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By

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Master of Public Health

Epidemiology

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Scott Fridkin, MD
Committee Chair

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Bachelor of Science
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Thesis Committee Chair: Scott Fridkin, MD

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Epidemiology
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ABSTRACT

Evaluating Disparities in Invasive *Staphylococcus aureus* Incidence in 5 Counties in Metropolitan Atlanta, Georgia During the COVID-19 Pandemic 2020-2021
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Invasive *Staphylococcus aureus* (iSA) has been shown to pose a disproportionate burden on Black and African American populations. Similarly, the COVID-19 pandemic has highlighted racial and ethnic disparities in healthcare access and outcomes. The purpose of this analysis was to measure the magnitude of change in incidence of iSA infections during the COVID-19 pandemic and to assess the impact of the COVID-19 pandemic on racial disparities in iSA incidence in five counties in the metro-Atlanta area from March 2020 to December 2021. Monthly, county-specific iSA and COVID-19 incidence rates were analyzed by race, susceptibility (MRSA or MSSA), and epi-onset category (hospital onset or community onset) to determine their effect on incidence of iSA. County-specific iSA rates were correlated with corresponding COVID-19 rates using Spearman's rank correlation, Kruskal-Wallis tests, and Poisson regression models. Increases in county-level COVID-19 incidence most strongly increased hospital onset iSA rates, as well as all iSA rates among non-Hispanic Black populations; although all categories of iSA increased with increasing COVID-19 rates, but to lessor degrees. There are a variety of systematic inequities and socioeconomic determinants that contribute to disproportionate disease impact that must be further researched to better understand the impact of the COVID-19 pandemic on disparities in outcomes related to healthcare-associated infections.

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DISCLAIMER

The primary dataset used in this project was collected by the Georgia Emerging Infections Program (GAEIP). The GAEIP was not involved in the analyses presented in this thesis.

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INTRODUCTION AND BACKGROUND

The COVID-19 pandemic has brought attention to racial and ethnic health disparities as disproportionate impact of disease was experienced by subsets of the global population. Recent research suggests that COVID-19 prevalence, hospitalizations, and mortality ratios are significantly higher in Black and Hispanic populations as compared to White individuals[13,17]. Disparities in health-related outcomes are exacerbated by systemic racism and social determinants of health that contribute to disproportionate morbidity, vaccination, hospitalization, and case fatality rates. An increased burden on healthcare workers and facilities during the pandemic may have facilitated inequities in care toward minority communities[1]. Similarly, environmental risk factors and minority health disparities predispose individuals to healthcare-associated infections (HAIs).

Staphylococcus aureus (SA) is one of the most common causes of healthcare-associated infections in the United States[6] and can cause bloodstream infections that affect approximately 120,000 individuals each year[11]. Invasive *Staphylococcus aureus*, or iSA, is a severe infection that can result from a *S. aureus* infection in normally sterile, deep body sites, such as the bloodstream, bones, joint fluid, cerebrospinal fluid, or internal organs, although bloodstream infections make up the vast majority (~90%) of cases[8,15]. There are two types of iSA infections, methicillin-resistant *Staphylococcus aureus*, or MRSA, and methicillin-sensitive *Staphylococcus aureus*, or MSSA. There are seven Emerging Infections Program sites in the U.S that conduct active population- and laboratory-based surveillance of iSA infections, including the Georgia Emerging Infections Program, or the GA EIP. The GA EIP conducts iSA surveillance for 8 counties in the metropolitan Atlanta area, also known as Health District 3 (HD3), which includes approximately four million residents. Routine, active surveillance of MRSA began in 2005 and surveillance of MSSA began in 2016.

Previous research conducted by EIP sites across the U.S. suggests that overall incidence rates of MRSA have decreased from 2005 to 2014[8]. Since 2019, it is apparent that MSSA cases are responsible for the overall increase in iSA rates that are observed in HD3. Although MRSA rates were relatively stable as compared to MSSA, the rates of invasive MRSA disease consistently remained two to three times higher in Black people as compared to White people during the same time period[8]. In 2016, a few EIP sites across the U.S. began collecting data on MSSA and revealed significant disproportionate burden of both MRSA and MSSA on patients who identified as Black or African American as compared to other racial groups[9]. In Georgia EIP surveillance sites, the racial disparity of iSA disease rates was greater for MRSA than MSSA[14]. Geographic areas within HD3 with greater Black populations experienced higher rates of MRSA[15]. Additionally, preliminary surveillance data from the GA EIP shows that a higher percentage of hospital onset cases were observed in 2020 and 2021 as compared to previous surveillance years in HD3. A study conducted across HCA Healthcare affiliated hospitals in 2020 showed that monthly burden of COVID-19 was positively correlated with MRSA infections in hospitals,[4] and an increased prevalence of MRSA bacteremia was observed in conjunction with high COVID-19 hospitalizations[5]. A previous analytical approach to study the impact of COVID-19 on HAIs used a predictive model to estimate the mean number of MRSA bacteremia cases per month and quantified the predictor as the number of COVID-19 patients per staffed bed. The study found that for each 0.1 increase in the monthly number of COVID-19 discharges, MRSA cases increased by 9% (95% CI: 4– 14%). Assuming no COVID-19 discharges, there were

44% (95% CI: 10–88%) more cases of MRSA than expected across the 148 hospitals in the study[4]. Former analytic approaches to study racial disparities with iSA infections involved researchers assessing the change in MRSA and MSSA rates stratified by SA type and whether the case was healthcare-associated or community onset, and adjusted incidence rates for other predictors of diseases, including age, sex, and temporality[8-9,15].

