Minnesota COVID-19 Lockdowns: The Effect on Acute Myocardial Infarctions and Revascularizations in the Community

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Abstract

Objective: To study associations between the Minnesota coronavirus disease 2019 (COVID-19) mitigation strategies on incidence rates of acute myocardial infarction (MI) or revascularization among residents of Southeast Minnesota.

Methods: Using the Rochester Epidemiology Project, all adult residents of a nine-county region of Southeast Minnesota who had an incident MI or revascularization between January 1, 2015, and December 31, 2020, were identified. Events were defined as primary in-patient diagnosis of MI or undergoing revascularization. We estimated age- and sex-standardized incidence rates and incidence rate ratios (IRRs) stratified by key factors, comparing 2020 to 2015—2019. We also calculated IRRs by periods corresponding to Minnesota's COVID-19 mitigation timeline: "Pre-lockdown" (January 1—March 11, 2020), "First lockdown" (March 12—May 31, 2020), "Between lockdowns" (June 1—November 20, 2020), and "Second lockdown" (November 21—December 31, 2020).

Results: The incidence rate in 2020 was 32% lower than in 2015—2019 (24 vs 36 events/100,000 person-months; IRR, 0.68; 95% CI, 0.62-0.74). Incidence rates were lower in 2020 versus 2015—2019 during the first lockdown (IRR, 0.54; 95% CI, 0.44-0.66), in between lockdowns (IRR, 0.70; 95% CI, 0.61-0.79), and during the second lockdown (IRR, 0.54; 95% CI, 0.41-0.72). April had the lowest IRR (IRR 0.48; 95% CI, 0.34-0.68), followed by August (IRR, 0.55; 95% CI, 0.40-0.76) and December (IRR, 0.56; 95% CI, 0.41-0.77). Similar declines were observed across sex and all age groups, and in both urban and rural residents.

Conclusion: Mitigation measures for COVID-19 were associated with a reduction in hospitalizations for acute MI and revascularization in Southeast Minnesota. The reduction was most pronounced during the lockdown periods but persisted between lockdowns.

T he coronavirus disease 2019 (COVID-19) pandemic has led to a decrease in admissions related to cardiovascular diseases in intensive care units and an increase in out-of-hospital cardiac arrests.[1] Fewer presentations of acute myocardial infarction (MI) and revascularization procedures in emergency departments have been documented in the first waves of the COVID-19 pandemic.[2-5]

However, most studies reporting a decrease in the number of events and incidence rates in the context of cardiovascular diseases were limited to the initial months of the pandemic (eg, March and April 2020).[5-8] The extent of this reduction over the entire year of 2020 is unclear, and it is unknown whether this reduction varied based on the COVID-19 mitigation strategies used. In

addition, most studies have compared 2020 rates to the previous 1 or 2 years,[5-8] but incidence rates may vary by year. The use of a limited number of years to estimate expected incidence may cause estimates to be affected by single-year variability.[9]

Investigating variation in hospitalization rates for acute MI and revascularization procedures during the year of 2020, and whether this variation differed by the type of mitigation strategy (ie, lockdowns, mandated social distancing, and mask wearing) and by demographic characteristics (eg, rurality), may provide critical insight to policymakers weighing costs and benefits of mitigation strategies. In this study, we compared the yearly and monthly incidence rates of acute MI and revascularization procedures — specifically, coronary artery bypass graft surgery (CABG) and percutaneous coronary intervention (PCI) — in 2020 to the previous 5 years (2015−2019) in a defined population residing in a nine-county region of Southeast Minnesota. In addition, we examined changes in incidence during four time periods corresponding to changes in the state of Minnesota's COVID-19 mitigation policies.

METHODS

Data Source

The Rochester Epidemiology Project (REP) has been previously described.[10] Briefly, the REP includes linked medical records from local health care providers for 1.7 million persons who have lived in a 27-county Midwest region after January 1, 2010. The REP captures health care information for approximately 60% of the population residing in this region. In addition, the REP captures health care information for approximately 90% of the population residing in a smaller nine-county region. This region includes the Minnesota counties of Dodge, Fillmore, Freeborn, Goodhue, Mower, Olmsted, Steele, Wabasha, and Waseca. This study was approved by Institutional Review Boards at Mayo Clinic and Olmsted Medical Center and was conducted in accordance with the Declaration of Helsinki. Persons who did not provide authorization to use their medical records for research were excluded.

