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Waco COVID Survey: A Community-Based SARS-CoV-2 Serological Surveillance Study in Central Texas

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Abstract

In early-2020, the epidemiology of the SARS-CoV-2 virus was still in discovery and initial reports about the role of asymptomatic individuals were developing. The Waco COVID Survey was implemented in mid-2020 with targeted serological surveillance to assess relationships among risk factors and asymptomatic transmission in McLennan County, Texas, USA. Because large-scale random sampling of the population was not feasible, a targeted and repeated sampling of specific clustered groups of asymptomatic individuals was employed. This included four waves (initial intake [n = 495], two follow-ups separated by a month [n = 348; n = 287], and a final follow-up one year later [n = 313]) of sampling participants in different risk categories: (a) healthcare workers (e.g., physicians, nurses, etc.) and first responders, (b) essential service employees (e.g., convenience and grocery stores, restaurants focused on delivery and carry-out), (c) employees whose businesses began reopening on May 1 (e.g., dine-in restaurants, churches, etc.) including church attendees, and (d) individuals that practiced intensive isolation. The survey collected information on demographics, compliance with public health recommendations, satisfaction with government responses, health history, attitudes regarding the SARS-CoV-2 virus and COVID-19 disease, health behaviors, personality, stress, and general affect. Results illustrate pandemic fatigue over time, the influence of political leniency on opinions and behaviors, the importance of face coverings in preventing infection, and the positive impact of vaccination in the community. This project remains one of the largest longitudinal SARS-CoV-2 antibody seroprevalence surveys in the US, and details for successful implementation and community involvement are discussed.

Keywords COVID-19 · Serological surveillance · Pandemic · Health behaviors

Introduction

During the first wave of the coronavirus disease 2019 (COVID-19) pandemic in March 2020, the epidemiology of the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) virus was still in discovery. Initial assumptions and reports about the rate of transmission, including the basic reproduction number (R_0) and the role of asymptomatic individuals, were developing [1, 2]. The risk of viral transmission could not be calculated based only using the number of symptomatic cases, the number of PCR-positive cases, or the number of hospitalizations or deaths in a given time or location. Organized serological testing was needed [3, 4], particularly in different local and regional settings that varied by government-regulated business, school, and social lockdowns and re-openings. Safely relaxing social distancing measures and reopening businesses and schools depended on the calculation of risk of transmission in various local populations.

In Texas, USA, a shelter-in-place order began on March 13, 2020, with non-essential businesses reopening on May 1, 18, and 22, followed by other relaxations of safety measures. Variation in local public health requirements throughout the world precluded the accurate use of advanced epidemiological models based on the mixing of populations

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(infected, susceptible, and recovered individuals with different risk factors for morbidity and mortality). In the absence of large-scale testing (unavailable locally at the time), targeted serological surveillance was chosen as a mechanism to begin assessing the relationships among behavioral and biological risk factors and asymptomatic transmission in McLennan County, Texas.

Project Background

In April 2020, the Waco COVID Survey began as a collaboration between Baylor University and Waco Family Medicine. Located in Waco, Baylor University is the oldest college in Texas. It is a private not-for-profit R1 institution (Carnegie Classification) with a population of around 21,000 students. Waco Family Medicine is a Federally Qualified Health Center providing health care to underserved residents of McLennan and Bell counties. Collaborators from both institutions identified a need for serological surveillance of asymptomatic individuals early in the pandemic, began establishing the project presented here, and obtained local sponsorship from the Cooper Foundation and Rapoport Foundation of Waco.

This community-driven effort was launched on July 11, 2020. The purpose was to sample asymptomatic individuals from McLennan County that differed by risk of viral transmission for serological determination of past or current SARS-CoV-2 infection, to monitor for any temporal changes in transmission and clinical characteristics, and to make recommendations regarding local public health prevention strategies enforced through the Waco-McLennan County Public Health District. Due to limited resources, randomly sampling thousands of individuals to accurately determine viral spread was not feasible. Therefore, a targeted and repeated sampling of specific clustered populations was employed. This was to include recovered individuals along with asymptomatic household members, but staffing limitations in the Waco-McLennan County Public Health District prohibited the contact of previously-hospitalized participants. Therefore other risk groups were identified: (a) those in healthcare (e.g., physicians, nurses, etc.) and first responders (high exposure group but with generally intensive use of personal protective equipment), (b) essential service employees (e.g., convenience stores, grocery stores, lawn maintenance and construction companies, restaurants that focused on delivery and carry-out) who may have occasionally used face coverings but may have also reasonably broken social distancing recommendations, (c) other employees whose businesses began reopening on May 1 (e.g., dine-in restaurants, churches, movie theaters, etc.) (https://www.dshs.state.tx.us/coronavirus/opentexas.

