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The impact of COVID-19 lockdown measures on ED visits in Lebanon

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ABSTRACT

Introduction: As the COVID-19 pandemic spread globally, emergency departments (ED) around the world began to report significant drops in volumes and changes in disease patterns. During the early COVID-19 period, Lebanon followed an aggressive containment approach to halt the spread of the disease.

Objective: This study aims to examine the impact of the different national containment measures and the early COVID-19 outbreak in Lebanon on ED visit volume and disease spectrum in a single center ED in Lebanon.

Methods: This study is a secondary analysis of ED visit administrative data, comparing ED visits during the three months period prior to the first identified COVID-19 case in Lebanon with the first 3 months post-COVID-19. A time series analysis of ED visit trends in relation to the major lockdown measures was conducted. Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS, version 27) and STATA version 15 (StataCorp LLC., College Station, TX). Statistical significance was set at 0.05.

Results: The daily ED visit volume significantly decreased in response to the closure of educational institutions (19.96% per day, p -value = 0.04) and the declaration of public mobilization state with border closure (97.11% per day, p -value <0.0001). ED visits decreased by 47.2% post-COVID-19. The drop was highest amongst pediatric patients (66.64%). Patients who presented post-COVID-19, compared to pre-COVID-19 were older (40.39 ± 24.96 vs 33.71 ± 24.83 , p -value <0.0001), had higher hospital admission rates (28.8% vs. 22.1%, p -value <0.0001), higher critical care admission rates (5.6% vs. 3.5%, p -value <0.001), and double mortality rate (0.4% vs 0.2%, p -value = 0.006). While visits for most diseases dropped, the odds of presenting to the ED post-COVID19 were higher for bacterial infections and non-communicable disease and lower for injuries and communicable diseases.

Conclusion: ED visits dropped significantly during the COVID-19 containment period. Understanding the trends of changes in disease entities is important for ED staffing purposes during the pandemic and the varying containment efforts. While stringent lockdown measures were associated with drops in ED visits, understanding the reason behind these drops, specifically whether behavioral or related to true drops in disease prevalence, needs further exploration.

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1. Introduction

The first case of the SARS-CoV-2 virus was reported in Wuhan, China on the 31st of December 2019. The World Health Organization considered the corona virus disease 2019 (COVID-19) to be a public health emergency in January 2020, declaring it a pandemic shortly thereafter in March 2020 [1]. Worldwide, as governments were struggling to contain the virus through prevention and public awareness campaigns, social distancing regulations, and lockdown measures, emergency departments (ED) ramped up training and preparedness plans to face

the pandemic. At the same time, reports of drops in ED visits and changes in visit characteristics began to emerge.

Around the world, EDs began to report significant drops in volumes. In a national study in the United States, ED volumes were found to have dropped by 23% during the community transmission phase of COVID-19 [2]. A sharper drop of 39% was reported in a single-center study in Norway, despite only a local transmission status of the pandemic [3]. Similarly, studies during the phase of local transmission and lockdown in Italy reported drops of 50 to 88% [4–6]. Despite the low prevalence of COVID-19 during the study period, a single-center study in Taiwan reported a 33% drop in ED volume [7].

In addition, reports on variations in the patterns of specific diseases started emerging. Changes in cardiovascular disease trends were particularly notable. In a national US study, ED visits decreased by 23% for myocardial infarction [8]. A significant reduction in hospital admissions

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for acute coronary syndrome by 45% was reported in a single-center study in Italy [4]. Similar trends were reported in national studies in Austria and England, with drops of 39.4% and 40% respectively [9,10]. Moreover, the number of patients presenting to the ED for stroke was noted to have dropped by 20% in the US [8], by 25% in a single hospital in Cueno, Italy [4], and by 20% in London, Ontario, Canada [11]. Significant drops in pediatric ED visits were reported in Italy [5,6], the UK [12], and Argentina [13] by 88%, 30%, and 88.6%, respectively.