Study Population

We used the REP to identify all adult (age ≥18 years) residents in the nine-county region who had an incident (first-ever) MI diagnosis, CABG, or PCI procedure between January 1, 2015, and December 31, 2020. Persons with an incident event included those who were diagnosed by billing codes with an MI as a primary in-patient diagnosis (ST-segment elevation MI, non−ST-segment elevation MI, or type 2), received CABG surgery, PCI procedures, or had CABG/PCI status (ie, they received the CABG/PCI procedure outside of the REP coverage area but were followed by an REP provider). A complete list of diagnosis, procedures, and status codes considered is shown in Supplemental Table 1 (available online at https://mcpiqojournal.org).

Minnesota COVID-19 Mitigation Policies During 2020

There were three major COVID-19−related state orders that may have influenced health care−seeking behavior among residents of this region (Figure 1). First, a peacetime state of emergency was declared on March 12 with corresponding lockdown strategies used (eg, closure of schools and pause in elective surgeries). Second, lockdown strategies began to lift on June 1, barbershops and salons re-opened and restaurants resumed outdoor dining. Finally, on November 21, several businesses (eg, indoor dining, gyms) were closed and social gatherings outside of one's household were suspended for a 4-week period. During this period, hospitals did not reduce or stop elective surgeries and patients had access to medical care. Based on these events, we categorized 2020 into four periods: "Pre-lockdown" (January 1 to March 11), "First lockdown" (March 12 to May 31), "Between lockdowns" (June 1 to November 20), and "Second lockdown" (November 21 to December 31).

Statistical Analyses

Incidence rates of MI or revascularization were calculated for each month from 2015 to 2020 using the counts of incident events as the numerators, and the denominators were the monthly population age 18 years or older for the nine-county region as determined by
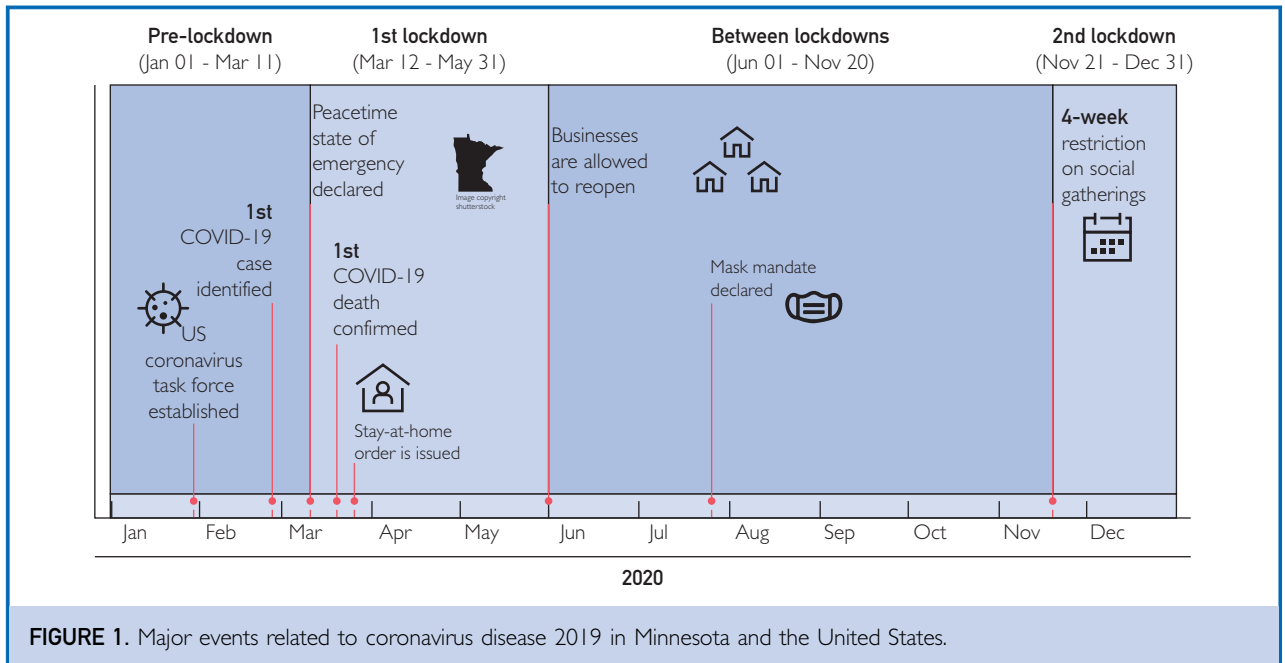
FIGURE 1. Major events related to coronavirus disease 2019 in Minnesota and the United States.

