COVID-19
Serology Analysis Among Essential Workers

Bureau of Epidemiology

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Executive Summary

Background

COVID-19 was first identified in Pennsylvania on March 6, 2020 and has caused widespread transmission over multiple waves ever since. The initial wave of the pandemic in the spring of 2020 heavily affected residents and staff in long-term care facilities and healthcare personnel working in acute care settings where COVID-19 patients presented for evaluation and care. The first wave also included workers in the agricultural sector and other professions where employees worked in close proximity with each other or the public and had limited ability to work remotely and access to personal protective equipment was not uniform.

The second wave of cases began in the early fall of 2020 and included instances where several universities seeded large community outbreaks as students returned to campus and resumed academic, athletic, and social activities. The fall wave continued into the winter and recorded the highest burden of case reports since the start of the pandemic at the same time when the first vaccines became available. Vaccine administration initially focused on the long-term care environment, essential workers, and other people at higher risk for severe disease. Initial vaccination efforts, universal masking, and continued social distancing were working to decrease case counts as the winter progressed, however as warmer weather returned and vaccine supply continued to not meet demand, cases began to increase in March and April 2021 causing a significant third wave. By July of 2021 in Pennsylvania, most people seeking vaccine had received their series, case counts fell to early pandemic lows and social distancing and masking were relaxed on a wide scale. As the summer of 2021 progressed, large waves of cases predominated by variant strains spread throughout areas of the world and southern United States. Pennsylvania also experienced another large wave of cases through the late summer and fall months with these novel variant strains. During the first week of January 2022, Pennsylvania experienced the highest number of reports since the pandemic began even as booster doses of vaccine continued to be offered.

To assess ongoing risk for community spread of SARS-CoV-2, the Pennsylvania Department of Health Bureau of Epidemiology (BOE) has been tracking previous infection and response to vaccination through antibody testing and administering questionnaires among select populations of interest. The Bureau has identified workers in critical sectors unable to work remotely as a critical population to better understand previous infection rates and attitudes around vaccine uptake and infection prevention.

Pennsylvania government workers had to report for work in public worksites as part of responding to the ongoing COVID-19 public health emergency. The Pennsylvania Department of Health, Emergency Management Agency, and Governor's Office all worked on-site throughout the response and therefore had some increased risk for infection from community and workplace exposures. The Department of Health's Bureau of Laboratories (BOL) also required continuous on-site work to perform routine tests and escalated testing for COVID-19. These staff also continued to have community and workplace exposures during this period of widespread adoption of social distancing and work from home recommendations. The transportation sector was often unable to work remotely and many,

by the nature of their work, had continued daily exposure to the public. This includes employees at major airports that continued operations during the pandemic.

In December of 2020, the BOE through its Serology Workgroup developed a protocol describing three main objectives to understand susceptibility among a critical workforce unable to work remotely and who have direct ongoing contact with the public to include:

1. Estimate the seroprevalence of SARS-CoV-2 among essential workers from a variety of settings and compare with other existing data to understand disease burden and level of protection in these groups
2. Identify community and work-related habits and attitudes associated with protection from infection among those without antibodies compared to those with antibodies
3. Track antibody levels and compare with vaccine administration histories to assess ongoing protection in a critical workforce

A full protocol for recruitment, attaining consent, sample collection, laboratory analyses, and questionnaire data collection and management was developed and received approval from the Pennsylvania Department of Health Institutional Review Board (IRB). In addition, the Serology Workgroup also engaged the Centers for Disease Control and Prevention (CDC) serology task force through the Region 3 Liaison Officer of the COVID-19 Emergency Response group to review existing literature and help refine the objectives considerate of other similar studies occurring in other states.

Summary of Findings

Antibody tests were collected over a 3-month period early in 2021 when vaccine first became available. Due to this, vaccination status (defined at the time as partial, full, or unvaccinated) varied among the groups at each antibody test collection point. The test used in this study (EUROIMMUN IgG spike protein antibody) will typically result positive among people approximately 7-14 days after previous infection or vaccination. These caveats are necessary to understand when interpreting the following results.

