



# Impact of the COVID-19 pandemic on gender disparities in acute coronary syndrome patterns

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## ABSTRACT

**Background:** Global evidence has emerged showing fewer Acute Coronary Syndrome (ACS) cases than expected during the COVID-19 pandemic. Our study aims to evaluate the incidence of ACS before and after the onset of the COVID-19 pandemic and analyze differences in gender distribution, and type of presentation.

**Methods:** This is a retrospective study of 997 patients who presented to Huntsville Hospital's catheterization lab for elective and emergency catheterization for ACS and non-ACS during a four-week period from February 26, 2020, to March 10, 2020, and from March 25, 2020, to April 8, 2020, and compared with the equivalent weeks in 2019.

**Results:** We report a 45.5% decrease in ACS cases presenting during the COVID-19 pandemic between March 25, 2020, to April 8, 2020 compared to equivalent weeks in 2019, with a significant drop in percentage of female patients presenting by 30.6%. Upsurge in STEMI cases and a drop in NSTEMI cases was observed during the COVID pandemic compared to 2019.

**Conclusions:** Patients presenting after the onset of the pandemic had elevated cardiac markers, representing higher severity and potentially presenting later in the disease course. The number of total ACS cases and percentage of females presenting to the catheterization lab before the COVID surge (February/March 2019 and 2020) almost remained stable. This comparison data provides validity that the drop in ACS case volume and females in March/April 2020 is more likely due to the pandemic and not due to improvements in overall cardiovascular health metrics. Reasons for this disparity are likely multifaceted and deserve further investigation.

## 1. Objective

Our study aims to evaluate the incidence of ACS before and after the onset of the COVID-19 pandemic and analyze differences in gender distribution, severity, and type of presentation.

## 2. Methods

This evaluation is an Institutional Review Board (IRB) exempt retrospective, observational study performed in an 1100 bed large community hospital in Huntsville, Alabama, USA. We performed chart review of 997 patients who presented to Huntsville Hospital Cardiac Catheterization lab for elective and emergency catheterization for non ACS and ACS [NSTEMI, Unstable angina (UA), STEMI] during a 4-week period from February 26, 2020, to March 10, 2020, and from March 25,

2020, to April 8, 2020, and compared with the equivalent weeks in 2019. Out of 997 only 445 patients underwent cardiac catheterization for acute coronary syndrome. Remaining patients underwent cardiac catheterization for causes other than acute coronary syndrome, such as atrial septal defect closure, pulmonary arterial hypertension to assess hemodynamics in the heart chambers, cardiac myxoma, treatment of valvular heart disease (e.g., transcatheter mitral valve repair), assessment of the congenital heart diseases like cor triatriatum. Demographic information, type of ACS, initial and peak troponin levels, initial CKMB, past medical history [hypertension (HTN), diabetes (DM), stroke, atrial fibrillation, congestive heart failure (CHF)], and past surgical history [percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG)] were also collected and analyzed (see [Table 1](#)).

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**Table 1**  
Characteristics of the Patients.

	(Feb 26 - Mar 16) 2019	(Mar 25 - Apr 8) 2019	(Feb 26 - Mar 16) 2020	(Mar 25 - Apr 8) 2020
<b>Total number of ACS patients</b>	112	145	109	79
<b>NSTEMI/UA</b>	95 (84.8%)	118 (81.4%)	86(78.9%)	53 (67.1%)
<b>STEMI</b>	17 (15.2%)	27(18.6%)	23(21.1%)	26 (32.9%)
<b>Age (years, mean)</b>	65	64	63	61
<b>Females</b>	46 (41.07%)	59 (40.69%)	46 (42.20%)	8 (10.13%)
<b>Males</b>	66 (58.93%)	86 (59.31%)	63 (57.80%)	71 (89.87%)
<b>Diabetes</b>	37.90%	45.80%	39.50%	15.50%
<b>HTN</b>	90.50%	83%	80.20%	27%
<b>Tobacco</b>	45.30%	46.60%	52.30%	16.90%
<b>H/O PCI</b>	32.70%	39.80%	50%	19.60%
<b>H/O CABG</b>	6.30%	15.20%	2.30%	10.10%
<b>CHF</b>	28%	11.90%	20%	6.70%
<b>Stroke</b>	8.40%	9.30%	4.60%	2.70%
<b>Atrial fib</b>	20%	5.80%	8.50%	2.70%

**3. Results**

On March 17, 2020, the first case of COVID-19 was diagnosed in Huntsville, Alabama, USA. Total 112 patients, with 41.07% of them being females, presented with ACS in February/March 2019, while 109 patients, with 42.2% females, presented with ACS during the same period (February/March) in 2020. In March/April 2019, 145 patients with 40.69% females presented with ACS, while only 79 patients with 10.13% females presented with ACS during the same period (March/April) in 2020. This represents a decrease by 45.5% of total ACS cases and, most notably, 30.56% of female patients during the COVID-19 pandemic. Across both 2019 study periods and as compared to February/March 2020, Huntsville Hospital saw a steady volume of females presenting with ACS and total ACS cases. This data provides

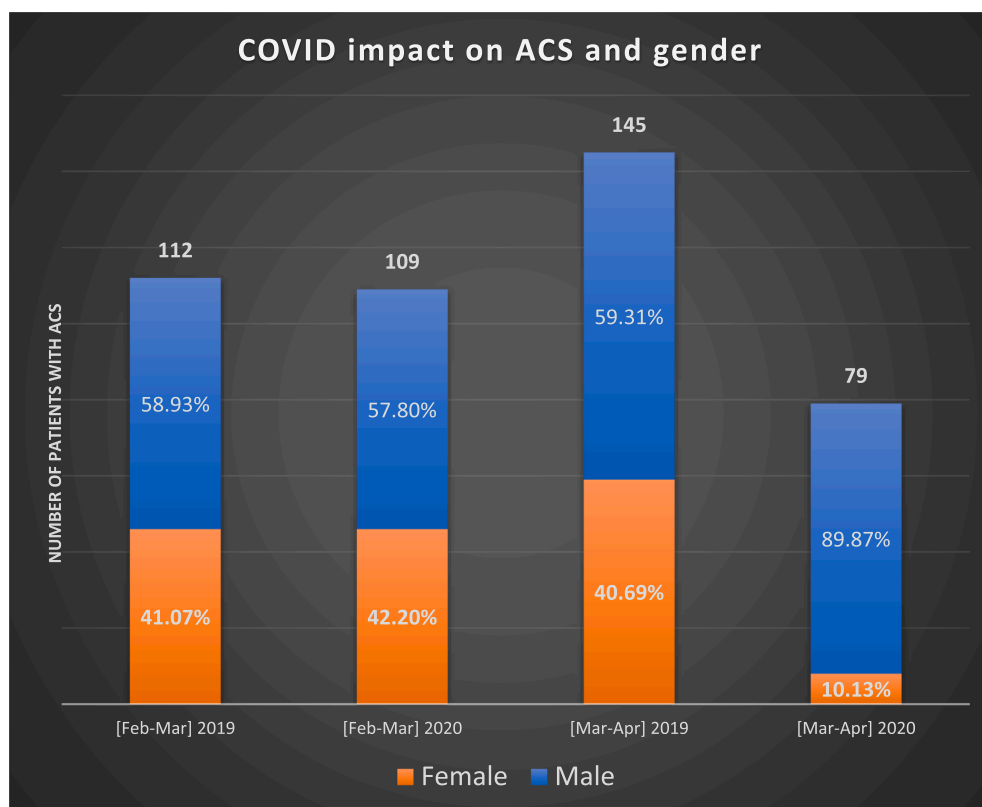
validity that the drop in females and ACS case volume in March/April 2020 is more likely due to the COVID pandemic and not due to improvements in overall cardiovascular health metrics (see Fig. 1).

More patients presented having progressed to STEMI after the COVID pandemic onset than before. In February/March 2019, 84.8% presented with NSTEMI/UA, 15.2% presented with STEMI, while in 2020, 78.9% presented with NSTEMI/UA, and 21.1% patients presented with STEMI which shows increase in STEMI cases by 5.9%. In March/April 2019, 81.4% presented with NSTEMI/UA, 18.6% presented with STEMI, while in 2020, 67.1% presented with NSTEMI/UA, and 32.9% patients presented with STEMI. Of significant note, STEMI cases increased by 14.3%, during the COVID pandemic in comparison with 2019.

Mean admission troponin, peak troponin, and admission CKMB of NSTEMI/UA cases in February/March 2019 is 164.8 ng/l, 403.7 ng/l, and 12.9 ng/ml, respectively. Mean admission troponin, peak troponin, and admission CKMB in February/March 2020 are 163.6 ng/l, 392.1 ng/l, and 12.5 ng/ml, respectively. Mean admission troponin decreased by 1.2 ng/l, mean peak troponin by 11.6 ng/l, and mean admission CKMB by 0.4 ng/ml during February/March 2020 compared to similar weeks in 2019.

NSTEMI/UA patients' mean admission/peak troponin and CKMB were higher during COVID pandemic in March/April 2020, representing higher severity and potentially presenting later in the disease course. Mean admission troponin, peak troponin, and admission CKMB of NSTEMI/UA cases in March/April 2019 is 261.3 ng/l, 392.2 ng/l, and 7.2 ng/ml, respectively. Mean admission troponin, peak troponin, and admission CKMB in March/April 2020 are 293.6 ng/l, 527.3 ng/l, and 11.3 ng/ml, respectively. Mean admission troponin was elevated by 32.3 ng/l, mean peak troponin by 135.1 ng/l, and mean admission CKMB by 4.1 ng/ml during March/April 2020 compared to similar weeks in 2019.