aspx) including church attendees, and (d) individuals from families that practiced intensive isolation as a result of the social distancing recommendations. Besides allowing for investigation of variation in risk exposure (based on occupation and degree of social distancing), a strength of the present project was that all individuals would be repeatedly assessed over the course of three months, with an additional follow-up one year later (see Fig. 1 for diagram of study progression). The study followed individuals across time as social distancing restrictions were lifted.

Perspective Complete random sampling was impractical, so we targeted specific participant populations. We aimed to avoid the ecological fallacy, and concede that our study population does not reflect the general community (see below).

In response to the public health emergency of the pandemic, this project functioned as a public health surveillance activity, approved and endorsed by the Waco-McLennan County Public Health District. As such, this project met exclusion criteria for institutional review board approval at 45 CFR 46.102(e) & (l) for Baylor University researchers, staff, and volunteers. Participation of Waco Family Medicine researchers, staff, and volunteers for the present project was approved by the institutional review board at Ascension Providence Hospital and Medical Center of Waco, Texas.

Project Specifics

Additional information about the study procedure is available in the Supplementary Materials. Study advertisement took place online using Facebook (targeted to McLennan County residents) and Twitter, the Waco Tribune-Herald newspaper, and via email to the Hillcrest and Ascension Providence Hospital staff, Waco City Council, McLennan County Sheriff's Office, Baylor Department of Public Service, Hispanic-American Chamber of Commerce, Community Race Relations Coalition, local chapter of the NAACP, Cen-Tex African-American Chamber of Commerce, Junior League of Waco, Waco and Midway Independent School District personnel, and various churches and radio stations. Endorsements from local physicians, Baylor administrators, the Mayor's office, Public health authority, and the Waco-McLennan County Public Health District were posted online. A QR code on print and online advertisements directed interested participants to the study website.

Perspective Community buy-in is essential to recruitment and participation. Significant effort was made to maximize participation by minority populations. This was particularly
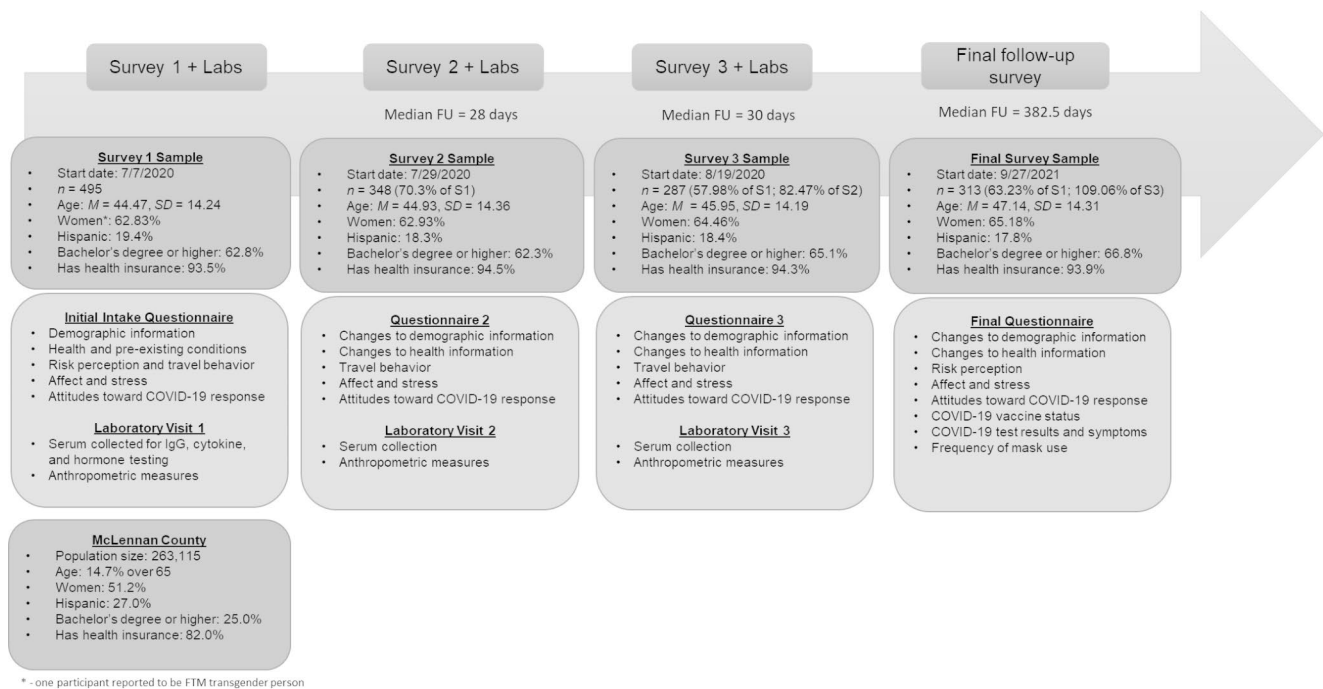
Fig. 1 Diagram of study progression and details of measures collected at each appointment

the case because the study was limited to those with regular access to email.

A HIPAA-compliant, secured website was created specifically for this study. The website explained the study process where potential participants could create an account, provide information regarding inclusion criteria, and agree to the scope of the project. Inclusion criteria required participants be at least 18 years of age, have lived in McLennan County since December 2019, and be fluent in either English or Spanish. They must NOT have had any signs or symptoms of COVID-19 since May 1, 2020 (including cough, shortness of breath or difficulty breathing, pain or pressure in the chest, body temperature equal to or above 100 degrees Fahrenheit, chills, repeated shaking, sore throat, temporary loss of taste or smell, persistent headache, inability to stay awake, recent confusion, bluish lips or face, muscle pain, vomiting, nausea, or diarrhea).

Final sample size was determined by both the number of willing participants, and ultimately, the number of participants that could feasibly be supported by the financial resources and staff available for the study. Over 1500 potential participants registered online for this project, but because of limited resources we were only able to accommodate one-third of those interested (see results below), despite the tremendous community response. There were some people who registered that did not meet the general inclusion criteria and so were not processed further. There were also many who attempted to self-assign into the high

isolation group but reported travel outside of the County or attendance at large gatherings after the shelter-in-place order, disqualifying them from further participation in the isolating group.

All communications were sent using a secured Baylor email address. Potential subjects who qualified for participation were invited via email to complete an online survey designed in Qualtrics. All surveys, emails, and website materials were available in English and Spanish. All surveys, emails, and website materials were professionally translated into Spanish through a paid service.

The intake survey included 103 questions (mostly multi-part each; approximately 45 min in length) about contact information, demographics, education, socioeconomic status, household composition (and health status of household members), religiosity, political leniency, occupation history, use of personal protective equipment, hygiene, compliance with shelter-in-place orders, satisfaction with government responses to the pandemic, use of face coverings, social distancing, travel, changes in behavior since the pandemic began, complete health history, medication usage, any pre-existing conditions, knowledge and attitudes regarding the SARS-CoV-2 virus and COVID-19 disease, diet, alcohol consumption, activity levels, sleep, weight change, general risk avoidance, germ aversion, mental health and stress, and general affect. The intake survey began with a signed informed consent agreement.

Perspective We wanted to avoid reinventing the wheel and so chose to use mainly previously validated survey materials. We were not concerned with survey length in this particular case given the high motivation for subject participation.

Research personnel checked each survey for completeness before emailing participants to schedule a one-hour timeslot visit to the clinic for further processing (within one week of completing the intake survey). This ensured adequate completion of the questionnaire prior to sample collection (and so avoided missing data). Clinic appointments took place in a private area dedicated for study use inside of the Madison Cooper Community Clinic, adjacent to the Waco Family Medicine's main clinic, located centrally in Waco and accessible by public transportation.

