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The impact of the COVID-19 pandemic on the utilization of emergency department services for the treatment of injuries

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ABSTRACT

Context: The global COVID-19 pandemic has had a major impact on the utilization of healthcare services; however, the impact on population-level emergency department (ED) utilization patterns for the treatment of acute injuries has not been fully characterized.

Objective: This study examined the frequency of North Carolina (NC) EDs visits for selected injury mechanisms during the first eleven months of the COVID-19 pandemic.

Methods: Data were obtained from the NC Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT), NC's legislatively mandated statewide syndromic surveillance system for the years 2019 and 2020. Frequencies of January – November 2020 NC ED visits were compared to frequencies of 2019 visits for selected injury mechanisms, classified according to International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM) injury diagnosis and mechanism codes.

Results: In 2020, the total number of injury-related visits declined by 19.5% ($N = 651,158$) as compared to 2019 ($N = 809,095$). Visits related to motor vehicle traffic crashes declined by a greater percentage (29%) and falls (19%) declined by a comparable percentage to total injury-related visits. Visits related to assault (15%) and self-harm (10%) declined by smaller percentages. Medication/drug overdose visits increased (10%), the only injury mechanism studied to increase during this period.

Conclusion: Both ED avoidance and decreased exposures may have contributed to these declines, creating implications for injury morbidity and mortality. Injury outcomes exacerbated by the pandemic should be addressed by timely public health responses.

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1. Introduction

On January 8, 2020, the Chinese Center for Disease Control and Prevention officially announced that a novel coronavirus, later named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), was the causative agent of a pneumonia of unknown etiology (COVID-19) that had been spreading in China since December 2019 [1,2]. As of

November 23, 2020, COVID-19 had spread from China to 221 countries, resulting in over 58 million confirmed cases and 1.4 million deaths [3].

The United States (US) had its first confirmed case of COVID-19 on January 29, 2020 [4]. As of November 23, 2020, the US had confirmed over 12 million cases and 255,000 fatalities, with all 50 States and the District of Columbia reporting cases and fatalities [5].

To reduce disease transmission and the burden on the US healthcare system, federal, state, and local social/physical distancing measures (i.e., “stay-at-home” orders) were implemented across the nation. These measures limited gathering sizes, closed schools and nonessential businesses, and encouraged residents to stay-at-home [6]. Evidence suggests that these measures, even heterogeneously implemented, reduced COVID-19 transmission [7].

The COVID-19 pandemic has had widespread direct effects on health and well-being of communities and indirect effects on policy, economics, and society. The impact on injury incidence and healthcare utilization has not been well-described at the population-level for a variety

Abbreviations: ED, emergency department; ICD-10-CM, International Classification of Diseases, 10th Revision, Clinical Modification; MVT, motor vehicle – traffic; NC, North Carolina; NC DETECT, North Carolina Disease Event Tracking and Epidemiologic Collection Tool; OD, overdose; Q, quarter; SARS-CoV-2, Severe Acute Respiratory Syndrome Coronavirus 2; US, United States.

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of unintentional and intentional injury mechanisms. We have used near-real time North Carolina (NC) emergency department (ED) visit data to enumerate injury-related ED visits during the 2020 pandemic and to compare the frequency of these ED visits to the corresponding period in 2019.

2. Methods

We collected aggregate ED visit data from the NC Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT), NC's statewide syndromic surveillance system. NC DETECT is legislatively mandated to collect data from all 24/7, acute care, hospital-affiliated, civilian EDs in the State. NC DETECT collects, harmonizes, cleans, monitors data quality, and implements standardized case definitions for surveillance use [8,9].

We obtained weekly counts of all ED visits from January to mid-November in 2019 and 2020 (12/30/2018–11/16/2019 and 12/29/2019–11/14/2020). In NC DETECT, all "weeks" start on a Sunday and end on a Saturday. We defined quarters by week numbers (1–13, 14–26, 27–39, and 40–52). Q4 data was only available through mid-November 2020 at time of publication, so the table comparisons constrain to that point for both years (see Table 1 footnote).

We examined the total number of ED visits and number of injury-related ED visits (presence of an International Classification of Diseases,

10th Revision, Clinical Modification [ICD-10-CM] injury diagnosis or mechanism code) using standard reporting functions available to authorized NC DETECT users. These case definitions are based on nationally standardized ICD-10-CM and keyword case definitions from the Center for Disease Control (CDC), Council of State and Territorial Epidemiologists (CSTE), and deep studies of the NC local context. The full list of the case definitions are available at <https://ncdetect.org/case-definitions/> [8].

We report total and cause-specific injuries (based on ICD-10-CM injury mechanism codes), including falls, motor vehicle traffic crashes (MVTs), medication/drug overdoses, assaults, and self-harm/suicide events.

We calculated count and percent changes in ED visit counts from 2019 to 2020. We assessed statistical significance of select trend and baseline changes after March 3, 2020, the date of the first reported NC case, by a Poisson distributed generalized linear model. All analyses were completed in RStudio® [9].

3. Results

Fig. 1 displays the weekly number of NC ED visits from January to mid-November in 2019 and 2020, with COVID-like-illness (CLI) ED visits and key pandemic milestones as reference. Table 1 enumerates these changes to total and mechanism-specific ED visits by quarter. Fig. 2 displays weekly mechanism-specific ED visit counts against a LOESS smooth line to aid visual interpretation.

The number of total NC ED visits in 2020 showed only a small reduction (−3%) compared to quarter 1 (January through March), moving from approximately 91,000 weekly visits in 2019 to 88,000 in 2020. That reduction began sharply in mid-March after the first NC case of COVID-19 was confirmed on March 3, 2020 [10]. A US National Emergency was declared soon after on March 13, 2020, followed by a NC Stay at Home order on March 30, 2020 [11,12]. Total ED visits dramatically declined in quarter 2, from approximately 96,000 weekly visits in 2019 to just 61,000 in 2020 (−36%). This decline in total ED visits rebounded some in Q3, from 92,000 weekly visits in 2020 to 78,000 in 2020 (−15%). At the time of publication in Q4 this reduction seems to be holding steady (−15%).

The total number of injury-related ED visit counts displayed a similar pattern to total ED visits counts, with declines of 5%, 35%, and 17% in quarters 1, 2, and 3, respectively. There was, however, considerable variation across injury intents and mechanisms.

Among unintentional injury mechanisms, falling-related NC ED visits displayed similar trends to total ED and injury-related ED visit counts. The percent decrease for the number of MVT-related NC ED visits far exceeded other injury intents and mechanisms, declining 16%, 48%, and 22% in quarters 1, 2, and 3. The decline in transportation injury-related ED visits was not universal across modes, e.g., NC bicycle crash-related ED visits increased by nearly 10% during the months of March–April 2020 vs 2019 (data not displayed). Contrasting other injury mechanisms, the number of monthly unintentional medication/drug overdose-related NC ED visits was unchanged in quarter 1 (+0.6%) and increased in quarter 2 (+6%) and quarter 3 (+19%). In quarter 3 this represented an additional 57 medication/drug overdose-related ED visits each week compared to 2019. A test for increased baseline found this post-COVID-19 increase statistically significant for medication/drug overdose ($p < 0.0001$) and increased trend during 2020 for all injury, falls, MVT, and self-harm / suicide ($p < 0.0001$).

For intentional injury mechanisms, assaults followed similar trends to total NC ED and injury-related ED visits. Conversely, ED visits related to self-harm/suicide did not experience as substantial a decline as most other injury mechanisms in quarter 2 (−26% for self-harm vs. −35% for all injury-related ED visits) and has nearly recovered to 2019 levels in quarter 3 and quarter 4 to date (−3%).