In Lebanon, the first case of COVID-19 was identified on the 21st of February 2020. Given the low resource setting and country specific challenges, the government took a very aggressive approach to containment, that included the closure of educational institutions and entertainment venues, the declaration of a state of general mobilization on March 15, 2020 with curfew hours, as well as full border closures on March 18, 2020 [14,15] when cases were still 99 [16]. This resulted in a drop in the COVID-19 growth rate from a peak of 4.6 to less than 1 by end of April, when a phased re-opening of the country was initiated. [14]. In parallel to the containment efforts, the health sector was mobilizing preparedness plans, designating COVID-19 receiving hospitals, increasing personal protective equipment and ventilators stockpiles, as well as critical care capacity. While COVID-19 cases during this period remained contained reaching 1220 cases by end of May, with a country case count of 174.49 per million population [17], reports of drops in ED visits began to emerge.

This study aims to examine the impact of the different national containment measures and the early COVID-19 outbreak in Lebanon on the pattern of ED visit utilization and the variation in ED visits disease spectrum in a single-center hospital in Beirut, Lebanon.

2. Methods

2.1. Study design and setting

We carried out a secondary analysis of ED visit administrative data, comparing ED visits during the first three months after the first locally identified COVID-19 case in Lebanon (between February 21 and May 31, 2020; thereafter referred to as “post-COVID-19”), to the preceding three months period between November 12, 2019 to February 20, 2020 (thereafter referred to as “pre-COVID-19”), at the American University of Beirut Medical Center (AUBMC) ED, a 384-bed tertiary care teaching hospital in Beirut, Lebanon. The ED is one of the largest in the country, seeing around 57,000 visits per year, 28% of which are

pediatrics. It consists of three clinical areas: high acuity, low acuity, and pediatrics. Patients are triaged to sections based on a combination of Emergency Severity Index (ESI) and clinical criteria. All pediatric patients (less than 19 years of age) are seen in the pediatric section, while ESI 1 & 2 and more complex ESI 3 are seen in the higher acuity area, and lower acuity ESI 3, 4 & 5 in the low acuity section. The ED is staffed by a mix of Emergency Medicine trained physicians and practitioners with extensive EM experience. On average, 80% of ED patients are insured, while the remaining 20% are self-payers.

During the early COVID-19 period covered in this study, Lebanon followed an aggressive containment approach. Fig. 1 presents the timeline of containment measures along the variation in daily ED visit volume across the pre- and post-COVID-19 periods. Four major containment measures were identified, namely the closure of educational institutions, closure of entertainment venues, the declaration of a public mobilization state which included the closure of borders (airport, marine, and land borders), and finally the implementation of curfew hours from 7:00 pm to 5:00 am.

This study was considered to be exempt from human subject research by the Institutional Review Board at the American University of Beirut.

2.2. Participants

We included all adult and pediatric ED visits during the aforementioned pre-COVID-19 and post-COVID-19 periods. We excluded visits that were cancelled, incomplete or left without being seen.

2.3. Data collection and measurements

De-identified data was extracted from an administrative database. Variables included patient demographics (age and gender) and ED Visit Characteristics including ESI, length of stay, ED disposition, guarantor, and ICD-10 diagnosis codes. The Clinical Classifications Software (CCS) for ICD-10-CM beta version tool was used to collapse the ICD-10 codes into a reduced number of clinically meaningful categories.

2.4. Statistical analysis

Descriptive statistics were performed using number and percentage for categorical variables, whereas mean and standard deviation (SD) were used for continuous variables. The comparison between the

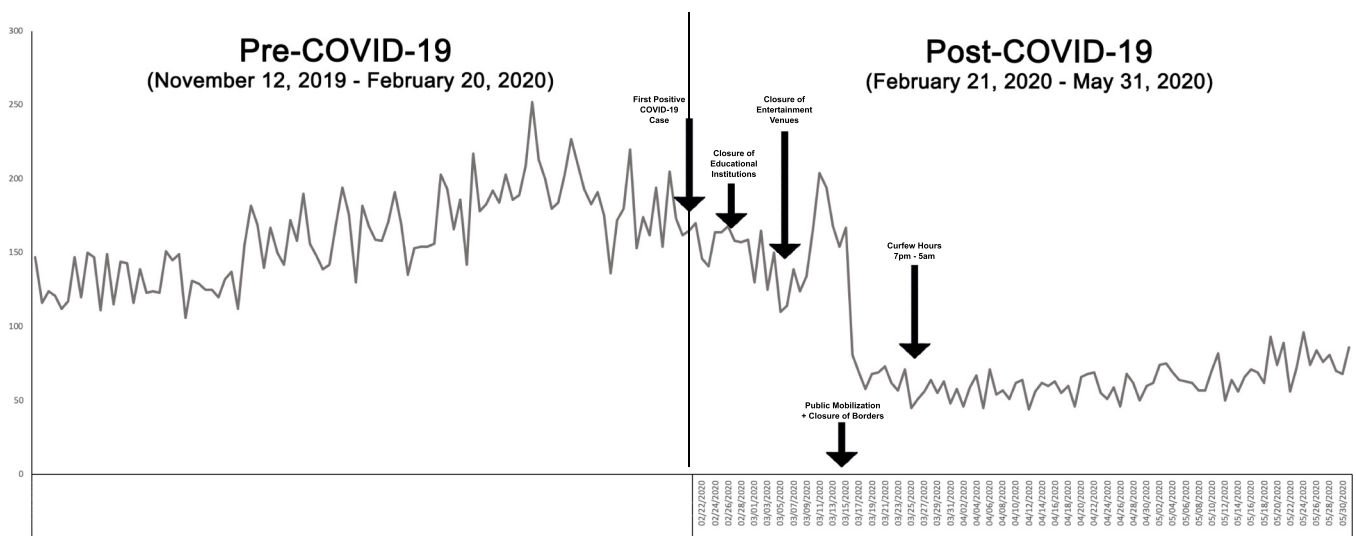


Fig. 1. The variation in daily ED visit volume along the time line of containment measures taken during the post COVID19 period.

post-COVID-19 and the pre-COVID-19 periods, and categorical variables were assessed by the Pearson chi-square test, whereas the Student's *t*-test was used to assess the association with continuous variables. The percent drop in visits by diagnosis and the odds ratios of presenting to the ED for a specific diagnosis were examined, comparing the post-COVID-19 to pre-COVID-19 period. Diagnoses with a total visit count of less than 60 throughout the study period (constituting diagnoses that were less than 2% of overall visits) were excluded from the final analysis.

A time series analysis of ED visit trends in relation to the major containment measures was conducted using the Newey command (considering Newey-West standard errors). Hallmark events were the date of the first identified COVID-19 case in Lebanon, and the dates of the four major containment measures listed above. The change in ED visits trend was assessed in relation to each hallmark event.

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS, version 27) and STATA version 15 (StataCorp LLC., College Station, TX). *P*-value <0.05 was used to indicate statistical significance.

3. Results

Table 1 presents a comparison of patient demographics and ED visit characteristics between the two periods. During the post-COVID-19 period there were a total of 8587 ED visits, in comparison to 16,271 visits in the pre-COVID-19 period; the latter is equivalent to a 47.2% decrease in ED visit volume post-COVID-19. The drop was seen in visits of all age groups but was highest amongst pediatric patients and lowest amongst the elderly (66.64% in 1–17 years; 46.76% in 18–44 years; 32.76% in 45–64 years; 26.98% in ≥65 years). Similarly, the drop in absolute visit

number was seen across all ED sections, but was most significant in the pediatrics section (34.34% in high acuity, 43.23% in low acuity, 67.8% in pediatrics) (Table 1).

The average age of patients who visited the ED post-COVID-19 was significantly higher compared to the pre-COVID-19 period (40.39 ± 24.96 vs 33.71 ± 24.83, *p*-value <0.0001). No difference in gender distribution across the two time periods was noted (*p*-value = 0.729), and the ED length of stay was significantly higher post-COVID-19 (3.46 h ± 5.98 vs. 2.83 h ± 4.36, *p*-value <0.0001). Hospital admission rates increased post-COVID-19 (28.8% vs. 22.1%, *p*-value <0.0001), with a significant increase in the rate of critical care admissions (5.6% vs. 3.5%, *p*-value <0.001). Finally, the proportion of deaths significantly doubled during the post-COVID-19 period (0.4% vs 0.2%, *p*-value = 0.006).

Fig. 2 displays the percent drop in visits by diagnosis as well as the odds ratios of presenting to the ED for a specific diagnosis during the post-COVID-19 period compared to pre-COVID-19. While there was an overall percent drop across all diagnoses except for fever of unknown origin, epilepsy and convulsions, and malaise and fatigue, the biggest drops in percentages of diagnoses presenting to the ED were for diagnoses pertaining to trauma or communicable diseases. Accordingly, ED diagnoses that displayed lower odds of ED visits post-COVID-19 compared to pre-COVID-19 included sprains and strains (OR 0.72, 95% CI 0.58 to 0.89), injuries and conditions due to external causes (OR 0.68, 95%CI 0.60 to 0.77), other fractures (OR 0.83, 95%CI 0.53 to 1.33), viral infections (OR 0.75, 95%CI 0.66 to 0.85), influenza (OR 0.15, 95% CI 0.12 to 0.19), intestinal infections (OR 0.64, 95%CI 0.47 to 0.87), acute bronchitis (OR 0.33, 95%CI 0.21 to 0.53), and otitis media and related conditions (OR 0.31, 95%CI 0.21 to 0.44), amongst others.

On the other hand, we found the odds of ED visits for cardiac arrest and ventricular fibrillation (OR 1.63, 95%CI 1.00 to 2.65), coronary

Table 1
Comparison of patient demographics and ED visit characteristics between the first three months after the first locally identified COVID-19 case in Lebanon (Post-COVID-19) and the preceding 3 months period (Pre-COVID-19)

		Pre-COVID-19 Nov12, 2019 – Feb 20, 2020 (N = 16,271)	Post-COVID-19 Feb 21, 2020 – May 31, 2020 (N = 8587)	p-value
Patient Demographics				
Age	Mean (±SD)	33.71 (±24.83)	40.39 (±24.96)	<0.001
Age Categories	1–17 years	4640 (28.5%)	1548 (18.0%)	<0.001
	18–44 years	6597 (40.5%)	3512 (40.9%)	
	45–64 years	2573 (15.8%)	1730 (20.1%)	
	65 years and older	2461 (15.1%)	1797 (20.9%)	
Gender	Male	8433 (51.8%)	4471 (52.1%)	0.729
	Female	7838 (48.2%)	4116 (47.9%)	
ED Visit Characteristics				
Daily Volume	Mean (±SD)	161.10 (±30.49)	85.02 (±40.88)	<0.001
Emergency Severity Index (ESI)	ESI 1	50 (0.3%)	49 (0.6%)	<0.001
	ESI 2	1485 (9.1%)	1032 (12.0%)	
	ESI 3	14,146 (87.1%)	6962 (81.2%)	
	ESI 4	434 (2.7%)	419 (4.9%)	
	ESI 5	118 (0.7%)	109 (4.9%)	
LOS	Mean (±SD)	2.83 (±4.36)	3.46 (±5.98)	<0.001
ED Disposition	Home/AMA	12,539 (77.2%)	5963 (62.5%)	<0.001
	Admit	3581 (22.1%)	2472 (28.8%)	<0.001
	General	3017 (18.5%)	1995 (23.2%)	<0.001
	Critical Care	564 (3.5%)	481 (5.6%)	<0.001
	Transfer to Another Facility	45 (0.3%)	54 (0.6%)	<0.001
	Dead	36 (0.2%)	36 (0.4%)	0.006
	LWBS	38 (0.2%)	52 (0.6%)	<0.001
ED Sections	High Acuity	6601 (40.7%)	4334 (50.6%)	<0.001
	Low Acuity	4626 (28.5%)	2626 (30.7%)	
	Pediatrics	4987 (30.8%)	1605 (18.7%)	
Guarantor	Self-Payer	1975 (12.1%)	1849 (21.6%)	<0.001
	Insurance or 3rd party payment	14,282 (87.9%)	6714 (78.4%)	

a: Adult critical care units: COVID ICU, Cardiac Catheterization, Coronary Care, Heart Failure Unit, Intensive Care Unit, Neurology ICU, Respiratory Care Unit.

b: Pediatric critical care units: Pediatric ICU, Pediatric Step Down, Neonatal ICU.

