**City of Holyoke Serosurvey Report**

**April 14th, 2021**

**Overview**

The objective of this work was to measure the seroprevalence of antibodies against SARS-CoV-2, the virus that causes COVID-19 in the city of Holyoke, MA. This gives us information on the percentage of the population that has been exposed to the virus in the past and continue to have antibodies, which is a more accurate reflection of the number of infections in the city compared to a cumulative count of positive RT-PCR test results. Additionally, we sought to understand if there were any specific characteristics or groups of individuals that have been disproportionately affected by the virus. This work has important public health implications because it allows us to understand how many individuals have been infected, how much of the population is still at risk of becoming infected, and highlights factors that can be targeted by public health interventions to lower the risk of being infected with SARS-CoV-2.

For this work, 2000 addresses in Holyoke were randomly selected for participation in the study. We conducted outreach to potential participants by mail, phone and home visits. All household members for selected addresses were invited to participate. Participants were asked to fill out household and individual surveys and return a blood sample to test for antibodies against SARS-CoV-2. We measured two types of antibodies: IgG antibodies, which signify that the individual was infected in the past, and IgM antibodies, which signify that individuals were recently infected. Participant enrollment began on November 5th, 2020 and ended on December 31st, 2020. Most blood samples were received by the end of January 2021.

Overall, 280 households including 472 individuals chose to participate in the study. Table 1 compares the demographic characteristics for study participants to the entire City of Holyoke, reflecting the representativeness of the study sample. Compared to the population of Holyoke, the participants in the study sample were more likely to identify as female, older, and white, and less likely to identify as Hispanic or Latino/Latina

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| **Table 1. Unweighted demographic characteristics of survey participants,** |  |
| **compared with 2019 American Community Survey estimates for the city -**  |
| **Holyoke, MA, USA, November 1 – December 31** |  |  |  |
|  | **Participants** | **Holyoke City1** |
| **Characteristic** | N = 472 | % | N = 40241 | % |
| **Gender** |  |  |  |  |
| Female | 263 | 55.7% | 20747 | 51.6% |
| Male | 200 | 42.4% | 19494 | 48.4% |
| Transgender woman2 | < 10 | <2.0% | - | - |
| Transgender man | < 10 | <2.0% | - | - |
| Non-binary | < 10 | <2.0% | - | - |
| Prefer not to answer | < 10 | <2.0% | - | - |
| Other | < 10 | <2.0% | - | - |
|  |  |  |  |  |
| **Age group (years)** |  |  |  |  |
| 0-19 | 50 | 10.6% | 10406 | 25.8% |
| 20-44 | 130 | 27.5% | 14335 | 35.7% |
| 45-59 | 135 | 28.6% | 7607 | 18.9% |
| 60-84 | 149 | 31.6% | 7019 | 17.4% |
| 85+ | 8 | 1.7% | 874 | 2.2% |
|  |  |  |  |  |
| **Race/Ethnicity** |  |  |  |  |
| Hispanic | 126 | 26.7% | 21704 | 53.9% |
| Non-Hispanic | 346 | 73.3% | 18537 | 46.1% |
|  White | 311 | 65.9% | 16636 | 41.3% |
|  Black | 10 | 2.1% | 1162 | 2.9% |
|  Asian | < 10 | <2.0% | 239 | 0.6% |
|  American Indian, Alaskan Native | < 10 | <2.0% | 78 | 0.2% |
|  Native Hawaiian, Other Pacific Islander | < 10 | <2.0% | 0 | 0.0% |
|  Other Race | < 10 | <2.0% | 3 | 0.0% |
|  Two or more races | < 10 | <2.0% | 419 | 1.0% |
| Prefer not to answer | < 10 | <2.0% | - | - |

1U.S. Census Bureau (2019). American Community Survey, Demographic and Housing Estimates. Table DP05.

2An N of < 10 and % of < 2.0 indicates that there were less than 10 respondents in this group. Given the small sample sizes in this group, we did not present absolute numbers in order to protect participant privacy.

Of the 472 individuals that enrolled in the study, 328 provided a blood sample to test for antibodies, allowing us to measure the prevalence of prior or recent infection. Table 2 shows the “unweighted” prevalence, broken down by antibody type. This is the prevalence before taking into account the differences in our survey participant demographics relative to the city’s demographics.

We then performed a statistical procedure called “weighting.” This takes into account the differences in our survey participants compared to the city as a whole and gives a more representative measure of SARS-CoV-2 antibody prevalence. To better understand the process of weighting, we provide an illustrative example. Hispanic or Latino/Latina residents comprised 26.7% of survey participants but represent 53.9% of the population of Holyoke. This means that Hispanic or Latino/Latina residents were less likely to participate in the study. And, Hispanic or Latino/Latina participants were *more* likely to have antibodies against SARS-CoV-2 than non-Hispanic participants (Table 3). The weighted prevalence estimates reflect what we would expect the city-wide estimates to be if individuals identifying as Hispanic or Latino/Latina had participated in the study at a frequency that was similar to their proportion of the city population (53.9%). An important assumption in weighting is that within groups of race, ethnicity, gender and age, the antibody status of those who did and those who did not participate is comparable.

This weighted analysis showed that the prevalence of infection in Holyoke was 13.9% (Table 2).