Table 1
Comparison of North Carolina emergency department visits for selected injury mechanisms, by quarter, 2020 vs. 2019

Selected measure/ injury mechanism	2019		2020		Percent change %
	N	Weekly average	N	Weekly average	
All ED visits	4,272,512	92,881	3,506,396	76,226	−17.9%
Q1	1,179,038	90,695	1,146,352	88,181	−2.8%
Q2	1,246,777	95,906	792,547	60,965	−36.4%
Q3	1,197,224	92,094	1,015,472	78,113	−15.2%
Q4 ^a	649,473	92,782	552,025	78,861	−15.0%
Injury-related ED visits	809,095	17,589	651,158	14,156	−19.5%
Q1	190,127	14,625	181,383	13,953	−4.6%
Q2	245,215	18,863	160,307	12,331	−34.6%
Q3	247,168	19,013	204,599	15,738	−17.2%
Q4 ^a	126,585	18,084	104,869	14,981	−17.2%
Falls	193,572	4208	157,180	3417	−18.8%
Q1	49,762	3828	45,911	3532	−7.7%
Q2	57,270	4405	38,717	2978	−32.4%
Q3	56,924	4379	47,262	3636	−17.0%
Q4 ^a	29,616	4231	25,290	3613	−14.6%
MVTs	74,101	1611	52,874	1149	−28.6%
Q1	19,318	1486	16,291	1253	−15.7%
Q2	22,308	1716	11,573	890	−48.1%
Q3	20,704	1593	16,105	1239	−22.2%
Q4 ^a	11,771	1682	8905	1272	−24.3%
Medication/Drug ODs	13,454	292	14,762	321	9.7%
Q1	3450	265	3469	267	0.6%
Q2	4176	321	4430	341	6.1%
Q3	3861	297	4601	354	19.2%
Q4 ^a	1967	281	2262	323	15.0%
Assault	24,805	539	21,053	458	−15.1%
Q1	6054	466	5585	430	−7.7%
Q2	7579	583	5598	431	−26.1%
Q3	7466	574	6690	515	−10.4%
Q4 ^a	3706	529	3180	454	−14.2%
Self-harm/Suicide	10,626	231	9520	207	−10.4%
Q1	2855	220	2682	206	−6.1%
Q2	3167	244	2352	181	−25.7%
Q3	2964	228	2888	222	−2.6%
Q4 ^a	1640	234	1598	228	−2.6%

^a Q4 is only through 11/16/2019 and 11/14/2020. Total ED visits in 2019 is also constrained to this same period for comparison to 2020 visits to date. Abbreviations: ED = emergency department; MVT = motor vehicle traffic; OD = overdose; Q = Quarter.

