COVID-19 AMONG COMMUNITY-DWELLING RESIDENTS OF SAGINAW COUNTY, MI: RACE/ETHNICITY AND URBAN/RURAL CONSIDERATIONS

By

Rachel A. Dodak

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ABSTRACT

Examining community trends related to demographic and socioeconomic risk factors associated with COVID-19 has been vital in informing public health strategies since the onset of the pandemic. This study is an exploratory epidemiological analysis of COVID-19 incidence and associated risk factors in individuals residing in Saginaw County, Michigan. This descriptive study used data on 2619 COVID-19 cases among Saginaw County, Michigan, residents confirmed between January and September of 2020 in the Michigan Disease Surveillance System. Two analyses were performed, one to examine COVID-19 outcomes (e.g., incidence, hospitalization, and mortality) between city and non-city residents by race/ethnicity, and the other to explore the association between household size and risk of COVID-19 infection at the census-tract level. Compared to those residing outside the city, city-dwelling Non-Hispanic White and Hispanic residents were more likely to have tested positive for COVID-19 (CIRR=1.28, 95% Wald CI: 1.08-1.51, p=0.004 and CIRR=1.87, 95% Wald CI: 1.49-2.35, $p<0.0001$, respectively) and were more likely to be hospitalized from COVID-19-related illness (CHRR=1.8, 95% Wald CI: 1.09-2.98, p=0.021 and CHRR=4.22, 95% Wald CI: 1.98-9.00, p=0.0002, respectively). Also, the COVID-19 incidence rate decreased, albeit non-significantly, with increasing household size per census tract (β=-0.26, p=0.29). The urban-rural race/ethnicity COVID-19 disparities between Non-Hispanic White and Hispanic residents point to geographic and/or race/ethnic inequities in access to testing, treatment, and/or preventative measures for residents of Saginaw County, Michigan.

This thesis is dedicated to my parents, Tony and Janell Dodak, for their unending love and support throughout my education.

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INTRODUCTION

After the first reporting of COVID-19 cases emerged from China in December of 2019, the SARS-CoV-2 virus spread worldwide,[1] precipitating a global pandemic with major public health implications. Since then, COVID-19 has continued to spread, despite the development and administration of vaccines, and numerous sub-variants have continued to emerge. As of August 2022, the CDC reports over 93.1 million cases of COVID-19 in the United States.[1] Some 1,034,118 deaths are currently attributable to the virus, with mortality projections of about 16,154 deaths over the next month.[1] In Michigan, the CDC is also reporting a high transmission level, with a weekly case rate of 189 per 100,000 individuals reported as of 8/21/2022.[2]

Analyses of both national and region-specific COVID-19 cases demonstrate that a major risk factor for contracting the virus is one's race/ethnicity, while housing, work environment and social conditions likely also impact the spread of COVID-19 within and between race/ethnic groups differently.[1] Additionally, individuals of low socioeconomic status (SES) are also more likely to have health conditions that may put them at higher risk of severe COVID-19.[3] Access to testing and care have also been shown to affect COVID-19 incidence and mortality rates.[4,5] Community trends in these demographic and socio-economic factors are therefore of interest to public health officials, as they inform their strategies with respect to disease measurement, prevention, and mitigation of COVID-19.[6]

One way to shed light on race/ethnic disparities and COVID-19 is to compare cases emanating from urban and rural areas. Social distancing, quarantine measures, testing, and treatment in response to COVID-19 have been difficult to implement effectively across cities because of their high population density, and especially so in populations with low SES and areas with poor access to basic infrastructure services.[4,5,7] Therefore, urban areas are more

challenged by community spread. However, rural areas tend to have increased susceptibility to severe infection or death consistent with vulnerable populations having less access to health care, higher proportions of underlying health conditions, more elderly, a lack of health insurance, and lower vaccination rates.[8-14] Therefore, comparing incidence, hospitalization, and mortality rates between urban and rural areas may not only be indicators for how social and economic factors impact the spread and severity of the disease, but also for geographic differences in testing and health care access.