Sampling took place three days per week, including early mornings, late evenings, and weekends (to accommodate most working schedules of participants). Research personnel began each day with a self-assessment of signs and symptoms of COVID-19 disease. Upon arrival, participants were required to (a) have their temperature taken using a non-touch forehead thermometer, (b) use provided hand sanitizer, and (c) wear a provided face covering (surgical mask). If participants were experiencing any symptoms of COVID-19 disease (although none did), they would have been denied entry into the facility and disqualified from the study.

Perspective Our system was designed to minimize the probability of infection transmission associated with project participation.

Serum samples were analyzed using an ELISA method to quantify the immunoglobulin-G (IgG) antibody against the ACE2 spike protein of the SARS-CoV-2 virus using the commercially available EUROIMMUN kit (EI # 2606–9601), an externally validated product approved by the FDA under Emergency Use Authorization. Although the assay demonstrates high sensitivity and specificity, it was communicated to participants that there was a relatively low possibility that some individuals (using whatever serological assays available) would test positive when they are not infected (possibly because they were infected at some point in their life with a similar coronavirus), or would test negative when they are infected (which would lead to an underestimation of community risk). Furthermore, not all people infected with SARS-CoV-2 virus would produce sufficient levels of IgG to be detected, and antibody levels decline with time [5]. However, no survey participants tested positive for SARS-CoV-2 virus antibodies in the present study. Multiple healthcare workers did test positive using our procedures, but they were not part of the present study. Furthermore,

multiple samples unrelated to the present project produced positive results in the present lab analyses, which were further confirmed positive using quantitative PCR techniques. Therefore, the results identified here most likely reflect true lack of infection in the study sample cohort, which may reflect strong adherence to public health recommendations.

Perspective It was critical to us that we were clear with participants about the limitations of any laboratory tests. Great care was taken to inform participants about the testing limitations, especially to avoid misconceptions about the possibility of future infection or results that might have altered their motivation for further healthy behaviors.

At the end of each clinic visit, participants were scheduled for a follow-up survey and additional clinic visit within four weeks. This was repeated one more time, and then a final follow-up one year later. At the end of each visit, participants were entered to win a gift card (200 gift cards each worth $10, 40 gift cards each worth $25, and 20 gift cards each worth $100) from the regional grocery store chain. The basic odds of winning a gift certificate were 1 in 13 overall, and the odds increased for a person each time they were sampled. Winners were contacted via email to collect their gift cards at the clinic.

Perspective It was important to us that we provided healthy options for compensation rather than a gift certificate to retail outlets. Furthermore, while participation was minorly incentivized, the overwhelming majority of subjects expressed that they were driven to participate by a desire to help the community in difficult times.

Survey Specifics

Here we provide a summary of some of the questions included in the survey, with the aim of identifying changes in risk behaviors and biology throughout the first wave of the pandemic, well before established therapeutics and vaccines were available. Additional information about health behavior measures and data reduction is available in the Supplementary Materials.

COVID-19 Risk Perceptions, Stress, and Affect

At both the initial intake and final follow-up surveys, participants responded to the same three items from the pathogen subscale of the Three Domains of Disgust Scale [6], as well as three items from the germ aversion and perceived infectability subscales of the Perceived Vulnerability to Disease

Scale [7]. Perceived COVID-19 knowledge and risk were assessed at the first and final surveys using the following questions: (a) "How would you rate your knowledge level on how to prevent spread of COVID-19?"; (b) "What do you consider to be your own probability of getting infected with COVID-19?"; and (c) "How severe would contracting COVID-19 be for you (how seriously ill do you think you will be)?". Participants responded to these questions using 7-point scales (1 = very low, 7 = very high).

Participants also completed the Positive and Negative Affect Schedule (PANAS) and short-from Perceived Stress Scale (PSS-4) in each survey [8, 9].