- A total of 361 workers submitted a sample for antibody testing between January 19 and April 14, 2021. Of these, 159 (44%) were government workers where 119 were tested in January, and 40 tested in March. The remaining 202 workers (56%) were affiliated with the Philadelphia International Airport and were all tested in April.
- Among the entire cohort, 199 (55%) were unvaccinated at the time their blood was collected for antibody testing and 30 of these workers tested positive for SARS-CoV-2 antibodies estimating a previous infection rate of 15%. This is a high rate of previous infection compared to case reports for the general population during the same time period (6% – 8% state population reported as a case in PA-NEDSS) that suggests non-remote working may be associated with greater risk of infection.
- Six percent of unvaccinated government workers tested in January were positive, whereas 24% of unvaccinated transportation workers tested in April were positive. Though these transportation workers were tested later in the pandemic, the estimate of 24% positivity among those unvaccinated is considerably higher than case reports from the general public at the same time (8% of state population reported in PA-NEDSS). This

difference suggests that working in the transportation sector such as at an international airport with ongoing contact with the public poses greater risk for exposure. Therefore, recommendations for prevention of transmission of respiratory viruses should consider this and be more protective for these workers.

- Among the 76 people considered fully vaccinated, all of them (100%) tested positive for antibodies suggesting high effectiveness of the vaccine in this population shortly after receiving a primary series. Among the 71 participants considered partially vaccinated, 58 (82%) tested positive for antibodies which supports good response in producing antibodies after one dose of vaccine, but also shows an additional benefit from completing a primary series.

- A total of 238 questionnaires were completed by all participants (overall response rate = 66%). Government workers completed 139 questionnaires of all questionnaires submitted (58%) while 99 transportation workers completed a questionnaire (42%).

- Since March of 2020, transportation workers were significantly more likely to work in-person more days each week than government workers (82% more than 3 days per week compared to 60% respectively), were more likely to leave their home more than 4 times per week (42% compared to 19% respectively), were more likely to use any public transportation (39% compared to 18% respectively), and traveled more than 8 times outside of Pennsylvania (28% compared to 4% respectively), potentially leading to more exposures and infections.

- By self-report, 12% of transportation workers had a known previous diagnosis of COVID-19 and 24% of unvaccinated transportation workers tested positive for antibodies indicating previous infection. This suggests that many of these workers were infected and unaware of the potential to transmit virus to co-workers and the traveling public. Surveillance testing to identify asymptomatic infected workers may be of value in the future to identify and exclude contagious persons in public work settings.

- Of the 139 unvaccinated participants, only 7% expressed true vaccine resistance, and 23% expressed hesitancy in accepting vaccine because they were either unsure or wanted to wait and see how it went for other people first. These findings suggest that many workers in this critical workforce are accepting of vaccine and only a small percentage of this workforce is averse to getting vaccinated.

These overall findings show a high rate of infection for workers that were unable to work remotely during the first year of the pandemic. Employees in the transportation sector had the highest rates of previous infection and had more community and travel-based exposures. Recommendation to control transmission for viruses similar to SARS-CoV-2 should emphasize remote working options, and stricter infection control practices while at work to protect this critical workforce.

Methods

Recruitment of Agencies

Pennsylvania Emergency Management Agency's (PEMA) headquarters served as a central hub for COVID-19 response activities and the location where DOH, PEMA, and other state and federal staff were stationed during the response. Staff reporting to the PEMA building in December 2020 were invited to participate in antibody testing. The Bureau of Laboratories, in addition to performing the testing, were also approached for inclusion to have the voluntary antibody test. Finally, existing relationships with the chief operations officer and CDC Quarantine Station officer in charge at the Philadelphia International Airport were leveraged to engage airport agencies for participation. A staff physician from the Department of Health signed and submitted the medical standing order for the antibody test using the existing account for the Bureau of Epidemiology in the BOL web-based portal.