REP census data for 2015−2018[10] with extrapolation to estimate the 2019 and 2020 populations. Age was determined as of July 1 of each year. Overall rates and rates stratified by patient characteristics, which included sex, age (ie, 18−39, 40−49, 50−59, 60−69, 70−79, and 80+; in addition, 18−64 vs 65+), self-reported race (white, black, other/unknown), self-reported ethnicity (Hispanic vs non-Hispanic/unknown), and area of residence (urban vs rural) were calculated. Urban versus rural residence was defined based on the rural-urban commuting area codes, such that ZIP codes with primary rural-urban commuting area greater than or equal to 4 were defined as "rural," (ie, locations not associated with a metropolitan area).[11] Population sizes by residence (rural vs urban) were not available. However, because 55% of residents in the nine-county region resided in an urban area in 2019 according to the REP census data, stratifications by residence (rural vs urban) assumed that 55% of the population resided in an urban location and that this percentage did not change over the study period. Overall and stratified rates were also determined for each individual year from 2015 to 2020, the combined years of 2015 to 2019, and each of the four periods of 2020 representing the various lockdown strategies (and the corresponding four periods in 2015−2019 for comparison purposes) with population sizes proportionally determined for each period. For example, the pre-lockdown period from January 1 to March 11 corresponds to 2.38 months of observation for the time period. All rates were directly standardized to the age and sex distribution of the 2010 US total population except for rates stratified by age and by sex, which were standardized to the sex and age distribution, respectively, of the 2010 US total population. Incidence rate ratios (IRRs) were calculated by dividing the 2020 standardized incidence rate with the corresponding standardized incidence rate from 2015 to 2019.

RESULTS

During the study period, 767 persons did not provide authorization to use their medical records for research and were excluded from the study. Overall, a yearly average of 1200 incident events were observed during 2015−2019 (746 [62%] men, and 305 [25%] between 60 and 69 years old), and 834 events were observed in 2020 (538 [65%] men, and 220 [26%] between 60 and 69 years old). The Table summarizes the number of events, incidence rates, and IRRs overall and by sex, age, race, ethnicity, and area of

TABLE. Number of Events, Incidence Rates, and Incidence Rate Ratios, Overall and by Demographic Characteristics[a,b]
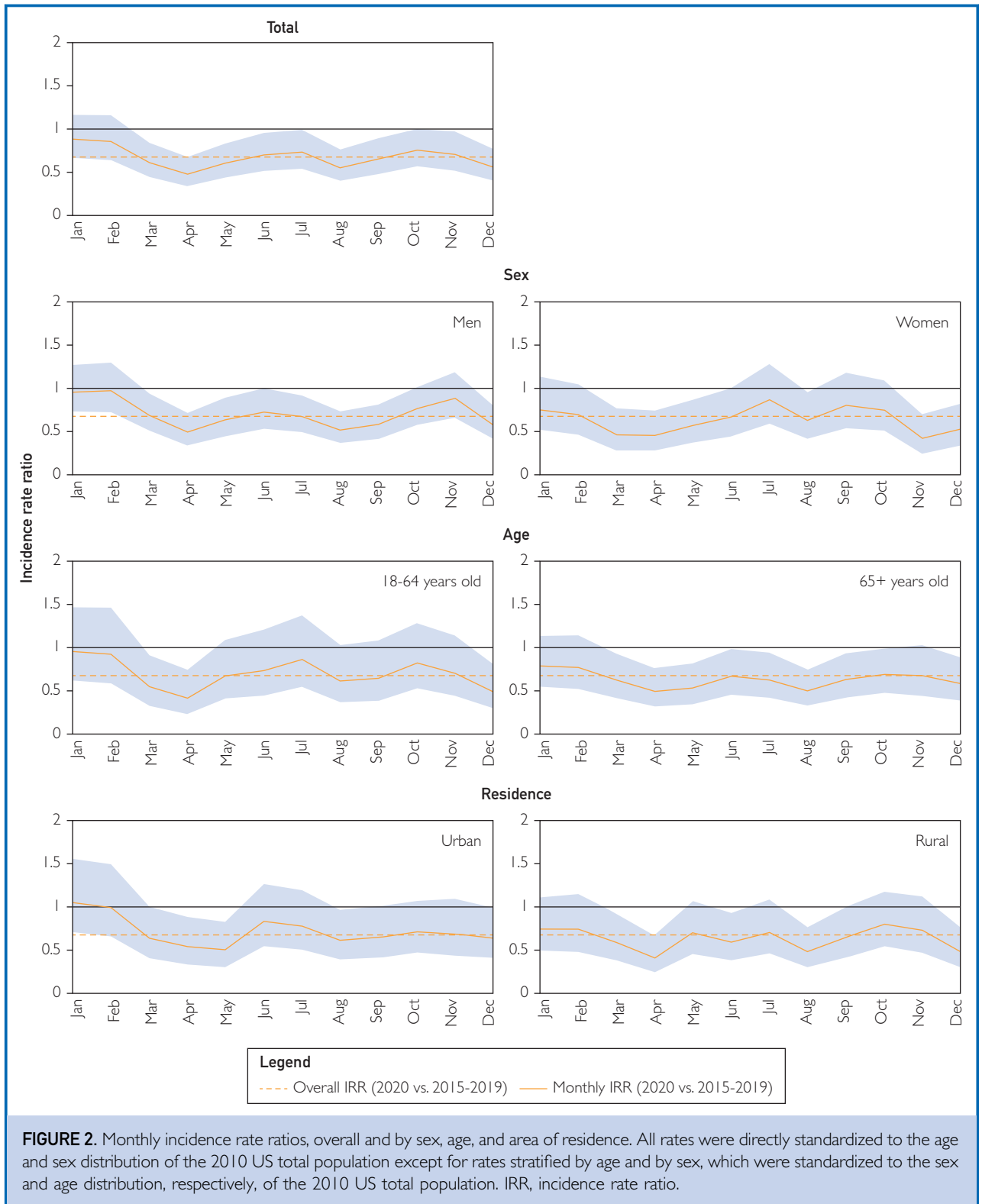
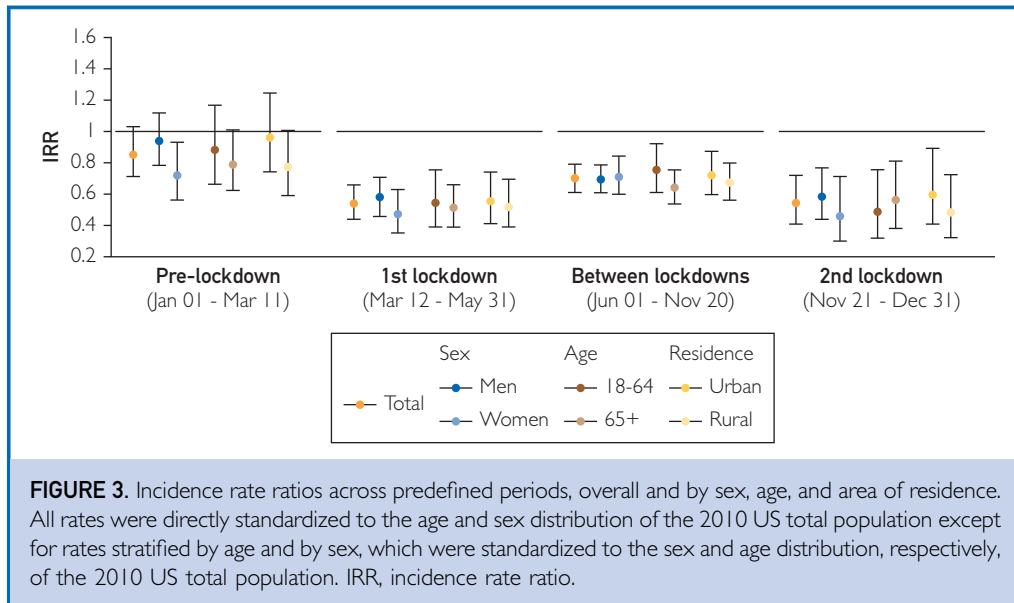| Characteristic | 2015—2019 | | 2020 | | |
	Events[c]	Incidence rate per 100,000 person-months (95% CI)	Events[d]	Incidence rate per 100,000 person-months (95% CI)	IRR (95% CI)
Total	1200	35.5 (34.6-36.4)	834	24.0 (22.4-25.7)	0.68 (0.62-0.74)
Sex					
Male	746	46.7 (45.2-48.2)	538	32.7 (29.9-35.5)	0.70 (0.63-0.78)
Female	454	25.0 (24.0-26.1)	296	15.8 (14.0-17.6)	0.63 (0.55-0.73)
Age, y[e]					
18—39	52	4.2 (3.7-4.7)	32	2.5 (1.6-3.4)	0.59 (0.38-0.92)
40—49	82	16.9 (15.3-18.5)	72	15.4 (11.8-19.0)	0.91 (0.66-1.25)
50—59	201	33.3 (31.3-35.4)	136	22.9 (19.1-26.8)	0.69 (0.55-0.86)
60—69	305	58.4 (55.4-61.3)	220	38.2 (33.1-43.2)	0.65 (0.55-0.78)
70—79	300	94.4 (89.6-99.2)	200	57.6 (49.6-65.5)	0.61 (0.51-0.73)
80+	259	118.6 (112.2-125.1)	174	77.4 (65.8-88.9)	0.65 (0.54-0.79)
Age groups, y					
18—64	482	18.5 (17.8-19.3)	341	13.0 (11.6-14.3)	0.70 (0.61-0.80)
65+	718	92.9 (89.9-95.9)	493	58.7 (53.5-63.8)	0.63 (0.56-0.71)
Race					
White	1110	37.4 (36.4-38.4)	758	25.4 (23.6-27.2)	0.68 (0.62-0.74)
African American	25	21.2 (17.5-24.9)	28	19.9 (12.5-27.2)	0.94 (0.55-1.61)
Other/unknown	65	22.4 (20.0-24.8)	48	14.0 (10.1-18.0)	0.63 (0.43-0.91)
Ethnicity					
Hispanic	28	15.3 (12.8-17.9)	19	9.1 (5.0-13.2)	0.59 (0.33-1.06)
Non-Hispanic/ unknown	1172	36.7 (35.8-37.6)	815	25.0 (23.3-26.7)	0.68 (0.62-0.74)
Residence					
Urban	569	30.7 (29.5-31.8)	422	22.1 (20.0-24.2)	0.72 (0.64-0.82)
Rural	626	41.2 (39.7-42.6)	409	26.2 (23.6-28.7)	0.64 (0.56-0.72)
Unknown	4	—	3	—	—

[a]IRR, incidence rate ratio.

[b]There were no events with unknown sex or age. All rates were directly standardized to the age and sex distribution of the 2010 US total population except for rates stratified by age and by sex, which were standardized to the sex and age distribution, respectively, of the 2010 US total population.

[c]Average number of events per year in 2015-2019, rounded down.

[d]Number of events in 2020.

[e]Age as of July 1 of the year.

residence. In 2020, the incidence rate of MI or revascularization was 24 cases/100,000 person-months (95% CI, 22.4-25.7), whereas in 2015—2019 it was 35.5 cases/100,000 person-months (95% CI, 34.6-36.4), reflecting a 32% decrease (IRR, 0.68; 95% CI, 0.62-0.74). We observed a reduction in incidence rates for 2020 across sexes (men, 30% reduction; women, 37% reduction), age groups (18—64 years, 30% reduction; 65+ years, 37% reduction), and area of residence (urban, 28% reduction; rural, 36% reduction). We also observed a reduction in incidence rates for 2020 among whites (32% reduction) and non-Hispanics (32% reduction). Incidence rates were similar between 2020 and 2015—2019 in the African American population and in the Hispanic population (ie, the upper CI of the IRRs crossed 1 in these groups). However, the absolute numbers of observed and expected events among these groups were too low for a meaningful interpretation (Table).

Figures 2 and 3 and Supplemental Table 2 (available online at https://mcpiqojournal.org) summarize incidence rates and IRRs for each month and period. Across the calendar months, April had the largest reduction in incidence rates (52% reduction; IRR, 0.48; 95% CI, 0.34-0.68), followed by August (45% reduction; IRR, 0.55; 95% CI, 0.40-0.76), and December (44% reduction; IRR,

FIGURE 2. Monthly incidence rate ratios, overall and by sex, age, and area of residence. All rates were directly standardized to the age and sex distribution of the 2010 US total population except for rates stratified by age and by sex, which were standardized to the sex and age distribution, respectively, of the 2010 US total population. IRR, incidence rate ratio.