Compared to March/April 2019, there was a decrease in the prevalence of clinical risk factors (e.g., hypertension, diabetes, CHF, stroke, atrial fibrillation, history of PCI, and CABG) among patients presenting



**Fig. 1.** COVID impact on ACS and gender. Total 112 patients, with 41.07% of them being females, presented with ACS in February/March 2019, while 109 patients, with 42.2% females, presented with ACS during the same period (February/March) in 2020. In March/April 2019, 145 patients with 40.69% females presented with ACS, while only 79 patients with 10.13% females presented with ACS during the same period (March/April) in 2020. This represents a decrease by 30.56% of female patients during the COVID-19 pandemic.

to the catheterization lab with ACS during the COVID pandemic.

#### 4. Discussion

The onset of COVID-19 correlated with a reduction in admissions for acute life-threatening conditions [1]. Using data from the Huntsville Hospital Catheterization lab, we report a decrease in total ACS cases with significant drop in percentage of females that presented during the COVID-19 pandemic between March 25, 2020, to April 8, 2020. Previous studies showed a nationwide downward trend in annual volumes of ACS and PCI [2,3] over the last several years. Conversely, Huntsville Hospital has seen a steady volume of ACS cases over the last year. Despite this trend, there was a precipitous drop by 45.5% of total ACS cases during the COVID-19 pandemic during the studied timeframe in March/April 2020 compared to equivalent weeks in 2019. Increased elevation of cardiac markers was observed with an upsurge in STEMI cases and a drop in NSTEMI cases during the COVID pandemic compared to 2019. This could possibly be in part due to some NSTEMI cases progressing to STEMI due to delayed hospital presentation. Reports from Italy [6], Austria [12], and Upstate New York [13] also documented a greater fall in percentage presenting with NSTEMI than STEMI.

The gender disparities are striking with a significant drop of 30.56% females presenting with ACS during the COVID pandemic, March/April 2020 compared to equivalent weeks in 2019. There was not much difference in percentage of females presenting to catheterization lab with ACS before COVID surge (February/March 2019 and 2020). This data shows that the sudden drop in females in March/April 2020 is likely due to COVID. Report from Upstate New York [13] also documented drop in females presenting with ACS during the COVID pandemic. Numerous studies [8–11] have shown women with ACS had a higher likelihood of presenting without chest pain and have their ACS misdiagnosed or mismanaged compared to males. This disparity we have seen at our institution, as well as in the referenced studies, is complex but likely driven, at least to a degree, by presentation of atypical symptoms, which may go unrecognized by both patients and providers. Reasons for this disparity are likely multifaceted and deserve further investigation.

We found that patients presenting to the catheterization lab with ACS during the COVID pandemic had lower overall number of risk factors (e. g., hypertension, diabetes) compared to 2019. Lai et al. [5] report that patients with out-of-hospital cardiac arrest during the COVID pandemic had increased incidence of hypertension, diabetes, and physical limitations.

Our results were similar to those observed in Northern Italy [6], Austria [12], and New York [13], which showed a significant decrease in ACS related hospitalization. Medical care avoidance behavior leading to a delayed presentation and decrease in ACS cases presenting to the hospital during the COVID pandemic has been reported in northern Italy [7], which caused serious sequelae or even death. In contrast Sofi F et al. [14] study analyzed the impact of COVID pandemic on STEMI worldwide through a meta-analytical approach that included 79 articles, >111000 STEMI cases from 57 countries and revealed 20 % decline in hospitalization for STEMI due to lack of available hospital beds as they are overwhelmed with COVID patients and limitation to access to care. Parallely other studies [4,5] have shown increased out-of-hospital cardiac arrests and deaths during the COVID-19 pandemic compared with 2019. These disparities highlight urgent need for further investigation. This could be due to patient anxiety about COVID exposure is taking longer to present to the hospital after the onset of symptoms with an overall decrease in ACS cases and an increase in out of hospital cardiac arrests. Given the need to prevent the worsening of future complications of ACS, every effort should be taken to address the public's fear that they might contract COVID-19 by going to the hospital to reduce possible collateral damage caused by COVID-19.

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#### CRediT authorship contribution statement

**Usha Yendrapalli:** Formal analysis, Methodology, Writing – original draft. **Sawyer Mullen:** Data curation. **Ahmed Elawad:** Writing – review & editing. **Jacqueline L. Green:** Conceptualization, Methodology, Supervision.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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