The final list of participating agencies included:
- Governor's Office
- Pennsylvania Emergency Management Agency (PEMA)
- Pennsylvania Department of Health (DOH)
    - Bureau of Community Health Services
    - Bureau of Emergency Medical Services
    - Bureau of Emergency Preparedness and Response
    - Bureau of Epidemiology
    - Bureau of Laboratories
- Philadelphia International Airport
    - Transportation Security Administration
    - CDC Quarantine Station
    - Customs and Border Protection
    - Airport Operations and the Marketplace
    - American Airlines

Participant Recruitment and Consent

All staff identified through the above listed agencies were eligible to participate in the study. Recruitment was done in partnership with agency leadership who issued email invitations to staff that included a QR (Quick Response) code that linked to an online questionnaire through Microsoft™ Forms where people could self-register for the antibody test 2-3 weeks before the scheduled blood collection activities. Registered staff received instructions on blood collection clinic details over email and flyers were posted on the day of sampling to invite additional people to participate. Participant consent forms were issued and signed on-site prior to enrollment. In addition to collecting consent to participate in the study, these forms also collected participant contact information, date of birth, gender, and race/ethnicity. Consent forms and study protocols were approved by the Department's IRB.

Data Collection, Sample Collection and Results Management

Multiple separate blood collection activities were scheduled for each of the cohorts. DOH/PEMA/Governor's Office blood collection was conducted at the PEMA Headquarters building on January 19, 2021. The BOL staff cohort had their blood collection on site at the laboratory in Exton on March 25, 2021. Agency staff associated with the Philadelphia International Airport had their blood collected over a 2-day operation in a staff training room within the airport security perimeter on April 13 and 14, 2021. Volume of participants who pre-registered was used to develop the blood collection field team structure on each day. Registration, line management and specimen processing staff were provided by the Epidemiology Research Associates from the Northeast, South Central, and Southeast District Offices, PEMA and other DOH employees. Nurse phlebotomists were provided by a staff augmentation agency GHR (General Healthcare Resources). Overall medical direction was provided on site by the BOE COVID-19 Medical Epidemiologist at all operations.

Once consent was completed and participants were enrolled in the study, staff collected information about participants' COVID-19 vaccine history (dates of dose(s), and product) by asking to see their vaccination card or by self-report. These data were recorded by research staff on paper and were later entered into an Excel document. After vaccine history was attained, a blood draw was taken for the detection of SARS-CoV-2 IgG antibodies in serum. All samples were centrifuged within 2 hours of collection on site, refrigerated, and delivered to BOL within 40 hours after collection. Samples were processed using the EUROIMMUN Anti-SARS-CoV-2 enzyme-linked immunosorbent assay (ELISA) to detect IgG antibodies to spike protein.

Results of the antibody tests were distributed over secure email to all participants or delivered directly in staff mailboxes using paper letters if the facility preferred this method. Results were delivered with an updated fact sheet and an invitation to speak to the COVID-19 Medical Epidemiologist over defined office hours if there were questions about how to interpret their results. Individuals who were unable to access their results were referred by agency leadership or reached out directly to the dedicated resource account for this study. Finally, a link to an online 30-item questionnaire (hosted on Microsoft™ Forms) was also distributed to all participants within the secure email results communication or issued on paper at the blood collection clinic for walk in participants when appropriate. This questionnaire collected information on behaviors, perceptions, and attitudes that may impact risk of contracting COVID-19. Reminder emails were sent two weeks later to encourage more participants to complete the questionnaire.

Statistical Analysis

Questionnaire data, laboratory data, and participant registration data were cleaned and analyzed in SAS Enterprise Guide, version 88.1 software (SAS Institute Inc., Cary, NC, USA). Data were summarized by participant type (government employee or transportation employee) and summary statistics presented. To assess the impact of vaccination on serology results, serology results were further stratified by vaccination status and participant type. Participants were considered fully vaccinated if they met the CDC criteria of being fully

vaccinated (at least 14 days past the completion of a full vaccine series at the time samples were collected). Participants were considered partially vaccinated if they received 1 dose of a 2 dose vaccine series at least 7 days prior to submitting a sample and were considered unvaccinated if they received no vaccine doses or 1 dose of a 2 dose series less than 7 days prior to submitting a sample. Differences in survey data collected among government and transportation employees were assessed using chi-square or Fisher's exact tests for categorical variables and Kruskal-Wallis tests for continuous variables.