FIGURE 3. Incidence rate ratios across predefined periods, overall and by sex, age, and area of residence. All rates were directly standardized to the age and sex distribution of the 2010 US total population except for rates stratified by age and by sex, which were standardized to the sex and age distribution, respectively, of the 2010 US total population. IRR, incidence rate ratio.

Supplemental Table 3 [available online at https://mcpiqojournal. org]). Among the stratification groups across the predefined periods, the lowest IRR was for women during the second lockdown (54% reduction; IRR, 0.46; 95% CI, 0.30-0.71). Finally, the proportions of specific types of incidence events were similar between 2020 and the previous year (Supplemental Table 4, available online at https:// mcpiqojournal.org). These data suggest that the observed decreases in incidence were not due to a decrease in only a specific diagnosis or procedure.

0.56; 95% CI, 0.41-0.77). During the months before March 12, the incidence rates for 2020 were comparable to those for 2015—2019; for example, January (IRR, 0.88; 95% CI, 0.67-1.16) and February (IRR, 0.86; 95% CI, 0.64-1.16). From March onwards, however, monthly incidence rates for 2020 were consistently lower than those for 2015—2019. Specifically, during the first lockdown period, there was a 46% reduction in incident events compared to 2015—2019 (IRR, 0.54; 95% CI, 0.44-0.66). After lockdown restrictions began to lift on June 1, there was an increase in the incidence rate relative to the first lockdown period, but rates for this period in 2020 were still significantly lower than the rates for the same period in 2015—2019 (IRR, 0.70; 95% CI, 0.61-0.79). A second lockdown period was announced on November 21, and during this period, rates were 46% lower than their respective 2015—2019 rates (IRR, 0.54; 95% CI, 0.41-0.72).

Next, we stratified our analyses by sex, age, and area of residence. The overall monthly pattern remained; that is, April, August, and December were the months with lowest IRRs across stratification factors (Figure 2). Across the predefined periods, results were consistent across different sexes, ages, and area of residence (Figure 3,

DISCUSSION

In this study, we examined associations between Minnesota COVID-19 mitigation strategies and incidence rates of acute MI or CABG/ PCI procedures in a defined Minnesota population. The first COVID-19 case identified in Minnesota was on February 25, 2020, and state-wide mitigation policies were implemented beginning on March 12, 2020. From March onwards, the incidence rates of acute MI or CABG/PCI procedures were consistently lower compared to the previous 5 years, even during periods when policies were relaxed. Declines were observed across age, sex, and area of residence, suggesting that COVID-19 mitigation policies had a similar impact across the entire population.

The lowest monthly incidence rate in 2020 (relative to 2015—2019) occurred in April, followed by August and December. The determinants of these trends cannot be characterized with certainty in ecological studies. Nonetheless, the observed trends in acute MI or CABG/PCI coincided with COVID-19 mitigation efforts in our region. In April, the peacetime state of emergency announced on March 12 was still in place. The fact that this was the first restriction measure

announced by the state, coupled with the many unknowns about COVID-19 contagion at the time,[12] may have contributed to fear of COVID-19 exposure in emergency departments among persons at risk of acute MI and other acute conditions. Alternatively, other factors may have contributed to the observed decline. For example, Minnesota observed a reduction in influenza cases in 2020 after COVID-19 mitigation strategies were implemented,[13] which may have contributed to reduced rates of acute MI and CABG/PCI in some subpopulations in that year.[14]

The second biggest reduction occurred in August, a month in between lockdown periods (June 1–November 20). During this period, there was a slight increase in IRRs relative to the first lockdown period, but incidence rates were still significantly lower than the incidence rates based on previous years for that period. The reduction in incidence rates in August occurred shortly after the implementation of a statewide mask mandate in all indoor businesses and public indoor spaces announced on July 25. It is possible that the mask mandate influenced health care–seeking behavior of persons at risk of hospitalization for MI and revascularization. Exposure is particularly worrisome among patients with chronic cardiovascular conditions as they are more likely to develop severe COVID-19, and such comorbidities can greatly reduce prognosis.[15] To our knowledge, no studies have investigated changes in incidence rates of acute MI or CABG/PCI procedures during this period or after mask mandates. However, mask mandates occur within the context of other state closure policies, which have been documented to coincide with decreased ambulatory visits.[16]

The third biggest reduction in incidence rates occurred in December, when the 4-week closure of businesses and suspension on social gatherings announced on November 21 were still in place. This announcement coincided with a second wave of COVID-19 infections in the community, which may have again contributed to fear of COVID-19 exposure among persons at risk of hospitalization for MI and revascularization.