Vaccine, Vaccine Hesitancy, and Mask Use

In the final follow-up survey, participants were asked to indicate (a) whether or not they had received a COVID-19 vaccine, (b) dates of vaccination, (c) which vaccine they had received, (d) how many doses they had received, (e) if they experienced side effects, and if so, which and how severely (1 = not at all severe, 7 = very severe), and (f) whether or not they hesitated to receive the vaccine. Vaccine hesitancy was assessed using the question, "Were you convinced from the beginning that you wanted to get a vaccine, or did you hesitate and wait for some time?," using a 7-point scale (1 = hesitated a lot and waited, 7 = did not hesitate or wait). Participants were also given the opportunity to respond to an open-ended question about why they did or did not receive a COVID-19 vaccine (responses shown in Supplementary Materials).

Frequency of mask wearing was also assessed in the final follow-up survey. Participants responded to each, "How often do you wear a mask in public when you are indoors (e.g., grocery store) around people you do not know?" and "How often do you wear a mask in public when you are outdoors (e.g., public park) around people you do not know?," using a 7-point scale (1 = never, 7 = all the time).

SARS-CoV-2 Infection and Symptoms

Participants were asked whether or not they had received a positive SARS-CoV-2 PCR or antigen test in the time between their last date of participation and the final follow-up survey. Those who had received a positive test were asked to provide the date of the test, as well as whether or not they experienced symptoms, which symptoms occurred, and how severe those symptoms were (1 = mild, 5 = admitted to intensive care unit).

Demographic Variables

A number of demographic variables were included as covariates in the models tested in the current study, including age, sex, Hispanic ethnicity, occupation as healthcare worker or first responder, political affiliation (1 = Republican/Lean Republican, 2 = No Lean, 3 = Democrat/Lean Democrat), and highest level of education completed (1 = did not complete high school or receive GED, 9 = doctoral level degree).

Results

Changes in Health Behaviors

All analyses were conducted using SPSS (v26) and R statistical software [10]. Regarding changes in physical activity, responses to the initial intake survey revealed that over half of participants did not report changes in vigorous exercise (57.6%), moderate exercise (54.8%), and sitting/reclining (62.2%) between March 13, 2020, and the time of their first appointment. Among those whose levels of activity did change during this period, decreases in vigorous exercise were more common than increases (29.0% vs. 13.4%). The opposite was true for moderate exercise (decrease: 17.0%, increase: 28.1%), and sitting/reclining (decrease: 5.4%, increase: 32.4%).

Data from the first two follow-up surveys showed that the overwhelming majority of participants did not report further changes in general physical activity at the time of the second (94.0% stayed the same) or third (93.0% stayed the same) in-person appointments. While responses to the final follow-up survey also indicated that most participants did not change their general physical activity in the year following their final in-person appointment (82.6% stayed the same), increases in activity (12.2%) were more common than decreases (5.2%).

Similar to physical activity, around half of participants reported that their weight and intake of unhealthy foods stayed the same between March 13, 2020, and their first appointment. Among those who did report changes, there were nearly twice as many participants who experienced an increase (weight: 31.4%, unhealthy eating: 31.1%) than a decrease (weight: 17.2%, unhealthy eating 15.4%). Responses at the follow-up appointments suggested that neither weight nor unhealthy food intake changed considerably after the initial intake survey (> 90% stayed the same).

Most participants did not report changes in sleep quality (70.2%) or quantity (62.6%) since March 13, 2020 (i.e., at the initial intake survey). For each, decreases (quality: 19.6%, quantity: 20.3%) were more common than increases (quality: 10.2%, quantity: 17.1%). Although questions

about sleep were not included in the first two follow-up surveys, responses to the final survey indicated that overall sleep quality stayed the same for the majority of participants (91.9%) in the year following their last laboratory session.

About a quarter of participants reported increases in the number of alcoholic drinks they consumed per week during the period between the beginning of the pandemic and their first appointments. Only 8.8% reported a decrease in alcohol consumption within this time frame. Questions about drinking behavior were not included in the first two follow-up surveys, but results of the final survey revealed that 93.9% of participants reported no change in the number of alcohol drinks they consumed per week since their last in-person session.

Changes in Disgust and COVID-19 Risk Perceptions

Participants responded to questions about perceived vulnerability to disease (i.e., germ aversion and perceived infectability), pathogen disgust sensitivity, perceived knowledge about COVID-19 disease, and perceived risk of SARS-CoV-2 virus infection and severe COVID-19 disease in both the initial intake survey and over a year later in the final follow-up survey. We examined within-individual changes in these variables over time using repeated-measures ANOVAs.