Findings

Demographics, Serology, and Vaccination Data by Participant Type

Table 1 summarizes demographic data, serology results, and vaccination data collected among essential worker participants. A total of 361 essential workers submitted a serology sample as a part of this study. This includes 159 government employees and 202 transportation employees. In addition, 238 (65.9%) participants submitted a completed questionnaire, 87% of all government workers and 49% of all transportation workers.

Among samples collected, which included both unvaccinated and vaccinated workers, 29% of government employees and 58% of transportation employees tested positive for SARS-CoV-2 antibodies. A total of 3 participants (1 government employee and 2 transportation employees) tested borderline. Twenty-one percent of government employees and 23% of transportation employees, were fully vaccinated at the time they submitted samples and an additional 9% of government employees and 29% of transportation employees were partially vaccinated. The most common vaccine received by fully or partially vaccinated government employees was the Moderna vaccine (86%) followed by the Pfizer vaccine (14%). The most common vaccine received by fully or partially vaccinated transportation employees was the Pfizer vaccine (59%) followed by the Moderna vaccine (38%). A total of 4 participants (all transportation employees) received the Johnson and Johnson vaccine.

Across both sites, the majority of participants were white (71%) and non-Hispanic (86%). Participants ranged in age from 23-74 years. Over half of government employee participants were female (52%) while over half of transportation employee participants were male (59%).

Table 1. Demographics, Serology, and Vaccination Data by Participant Type

	Government Employees	Transportation Employees	Total
Collection Dates	1/19/2021, 3/25/2021	4/13/2021, 4/14/2021	
Total Participants	159	202	361
Total Questionnaires Completed (% completed among those who submitted samples)	139 (87%)	99 (49%)	238 (66%)
Serology Results, N (%):			
Positive	47 (29%)	119 (58%)	166 (46%)
Negative	111 (70%)	81 (40%)	192 (53%)
Borderline	1 (<1%)	2 (2%)	3 (1%)
Vaccination Status, N (%):[1]			
Fully Vaccinated	30 (21%)	46 (23%)	76 (22%)
Partially Vaccinated	13 (9%)	58 (29%)	71 (21%)
Unvaccinated	101 (70%)	98 (48%)	199 (58%)
Vaccine Received, N (%) (among fully or partially vaccinated):[2]			
Pfizer	5 (14%)	61 (59%)	66 (47%)
Moderna	31 (86%)	39 (38%)	70 (50%)
J & J	0 (0%)	4 (4%)	4 (3%)
Gender, N (%):			
Female	82 (52%)	82 (41%)	164 (45%)
Male	77 (48%)	120 (59%)	197 (55%)
Other	0 (0%)	0 (0%)	0
Race, N (%):[3]			
White	131 (86%)	120 (60%)	251 (71%)
Black	4 (3%)	64 (32%)	68 (19%)
Asian	11 (7%)	7 (3%)	18 (5%)
Other	7 (4%)	8 (4%)	15 (4%)
Ethnicity, N (%):[4]			
Hispanic	5 (10%)	7 (22%)	12 (14%)
Non-Hispanic	47 (90%)	25 (72%)	72 (86%)
Age Median (Median):	49 (23-74)	48 (25-74)	49 (23-74)

[1] Missing: N=15; [2] Missing: N=7; [3] Missing: N=9; [4] Missing: N=277

Serology Results by Vaccination Status

Table 2 summarizes serology results by vaccination status and participant type. All participants who were fully vaccinated tested positive for SARS-CoV-2 antibodies and 82% of partially vaccinated participants tested positive for SARS-CoV-2 antibodies. Among those who were not vaccinated, 85% did not test positive for SARS-CoV-2 antibodies.