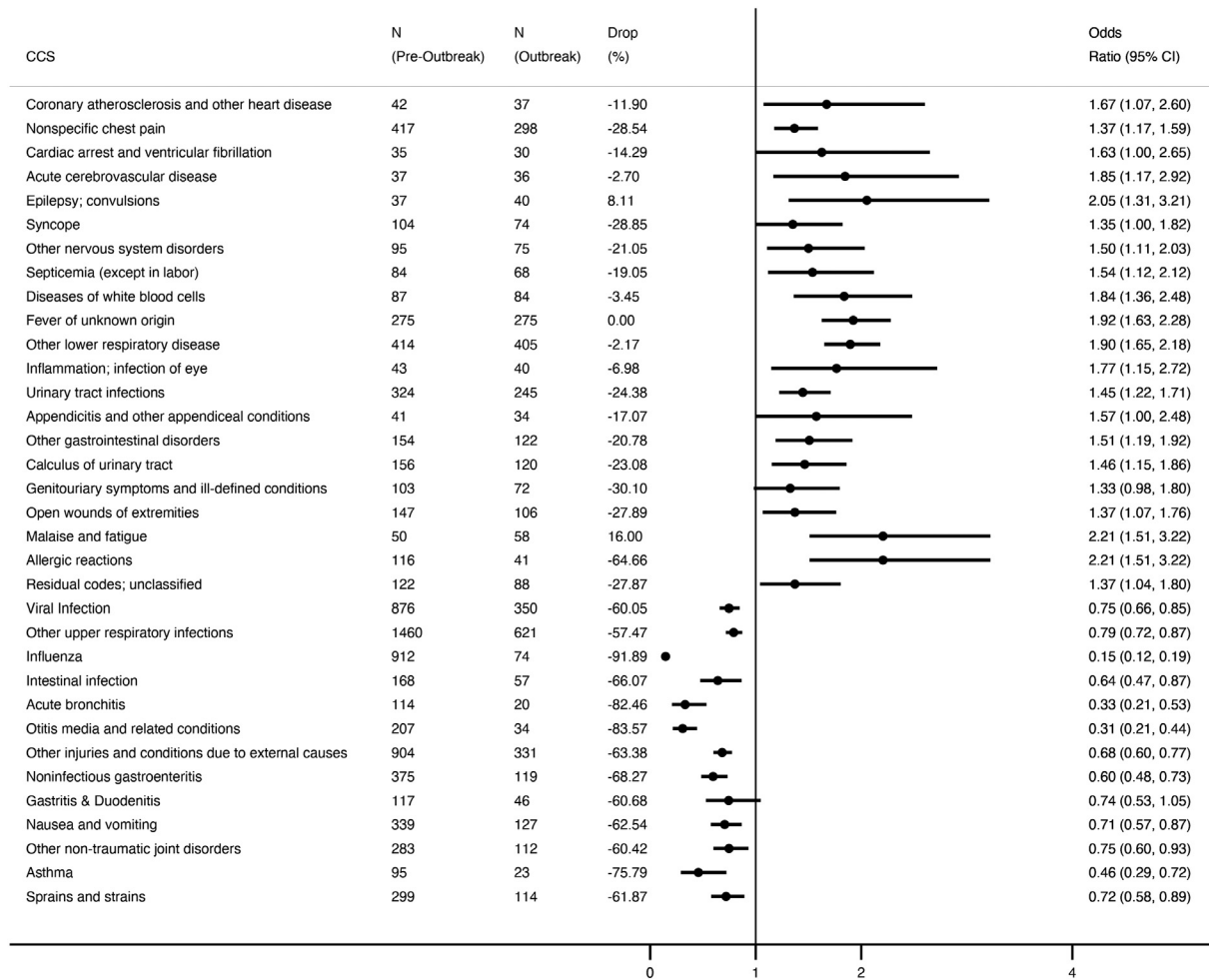


Fig. 2. The percent drop in ED visits by diagnosis and the odds ratios of presenting to the ED for a specific diagnosis post COVID19 compared to the pre COVID19 period.

atherosclerosis (OR = 1.67, 95%CI 1.07 to 2.60], and nonspecific chest pain (OR 1.37, 95%CI 1.17 to 1.59) to be higher post-COVID-19 compared to pre-COVID-19. Similarly, higher odds of ED visits for post-COVID-19 period were observed for acute cerebrovascular disease (OR = 1.85, 95%CI 1.17 to 2.92]), transient ischemic cerebral ischemia (OR 2.65, 95%CI 1.18 to 5.98), epilepsy and convulsions (OR 2.05, 95% CI 1.31 to 3.21), and syncope (OR 1.35, 95%CI 1.00 to 1.82), in comparison to pre-COVID-19. Moreover, diagnoses pertaining to bacterial infections including septicemia (OR 1.54, 95%CI 1.12 to 2.12), diseases of white blood cells (OR 1.84, 95%CI 1.36 to 2.48), other lower respiratory disease (OR 1.90, 95%CI 1.65 to 2.18), and urinary tract infections (OR 1.45, 95%CI 1.22 to 1.71) displayed higher odds of ED visits post-COVID-19 compared to pre-COVID-19.