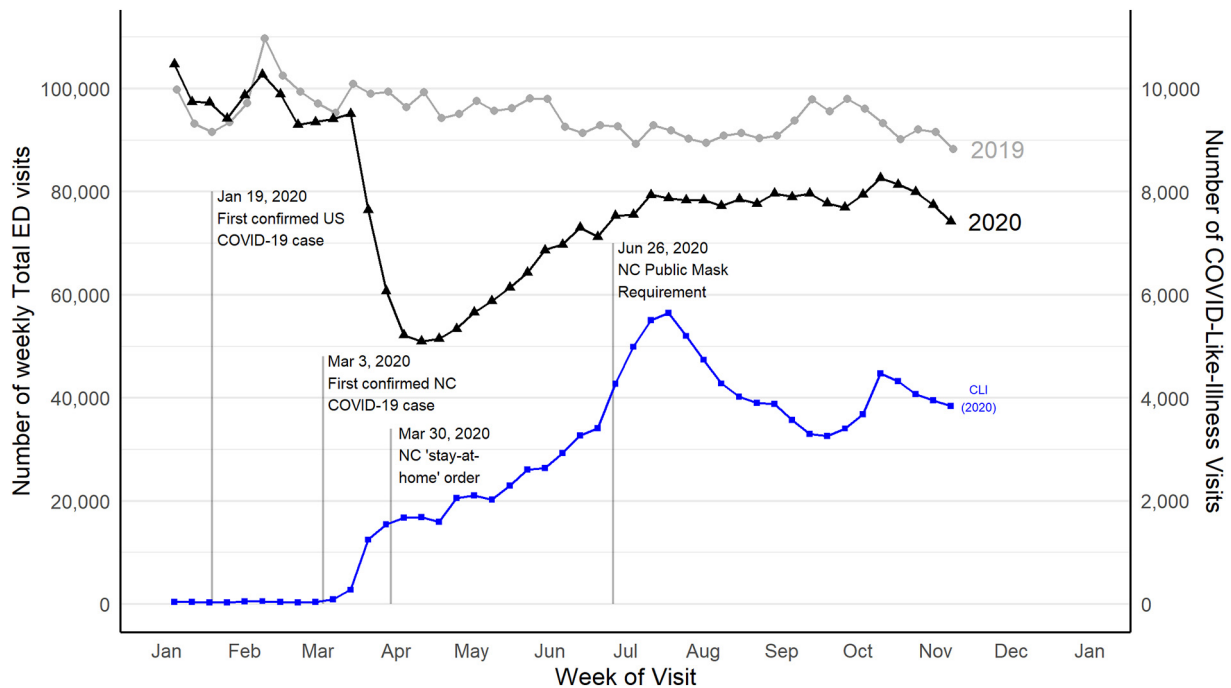


Fig. 1. Total number of weekly North Carolina emergency department (ED) visits vs. COVID-Like Illness ED visits, with key dates related to the spread and control of COVID-19 in the United States and North Carolina: January to mid-November 2019 & 2020. CLI visits are visually inflated by a factor of 10 on second axis for ease of interpretation. Abbreviations: US = United States; NC = North Carolina; ED = emergency department; CLI = COVID-Like Illness; Jan = January; Feb = February; Mar = March; Apr = April; Jun = June; Jul = July; Aug = August; Sep = September; Oct = October; Nov = November; Dec = December.

These are all novel changes. As an example, no prior year (2016 through 2018) compared to 2019 was more than 1.7% different for all injury and 1.4% different for total ED visits (compared to -19% and -18% for 2020 vs. 2019, respectively).

4. Discussion

Consistent with national estimates, from January to mid-November 2020 the total number of NC ED and injury-related ED visits decreased by 18% and 20%, respectively, following enactment of federal, state, and local policies aimed at reducing COVID-19 transmission [13]. The largest decline in NC injury-related ED visit counts was observed in quarter 2, with the number of visits in April 2020 nearly half that of 2019. Considerable variation by injury mechanism was observed, including greater reductions in MVT visits, lower reductions in self-harm visits, and significant increases in medication/drug overdose-related visits.

Several explanations for the observed decline in NC injury-related ED visits are possible. For certain injury mechanisms, the reduction in ED visits may be related to decreases in exposure, with more people staying home and avoiding activities that may result in injury. For example, reductions in MVT ED visits trend with US traffic volumes declining 30%–50% during this period [14].

Another likely contributor to the drop in ED visits is patient anxiety about contracting the SARS-CoV-2 virus while receiving healthcare. Patient ED avoidance for the treatment of minor injuries reduces hospital transmission of COVID-19 and frees up limited healthcare resources for treating more severely ill and injured patients (including patients with COVID-19). However, patients delaying or avoiding medical treatment risk exacerbating injury morbidity and mortality (e.g., wound infections). In New York City, there were 5293 excess deaths during the COVID-19 pandemic that were not confirmed or suspected COVID-19 cases, many assumed to be consequences of delaying medical care for serious medical conditions [15]. Recent evidence supports this conclusion, as national ED visit counts

have decreased by more than 20% for life-threatening conditions, including myocardial infarction and stroke [16].