The COVID-19 pandemic brought about concerns regarding infection prevention measures in hospitals as healthcare systems experienced supply shortages, high hospitalization rates, staffing limitations, and an increase in complex, high-risk patients. An overwhelming increase in hospitalized COVID-19 cases necessitated changes in protocols to expend labor and supplies most effectively. Infection prevention services and practices may have been disrupted by the reprioritization of routine operations which generates concern regarding the burden of healthcare-associated infections[3,18]. According to 2020 data from the Centers for Disease Control and Prevention's (CDC) National Healthcare Safety Network (NHSN), monthly burden of COVID-19 was positively correlated with MRSA infections in hospitals[4]. An increased prevalence of MRSA bacteremia was also observed in the first and third quarters of 2021, and in conjunction with high COVID-19 hospitalizations[5]. The simultaneous increase in *Staphylococcus aureus* and COVID-19 is partially attributed to the overwhelming of hospital systems and a reduction of infection prevention efforts, but there is limited research on how racial and ethnic disparities during the pandemic may have exacerbated overall population burden of iSA[4].

This study utilizes a novel analytic approach to measure the magnitude of change in incidence of iSA infections during the COVID-19 pandemic in Georgia's Health District 3, which is the metro-Atlanta area, from March 2020 to December 2021. To assess the impact of the

COVID-19 pandemic on racial disparities in iSA incidence, it is of interest to model iSA incidence rates alongside COVID-19 incidence rates and estimate differences in disease risk by race in each county in HD3, in metropolitan Atlanta, GA. Specifically, this study aims to evaluate whether there is a disproportionate risk of iSA in Black and African American populations. In addition to observing overall, county-level changes in disease incidence by race, stratifying by other predictors of interest such as epidemiologic class (hospital onset or community onset) and SA type (MRSA or MSSA) may reveal variations in the type of iSA disease burden correlated with COVID-19 rates.

METHODS

This study utilized retrospective data on MRSA and MSSA patients from March 2020 through December 2021 through a population-based active surveillance program established by the Centers for Disease Control and Prevention (CDC), known as the GA EIP. The GA EIP is a collaboration between the Georgia Department of Public Health (GDPH), the Emory University School of Medicine, the CDC, and the Atlanta Veteran Affairs Health System to respond to emerging infectious diseases state-wide.

The study population consisted of residents of 8 counties in the metropolitan Atlanta area, which include the counties Fulton, Dekalb, Cobb, Gwinnett, Clayton, Douglas, Newton, and Rockdale which are all part of HD3. Population denominators to calculate incidence rates were obtained from GDPH's Online Analytical Statistical Information System (OASIS). Monthly, county-specific populations were calculated by dividing the yearly population for each of the counties by twelve, or the number of months in the year. The population under surveillance consisted of 3,491,542 residents from March to December 2020 and 4,206,751 residents from January to December 2021 in the 8-county metro-Atlanta area in HD3 (Table 1).

iSA Case Definitions

The GA EIP defines an iSA case "as a resident of HD3 from whom *S. aureus* has been isolated from a normally sterile site (blood, bone, CSF, joint, internal organs, body fluids, etc.) under sterile conditions". Case demographic information was obtained from case report forms (CRFs) which are completed for invasive MRSA and MSSA cases that reside in HD3. Case ascertainment and data collection are conducted by surveillance officers who regularly review medical records for clinical and demographic data and work closely with area hospital microbiology labs and commercial labs to verify sterile cultures for patients that reside in HD3[8].

The Georgia Department of Health's Emory COVID-19 Response Collaborative (ECRC) provided COVID-19 case counts by county, study month, and race for all confirmed COVID-19 cases in HD3. This data was downloaded from the State Electron Notifiable Disease Surveillance Systems (SENDSS) on December 4, 2022, and the last reported case of COVID-19 in the dataset was on December 2, 2022.

The iSA race categories were modeled after the ECRC categorization of race into mutually exclusive groups of Hispanic, non-Hispanic Black, non-Hispanic White, and other non-Hispanic cases. Race is obtained from medical records. The proportions of "unknown" race for iSA cases by each covariate were small (<5%) and were not imputed for the purposes of this study. Overall, 2.6% (114) of iSA cases identified as "unknown" race and were removed from the analysis. Race-specific population denominators for the 8 counties in the study were retrieved from OASIS.

EIP uses the date of incident specimen collection (DISC) and other CRF variables to categorize iSA cases into epidemiologic classes that distinguish whether infection onset was associated with healthcare. Hospital onset cases had their iSA culture collected more than three days following acute care hospital admission. Healthcare associated-community onset (HACO) are cases with a DISC less than or equal to three days following acute care hospital admission or in an outpatient setting and have at least one other health-related risk factor as determined through CRF review. Community associated cases have cultures collected less than or equal to three days after acute care hospital admission or in an outpatient setting, and do not have predefined risk factors. Non- Fulton County MSSA cases use a dichotomous distinction which reduces the three traditional epidemiologic classifications into two epidemiologic onset categories[8]. This analysis used this modified method which combines community associated and HACO cases into a single group, community onset (CO), and distinguishes these from hospital onset cases. Susceptibility, or resistance to methicillin, defines SA type, and is received from microbiology lab results for iSA cultures. Less than 1% of iSA cases were removed from analyses involving epi-onset status and *S. aureus* susceptibility due to missing values.

COVID-19 Case Definitions

The Georgia Department of Health's Emory COVID-19 Response Collaborative (ECRC) provided COVID-19 case counts by county, study month, and race for all confirmed COVID-19 cases in HD3. A confirmed COVID-19 case at the time of data extraction for this study was defined as an individual who had a positive polymerase chain reaction (PCR) test for COVID and resided in one of 8 counties, Fulton, Dekalb, Cobb, Gwinnett, Clayton, Douglas, Newton, and Rockdale. This data was downloaded from SENDSS in early December of 2022. Across the course of the study period, there were 477296 confirmed cases of COVID-19 in the 8 counties in HD3.

To measure the magnitude of change in incidence of iSA infections during the COVID-19 pandemic, COVID-19 incidence was grouped into quartiles based on the variable it stratified on (Table 2). It was determined that to assess the effects of an increase in COVID-19 incidence on iSA incidence, quantifying the predictor as quartiles was necessary since the incidence rates for COVID-19 were much larger in scale than iSA incidence. Assessing the effects of a one-unit increase in COVID-19 incidence on iSA incidence would not be meaningful, and the magnitude of change in disease incidence would be better understood as a one-quartile increase.

Statistical Analyses

To test for a correlation between county-level, monthly iSA incidence and COVID-19 incidence, a non-parametric test, the Spearman correlation test, was used. The Spearman correlation tests involved an overall analysis of the association between COVID-19 incidence quartile and iSA incidence, then stratified by other covariates of interest including race, epi-onset category, and SA type to determine whether the association was subset to iSA cases with shared racial identities or similar disease types. Kruskal-Wallis tests are another non-parametric test used to assess monthly, county-level variability in iSA and COVID-19 incidence. The Kruskal-Wallis tests were used to observe whether the median values for disease incidence rates on a county and month level differed, and if this variability was detected in the various race groups, epi-onset categories, and SA types. A Poisson regression analysis was used to model the impact of monthly, county-level COVID-19 incidence on iSA incidence. The models looked at county-specific incidence rates of disease overall, then separately for race, epi-onset category, and SA type to observe the effect of a one-quartile increase in COVID-19 incidence on monthly iSA incidence, accounting for county fixed effects. Regarding these Poisson regression models, county can be viewed as a constant, or is fixed, so it does not affect the relationship between the explanatory and response variables. Any change observed that is attributed to county is the same over the course of the study period.

RESULTS

Data was analyzed from 3,887 iSA cases and 435,895 COVID-19 cases in five counties in metropolitan Atlanta from March 2020 to December 2021. HD3 consists of 8 Georgian counties, but for the purposes of this analysis, Douglas, Newton, and Rockdale counties were removed due to their relatively small population size and the absence of iSA cases in approximately 50% of observations when the dataset was stratified by county, study month, and race. Over the course of the study period, Fulton County had the greatest iSA and COVID-19 counts with 1,181 and 126,976 case counts, respectively. However, when accounting for county population size, Clayton County had the highest cumulative iSA incidence of 74 cases per 100,000 people. Douglas county, with a relatively small population size, had the greatest cumulative COVID-19 incidence of 6,909 cases per 100,000 people from March 2020 to December 2021 (Table 1).

Across the twenty-two-month study period, monthly iSA incidence varied by county and followed no particular pattern during the various waves of the pandemic (Figure 1A). Conversely, there is little variation in monthly COVID-19 incidence for the five counties in metro-Atlanta throughout the study period (Figure 1B). Monthly median values for iSA incidence were observed across quartiles of COVID-19 incidence to further understand the variability of monthly disease incidence within various population categories. Monthly median iSA incidence in cases that identified as non-Hispanic Black (P = 0.07) and non-Hispanic White (P = 0.13) increased more consistently than in other iSA race categories as COVID-19 incidence increased from one quartile to the next. According to the results of the Kruskal Wallis tests, there is a significant difference between monthly median iSA incidence and COVID-19 incidence quartile for hospital onset (P<0.01) and community onset (P<0.05) cases, although the median iSA incidence values did not consistently increase by COVID-19 quartile. A similar observation was made for MRSA (P<0.05) and MSSA (P=0.001) cases where there was a significant difference in median iSA incidence across the four COVID-19 quartiles, but the median iSA values only increased slightly until the fourth COVID-19 quartile, where a larger increase was observed (Table 3).

The relationship between county-specific monthly iSA incidence and COVID-19 incidence for the five counties during the study was found to be weak as a result of the Spearman rank correlation test (r_s = 0.29, P<0.01). There is a lot of variability in the raw, monthly disease incidence values by county (Figure 2). When stratified by race, there was a significant correlation between monthly, county-specific iSA and COVID-19 incidence for non-Hispanic

Black (r_s = 0.23, P<0.05) and non-Hispanic White individuals (r_s = 0.19, P<0.05), although the relationships were weak in both race categories.

Figures 4A and 4B show the relationship between county-specific, monthly iSA incidence and COVID-19 incidence stratified by epi-onset category, hospital onset or community onset, and susceptibility (MRSA or MSSA). There tends to be lower county-level, monthly iSA incidence for hospital onset cases as opposed to community onset cases, and arbitrary variation in COVID-19 incidence. There is a weak relationship between iSA and COVID-19 county-level, monthly incidence in hospital onset and community onset cases. The scatterplots stratified by MRSA and MSSA also indicate a weak relationship between iSA and COVID-19 county-level, monthly incidence (Figures 4C and 4D).

The Poisson regression analysis looked at the effect of a one quartile increase in monthly COVID-19 incidence quartile on monthly iSA incidence, accounting for county fixed effects. The crude model involves the predictor, COVID-19 incidence quartile, and the continuous, dependent variable, iSA incidence. For each quartile increase in county-specific COVID-19 incidence, there was an 8% (95% CI, 5-10%; P<.001) increase in iSA incidence. For non-Hispanic Black cases, this relative increase was 9% (95% CI, 7-11%; P<.001) compared to only a 5% increase among White residents. In contrast, there was no difference in the magnitude of the association between COVID-19 incidence and iSA incidence between MRSA and MSSA incidence; each SA type had a similar increase of 8% (95% CI, 5-10%; P<.001). The largest increase in monthly iSA incidence observed in these Poisson models was for hospital onset cases in which there was a 16% (95% CI, 5-11%; P<.001) increase for each quartile increase in COVID-19 incidence; however there remained a significant association among community onset iSA with a 6% (95% CI, 4-8%; P<.001) increase per quartile increase in COVID-19 incidence (Table 4).

DISCUSSION

This study quantified the impact of changes in COVID-19 incidence and various scenarios of invasive *S. aureus* infection (mostly bloodstream infections) on a county-wide level. The subset of invasive *S. aureus* affected most strongly was hospital onset infections, as previously suggested by GA EIP data and a previous study in HCA Healthcare affiliated hospitals. However, we also illustrate as monthly COVID-19 incidence increased, non-Hispanic Black and African American populations experienced a significant increase in iSA incidence almost twice as large as the increase measured among White residents. This analysis reflects the changes in magnitude of iSA alongside community COVID-19 rates, rather than solely in healthcare settings, and supports existing research on racial disparities related to COVID-19[2,8-9,16].

The COVID-19 pandemic highlighted health disparities and systematic barriers regarding disease surveillance, management, prevention, and treatment. The differences in COVID-19 vaccination rates, hospitalizations, and case fatalities were widely apparent in Black and African American populations across the U.S. The social determinants of health, such as economic status, education level and living conditions are strongly correlated with health outcomes as they may influence an individual's access to health services, health literacy, insurance status, and comorbidities or underlying risk factors for disease[2,16]. The effects of socioeconomic disparities on COVID-19 outcomes were stark in marginalized populations and racial minorities.

In Georgia, in 2021, there was a 9.5% difference in the proportion of Black people as compared to the proportion of White people vaccinated for COVID-19 throughout the state. The vaccination disparity is only partially attributed to vaccine hesitancy, but primarily due to factors resulting from structural racism such as residential segregation, or redlining, limitations in transportation to healthcare facilities, lack of support from employers, discrimination in healthcare, and immigration status[16]. Overt differences in socioeconomic determinants of health for Black and African American communities contribute to an increased risk of COVID-19 infection, severity, and fatality, which, consequently, put these same populations at risk for other diseases, such as healthcare-associated infections.

Hospital onset iSA cases experienced a remarkable 16% increase in monthly, county-level disease rates as monthly, county-level COVID-19 incidence increased by one quartile. Overall, the GA EIP saw a greater number of hospital onset iSA cases during the pandemic years as compared to previous years. This analysis further supports these findings as an increase in hospital onset iSA incidence was observed alongside increases in the level of COVID-19 in the population.

As hospitals experienced overcrowding due to the surge in COVID-19 cases during the pandemic, there was a shortage in medical personnel which forced facilities to transfer their employers to different departments or take on additional patients and responsibilities. As a result, infection prevention protocols and HAI surveillance activities may not have been adhered to as carefully which increases the risk of patients developing HAIs[10]. As COVID-related hospitalizations increased, so did the overall disease severity in hospitals, the likelihood of patients having comorbidities, and the number of immunocompromised patients[2]. These are direct risk factors for HAIs that occur at disproportionate rates among Black and African American populations. Historically, iSA infections have occurred at consistently higher rates in Black people than White people, and this is largely attributed to underlying structural inequities in healthcare that lead to poorer health outcomes for racial minorities. Risk factors for COVID-19 are similar to those for HAIs, and often result from socioeconomic disparities that affect access to and quality of healthcare[7].

Monthly, county-level incidence in MRSA and MSSA increased by the same percentage in the five counties in HD3 from March 2020 to December 2021 as COVID-19 incidence increased by one quartile. Trends in iSA incidence prior to the pandemic suggest that MSSA drove the overall increase in iSA while MRSA rates remained fairly stable from year to year[8]. More recent research shows a correlation between MRSA rates in hospitals and COVID-19 hospitalizations[4]. Research on MSSA incidence during the pandemic is limited and its relationship with COVID-19 incidence is not as well understood.

A strength of this study is that the GA EIP conducts routine, active surveillance of iSA infections in HD3 which likely ensures that the true number of iSA cases were captured. Additionally, this study was able to visualize iSA and COVID-19 cases at a monthly level and by county, which enables a detailed evaluation of changing disease rates over time. Evidently, delays in diagnosis or testing introduce the potential for inaccuracy in some of these monthly incidence values, but the visualizations of monthly cases (Figure 1) are plausible and align with publicly available surveillance data. For the purposes of this study, COVID-19 cases were defined as those who were laboratory confirmed by PCR. Therefore, those who tested positive for COVID-19 via antigen tests or at-home rapid tests were not accounted for in this study.

Although the study has some limitations regarding disease surveillance, the analysis methods were able to successfully explore the issue of racial disparities in iSA incidence during the pandemic.

PUBLIC HEALTH IMPLICATIONS

The remarkable increase in iSA incidence in Black and African American populations as the level of COVID-19 increased on a monthly, county level is alarming, and warrants more research into the factors that contribute to the disproportionate impact of HAIs during the pandemic. This analysis provides further insight into how the COVID-19 pandemic has impacted MRSA and MSSA incidence rates within metro-Atlanta and highlights the systematic inequities and disparities that exist within the healthcare system. Healthcare-associated infections can lead to prolonged hospital stays, increased morbidity and mortality rates, and high healthcare costs. When these infections disproportionately affect a specific group, such as non-Hispanic Black and African American people, it further exacerbates existing health disparities and can contribute to a widening gap in health outcomes. Addressing these disparities requires a multi-faceted approach, including addressing systematic racism in the healthcare system, improving access to quality healthcare, and addressing social determinants of health that disproportionately affect Black and African American communities.

TABLES AND FIGURES

Table 1. Invasive *S. aureus* and COVID-19 case counts and incidence (per 100,000 people) by county, 8 counties of metropolitan Atlanta, March 2020-December 2021

	iSA Counts	**COVID-19 Counts**	**Population Denominator**	**iSA Incidence***	**COVID-19 Incidence***
County					
Fulton	1,181	126,976	1,963,169	60	6,468
Dekalb	863	77,732	1,392,726	62	5,581
Cobb	774	89,879	1,402,589	55	6,408
Gwinnett	670	106,236	1,750,068	38	6,070
Clayton	399	35,072	540,972	74	6,483
Douglas	175	18,594	269,137	65	6,909
Newton	143	12,562	209,768	68	5,989
Rockdale	110	10,245	169,864	65	6,031
Total	4,315	477,296	7,698,293	56	6,200

*Incidence is the rate of disease per 100,000 population

Table 2. Cutoff values for defining quartiles of county-specific monthly incidence of COVID-19 infection (per 100,000 population), 5 counties of metropolitan Atlanta, March 2020 – December 2021.

		Range of COVID-19 Incidence			
Population Category	**Observations**	**Q1**	**Q2**	**Q3**	**Q4**
County	110	304-2,331	2,332-3,817	3,817-9,717	9,718-24,095
Race	440	173-2,176	2,177-4,125	4,126-8,445	8,446-30,998
Epi-Onset	220	304-2,331	2,332-3,817	3,818-9,820	9,821-24,095
Susceptibility	220	304-2,331	2,332-3,817	3,818-9,820	9,821-24,095

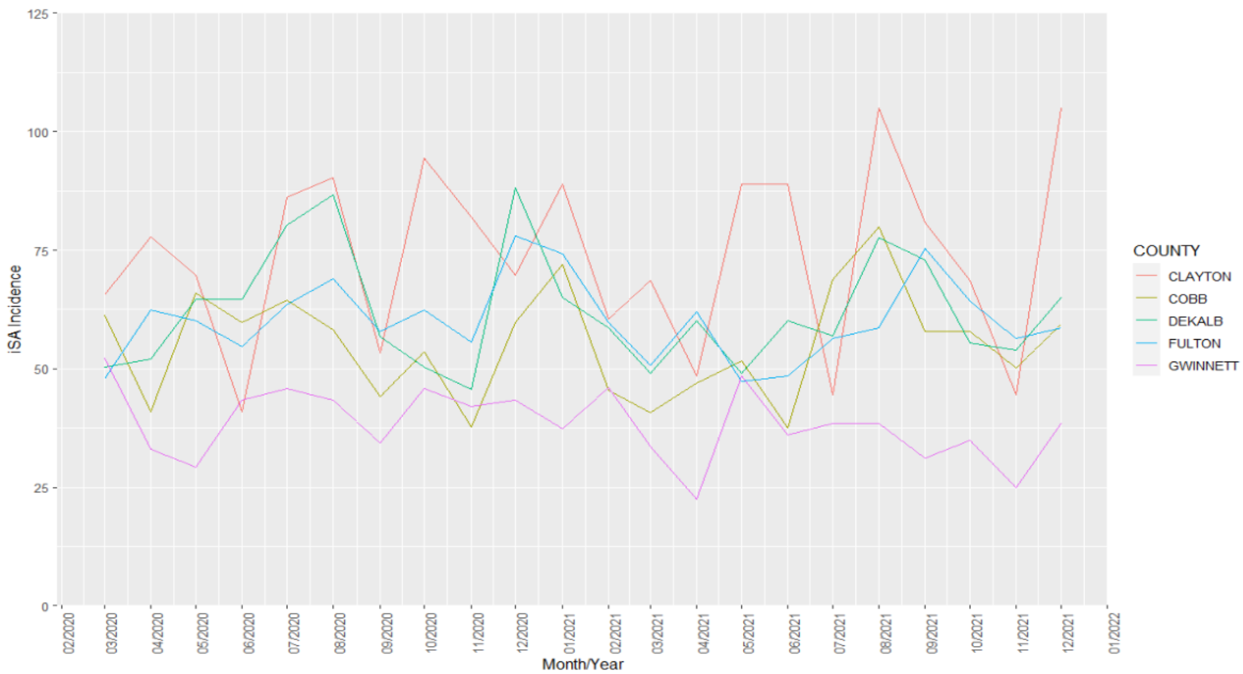
Note. Within the population categories, there are 5 counties (Clayton, Cobb, Dekalb, Fulton, and Gwinnett), 4 race groups (Hispanic, non-Hispanic Black, non-Hispanic White, and other non-Hispanic), 2 epi-onset categories (hospital onset and community onset), and 2 susceptibility categories (MRSA and MSSA).

Table 3. Variability in county-specific monthly incidence of invasive *S. aureus* infection (per 100,000 population) during different scenarios of the COVID-19 pandemic (lowest quartile to highest quartile of COVID-19 infection rates), 5 counties of metropolitan Atlanta, 22 months (March 2020 – December 2021).

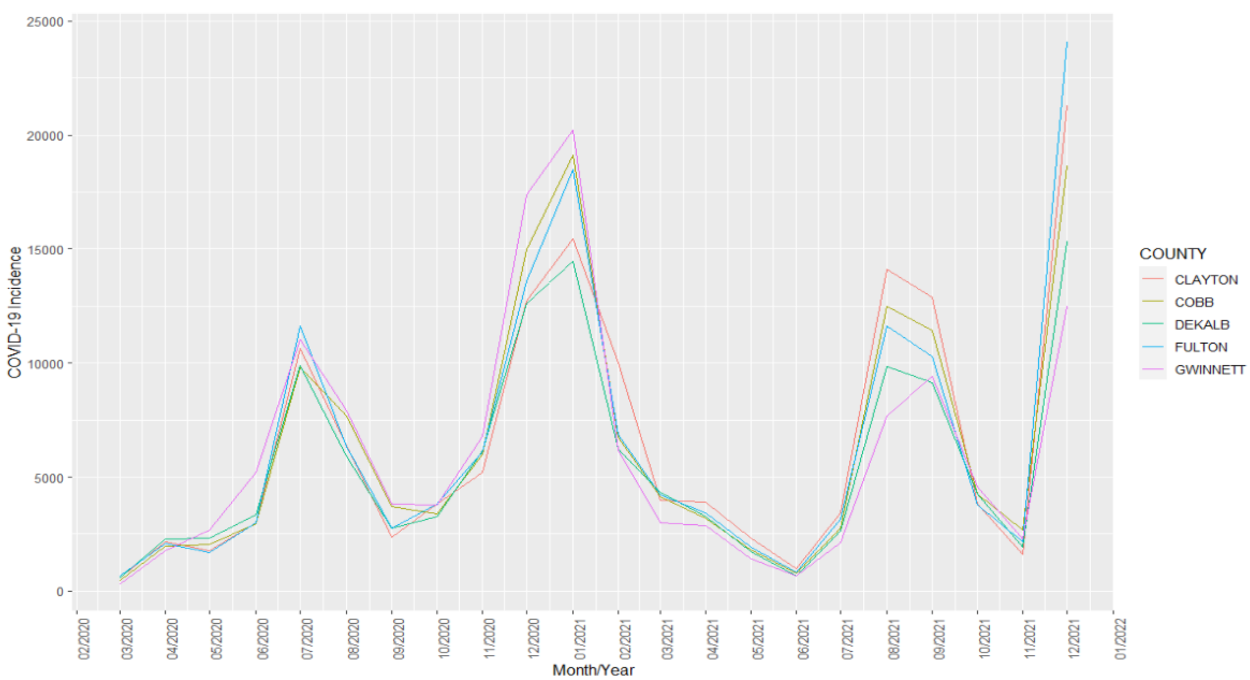
	Monthly median (range) iSA Incidence per 100,000				
Population Category	**COVID Quartile 1**	**COVID Quartile 2**	**COVID Quartile 3**	**COVID Quartile 4**	**P-value**
Race					
Non-Hispanic Black	59 (9-102)	61 (9-105)	67 (22-95)	72 (30-124)	0.07
Non-Hispanic White	57 (34-192)	53 (34-240)	62 (29-286)	76 (34-240)	0.13
Hispanic	28 (0-120)	30 (0-80)	24 (0-77)	31 (0-93)	0.70
Other (non-Hispanic)	0 (0-57)	16 (0-114)	19 (0-114)	8 (0-57)	0.14
Epi-onset					
Hospital onset	9 (4-21)	8 (3-24)	11 (2-24)	16 (4-29)	0.0022
Community onset	42 (21-85)	44 (19-69)	39 (26-74)	52 (27-93)	0.015
Susceptibility					
MRSA	20 (5-33)	20 (5-36)	22 (7-53)	27 (8-48)	0.017
MSSA	30 (4-62)	32 (17-53)	32 (21-57)	41 (25-65)	0.0010

Note. P-values were obtained from the Kruskal-Wallis tests for each population category to assess county-specific monthly variability in iSA incidence by COVID-19 quartile.

A. Overall iSA Incidence



B. Overall COVID-19 Incidence



Figures 1A-1B. Monthly disease incidence (per 100,000 people) by county in 5 counties of metropolitan Atlanta from March 2020 to December 2021. The top figure (1A) is overall iSA incidence by county over the study period and the bottom figure (1B) is overall COVID-19 incidence by county over the study period.

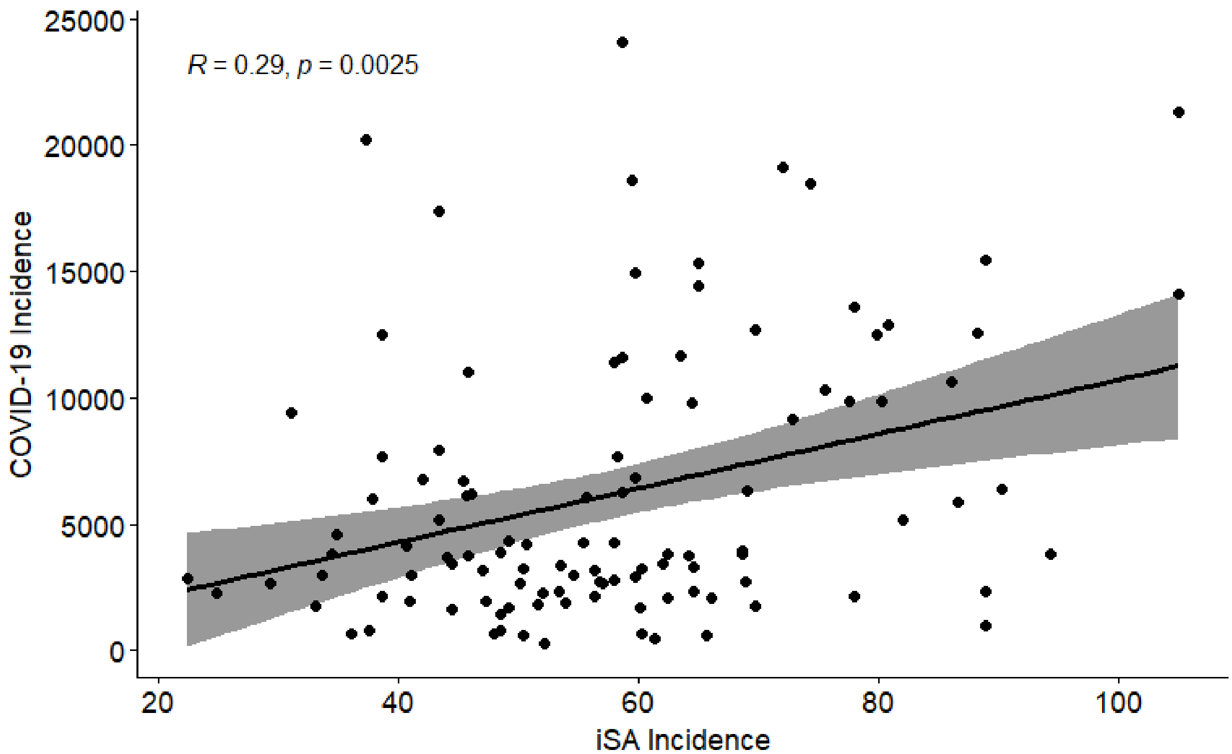
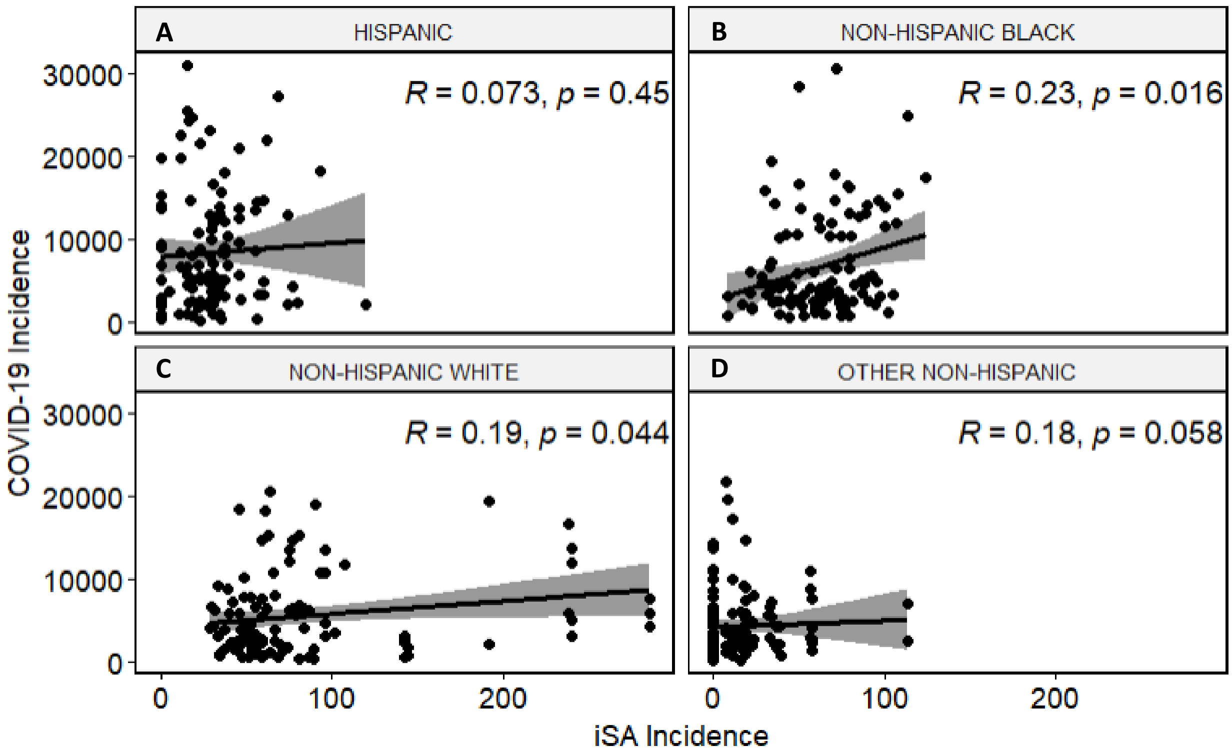
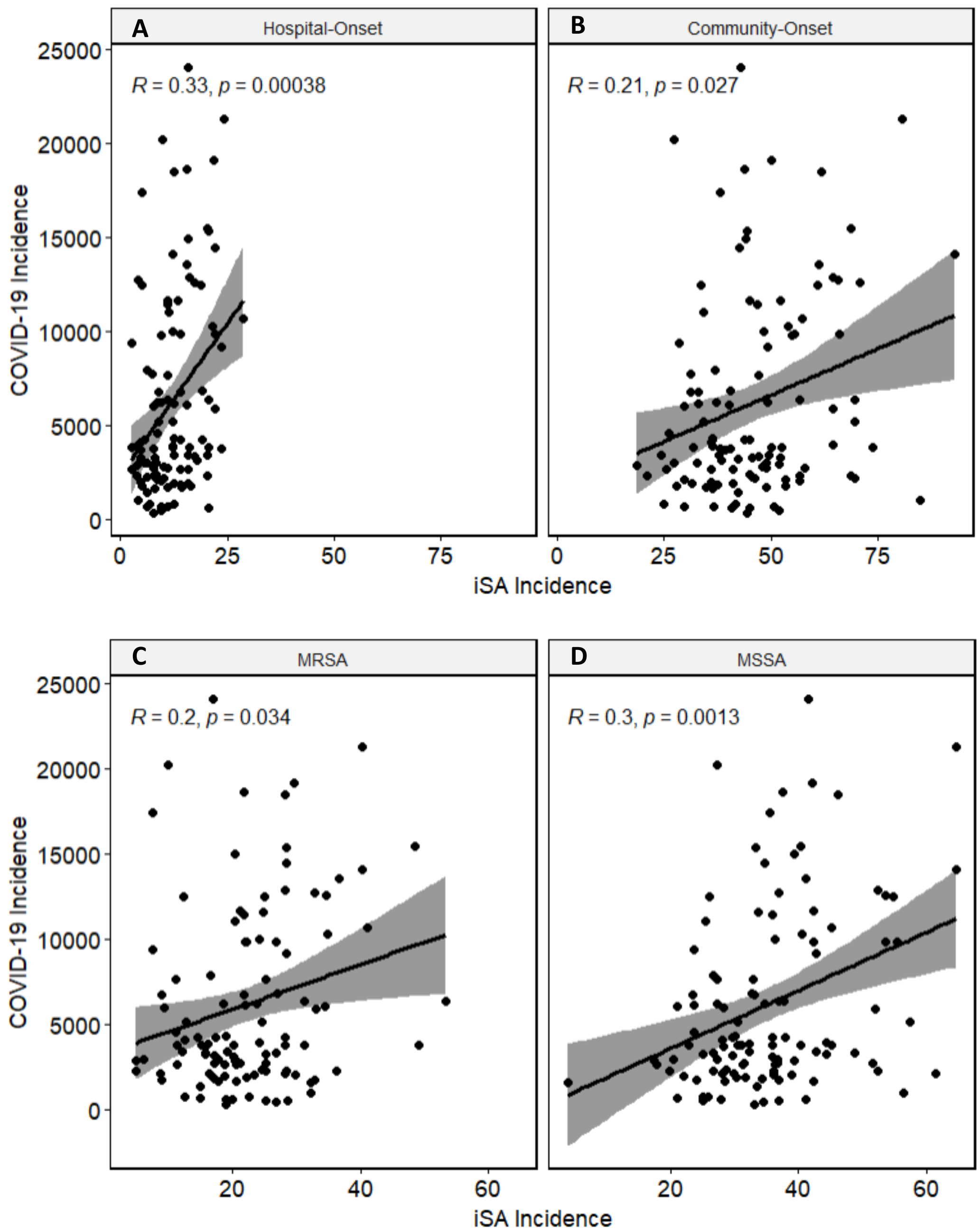