A time series analysis showed a significant decrease in daily ED visits by 19.96% per day upon the closure of educational institutions (p -value = 0.04) and by 97.11% per day upon the declaration of a public mobilization state that coincided with closure of borders (p -value <0.0001). The drops in daily ED visits secondary to the closure of entertainment venues and the application of curfew hours were not found to be statistically significant (Table 2).

4. Discussion

Our study found a 47.2% decrease in the ED visits volume during the first three months after the first locally identified COVID-19 case in Lebanon, in comparison with the preceding three months period. There was a notable decline in pediatric ED visits compared to other

age groups. Lockdown of educational institutions and border closure was associated with the greatest drop in ED visits, whereas curfew measures and lockdown of entertainment venues was not associated with a significant change in ED visits. ED visits during the post-COVID-19 period included a sicker cohort as reflected by older age, the higher rates of hospital admissions, higher rates of critical care admission and higher mortality rate. In addition, we observed changes in the spectrum of ED visit diagnoses presenting to the ED during the post-COVID-19 period. Despite a drop in absolute numbers of most diagnoses, certain diagnoses displayed higher odds of ED visits post-COVID-19 and thus behaved as COVID-19 non-elastic. These were generally related to bacterial infections and non-communicable diseases. In contrast, injuries and communicable diseases were found to be more COVID-19 elastic with high drops in both absolute number of visits as well as the odds of ED visits for related diagnosis.

This study is the first to examine the effect of the different COVID-19 containment measures on ED visits and explore the changes in ED visits

Table 2
Interrupted time-series analysis of ED visits trend post-COVID-19

	Change in Trend	95% CI	P-value
Closure of educational institutions	-19.96	-38.32; -1.61	0.04
Closure of entertainment venues	20.22	-5.22; 45.67	0.11
Public Mobilization + Closure of Borders	-97.11	-121.53; -72.69	<0.0001
Curfew Hours 7 pm-5 am	-7.9	-16.25; 0.45	0.06

during the initial phase of COVID-19 in the Lebanese context. The study period's significance lies in it being a period of low community prevalence of COVID-19, allowing for an exploration of ED visits trends in the context of limited COVID-19 disease interaction but significant behavioral changes amidst a lockdown. This is not only within a context of adherence to health protective measures such as physical distancing, mask wearing and hand hygiene, but also in a setting where stringent disease containment measures were in place, including the closure of educational institutions, entertainment venues, and borders, and the implementation of curfew hours.

Our findings are consistent with other studies that have reported a drop in overall volumes of ED visits during the early outbreak phase coupled with a sicker cohort of patient presentations to the ED. A study conducted at a tertiary care center in Taipei, Taiwan, reported a drop in ED visits volume despite the low prevalence of COVID-19 in the community, particularly in the category of patients with ESI scores of 2 to 5, while the number of the sickest patients remained unchanged [7]. In our study, even though we saw a drop in the absolute numbers of all acuity levels (except for ESI 1), ED length of stay, acuity by section, and admission to critical care areas increased reflecting the higher complexity of patients who continued to seek care in the ED during this period. Similarly, while overall number of patients with a “death” disposition did not increase, the rate of death went up post-COVID-19 to 0.4% from 0.2%, with an increase in in-ED death from 5 to 8 patients (60%). This pattern is in line with that observed in Taipei, where number of out-of-hospital cardiac arrest cases remained unchanged but in-ED mortality increased [7]. This is in contrast to what was reported in Lombardy, Italy, where mortality increased 58% compared to the prior year during a period of high COVID-19 community transmission [18]. Since COVID-19 spread was low during the time period of our study with only 1191 cases nationally and 26 fatalities, our findings suggest that patients were potentially self-triaging rather than experiencing complications of COVID-19 that led to the higher complexity of visits. The reasons behind self-triage and ED avoidance as well as the impact of self-triage on population health need further exploration.