Not all injury mechanisms experienced large declines in ED visit counts during the COVID-19 pandemic. NC ED visits related to drug overdoses increased and self-harm visits decreased less sharply than for other injury mechanisms. Similar trends have been observed using national syndromic surveillance data [17]. These trends may be related to the exacerbation of substance use, anxiety and stress-related disorders during the pandemic [18–21]. It is vital that resources are allocated to tackle the pandemic's effect on mental health, substance use, and violence.

Finally, the absence of injury-related ED visits does not guarantee the absence of injury. While ED visits are often used as proxies for injury incidence, these data may be uniquely insufficient during pandemics that reduce healthcare-seeking behavior. Individuals avoiding healthcare for safety concerns has serious injury surveillance implications.

4.1. Limitations

NC DETECT ED visit data are collected primarily for patient care and hospital administrative/billing purposes. Public health surveillance is a secondary function. While NC population-based ED visit data have many benefits and results may mirror other geographies, results may not be generalizable to all US jurisdictions. Other data sources (EMS, poison center, deaths) may also yield invaluable insights.

5. Conclusion

The COVID-19 pandemic has had a substantial impact on ED utilization patterns for the treatment of injuries, with NC injury-related ED visits declining an average of 20% since January 2020. Possible explanations include a decrease in exposure to certain factors, such as road traffic volume, and reductions in ED utilization and healthcare seeking behavior related to anxiety about contracting