There was a total of 199 unvaccinated participants from both government workers and transportation workers and among these 30 (15%) tested positive for antibodies. A total of 24 (80%) of these individuals were transportation employees and 6 (20%) of these were government employees. A total of 17 of these individuals completed a questionnaire to gather additional information on previous COVID-19 infection and exposures. Among those who

completed a questionnaire, a total of 10 (59%) reported being previously infected with COVID-19 and 9 (53%) reported being a close contact of someone with COVID-19.

Table 2. Serology Results by Vaccine Status and Participant Type[1]

Study Sites	Serology Results	Fully Vaccinated	Partially Vaccinated	Unvaccinated
Government Employees	Positive	30 (100%)	9 (69%)	6 (6%)
	Negative	0 (0%)	4 (31%)	94 (93%)
	Borderline	0 (0%)	0 (0%)	1 (1%)
Transportation Employees	Positive	46 (100%)	49 (84%)	24 (24%)
	Negative	0 (0%)	8 (14%)	73 (74%)
	Borderline	0 (0%)	1 (2%)	1 (1%)
All Essential Workers	Positive	76 (100%)	58 (82%)	30 (15%)
	Negative	0 (0%)	12 (17%)	167 (84%)
	Borderline	0 (0%)	1 (1%)	2 (1%)

[1] Percentages are calculated within vaccination group (i.e., the percentage who had that serology result within each vaccination category). Missing: N=15.

Questionnaire Data Summary

Across both sites a total of 238 participants (66%) completed an online questionnaire. Government workers completed 139 questionnaires of all questionnaires submitted (58%) while 99 transportation workers completed a questionnaire (42%). Among all participants who completed a questionnaire, 25 (11%) had previously been diagnosed with COVID-19 and 76 (32%) had been a close contact of someone who was previously diagnosed with COVID-19 and had to quarantine. A total of 26 (11%) participants had a household member who had previously been diagnosed with COVID-19. Twelve transportation workers reported a previous COVID-19 diagnosis (12%), and 36 (37%) reported having a close contact requiring quarantine.

Among the 238 participants who completed a questionnaire, most reported that they work 5 days per week (n=135, 57%) and reported leaving home at least 2 times per week (n=188, 79%) and that they "always" wear a mask while at work (n=184, 77%). However, only 50% reported that they "always" maintain social distance while at work (n=119) and washing their hands at least 5 times per day (n=206, 87%). A total of 128 participants (54%) reported that they knew someone who had died of COVID-19. Transportation workers worked in-person more days each week than government workers (82% more than 3 days per week compared to 60% respectively), were more likely to leave their home more than 4 times per week (42% compared to 19% respectively), were more likely to use any public transportation (39% compared to 18% respectively).

Most participants reported that they did not travel outside of the United States (n=222, 93%) but that they traveled outside of Pennsylvania 1-3 times since March 2020 (n=109, 46%), and 28% of transportation workers reported that they traveled outside of Pennsylvania more than 8 times compared to 4% of government workers. Over 60% (n=146) reported that they have at least one pre-existing health condition and 58% reported that they wear glasses at work (n=139). The median number of individuals that participants shared a household with is 2. The median number of household members <18 years of age is 0. The median number of household members >/= 65 years is also 0.

A total of 43 (18%) participants reported any hesitancy towards receiving the vaccine. These include participants who selected one of the following responses when asked to select the statement that described their current attitudes towards the COVID-19 vaccine: "I don't want to get the vaccine.", "I'd like to wait and see how it goes for other people first before I get it.", "It was offered to me and I declined.", and "I'm really not sure."

Table 3. Questionnaire Data Summary

	Government Employees	Transportation Employees	Total	p-value[8]
Collection Dates	1/19/2021, 3/25/2021	4/13/2021, 4/14/2021		
Total Participants	159	202	361	
Total Questionnaires Completed (% completed among those who submitted samples)	139 (87%)	99 (49%)	238 (66%)	
Previous known COVID-19 diagnosis, N (%)[1]	13 (9%)	12 (12%)	25 (11%)	0.08
Previously hospitalized for COVID-19, N (%)	0 (0%)	0 (0%)	0 (0%)	NA
Previous close contact, N (%)[2]	40 (29%)	36 (37%)	76 (32%)	0.43
Household member previously diagnosed with COVID-19[3]	13 (10%)	13 (14%)	26 (11%)	0.29
Days of in-person work per week[1]				
0 days a week (fully remote)	7 (5%)	0 (0%)	7 (3%)	<0.001
Less than 1 day a week	13 (9%)	3 (3%)	16 (7%)	
1 day a week	6 (4%)	2 (2%)	8 (3%)	
2 days a week	16 (12%)	6 (6%)	22 (9%)	
3 days a week	13 (9%)	7 (7%)	20 (8%)	
4 days a week	6 (4%)	15 (15%)	21 (9%)	
5 days a week	72(52%)	63 (64%)	135 (57%)	
More than 5 days a week	6 (4%)	2 (2%)	8 (3%)	
Frequency of mask wearing mask at work, N (%):[4]				
Always	101 (73%)	83 (86%)	184 (78%)	0.06
Sometimes	32 (23%)	11 (11%)	43 (18%)	
Rarely	2 (1%)	1 (1%)	3 (1%)	
Does not apply to me	4 (3%)	1 (1%)	5 (2%)	
Frequency of social distancing at work, N (%):				
Always	68 (49%)	51 (52%)	119 (50%)	0.52
Sometimes	62 (45%)	42 (42%)	104 (44%)	
Rarely	6 (4%)	6 (6%)	12 (5%)	
Does not apply to me	3 (2%)	0 (0%)	3 (1%)	
Job Responsibilities involve direct patient care, N(%):[5]	2 (3%)	NA	2 (1%)	NA
Frequency of leaving home per week, N (%):				
Never	3 (2%)	3 (3%)	6 (3%)	<0.001
1 time	34 (24%)	10 (10%)	44 (18%)	
2 to 4 times	76 (55%)	44 (44%)	120 (50%)	
More than 4 times	26 (19%)	42 (42%)	68 (29%)	

	Government Employees	Transportation Employees	Total	p-value[8]
Collection Dates	1/19/2021, 3/25/2021	4/13/2021, 4/14/2021		
Frequency of handwashing per day, N (%):				
1-4 times	17 (12%)	15 (15%)	32 (13%)	<0.001
5-10 times	76 (55%)	33 (33%)	109 (46%)	
More than 10 times	46 (33%)	51 (52%)	97 (41%)	
Knows someone who has died of COVID-19, N (%)	63 (45%)	65 (66%)	128 (54%)	0.002
Travel outside of USA since March 2020, N (%)[2]				
Never	131 (96%)	91 (95%)	222 (95%)	0.11
Once	5 (4%)	2 (2%)	7 (3%)	
More than once	0 (0%)	3 (3%)	3 (1%)	
Travel outside of Pennsylvania since March 2020, N (%)[2]				
Never	50 (37%)	21 (22%)	71 (30%)	<0.001
1-3 times	71 (52%)	38 (40%)	109 (47%)	
4-7 times	10 (7%)	10 (10%)	20 (8%)	
8 or more times	5 (4%)	27 (28%)	32 (14%)	
At least one pre-existing health condition, N (%)	86 (62%)	60 (61%)	146 (61%)	0.84
Wears glasses, N (%)[1]	86 (62%)	53 (53%)	139 (59%)	0.18
Number living in household, Median (Range)[7]	2 (0-30)	3 (0-9)	2 (0-30)	0.12
Number living in household who are children (<18), Median (Range) [3]	0 (0-10)	0 (0-3)	0 (0-10)	0.28
Number living in household who are over 65 years old, Median (Range) [6]	0 (0-2)	0 (0-3)	0 (0-3)	0.24
Travel via any public transit since March 2020, N (%)	25 (18%)	39 (39%)	64 (27%)	<0.001
Current attitudes towards vaccine, N (%)				
I received one dose already.	36 (26%)	12 (12%)	48 (20%)	<0.001
I received two doses already.	33 (24%)	50 (51%)	83 (35%)	
I will get the vaccine as soon as it is offered to me.	51 (37%)	13 (13%)	64 (27%)	
I don't want to get the vaccine.	3 (2%)	5 (5%)	8 (3%)	
I'd like to wait and see how it goes for other people first before I get it.	7 (5%)	13 (13%)	20 (8%)	
It was offered to me and I declined.	0 (0%)	1 (1%)	1 (<1%)	
I'm really not sure.	9 (6%)	5 (5%)	14 (6%)	

[1]Missing: N=1; [2]Missing: N=4; [3]Missing: N=6; [4]Missing: N=3; [5]Only asked government employees; [6]Missing: N=7; [7]Missing: N=9; [8]P-values were calculated using Chi-Square or Fisher Exact tests (when at least one group contained less than N=5) for categorical variables and using Kruskal-Wallis tests for continuous variables to compare differences across sites.

Table 4. Attitudes Towards Vaccine Among Unvaccinated Participants N = 139

Accepting Vaccine	I received one dose already.	35 (25%)	**98 (70%)**
	I received two doses already.	0 (0%)	
	I will get the vaccine as soon as it is offered to me.	63 (45%)	
Hesitant Towards Vaccine	I'd like to wait and see how it goes for other people first before I get it.	18 (13%)	**32 (23%)**
	I'm really not sure.	14 (10%)	
Resistant to Vaccine	It was offered to me and I declined.	1 (1%)	**9 (7%)**
	I don't want to get the vaccine.	8 (6%)	

The majority of participants (70%) who were considered unvaccinated indicated that they either had received some vaccine or were planning to receive vaccine. Twenty-three percent expressed hesitancy, and 7% were resistant to getting vaccine.

Conclusions

As part of this analysis, a total 361 people submitted a blood sample for antibody testing and of those 202 were transportation workers and 159 were state employees. A total of 199 people (55%) had their blood collected before receiving any vaccine and among them, 15% tested positive for antibodies indicating previous infection among the entire cohort over the blood collection period from January 19, 2021 through April 14, 2021. Approximately 60% of all participants reported having at least one pre-existing health condition, a finding that indicates an existing risk factor for more severe disease from COVID among these essential workers. Six percent of government workers were antibody positive because of previous infection as compared to 24% of transportation workers. More frequent interactions with the traveling public could, in part, explain the increased infection rates among transportation employees, but they also had their blood collected later in the pandemic (April compared to January of 2021).

There were 139 (87%) and 99 (49%) completed questionnaires from government workers and transportation workers respectively that inform differences in risk and preventive actions between the two groups. Transportation employees reported more frequently being identified as a close contact of someone with COVID-19 as well as more frequent in-person work, leaving home more than 4 times per week, travel outside of Pennsylvania and use of public transportation since March of 2020 when the SARS-CoV-2 virus became widespread in the United States. They also report more frequent preventive actions to reduce infection risk that included use of masks while at work and washing their hands more than 10 times per day than did government workers. These data may suggest that limiting interactions with people is a more effective strategy for prevention of transmission. Increasing remote work whenever possible may be a better preventive strategy whenever possible recognizing that some direct services cannot be sustained this way. For those essential in person services, preventive strategies (mask wearing, hand washing) are still important to protect workers.

Several reasons may explain higher previous COVID-19 infection among transportation workers while having higher proportion of mask use and hand hygiene compared to government employees. Firstly, time of blood draw for transportation employees was almost 3 months after most government employees allowing for higher cumulative risk of infection. Secondly, the nature of the transportation employee work being indoor in a public space and higher volume of contacts to others directly increases exposure risk. Thirdly, ineffectiveness of certain types of masks that may have been used such as cloth masks, or ineffective usage of masks such as wearing below the nose or with incomplete seal to the face may have been different between these two groups. Fourth, many in the government workers cohort were Department of Health employees knowledgeable about infectious disease transmission and prevention from COVID. Lastly, non-responder bias may also impact the questionnaire results given over half of transportation employees did not respond to the questionnaires. Those non responders may exhibit different health behaviors and had higher risk of infection compared to those who responded. Disproportionate numbers of questionnaires responders among the two groups may inherently impact these findings.