While the odds of patients presenting with coronary atherosclerosis, and cerebrovascular disease were found to be higher during the outbreak period, the absolute number difference demonstrates a drop in the number of cases (Fig. 2). This pattern is similar to what has been observed in other countries. For instance, in the US, ED visits decreased by 23% for myocardial infarction in the first 10 weeks of the pandemic [8]. A significant reduction in admissions for acute coronary syndrome was also noted in the beginning of the pandemic in each of Austria [9], England [10] and Italy [4]. Similarly, a decrease in the number of patients presenting for stroke was noted in the US [8], Italy [4], and Ontario, Canada [11]. While absolute numbers of emergent cardiovascular illnesses dropped, these drops were lower than those seen for other illnesses in general for which patients may choose to seek care at other venues or delay care. Thus, while cardiovascular illness seems to be less COVID-19 elastic than other illnesses, the absolute volume drops suggest some change in health seeking behavior, the long-term effects of which are yet to be determined.

With regards to infectious diseases, post-COVID-19 ED visits in our study were more likely to be secondary to bacterial infections such as urinary tract infections and sepsis, rather than communicable viral illnesses such as influenza. This pattern was also observed in the US and Italy, particularly amongst pediatric patients, during the first few weeks of the pandemic [2,6,19,20]. This observation is probably explained by the association of communicable disease with social interactions and schooling. In-person schooling in Lebanon was stopped on March 18, 2020 and remained remote for the duration of the period. This, along with other physical distancing measures and the general adherence of the public to masks and hand hygiene measures, that occurred aggressively and early in our setting, likely resulted in sudden drops of communicable disease, particularly influenza in spite of having the post-COVID-19 period coincide with the typical influenza season in

Lebanon [21]. This is further supported by the association of a significant drop in overall ED visits after closure of in-person educational institutions including schools and universities. The findings of our study may serve as a basis for future uptake of measures towards controlling the spread of communicable diseases such as influenza. For instance, routine face mask usage during influenza season in addition to physical distancing, strict hand hygiene and consideration of temporary transition to on-line learning may help with limiting hospitalizations and mortality during influenza season. The containment measures also likely resulted in a decrease in injury-related visits to our ED, as people's work and outdoor activities were being restricted by curfews between March 15 and March 29, 2020. A drop in trauma-related ED visits has been reported in Spain and Belgium [18], yet the change in the volume of trauma cases was not homogeneous amongst studies conducted in Italy [7,20]. These changes likely explain the significant drop in pediatric visits which are primarily driven by fever of unknown origin, external injuries, upper respiratory tract infections, open wounds, and abdominal pain [20]. ED Avoidance due to fear of contracting communicable disease may also be a contributor that we did not explore in our study.

Our findings add to the growing body of literature on changes in volume and characteristics of ED visits during COVID-19 pandemic and uniquely the impact of lockdown measures on ED visit volumes. The long-term impact of the COVID-19 pandemic on ED visits throughout the evolving outbreak phases and the public health measures remains unclear. Studies from Taiwan showed that after the 2003 SARS outbreak, EDs did not recover baseline volumes till 4 months in one hospital [22] and not before 2 years in a SARS-designated hospital in Taipei city [23]. Understanding the trends in ED visits amidst COVID-19 is important for ED managers in adjusting resources and personnel. At the same time, from a public health standpoint, lockdown and other public health measures for containment of communicable diseases is notable and can potentially mitigate the spread of communicable diseases outside of the COVID-19 pandemic for diseases such as influenza.

4.1. Limitations

This study has several limitations. It is a single-centered analysis of administrative ED visit data conducted in a tertiary care center ED in Beirut, the capital of Lebanon. Hence, while we cannot claim the generalizability to other EDs within Lebanon, AUBMC ED is one of the largest EDs in the country with a wide catchment area that includes patients from all governates. Another major limitation is that this study explores ED visit characteristics, and thus it may not reflect what is happening at the population level in terms of acute illness or mortality. Furthermore, this study did not assess reasons behind changes in ED visits and is limited to identifying associations. In particular, understanding whether the reasons behind ED volume drops are behavioral or related to true drops in disease prevalence remains unanswered by our study. Further studies that would examine the patient's perceptions of barriers to ED utilization during such outbreaks is essential for better understanding of the utilization patterns identified.

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Declaration of Competing Interest

There are no competing interests to declare.

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