Seroprevalence of SARS-CoV-2 in a Guatemalan agricultural cohort and virus-specific antibody kinetics

University of Colorado Anschutz Medical Campus

Hashem Anabtawi, John David Beckham MD, Mario Santiago MD

University of Colorado School of Medicine, Department of Infectious Diseases

Background

The Agricultural Workers and Respiratory Illness Impact (AGRI) study focuses on the impact of Covid-19 on essential agricultural workers in Guatemala, who play a crucial role in the country's economy and global trade. Despite their exemption from certain pandemic precautions due to their economic importance, these workers face increased risks of contracting the virus due to constant exposure, comorbidities associated with their employment, and economic disincentives for quarantine. The study, initiated in June 2020, revealed a rise in SARS-CoV-2 seroprevalence by December 2020. To assess immunity dynamics and vaccine effectiveness, the study plans to reassess seroprevalence post-April 2021, considering Guatemala's vaccination strategies and potential reinfections. The focus is on understanding how immunity changes and evaluating the stability of SARS-CoV-2 antibodies, including the nucleocapsid antibody indicative of natural infection and the spike protein antibody related to vaccination. This comprehensive analysis aims to enhance our understanding of the impact of vaccination on disease burden and the duration of immunity among essential agricultural workers.

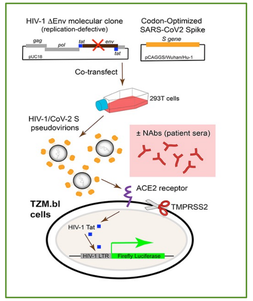
Methods

Seropositivity

- Eligibility criteria: age >18 years, continue employment with the agribusiness >1 year, access to a telephone, agreement to allow use of company-based absenteeism and job performance records.
- At enrollment, participants provided baseline demographic, occupational, socioeconomic, and clinical data as well as a venous blood specimen for screening of anti-SARS-CoV-2 nucleocapsid (anti-N) IgG
- Active influenza-like illness (ILI) surveillance and reporting to study nurse.
- ILI defined as fever, cough or shortness of breath in the last 10 days
- Study nurses collected a nasopharyngeal (NP) swab from workers with ILI
- NP swabs were placed in viral transport media and tested within 24 h for SARS-CoV-2 utilizing the Standard Q COVID-19 rapid antigen test.

Antibody Kinetics

- To evaluate the magnitude and stability of SARS-CoV-2 NAb responses, we utilized a lentivirus-based assay. The genetic makeup of the ancestral (Wuhan) spike protein was engineered with an HIV-1 envelope and incubated with ACE-2 receptor positive T cells along with patient serum samples.
- The samples were then analyzed through the Roche machine to develop a neutralization curve.



Results

Seropositivity

June 2020 to December 2020
42.6% (n=1334)

