, 50 (56.2%) had at least one household member with SARS-CoV-2 antibodies at baseline. 40 (44.9%) households had 0% cases, and 35 (39.3%) had 100% household seropositivity. Clustering of SARS-CoV-2 seropositivity by household was evident (ICC=0.63, 95% CI: 0.51-0.74).

Ongoing and future work

We have not completed all molecular assays yet but so far have identified seven samples that contain SARS-CoV-2 RNA, all from asymptomatic participants. Once follow visit samples have been processed by RT-PCR and ELISA, we will be able to better determine incidence of infection during the study period; however, incidence in this population appeared to be lower than in the general NC population during this time, possibly because so many had already been infected during the spring or summer of 2020. We plan to sequence RT-PCR-positive samples to look for transmission patterns and identify changes in infecting viral strains over time.

We have begun writing an article reporting the baseline data presented above. We hope to extend follow up on willing participants to 12 months. This cohort is unique for the high baseline seroprevalence and ongoing high exposure risk and is thus an opportunity to study the effect of natural immunity on risk of reinfection with SARS-CoV-2.

<u>Expenses</u>

Personnel *$244,800.66*

Study PI (Dr. Bowman) received 40% FTE during the study period.
Coinvestigator Dr. Richardson received 20% FTE during part of the study period.
One postdoctoral Infectious Diseases fellow was employed full-time for the duration of this project to help oversee and conduct research activities.
We employed three full-time coordinators, one administrative and two in the field.
Two full-time and one part-time phlebotomists/research assistants were hired to support field work, including sample collection and data entry.
We hired one full-time laboratory technician to process and analyze samples. In order to support weekend and nighttime sample deliveries, we also employed two part-time technicians. Additionally, and undergraduate worked approximately 10 hours a week in the lab.
The IDEEL laboratory administrator received a small portion of her salary for work dedicated to this project including ordering supplies, onboarding staff, and training technicians in necessary techniques.
An accountant in the department of Epidemiology received a small portion of her salary to manage award finances.

Consulting fees *$11,728.29*

Hispanic Liaison provided consulting services and advertising through their Facebook and text messaging media channels.

Equipment *$80,322.66*

Qiagen RNA/DNA extraction robot $29,367.52
Opentron Fluid Handling Machine $9450
Service agreements and smaller parts and equipment necessary for operation of the purchased equipment were also often labelled as equipment and included in this total. This includes a significant portion of laboratory supplies and kits. Three ipads and four iphones were also purchased; ipads were used for data entry and iphones were used for study coordinators to communicate with participants.

Supplies *$104,959.09*

Supplies included but were not limited to office supplies, biospecimen collections supplies (blood draw materials, specimen cups, etc.), personal protective equipment, cloth and surgical masks for participants, laboratory supplies, and miscellaneous other supplies necessary to complete the study.

Travel *$14,236.85*

Two vehicles dedicated to project use were rented for the duration of data collection (approximately 4 months). These expenses also include reimbursement for gas/mileage for these vehicles and for personal vehicle use for study visits.

Services and miscellaneous

Advertising $6806.64

This included costs for recruitment by Facebook boosts, flyers, and radio ads.

Printing $1129.29

This included costs for printing consent forms, flyers, and other study materials.

Communications $1066.74

This was for the mobile phone plan for the four iphones.

Postage and shipping $1047.00

Translation $652.49

Study materials and consent forms were translated from English to Spanish by CHICLE translation service.

Other $251.60

Participant compensation *$11,010.90*

Participants were compensated $25/visit for their time and expertise. Participants had 1-4 visits depending on length of enrollment in the study.

Rent and utilities *$9717.51*

We rented office space in Siler City for participant visits. Rent was $1920/month, plus utilities.

<u>Personnel</u>

All personnel were hired by UNC. One research coordinator was a Duke University student taking a semester off but was paid by UNC for her work on this project, which was unrelated to her degree program. With the exception of one faculty and one staff member paid by the department of Epidemiology, other staff were employed by the School of Medicine.

Personnel paid on this award included

Faculty	2
Staff	12
Post-docs	1
Undergraduates	1

Additional funding

We have not received additional funding related to this work at this time.