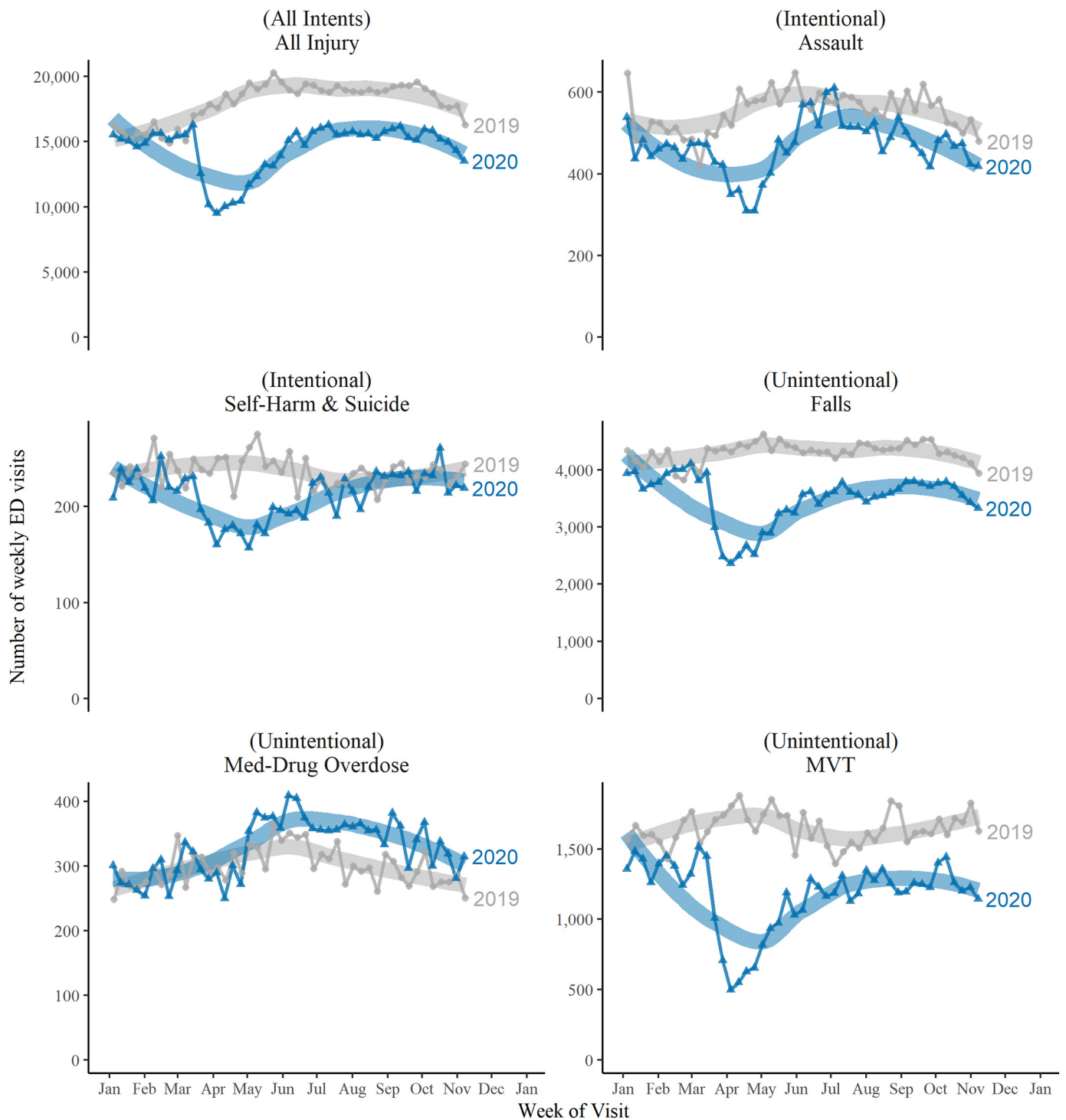


Fig. 2. Weekly North Carolina emergency department visits for selected leading causes of intentional and unintentional injuries: counts and LOESS smooth lines, January–November 2019 & 2020. Abbreviations: ED, emergency department; Jan = January; Feb = February; Mar = March; Apr = April; Jun = June; Jul = July; Aug = August; Sep = September; Oct = October; Nov = November; Dec = December.

the SARS-CoV-2 virus. Reductions in care-seeking behavior imply that current ED visit counts may underestimate total injuries more than usual. Social, economic, and other pandemic-related stressors may lead to increases in certain injury outcomes, causing increases in overdoses and proportionally smaller reductions in self-harm visits. Federal, state, and local governments should implement timely programs and policies to address injury outcomes exacerbated by the pandemic.

Data attribution and disclaimer

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validity or accuracy of methodology, results, statistical analyses, or conclusions presented.

Credit author statement

Katherine Harmon: Conceptualization, Project administration, Methodology, Writing – Original draft preparation. **Mike Dolan Fliss:** Data curation, Methodology, Visualization, Software, Writing – Original draft preparation. **Steve Marshall:** Conceptualization, Writing – review & editing. **Kathy Peticolas:** Project administration, Writing – review & editing. **Scott Proescholdbell:** Conceptualization, Writing – review & editing. **Anna Waller:** Supervision, Conceptualization, Writing – Original draft preparation.

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Competing interests

None declared.

Ethics approval

This study was reviewed and approved by the Institutional Review Board at the University of North Carolina at Chapel Hill. This study was also reviewed and approved by the North Carolina Division of Public Health.

Data statement

The data used in this study contain protected health information and are not available for posting.