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| **Table 2. Seroprevalence by antibody positivity profile**  |  |
| **Characteristic** | **No. tested** | **No. Positive** | **Unweighted seroprevalence, % (95% CI)** | **Weighted seroprevalence, % (95% CI)** |
| IgG or IgM | 328 | 27 | 8.2 (5.0 - 12.5) | 13.9 (7.8 - 21.8) |
| IgG only | 328 | 18 | 5.5 (3.1 - 8.7) | 8.0 (3.8 - 14.4) |
| IgG and IgM | 328 | 7 | 2.1 (0.9 - 4.1) | 3.8 (1.5 - 7.5) |
| IgM only | 328 | 2 | 0.6 (0.1 - 1.9) | 2.0 (0.4 - 6.0) |

The prevalence of infection was higher among individuals below the age of 44, individuals identifying as male and individuals identifying as Hispanic or Latino/Latina (Table 3). Additionally, individuals reporting a household COVID-19 exposure had a higher prevalence of antibodies compared to individuals that had a COVID-19 exposure outside the home, and those that did not have a COVID-19 exposure. As expected, individuals that reported a positive RT-PCR test for SARS-CoV-2 had a much higher seroprevalence of antibodies against SARS-CoV-2.

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| **Table 3. Seroprevalence1 by demographic characteristics** |  |
| **Characteristic** | **No. tested** | **No. Positive** | **Unweighted seroprevalence, % (95% CI)** | **Weighted2 seroprevalence, % (95% CI)** |
| **Age group (yrs)** |  |  |  |  |
| 0 - 19 | 27 | 3 | 11.1 (0.00 - 26.7) | 20.7 (2.2 – 39.2) |
| 20 - 44 | 76 | 11 | 14.5 (5.6 – 23.3) | 13.8 (5.6 – 22) |
| 45 - 59 | 94 | 6 | 6.4 (0.7 - 12.1) | 9.6 (0 -20.5) |
| 60 - 84 | 123 | 6 | 4.9 (1.1 - 8.6) | 4.8 (0 – 10.2) |
| 85 and over | 8 | 1 | 12.5 (0 - 35.8) | 42.9 (0 - 100) |
|  |  |  |  |  |
| **Gender** |  |  |  |  |
| Female | 180 | 16 | 8.9 (4.6 - 13.2) | 12.7 (5.5 – 19.9) |
| Male | 139 | 11 | 7.9 (3 - 12.8) | 15.3 (4.7 - 25.9) |
| Grouped categories3 | 9 | 0 | - | - |
|  |  |  |  |  |
| **Race/Ethnicity** |  |  |  |  |
| Hispanic | 66 | 9 | 13.6 (2.1 - 25.2) | 16.8 (5.7 – 28) |
| Non-Hispanic White | 239 | 17 | 7.11 (3.2 - 11) | 8.9 (3 - 14.7) |
| Non-Hispanic grouped categories4 | 23 | 1 | 4.3 (0 – 12.3) | 23.4 (0 – 59.4) |
|  |  |  |  |  |
| **Known exposure to a confirmed case of COVID-19** |  |  |  |  |
| No known exposure | 256 | 10 | 3.9 (1.6 – 6.3) | 6 (1.4 – 10.5) |
| Exposure to someone outside the home | 55 | 8 | 14.5 (4.5 – 24.6) | 17.5 (5.1 – 29.9) |
| Exposure to household member | 16 | 9 | 56.2 (33.8 – 78.7) | 71.6 (47 – 96.2) |
|  |  |  |  |  |
| **SARS-CoV-2 Testing** |  |  |  |  |
| Never tested | 167 | 3 | 1.8 (0 – 3.8) | 3.9 (0 – 8.9) |
| Tested but always negative | 139 | 12 | 8.6 (4 – 13.2) | 14.5 (5.2 – 23.8) |
| At least one positive test | 18 | 12 | 66.7 (45.5 – 87.8) | 88.5 (76.1 -100) |

1Seroprevalence for demographics groups based on total antibody positivity (i.e., either IgG or IgM positive).

2Weights were computed as the inverse probability of selection and adjusted so that the marginal distribution of age group, gender, race/ethnicity of the sample agreed with population estimates.

3Gender grouped categories includes transgender man, transgender woman, non-binary, and prefer not to answer. Categories were grouped given small sample sizes, which limited generation of survey weights, and to preserve privacy in a public report.

4Non-Hispanic grouped categories includes Black/African American, Asian, Native Hawaiian or Other Pacific Islander, American Indian or Alaskan Native, more than two races/ethnicities and those who preferred not to answer. Categories were grouped given small sample sizes and to preserve privacy in a public report.

**Summary and Key Points**

1. The Holyoke Community Antibody Study suggests that by the end of January 2021, the prevalence of infection with SARS-CoV-2 throughout the city was 13.9%. This is approximately double the number of cumulative reported cases, 2975 as of December 31st, 2020.
2. We identified several groups with higher seroprevalence rates, suggesting that they were more frequently infected with SARS-CoV-2 and thus at higher risk of infection:
	1. Individuals identifying as Hispanic or Latino/Latina had a higher seroprevalence of SARS-CoV-2 antibodies (16.8%) compared to individuals identifying as white (8.9%). This finding is consistent with well-documented nationwide racial and ethnic COVID-19 disparities.
	2. Seroprevalence of SARS-CoV-2 antibodies was highest among younger age groups. We did note a high seroprevalence among individuals over 85 years of age. Though this is consistent with historical findings highlighting that this is a high-risk group, the number of participants in this group was small, making it difficult to draw strong conclusions.
	3. Seroprevalence was highest among individuals reporting household COVID-19 contacts compared to other contacts, confirming that the household is a high-risk setting.
3. A seroprevalence of 13.9% suggests that by the end of January 2021, the city as a whole was far from the level of prior infections that would be protective against further surges of COVID-19, what is traditionally referred to as “herd immunity.” This reinforces the importance of rapidly and equitably deploying existing vaccines to prevent further infections, and to make sure that our vaccination efforts reach the communities that are at highest risk.