At the county-level, multiple studies have reported higher incidence, hospitalization, and mortality rates in rural areas compared to metropolitan/urban areas.[3,15-18] While some of these studies also analyzed rates by race/ethnicity, none have included an analysis of the urban/rural disparity by race/ethnicity, or within counties.

Household transmission of COVID-19 has also been an area of public health interest. For example, research on the association between larger household size and risk of COVID-19 infection has found significant results on both the individual- and county-level.[6,19-21] Significant results have also been reported on the individual-level after lockdown in the UK (but not prior).[16] Only a few studies have analyzed this association at the neighborhood-level, with conflicting results.[22,23]

For this reason, some researchers have developed neighborhood-level risk indices for major cities based on demographic and health characteristics of the population at the census-tract level – with the idea that there may be an increased risk for COVID-19 transmission, severe symptoms, or death.[24-26] Census tracts with a higher percentage of minority residents, higher rates of poor health outcomes, and lower SES, have been shown to have a higher predicted risk.[24-26] However, these analyses do not tell us how well the indices predict risk of disease, since

they do not include measurement of the association between COVID-19 and potential risk factors at the neighborhood-level. A single study that did so found that high income regions were more likely to have high cumulative incidence infection rates, likely due to more access to testing.[27]

Further study is needed to be able to effectively apply these findings to public health efforts, since these factors may vary in different regions. Nevertheless, findings from a previous analysis of census-tract level race/ethnicity COVID-19 data in the city of Saginaw, Michigan, indicate that there was a higher proportion of COVID-19 cases among Black/African American residents compared to White/Caucasian residents, in contrast to national data that have shown a higher proportion of White/Caucasian cases than Black/African American cases at that time.[1] This discrepancy prompted a more in-depth analysis of COVID-19 in Saginaw County with the goal to explore the county-specific impacts of urban and rural inequalities, neighborhood-level disparities, and average household size among county residents.

Th overarching purpose of this research was to examine the prevalence of COVID-19 infections among racial and ethnic minorities in Saginaw, Michigan. Additionally, this research evaluated socioeconomic factors that might help illuminate the distribution of the disease within and between specific communities. In order to accomplish these goals, a descriptive analysis was performed with two main objectives: (a) to compare, by race/ethnicity, the rates of cumulative incidence, hospitalization, and mortality of COVID-19 cases between residents of the city of Saginaw and residents of Saginaw County at-large and (b) to evaluate, by census tract, the association between household size and risk of becoming a confirmed COVID-19 case.

METHODS

Design & Study Population (the MDSS)

This is a descriptive analysis of positive COVID-19 cases among residents of Saginaw County, Michigan.

To derive the analytical samples, data for the 2619 confirmed cases among Saginaw County, Michigan, residents entered into the Michigan Disease Surveillance System (MDSS) from January 1st, 2020 to September 30th, 2020, was extracted (excluding those that were under the age of 18 years or prisoners). Any Michigan residents who are considered a Patient Under Investigation (PUI) as a potential COVID-19 case by health care providers, local health departments, laboratories, Quarantine Stations, or contact tracing systems may be entered into the MDSS.[28] These PUI's would be assigned a case status based on test results and/or diagnosis.[29] Those assigned a "Confirmed" case status had data collected prospectively from the time of case status assignment to the conclusion of self-isolation.[29] Socio-demographic, exposure, and clinical information was collected during the initial case interview.[29] Health status, development of symptoms, and case outcomes were monitored regularly during follow-up.[29] If an individual tested positive again 90 days after a previous infection, the new infection would be recorded under a different case number, with the same patient ID in the MDSS. There was one such patient with two infections in the initial sample that was retrieved, although this case was excluded for the purposes of the present analysis for not meeting inclusion criteria.

Sample Derivation

For the purpose of this research, any resident listed as a "Confirmed" case in the MDSS was considered a positive COVID-19 case. The data extracted included information for each case's

age, sex, race, ethnicity, address, assisted living status or long-term care residency, hospitalization status, and vital status. From the 2619 cases in the reference population, three analytic samples were derived to address this study's objectives (Figure 1).