Antibody Kinetics

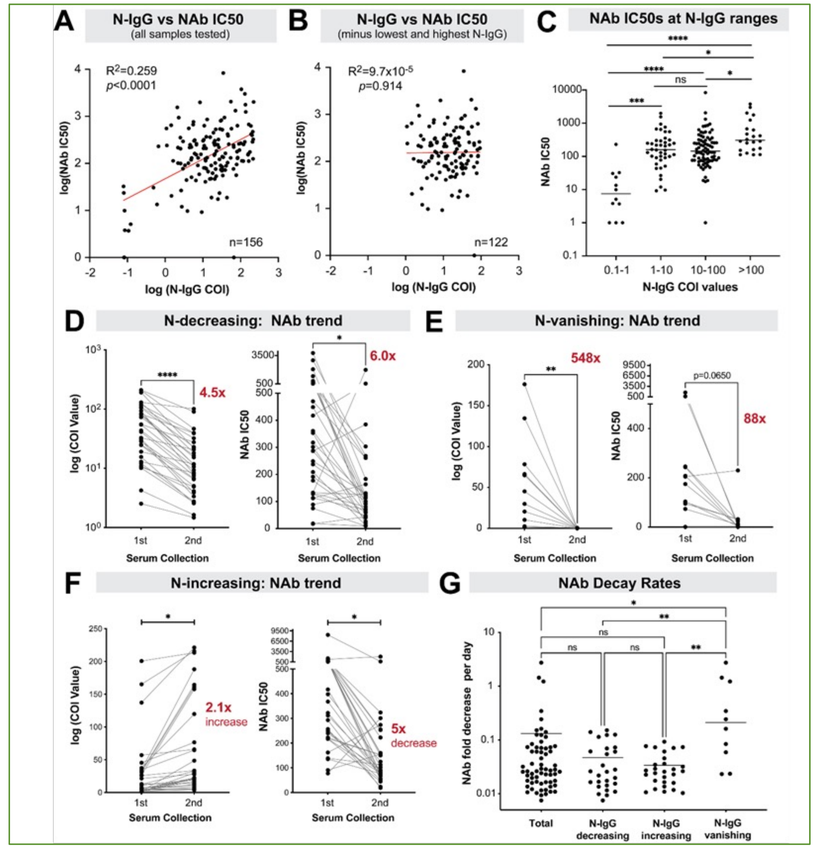


Figure 2. Assessment of neutralizing antibody responses among individuals with serum specimens. Collected at two time points and subjected to a lentivirus-based pseudovirion assay. (**A**) Correlations between NAb IC50s assessed against nucleocapsid IgG positive COI values using linear regression. (**B**) Serum specimens with COI values <1 and >100 removed. (**C**) Mean NAb IC50 values for 4 groups of nucleocapsid IgG COI values evaluated using ANOVA followed by Kruskal-Wallis test and grouped based on whether the nucleocapsid IgG positive COI values were (**D**) decreasing, (**E**) vanishing, or (**F**) increasing. Trends are highlighted in the graphs on the left of each panel. For each group, the NAb IC50 titers are assessed (right graphs on each panel) and differences evaluated using a 2-tailed paired Student's t-test. (**G**) The fold-decrease in NAb divided by the time interval between serum collection compared between specimens with various nucleocapsid IgG reactivity trends using ANOVA and Kruskal-Wallis test. For all panels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, **** $p < 0.0001$.

Discussion

1. **Seropositivity Trends:**
   1. The study reveals an increase in seropositivity among a population, rising from ~20% at enrollment to 42.6% during the "first wave" of the pandemic (June 2020 to December 2020).
   2. The quantitative analysis indicates a significant decline in immunity, with anti-SARS-CoV-2 neutralizing antibody levels decreasing by approximately 0.13x per day, reaching ~95% reduction within 6 months.
2. **Seroprevalence Studies' Significance:**
   1. Seroprevalence studies are crucial for estimating COVID-19 burden, identifying asymptomatic cases missed by passive surveillance.
   2. The high seropositivity rate among essential workers, especially agricultural workers, underscores the risks they face in maintaining food supplies during pandemics.
3. **Occupational Risk Factors:**
   1. Job type is identified as a significant risk factor for SARS-CoV-2 infection, with workers in packing plants demonstrating a twofold increase in risk compared to those working in the fields.
   2. These occupational risk factor findings suggest the need for job-specific interventions to reduce the risk of SARS-CoV-2 infection.
4. **Antibody Stability and Decline:**
   1. Assessments of blood specimens from seropositive individuals show that anti-N IgG reactivities remained detectable for approximately 150 days for the majority (85%) of participants.
   2. However, there was a substantial decline (>95%) in neutralizing antibody titers, indicating that anti-N IgG titers may not reliably predict changes in antibody neutralization over time.
5. **Reinfection and Future Considerations:**
   1. Despite the rapid decline in neutralizing antibody titers, as of October 2021, only two reinfections with clinical illness have been reported among workers who were seropositive at enrollment.
   2. Ongoing study is needed to understand the extent to which the rapid loss of humoral immunity influences reinfections, with a focus on the potential role of T cell responses in reducing severe illness, given their stability and potential resistance to virus escape.

Conclusions

Essential workers bear the burden of exemption among many government-enforced methods to reduce disease transmission from COVID-19, putting them at risk of clinical and economic hardship. The high seroprevalence thus far demonstrates the burden of disease among this cohort. We predict the seroprevalence will increase after analysis of the data through June 2022 due to declining quantity of neutralizing antibodies and uncertain protection against reinfection. We also hope to further analyze risk factors for disease incidence based off demographic data after all samples are analyzed from either the same patient over a second period of time or a new patient. We hope this data serves to guide future vaccine development and public health precautions for essential workers.

There are no disclosures

IRB Approval: COMIRB protocol #19-1836, 29 June 2021) and the Guatemala Ministry of Health National Ethics Committee (HRMC-560-2020, 12 June 2020

References: