COVID-19 Population Characteristics: Age and Sex Group

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Purpose: Examine which patient populations are most likely to be tested for COVID-19, test positive for COVID-19, and have the most severe outcomes.

Data: These analyses include 165,359 patients tested for COVID-19 and 66,017 COVID-19 positive patients as of April 17, 2020; data are pooled from 22 health systems representing 140 hospitals spanning 11 states and covering 86 million patients. Included patients are patients with a known outcome for COVID-19 (patient was never admitted to a hospital within 6 weeks of their COVID-19 positive date, was admitted and subsequently discharged from hospital, or died). All statistical significance is measured with chi-square tests.

Preliminary Observations: In this population of patients, women age 4-64 were slightly more likely to be tested for COVID-19 than men. Across multiple age groups, men were slightly more likely to test positive for COVID-19 and to be hospitalized or die.

Background

Since the start of the COVID-19 outbreak in December 2019, researchers around the world have investigated the intersection of factors and outcomes for this virus. Reports from the World Health Organization and international research groups have examined the relationship between age, sex, and COVID-19 positivity and severity. Evidence from these investigation suggests that older patients and/or male patients are more likely to experience severe disease, including hospitalization and death, when compared to younger patients and/or female patients.[1,2,3,4] In addition, another study proposed lower incidence of disease in younger demographics because they saw low numbers of younger patients in their population.[3] Since this study relied on analyzing patients sick enough to seek medical care, it can be inferred that if younger people were being infected at similar rates to older populations, they were more likely to be asymptomatic.[5] This study aims to contribute additional observations regarding the age and sex distribution of both testing and severity of disease during the early months of the pandemic experience in the United States.

Methods

De-identified summary-level data for the analyses presented here were aggregated from electronic medical records at 22 health systems in the United States, spanning 11 states and covering 86 million patients (as of April 17, 2020). Hospital systems contributed data to help examine questions relevant to the COVID-19 pandemic nationwide. This set of analyses includes 165,359 patients tested for COVID-19 and 66,017 COVID-19 positive patients. Included patients are patients with a known outcome for COVID-19 (patient was never admitted to a hospital within 6 weeks of their COVID-19 positive date, was admitted and subsequently discharged from hospital, or died). All statistical significance was measured with chi-square tests.

Patients were classified as **COVID-19 positive** if they had a positive SARS-CoV-2 lab result or a COVID-19 diagnosis (ICD-10 U07.1 or a diagnosis that falls under SNOMED code 840539006). Their positivity date is the earlier of either the positive SARS-CoV-2 lab result collection date or the earliest date a diagnosis was noted[1]. Diagnoses for suspected COVID-19 infection (SNOMED code 840544004) were not included.

A hospital admission was considered a **COVID-19 related admission** if the patient had a positive SARS-CoV-2 lab test or COVID-19 diagnosis during the admission, or if the hospital admission occurred within 14 days of the patient's COVID-19 positivity date (lab or diagnosis) and had any respiratory diagnosis J00-J99 (ICD-10).

Patient sex is the legal sex which are grouped by "Male," "Female," and "Other." Due to low numbers of patients who fell into the "Other" category, it was excluded from graphs for clarity.

[1] *Positive lab results for SARS-CoV-2 were identified by an abnormal flag as specified by the individual health systems. Positive diagnoses were determined by assessing patients' outpatient problem list, hospital problem list, hospital discharge diagnoses, encounter diagnoses, and billing diagnoses*

A simple three-level proxy for severity was used. The lowest severity includes patients who managed their illness in an outpatient setting with no hospital admission required. Intermediate severity includes patients who required hospital admission for COVID. The worst severity was death, and a COVID-related death is defined by a death date or discharge date with the discharge disposition of deceased within 6 weeks of their COVID-19 positivity date.

Preliminary Observations

Testing Rates by Age and Sex

Relative to the sex distribution in each age group in the overall patient population, chi-square tests indicate there is a statistically significant higher rate of COVID-19 testing among female patients ages 4-64 as compared to male patients in the same age groups, ($p < 0.05$) with a negligible effect size (<0.01).

Conversely, there is a statistically significant ($p < 0.05$) lower rate of COVID-19 testing among female patients age 65-84 as compared to male patients in the same age group, with a negligible effect size (<0.01).

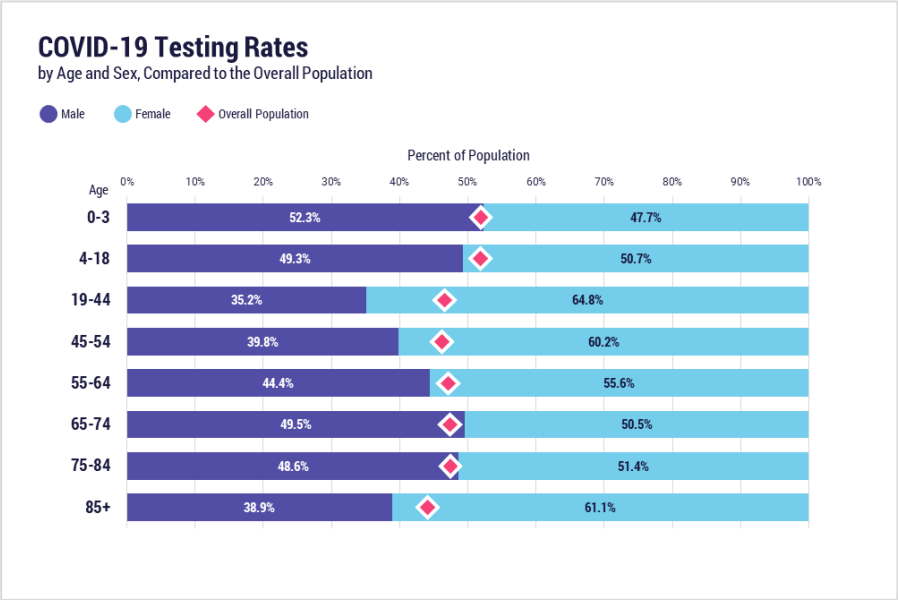

Figure 1. COVID-19 testing rates by age group and sex

The diamonds in Figure 1 depict the ratio of males to females in each age group in the overall population of 86 million patients.

Proportion of Positive COVID-19 Tests in Tested Population

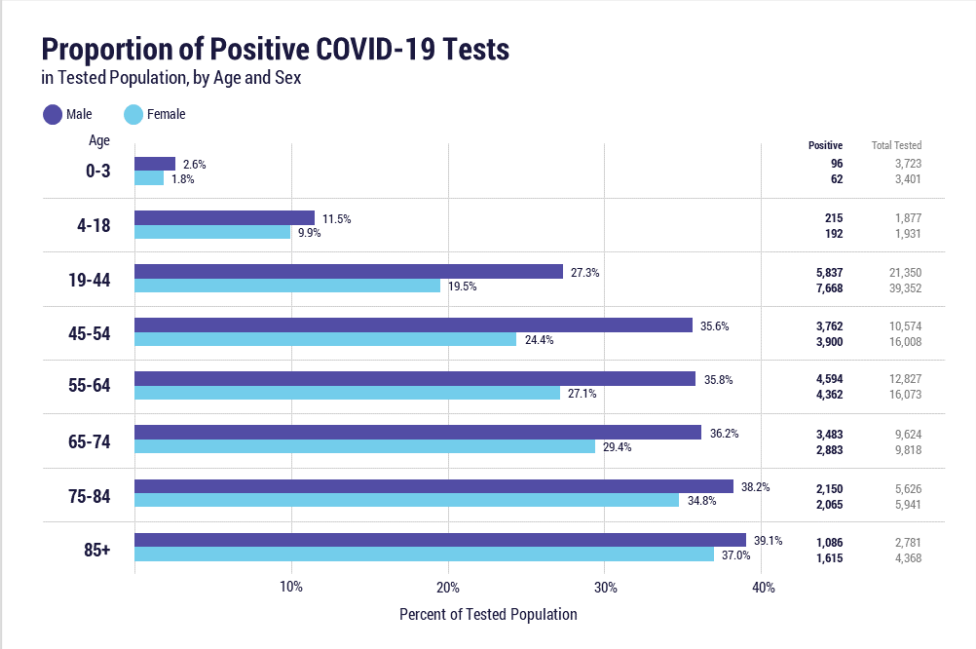

Figure 2. Proportion of positive COVID-19 tests

All adult male age groups tested positive for COVID-19 at a higher rate than adult female age groups. Figure 2 depicts the percentage of positive COVID-19 tests out of the total tests performed in the corresponding age and sex group.

Chi-square tests indicate a statistically significant ($p < 0.05$) higher rate of positive tests for male patients versus female patients for age groups 0-3 and 19-84, with a negligible effect size (0.09). Chi-square tests did not indicate statistically significant differences for patients age 4-18 or 85+.

Severity of Disease among COVID-19 Patients

Figure 3 shows the relative proportions of COVID-19 outcomes among positive patients who sought care for the virus (positive patients have lab positivity and/or a positive diagnosis). Among COVID-19 positive patients, the chi-square analysis indicated a statistically significant higher rate of more severe outcomes (hospitalization or death) for males as compared to females for ages 19-74 ($p < 0.05$), with a small effect size (0.17). Males age 75+ had a statistically significant higher rate of death than females but not hospitalization ($p < 0.05$), with a negligible effect size (0.08).

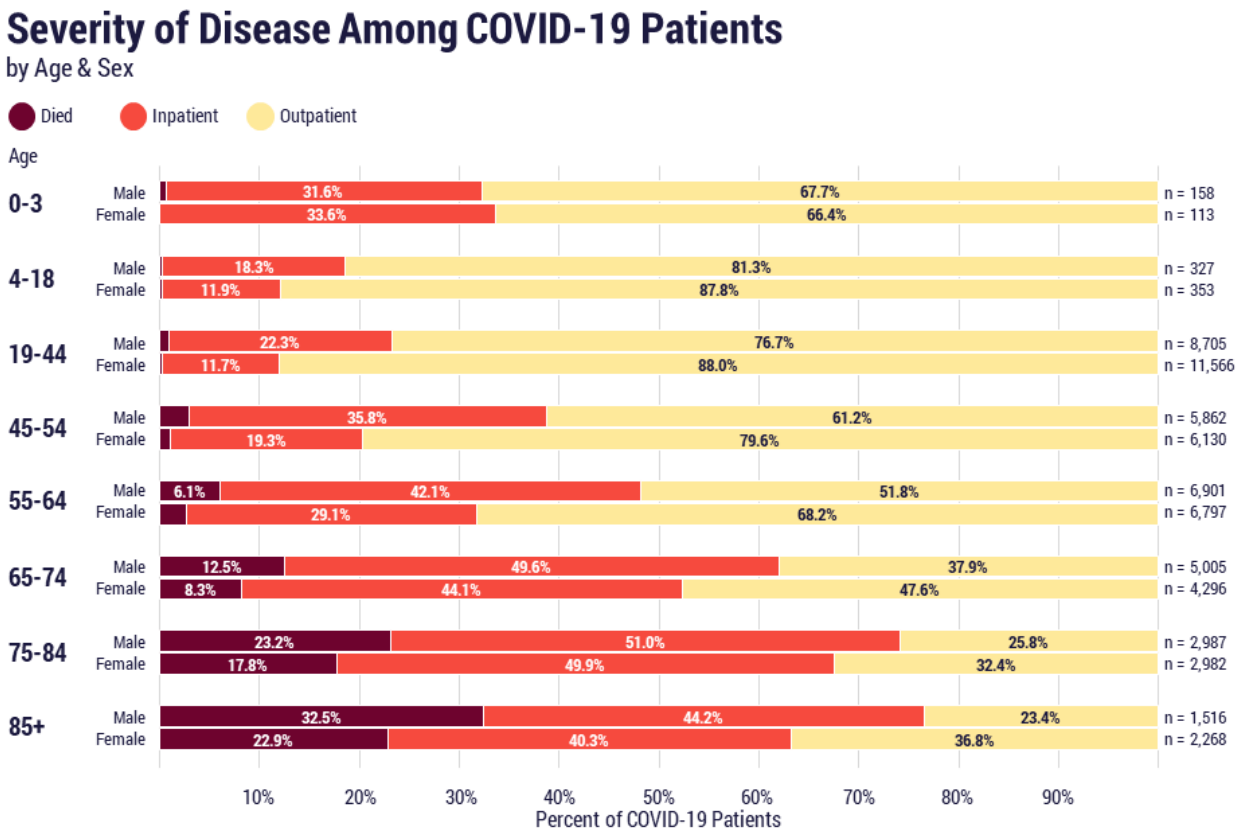

Figure 3. Outcome severity by age and sex

Discussion

This analysis suggests that there is an association between COVID-19 positivity and male sex, as well as an association between COVID-19 positivity and increasing age, findings that are similar to those found in other recent studies[1,2,3,4]. The data also suggest that older patients and male patients may have an increased rate of hospitalization and mortality. Factors contributing to the observed trend for higher testing among women under the age of 65 may include social or occupational factors that may be addressed with future studies.

There are limitations in the data set available at the time of this analysis:

The specific COVID-19 diagnosis via ICD-10 (U07.1) was not available prior to April 1, 2020. The ICD-10 code B97.29 recommended for use by the CDC prior to this date was not specific to COVID-19, so the COVID-19 population prior to April 1, 2020 is represented in our data solely by lab test results. Lab testing for SARS-CoV-2 across the country has had varying levels of sensitivity and specificity, so even using the positive lab test as a marker of a COVID-19 positive patient is an imperfect definition.

There was limited availability of and access to testing in the United States up to the point of this study. Due to these limitations, many patients were not tested who may have been COVID-19 positive. With that in mind, the above data

likely over-represents more severe illness requiring hospitalization and under-represents mild or asymptomatic illness that went untested. All levels of the U.S. healthcare system are continually adapting policies and practices based on factors that are changing dynamically, so who qualifies for testing at a specific hospital, hospital system, community, state level, or region of the country may have changed multiple times since the start of the pandemic. At this time, consistent and effective testing across healthcare organizations remains a challenge. This leads to imprecision in capturing a COVID-19 population.

The true number of deaths outside the hospital due to COVID-19 is unknown and is likely under-represented in the data presented here. Patients who die during a hospitalization will have this death recorded in the electronic medical record. However, for a community death to be reflected in the electronic medical record, the health system must have notification of the death and update the patient's chart to reflect the death. This is a challenge for health systems even outside of a pandemic, but may be more difficult currently due to health systems' limited bandwidth for follow-up.

For this analysis, an assumption was made that patients were hospitalized within the same hospital system at which they were tested. If patients did go elsewhere for hospitalization, the proportion of patients who were hospitalized may be understated.

Finally, this analysis did not include comorbidities as a potential covariate. Many comorbidities have been previously associated with severe COVID-19 outcomes, such as cardiovascular disease, pulmonary disease, diabetes, and hypertension,[6] and several of these are more prevalent in older or male populations.[7,8,9]

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