For objective (b), 244 long-term care (LTC) or assisted living residents and 25 cases missing address information were excluded. (Sub-analyses with LTC residents included were also performed – see Results and Discussion sections.) The resulting Sample 1 examined 2350 cases. Next, 308 cases with unknown race/ethnicity were excluded from Sample 1, leaving 2042 cases in Sample 2. Sample 2 was used for the incidence and mortality analyses for objective (a). Two more cases with unknown hospitalization status were excluded, leaving 2040 cases in Sample 3 for testing objective (a) related to hospitalization.

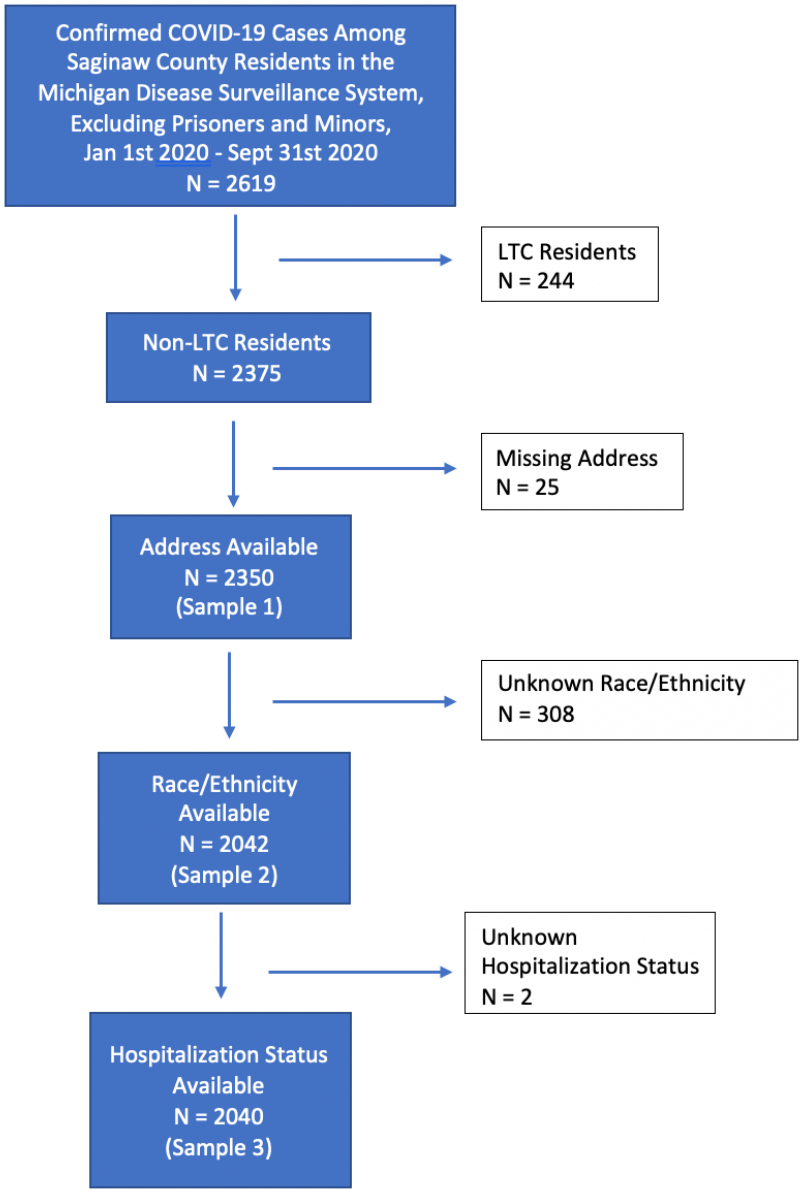
Variables

Race/ethnicity categories were divided into Hispanic, non-Hispanic Black, non-Hispanic White, and Other. Non-Hispanic Asian, American Indian/ Alaskan Native, Native Hawaiian/ Other Pacific Islander, and multi-racial individuals were grouped as Other.

Vital status indicated whether the case lived or had a COVID-19-related death during follow-up. A death is considered COVID-19-related if the disease is listed as a cause or contributing factor of death on the death certificate. Hospitalization status indicates whether the case was hospitalized as a result of COVID-19-related illness.

Household sizes were gleaned from the American Community Survey 2019 5-year estimate for average household size per tract in Saginaw County.

Figure 1: Sample Derivation



Analysis

SAS Studio 3.8 was used for all data analyses. Cumulative incidence, hospitalization, and mortality rates per 100,000 residents were calculated for objective (a). The 2020 decennial census was used to obtain the number of residents for these rates. The rates of interest were

compared between cases among city residents and those residing outside the city. To identify where a given case resided, individuals were matched to their census tracts via geocoding the addresses in ArcGIS. There are 19 census tracts within the city limits of Saginaw and 56 total census tracts in Saginaw County.

For objective (b), average household size per census tract was found in the 2019 American Community Survey (ACS) 5-year estimates. As the ACS used 2010 census tracts, the COVID-19 cases were remapped by the 2010 tracts for this objective instead of the 2020 tracts. A negative binomial model was fitted with the cumulative count of COVID-19 cases per tract offset by the 2019 ACS population estimates for the 2010 tracts as the dependent variable and with average household size per tract as the independent variable.

RESULTS

Table 1 presents the demographic and health-related characteristics among Saginaw County, Michigan, residents aged 18 years and older by the county census population, reference population, and the three analytic samples.

The county census population (about 150,500 individuals) is comprised of about 52% females and 48% males. The ten-year age strata (for ages 18-84) ranged from about 11,000 (ages 75-84) to over 27,000 (for ages 55-64). Seventy-one percent of individuals were Non-Hispanic White, 16.5% were Non-Hispanic African American, and 7.4% were Hispanic.

Comparatively, the reference population had a higher proportion of females (about 59%), similar age category distributions, and about a 60% lower proportion of NH Whites (71% and 12%, respectively). Slightly over 87% of individuals reported not being hospitalized and about 30% reported having a pre-existing condition.

Table 2 presents the demographic and health-related characteristics among county residents aged 18 years and older as well as among the city and at-large populations. The female-to-male percentages are roughly equal across the county, city and at-large populations (approximately 52% females to 48% males). The age ranges across all three populations are also roughly equal. Non-Hispanic Whites are fewest in the city census population, next highest in the county census population and highest in the at-large census population (39% vs. 71% vs. 80%, respectively).

Table 3 represents the cumulative incidence of COVID-19 cases among Saginaw County residents from January to September 2020.

The cumulative incidence for city-dwelling Non-Hispanic White residents compared with those living at-large is 1.3% and 1.0%, respectively. City-dwelling Non-Hispanic White

residents are significantly more likely to have tested positive for COVID-19 (CIRR = 1.28, 95% Wald CI: 1.08-1.51, p=0.004) compared to those residing outside the city. The results were similar when the same analysis was run with LTC residents included.

The cumulative incidence for city-dwelling Non-Hispanic Black residents compared with those living at-large is 2.4% and 2.3%, respectively. City-dwelling Non-Hispanic Black residents are more likely to have tested positive for COVID-19 (CIRR = 1.04, 95% Wald CI: 0.88-1.22, p=0.65) compared to those residing outside the city. This comparison is not statistically significant.

The cumulative incidence for city-dwelling Hispanic residents and for those residing outside the city is 3.7% and 2.0%, respectively. City-dwelling Hispanic residents are significantly more likely to have tested positive for COVID-19 compared to those residing outside the city (CIRR = 1.87, 95% Wald CI: 1.49-2.35, p<0.0001). The results were similar when the same analysis was run with LTC residents included.

The cumulative incidence for city-dwelling residents reporting as "Other" and for those residing outside the city is 5.2% and 4.0%, respectively. City-dwelling "Other" residents are significantly more likely to have tested positive for COVID-19 compared to those residing outside the city (CIRR = 1.28, 95% Wald CI: 1.00-1.63, p=0.0495.

Table 4 represents the cumulative hospitalization of COVID-19 cases among Saginaw County residents from January to September 2020.

The cumulative hospitalization for city-dwelling Non-Hispanic White residents compared with those living at-large is 0.15% and 0.08%, respectively. City-dwelling Non-Hispanic White residents are significantly more likely to become hospitalized from COVID-19 -related illness

(CHRR = 1.8, 95% Wald CI: 1.09-2.98, p=0.021) compared to those residing outside the city. The results were similar when the same analysis was run with LTC residents included.

The cumulative hospitalization for city-dwelling Non-Hispanic Black residents compared with those living at-large is 0.37% and 0.29%, respectively. City-dwelling Non-Hispanic Black residents are more likely to become hospitalized from COVID-19-related illness (CHRR = 1.3, 95% Wald CI: 0.83-2.03, p=0.25) compared to those residing outside the city. This comparison is not statistically significant.

The cumulative hospitalization for city-dwelling Hispanic residents and for those residing outside the city is 0.58% and 0.14%, respectively. City-dwelling Hispanic residents are significantly more likely to become hospitalized from COVID-related illness (CHRR = 4.22, 95% Wald CI: 1.98-9.00, p=0.0002) compared to those residing outside the city. The results were similar when the same analysis was run with LTC residents included.

Table 5 represents the cumulative mortality of COVID-19 cases among Saginaw County residents from January to September 2020.

The cumulative mortality for city-dwelling Non-Hispanic White residents compared with those living at-large is 0.04% and 0.03%, respectively. City-dwelling Non-Hispanic White residents are more likely to have died from COVID-related symptoms (CMRR = 1.31, 95% Wald CI: 0.50-3.38, p=0.58) compared to those residing outside the city. This comparison is not statistically significant.

The cumulative mortality for city-dwelling Non-Hispanic Black residents compared with those living at-large is 0.10% and 0.07%, respectively. City-dwelling Non-Hispanic Black residents are more likely to have died from COVID-19-related symptoms (CMRR = 1.58, 95%

Wald CI: 0.64-3.91, p=0.32) compared to those residing outside the city. Again, this comparison is not statistically significant.

The cumulative mortality for city-dwelling Hispanic residents and for those residing outside the city is 0.11% and 0.08%, respectively. City-dwelling Hispanic residents are more likely to have died from COVID-19-related symptoms (CMRR = 1.47, 95% Wald CI: 0.43-5.06, p=0.54) compared to those residing outside the city. This comparison is not statistically significant.

Note: Although not shown in tabular format, if average household size increases by 1, the difference in the logs of expected count for cumulative incidence of COVID-19 decreases by 0.35 per census tract. This finding is not statistically significant (p=0.16).

Tables

Table 1: Demographic and health-related characteristics among Saginaw County residents aged ≥18 years and the analytic samples

		County Census Population* Max N = 150,491		Reference Population N = 2619		Sample 1 N = 2333		Sample 2 N = 2029		Sample 3 N = 2027	
		n	%	n	%	n	%	n	%	n	%
Sex	Female	78,508	52.2	1554	59.3	1367	58.6	1186	58.5	1184	58.4
	Male	71,983	47.8	1045	39.9	946	40.6	833	41.1	833	41.1
	Unknown			20	0.8	20	0.9	10	0.5	10	0.5
Age	18-24	18,528	12.3	442	16.9	430	18.4	364	17.9	364	18.0
	26-34	23,423	15.6	459	17.5	453	19.4	392	19.3	392	19.3
	35-44	20,939	13.9	350	13.4	344	14.7	302	14.9	302	14.9
	45-54	24,459	16.3	409	15.6	399	17.1	337	16.6	337	16.6
	55-64	27,341	18.2	358	13.7	332	14.2	287	14.1	286	14.1
	65-74	20,276	13.5	283	10.8	228	9.8	213	10.5	213	10.5
	75-84	10,653	7.1	169	6.5	105	4.5	98	4.8	97	4.8
	>=85	4872	3.2	149	5.7	42	1.8	36	1.8	36	1.8
Race/ Ethnicity	NH White	105,856	71.2	306	11.7	294	12.6	294	14.5	294	14.5
	NH AA	24,500	16.5	599	22.9	562	24.1	562	27.7	562	27.7
	Hispanic	11,045	7.4	1283	49.0	1066	45.7	1066	52.5	1065	52.5
	Other	7203	4.9	115	4.4	107	4.6	107	5.3	106	5.2
	Unknown			316	12.1	304	13.0				
Hospitalized	Yes			324	12.4	225	9.6	216	10.7	216	10.7
	No			2290	87.4	2106	90.3	1811	89.3	1811	89.3
	Unknown			5	0.2	2	0.1	2	0.1		
Vital Status	Alive			2467	94.2	2268	97.2	1964	96.8	1964	96.9
	Dead			152	5.8	65	2.8	65	3.2	63	3.1
Pre-existing Conditions	Yes			793	30.3	595	25.5	568	28.0	568	28.0
	No			1826	69.7	1738	74.5	1461	72.0	1459	72.0

* For the county population, the American Community Survey (ACS) 5-year estimates were used for age and sex, and 2020 decennial census data was used for race/ethnicity. For the ACS estimates N = 150,491, and for the 2020 census data N = 148,604.

Table 2: Demographic characteristics among Saginaw County residents 18 years of age and older

		County Census Population* Max N = 150,491		City Census Population* Max N = 35,706		At-Large Census Population* Max N = 116,073	
		n	%	n	%	n	%
Sex	Female	78,508	52.2	18,981	53.2	59,527	51.9
	Male	71,983	47.8	16,725	46.8	55,258	48.1
Age	18-24	18,528	12.3	4928	13.8	13,600	11.9
	25-34	23,423	15.6	6650	18.6	16,773	14.6
	35-44	20,939	13.9	5910	16.6	15,029	13.1
	45-54	24,459	16.3	6089	17.1	18,370	16.0
	55-64	27,341	18.2	5956	16.7	21,385	18.6
	65-74	20,276	13.5	3566	10.0	16,710	14.6
	75-84	10,653	7.1	1762	4.9	8891	7.8
	>=85	4872	3.2	845	2.4	4027	3.5
Race/ Ethnicity	NH White	105,856	71.2	12,735	39.2	93,121	80.2
	NH AA	24,500	16.5	13,684	42.1	10,816	9.3
	Hispanic	11,045	7.4	4476	13.8	6569	5.7
	Other	7203	4.9	1636	5.0	5567	4.8

* For these populations, the American Community Survey (ACS) 5-year estimates were used for age and sex, and 2020 decennial census data was used for race/ethnicity. For the ACS estimates, county N = 150,491, city N = 35,706, and at-large N = 114,785. For the 2020 census data, county N = 148,604, city N=32,531, and at-large N = 116,073.

Table 3: Cumulative Incidence of COVID-19 Among Saginaw County Residents: Jan-Sept 2020

Race/ Ethnicity	Region	# Positive Cases	Census Population*	Cumulative Incidence†		CIRR‡ (95% Wald CI)	*p*-value
				%	Cases/1000		
Non-Hispanic White	City	160	12,735	1.26	13	**1.28 (1.08-1.51)**	**0.004**
	At-Large	914	93,121	0.98	10		
Non-Hispanic Black	City	321	13,684	2.35	23	1.04 (0.88-1.22)	0.65
	At-Large	244	10,816	2.26	23		
Hispanic	City	166	4476	3.71	37	**1.87 (1.49-2.35)**	**<0.0001**
	At-Large	128	6569	1.95	19		
Other	City	20	1636	5.20	52	0.77 (0.47-1.24)	0.28
	At-Large	89	5567	4.02	40		

***** Number of residents according to the 2020 decennial census.
† Positive COVID cases/number of residents.
‡ Cumulative Incidence Rate Ratio = City Cumulative Incidence/At-Large Cumulative Incidence.

Table 4: Cumulative COVID-19 Hospitalization Among Saginaw County Residents: Jan-Sept 2020

Race/ Ethnicity	Region	# Cases Hospitalized	Census Population*	Cumulative Hospitalization†		CHRR‡ (95% Wald CI)	*p*-value
				%	Hosp/10,000		
Non-Hispanic White	City	19	12,735	0.149	15	**1.80 (1.09-2.98)**	**0.021**
	At-Large	77	93,121	0.083	8		
Non-Hispanic Black	City	51	13,684	0.373	37	1.30 (0.83-2.03)	0.25
	At-Large	31	10,816	0.287	29		
Hispanic	City	26	4476	0.581	58	**4.22 (1.98-9.00)**	**0.0002**
	At-Large	9	6569	0.137	14		
Other	City	0	1636	0	0	1.0005 (1.00-1.001)	0.083
	At-Large	3	5567	0.054	5		

***** Number of residents according to the 2020 decennial census.
† COVID hospitalizations/number of residents.
‡ Cumulative Hospitalization Rate Ratio = City Cumulative Hospitalization/At-Large Cumulative Hospitalization.

Table 5: Cumulative COVID-19 Mortality Among Saginaw County Residents: Jan-Sept 2020

Race/ Ethnicity	Region	# Cases Died	Census Population*	Cumulative Mortality†		CMRR‡ (95% Wald CI)	*p*-value
				%	Died/100,000		
Non-Hispanic White	City	5	12,735	0.039	39	1.31 (0.50-3.38)	0.58
	At-Large	28	93,121	0.030	30		
Non-Hispanic Black	City	14	13,684	0.102	102	1.58 (0.64-3.91)	0.32
	At-Large	7	10,816	0.065	65		
Hispanic	City	5	4476	0.112	112	1.47 (0.43-5.06)	0.54
	At-Large	5	6569	0.076	76		
Other	City	1	1636	0.061	61	N/A	N/A
	At-Large	0	5567	0	0		

* Number of residents according to the 2020 decennial census.
† COVID deaths/number of residents.
‡ Cumulative Mortality Rate Ratio = City Cumulative Mortality/At-Large Cumulative Mortality.

DISCUSSION

Descriptive analyses show that Non-Hispanic White and Hispanic residents within the city of Saginaw are significantly more likely to test positive for COVID-19 and to become hospitalized from related illness compared to those residing outside the city. A non-significant increased risk for testing positive for COVID-19 was observed for Non-Hispanic Black city-dwelling residents. There were no statistically significant race/ethnicity-specific differences with respect to mortality. None of the results of this study were impacted by including or excluding LTC residence in the analyses.

The city to at-large comparisons are limited by sample size and the absence of adjustment for demographic and socioeconomic variables that may influence them, such as age, sex, and income. It is possible that lack of access to testing or healthcare due to lower socioeconomic status may contribute to the lack of significant associations found for Non-Hispanic Black city-dwellers. In contrast, better access to testing and healthcare could help explain the higher infection rates within the city.

Also, risk of testing positive for COVID-19 decreases with increasing household size per census tract, although this association is non-significant. This result is likely limited by the relatively small count of census tracts in Saginaw County and the low case counts within some of these census tracts. Future studies could improve upon this analysis by measuring household-by-household, rather than by census tract, and also by accounting for other variables related to exposure within the home -- such as household square-footage.

CONCLUSION

The urban-rural, race/ethnicity COVID-19 disparities between Non-Hispanic White and Hispanic residents point to geographic and/or race/ethnic inequities in access to testing, treatment, and/or preventative measures for residents of Saginaw County, MI. It is hoped that the results of these preliminary analyses will inform public health efforts to measure, track and mitigate the continued spread of COVID-19 in the county, and by extension, perhaps, improve the epidemiological understanding of the spread of other infectious diseases within and between Saginaw County communities.

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