For germ aversion, results revealed a modest, but statistically significant decrease between the initial intake survey ($M = 5.09$, $SD = 1.17$) and final survey ($M = 4.94$, $SD = 1.24$), $F(1, 312) = 5.78$, $p = 0.02$. Perceived infectability, on the other hand, did not change significantly across the study period ($p = 0.33$). Like germ aversion, pathogen disgust sensitivity also decreased from the first ($M = 4.64$, $SD = 1.34$) to final survey ($M = 4.30$, $SD = 1.40$), $F(1, 312) = 28.78$, $p < 0.001$. Perceived knowledge about the pandemic increased over time ($M_1 = 6.11$, $SD_1 = 0.90$; $M_2 = 6.24$, $SD_2 = 0.97$), $F(1, 312) = 5.95$, $p = 0.02$, while perceived probability of SARS-CoV-2 virus infection ($M_1 = 4.02$, $SD_1 = 1.55$; $M_2 = 3.58$, $SD_2 = 1.56$), $F(1, 312) = 19.18$, $p < 0.001$, and expected severity of COVID-19 disease if infected ($M_1 = 3.71$, $SD_1 = 1.53$; $M_2 = 3.39$, $SD_2 = 1.54$), $F(1, 312) = 13.93$, $p < 0.001$, both decreased. Overall, these results suggest that perceived risk declined in the year following participants' initial session, an effect perhaps attributable to the availability of COVID-19 vaccines, increases in knowledge about the pandemic, or even general pandemic fatigue [11].

Changes in Stress and Affect

A prior analysis using these data found that, in general, participants' levels of perceived stress and negative affect decreased from the initial intake survey to the second and third surveys [11]. Participants who completed the final follow-up survey nearly a year later also responded to questions about their stress and affect. To avoid redundancy with the previous analysis, we examined here whether these variables continued to change in the year following the conclusion of the in-person sessions using repeated-measures ANOVAs.

Results revealed that perceived stress decreased from the third appointment ($M = 2.45$, $SD = 0.73$) to final survey ($M = 2.32$, $SD = 0.71$), $F(1, 312) = 9.57$, $p = 0.002$. Despite this decrease in stress, negative affect appeared to increase during this period ($M_1 = 1.64$, $SD_1 = 0.59$; $M_2 = 1.74$, $SD_2 = 0.62$), $F(1, 312) = 8.57$, $p = 0.004$, while there were no significant changes in positive affect ($p = 0.70$).

Vaccine Hesitancy, Vaccination, and Mask Use at Time of Final Survey

Vaccine coverage of the sample was very high (93.6% receiving a single dose between September and October 2021) (see Table 1). Experiencing at least one side effect was common (first dose: 75.6%, second dose: 72.7%), but these side effects were generally reported as mild. Pain, redness, and swelling at the injection site and tiredness/fatigue were the most typical side effects reported. Despite high rates of COVID-19 vaccination, rates of influenza vaccination declined from 2020 to 2021; 79.6% of respondents reported receiving an influenza vaccine in 2020, while only 34.5% received one by the time of their participation in fall of 2021.

Reported vaccine hesitancy was relatively low ($M = 3.09$, $SD = 1.07$), which is unsurprising given the high number of participants that received the COVID-19 vaccine as well as the high level of education in this sample. Responses to open-ended questions about reasons for receiving or not receiving a COVID-19 vaccine are available in the Supplementary Materials. We conducted a linear regression analysis to examine whether demographic and COVID-19 risk perception variables predicted levels of vaccine hesitancy. Surprisingly, none of these predictors reached statistical significance ($p > 0.21$), including political affiliation.

Political affiliation, however, was related to frequency of mask use at the time of the final survey. Overall, participants reported wearing masks indoors more than outdoors (see Table 1), and results of regression analyses revealed that political affiliation was related to mask use in both contexts. Specifically, greater Democratic lean predicted greater frequency of mask wearing indoors, $b = 1.06$, $SE = 0.13$, $t = 8.14$, $p < 0.001$, and outdoors, $b = 0.78$, $SE = 0.12$, $t = 6.77$, $p < 0.001$. Older individuals also wore masks more often than younger people indoors, $b = 0.02$, $SE = 0.01$, $t = 3.17$, $p = 0.002$, and outdoors, $b = 0.02$, $SE = 0.01$, $t = 2.91$,

Table 1 Descriptive Statistics for Vaccination Rates, Vaccine Hesitancy, and Mask Use

Variable	Statistic
Vaccinated (n = 311)	
Yes	291 (93.6%)
No	20 (6.4%)
Received Both Doses (if applicable)	
Yes	261 (98.1%)
No	5 (1.9%)
Vaccine Type	
BioNTech, Pfizer	128 (44.0%)
Moderna	25 (8.6%)
Johnson & Johnson	138 (47.4%)
Reported Any Side Effect	
First Dose (n = 291)	220 (75.6%)
Pain, redness, swelling	26.4%
Tiredness/fatigue	30.3%
Headache	15.6%
Muscle aches	14.5%
Chills	5.9%
Fever	5.5%
Nausea	1.6%
Second Dose (n = 261)	208 (72.7%)
Pain, redness, swelling	27.0%
Tiredness/fatigue	22.4%
Headache	16.9%
Muscle aches	16.7%
Chills	8.7%
Fever	6.4%
Nausea	2.0%
Side Effect Severity	
First Dose (1–7)	$M = 2.31, Mdn = 2.00, SD = 1.39$
s Dose (1–7)	$M = 2.96, Mdn = 3.00, SD = 1.65$
Vaccine Hesitancy (n = 291)	
Level of Hesitancy Among Vaccinated (1–7)	$M = 3.09, Mdn = 3.00, SD = 1.07$
Mask Use (n = 312)	
Frequency Masking Indoors (1–7)	$M = 4.87, Mdn = 6.00, SD = 2.11$
Frequency Masking Outdoors (1–7)	$M = 2.49, Mdn = 2.00, SD = 1.79$

$p = 0.004$. Further, higher education predicted more frequent mask use indoors only, $b = 0.15$, $SE = 0.05$, $t = 2.81$, $p = 0.005$, and greater perceived risk for severe COVID-19 disease if infected predicted wearing masks more often both indoors, $b = 0.28$, $SE = 0.07$, $t = 3.88$, $p < 0.001$, and outdoors, $b = 0.23$, $SE = 0.07$, $t = 3.45$, $p < 0.001$. No other predictors reached statistical significance ($p > 0.07$).

Rates of SARS-CoV-2 Infection and Symptoms at Time of Final Survey

While all participants themselves had been asymptomatic since March 13, 2020, at the time of enrollment, 19.2% reported that at least one member of their household had developed symptoms of COVID-19 disease at some point. Across the next two follow-up appointments, only 1.1% of participants reported new symptoms in the household between the first and second appointments, and 3.5% reported new symptoms between the second and third. However, 31.7% of participants who completed the final follow-up survey reported that someone in their household exhibited symptoms of COVID-19 disease in the year following their final in-person appointment. Further, 16.7% of participants reported receiving a positive test themselves (PCR or antigen test) and 28.5% reported developing symptoms without being tested by the final survey (Table 2).

Approximately 75% of respondents who reported receiving a positive test were unvaccinated at the time of infection. Most participants reported experiencing mild to moderate symptoms of COVID-19; the most common symptoms were congestion/sinus issues, body aches, loss of taste or smell, and brain fog. One hospitalization occurred among those who were unvaccinated; none occurred among those who were vaccinated. We conducted regression analyses using the same set of covariates included in models for vaccine hesitancy to examine whether any demographic and risk perception variables were related to likelihood of SARS-CoV-2 infection and severity of symptoms if infected. Results of logistic regression revealed that higher age was associated with reduced likelihood of having received a positive test, $b = -0.03$, $SE = 0.02$, $t = -2.11$, $p = 0.03$. No other predictors approached statistical significance ($p > 0.10$). However, a follow-up analysis examined whether frequency of wearing masks indoors and outdoors predicted probability of infection. Both greater mask use indoors, $b = -0.20$, $SE = 0.07$, $t = -2.90$, $p = 0.004$, and outdoors, $b = -0.32$, $SE = 0.11$, $t = -2.90$, $p = 0.004$, were associated with lower likelihood of a positive test in the year following the last in-person session.