The reduction in hospitalization for MI and revascularization during a government lockdown is consistent with what has been observed in other contexts.[5-8] For example, in Spain, a substantial decrease in the number of diagnostic procedures (56%), PCI (48%), and PCI in ST-elevation myocardial infarction (40%) was observed for the week of March 16 through March 22 (during the first COVID-19 outbreak), compared to weeks before the outbreak.[4] Many explanations for the reduction in emergency room visits and in-patient admissions in cardiovascular units have been proposed, including patients' reluctance to visit the hospital due to fear of exposure,[3,8] overload of health care systems causing postponement of elective cardiac procedures,[17,18] and patients' misinterpretation of infarct-related symptoms as being related to acute respiratory infection.[3] Reductions in incidence rates are particularly important in the context of cardiovascular diseases, in which late presenters may experience worse prognosis and additional complications related to their untreated condition which may require longer hospital stays.[19]

The strengths of this study include a large sample size, an ability to extract comprehensive health care data, and the ability to stratify incidence rates by key factors (eg, sex, age, and area of residence). In addition, our estimates were standardized by age and sex to account for the fact that the population of these groups increased differently from 2015 to 2020; for example, the number of residents 65 years or older increased 13% from 2015 to 2020 (vs 1.6% for residents aged 18–64 years old) (Supplemental Table 5, available online at https://mcpiqojournal.org). However, there are several limitations. First, we examined temporal trends in acute MI or revascularization concomitant with COVID-19 mitigation efforts. This ecologic trend study design has well-known limitations regarding causal inference.[20] Second, our cohort is from the Upper Midwest and characteristics and health seeking behaviors may be different from other parts of the country. For example, this population reflects the characteristics of the Upper Midwest, and is mostly non-Hispanic whites.[10] It is possible that COVID-19–related state orders affected the health care–seeking behaviors among African Americans or Hispanics at risk of hospitalization for MI and revascularization differently from their white and non-Hispanic counterparts. Future research on incidence of cardiovascular

diseases during the COVID-19 pandemic may be powered to obtain more precise estimates in these groups. We did not investigate incidence of MI in patients who did not come to the hospital for care during the pandemic. Future research may account for such population by using other data sources, such as death certificates. We were not able to stratify analyses by type of event (diagnosis vs procedures), and there is a chance that the reduction in hospitalizations for acute MI and revascularization in Southeast Minnesota may have been primarily driven by a reduction in elective PCI and CABG procedures. The proportion of types of MI and revascularizations did not differ significantly between 2019 and 2020 (P=.213) (Supplemental Table 4), suggesting that the decrease in rates observed in 2020 (vs prior years) was not due to any particular type of MI or revascularization. However, future research with adequate sample sizes may compare rates of revascularization for ST-segment elevation MI and non–ST-segment elevation MI in 2020 (vs prior years) by month and pandemic period to help to disentangle whether and when the decrease in rates for 2020 (vs prior years) was primarily in MI or PCI/CABG. Finally, incidence patterns may vary by year. We determined the incidence rates for the reference period of 2015–2019 in an attempt to reduce the influence of a single year in our incidence rates, but there is always a chance that single year variability may have affected these estimates for specific months or periods.

CONCLUSION

Our study documents a consistent reduction in incidence rates of acute MI or revascularization procedures in the months during the pandemic (2020) compared to the previous five years (2015-2019) among residents of a nine-county region in Southeast Minnesota. The implementation of community restrictions encouraging a stay-at-home lifestyle is critical for limiting the spread of COVID-19 in the community, but they may also impact the health of patients in unexpected ways.[8] Our findings provide supportive evidence that the COVID-19 pandemic and associated mitigation measures reduced the rates of hospitalizations for acute MI or revascularization procedures in Southeast Minnesota.

SUPPLEMENTAL ONLINE MATERIAL

Supplemental material can be found online at https://mcpiqojournal.org. Supplemental material attached to journal articles has not been edited, and the authors take responsibility for the accuracy of all data.

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