Figure 2. Scatterplot and Spearman rank correlation coefficient with p-value for county-specific monthly invasive *S. aureus* incidence and COVID-19 incidence (per 100,000 people) for 5 counties in metropolitan Atlanta, 22 months (March 2020 – December 2021).



Figures 3A-3D. Scatterplots and Spearman rank correlation coefficients with p-values for county-specific monthly invasive *S. aureus* incidence and COVID-19 incidence (per 100,000 people), stratified by race, for 5 counties in metropolitan Atlanta, 22 months (March 2020 – December 2021).

Note. 104 observations removed due to unknown values for race.



Figures 4A-4D. Scatterplots and Spearman rank correlation of county-specific monthly invasive *S. aureus* incidence and COVID-19 incidence (per 100,000 people), stratified by epi-onset category and susceptibility, for 5 counties in metropolitan Atlanta, 22 months (March 2020 – December 2021).

Table 4. Results for a Poisson regression model fit to predict iSA county-level monthly case counts based on COVID quartile, stratified by covariates of interest, accounting for county fixed effects, in 5 counties of metropolitan Atlanta from March 2020 - December 2021.

Model No.	Covariate	Observations, N	Coefficient (exp)	95% Confidence Interval	P-value
1	**Crude**	110	1.08	(1.05, 1.10)	<0.001
2	**Race**				
	Non-Hispanic White	440	1.05	(0.99, 1.12)	0.09
	Hispanic		1.02	(0.95, 1.11)	0.5
	Non-Hispanic Black		1.09	(1.07, 1.11)	<0.001
	Other non-Hispanic		1.09	(0.95, 1.24)	0.2
3	**Susceptibility**				
	MRSA	220	1.08	(1.05, 1.10)	<0.001
	MSSA		1.08	(1.05, 1.11)	<0.001
4	**Epi-Onset**				
	Hospital onset	220	1.16	(1.09, 1.23)	<0.001
	Community onset		1.06	(1.04, 1.08)	<0.001

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