Regarding symptoms among those who did test positive, higher perceived risk for severe illness predicted higher actual symptom severity, $b = 0.28$, $SE = 0.09$, $t = 3.13$, $p = 0.003$, perhaps suggesting that individuals have somewhat accurate expectations about illness severity. No other significant predictors emerged ($p > 0.07$).

Table 2 Descriptive Statistics for Rates of SARS-CoV-2 Virus Infection and Symptoms

		Unvaccinated	Vaccinated	
Variable	Overall		1 dose	2 doses
Positive Test (n = 312)				
Yes	52 (16.7%)	39 (75.0%)	3 (5.8%)	10 (19.2%)
No	260 (83.3%)			
Not Tested, but Symptomatic (-)	74 (28.5%)			
Symptom Severity (+)				
Asymptomatic	1 (1.9%)	1 (2.6%)		
Mild	23 (44.2%)	16 (41.0%)	1 (33.3%)	4 (50.0%)
Moderate	21 (40.3%)	17 (43.5%)	2 (66.7%)	2 (25.0%)
Significant	6 (11.5%)	4 (10.3%)		2 (25.0%)
Hospitalized	1 (1.9%)	1 (2.6%)		
Common Symptoms (+)				
Congestion/Sinus Issues	16.9%			
Body Aches/Muscle Pain	14.0%			
Loss of Taste or Smell	11.9%			
Dizziness/Brain Fog	11.0%			
Headache	8.9%			
Fever	8.9%			
Chills	8.9%			
Cough	5.1%			
Dyspnea/Difficulty Breathing	3.4%			
Weakness/Fatigue	3.0%			
Sore Throat	3.0%			
Nausea/GI Issues	2.1%			
Eye Pain	2.1%			
Loss of Appetite	0.8%			

Note. (-) denotes sample of participants who did not received a positive test; (+) denotes sample of participants who did receive a positive test

Discussion

The results of the Waco COVID Survey have provided needed insights into how dynamics of COVID-19 transmission, health behaviors, and COVID-19-related attitudes have changed across the first two years of the pandemic in the community of McLennan County, TX. Moreover, findings from the project have also contributed to the understanding of how individual differences in risk perception and political affiliation shape responses to COVID-19 disease risk. For example, although individuals who lean Republican tend to express less concern about the pandemic and are less likely to wear masks in public, results of the current research revealed that they were not less likely than those who lean Democrat to receive a COVID-19 vaccine. While these findings may be unique to our sample—or the local community—they nonetheless indicate that health behaviors do not always align perfectly with reported perception of health risk [12]. Additional results from the study that may violate expectations included findings that reported levels of disgust, germ aversion, and stress all decreased across the study, while negative affect increased. These results may reflect the emergence of COVID-19 fatigue across time in the community [11].

The current research also provided additional support for the efficacy of personal protective equipment use and vaccination [13, 14]. Specifically, results revealed that individuals who reported wearing masks more often in public were less likely to receive a positive COVID-19 test than those who masked less often. Further, the overwhelming majority of participants who received a positive COVID-19 test during the study were unvaccinated at the time of infection. While there was only a single case of hospitalization due to COVID-19 in the sample, this participant was unvaccinated.

There are limitations of the current research that must be considered when interpreting the results. Most notably, the study utilized a convenience sampling approach, and thus, the demographic characteristics of the final sample were not fully representative of McLennan County as a whole (see Fig. 1). In addition, the final sample size for the study was slightly below the original target. However, the Waco COVID Survey was nonetheless one of the largest longitudinal SARS-CoV-2 antibody seroprevalence surveys conducted to date.

In summary, we hope that the Waco COVID Survey lays the groundwork for future community-focused surveillance projects that may help better understand factors that contribute to local disease transmission. In addition to this benefit, projects such as the Waco COVID Survey also provide unique opportunities for community involvement and for training future healthcare workers and researchers. The numerous student volunteers involved in the project were crucial to its success; the tangible and intangible skills students acquired through their involvement in the survey will serve them well on their way to becoming leaders in the local community and beyond.

Declarations

Conflict of Interest Statement: The authors declare that there are no conflicts of interest.

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