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References

- [1] Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *N Engl J Med.* 2020;382:1199–207. <https://doi.org/10.1056/NEJMoa2001316>.
- [2] Coronaviridae Study Group of the International Committee on Taxonomy of Viruses. The species severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2. *Nat Microbiol.* 2020;5:536–44. <https://doi.org/10.1038/s41564-020-0695-z>.
- [3] World Health Organization. Coronavirus Disease (COVID-19) Dashboard. <https://covid19.who.int/>; 2020. (accessed November 23, 2020).
- [4] Holshue ML, DeBolt C, Lindquist S, Lofy KH, Wiesman J, Bruce H, et al. First case of 2019 novel coronavirus in the United States. *N Engl J Med.* 2020;382:929–36. <https://doi.org/10.1056/NEJMoa2001191>.
- [5] Centers for Disease Control and Prevention. Cases in the U.S. Coronavirus Disease 2019 (COVID-19). <https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html>; 2020. (accessed November 23, 2020).
- [6] Kaiser Family Foundation. State Data and Policy Actions to Address Coronavirus 2020. <https://www.kff.org/health-costs/issue-brief/state-data-and-policy-actions-to-address-coronavirus/>. [Accessed 20 May 2020].
- [7] Lasry A, Kidder D, Hast M, Poovey J, Sunshine G, Winglee K, et al. Timing of community mitigation and changes in reported COVID-19 and community mobility - Four U.S. metropolitan areas, February 26–April 1, 2020. *MMWR Morb Mortal Wkly Rep.* 2020;69:451–7. <https://doi.org/10.15585/mmwr.mm6915e2>.
- [8] Carolina Center for Health Informatics, University of North Carolina at Chapel Hill. NC DETECT 2020. <https://ncdetect.org/>; 2020. (accessed May 19, 2020).
- [9] [dataset] North Carolina Division of Public Health, Carolina Center for Health Informatics. [Data file] North Carolina Disease Event Tracking and Epidemiologic Collection Tool Emergency Department Data, 2019–2020. NC DETECT. <https://ncdetect.org/>; 2020.
- [10] R Core Team. R: The R Project for Statistical Computing. <https://www.r-project.org/>; 2020. (accessed November 23, 2020).
- [11] North Carolina Department of Health and Human Services. North Carolina Identifies First Case of COVID-19 2020. <https://www.ncdhhs.gov/news/press-releases/north-carolina-identifies-first-case-covid-19>; 2020. (accessed May 26, 2020).
- [12] North Carolina Department of Health and Human Services. Governor Cooper Announces Statewide Stay at Home Order Until April 29, 2020. <https://www.ncdhhs.gov/news/press-releases/governor-cooper-announces-statewide-stay-home-order-until-april-29>; 2020. (accessed May 26, 2020).
- [13] The Whitehouse. Proclamation on Declaring a National Emergency Concerning the Novel Coronavirus Disease (COVID-19) Outbreak. <https://www.whitehouse.gov/proclamations/proclamation-declaring-national-emergency-concerning-novel-coronavirus-disease-covid-19-outbreak/>; 2020. (accessed May 26, 2020).
- [14] Hartnett KP, Kite-Powell A, DeVies J, Coletta MA, Boehmer TK, Adjemian J, et al. Impact of the COVID-19 pandemic on emergency department visits - United States, January 1, 2019–May 30, 2020. *MMWR Morb Mortal Wkly Rep.* 2020;69:699–704. <https://doi.org/10.15585/mmwr.mm6923e1>.
- [15] Institute of Transportation Engineers. COVID-19 Traffic Volume Trends. <https://www.ite.org/about-ite/covid-19-resources/covid-19-traffic-volume-trends/>; 2020. (accessed July 1, 2020).
- [16] New York City Department of Health and Mental Hygiene (DOHMH) COVID-19 Response Team. Preliminary estimate of excess mortality during the COVID-19 outbreak - New York City, March 11–May 2, 2020. *MMWR Morb Mortal Wkly Rep.* 2020;69:603–5. <https://doi.org/10.15585/mmwr.mm6919e5>.
- [17] Lange SJ, Ritchey MD, Goodman AB, Dias T, Twentyman E, Fuld J, et al. Potential indirect effects of the COVID-19 pandemic on use of emergency departments for acute life-threatening conditions - United States, January–May 2020. *MMWR Morb Mortal Wkly Rep.* 2020;69:795–800. <https://doi.org/10.15585/mmwr.mm6925e2>.
- [18] Holland KM, Jones C, Vivolo-Kantor AM, Idaikkadar N, Zwald M, Hoots B, et al. Trends in US emergency department visits for mental health, overdose, and violence outcomes before and during the COVID-19 pandemic. *JAMA Psychiat.* 2021. <https://doi.org/10.1001/jamapsychiatry.2020.4402>.
- [19] Horesh D, Brown AD. Traumatic stress in the age of COVID-19: a call to close critical gaps and adapt to new realities. *Psychol Trauma.* 2020;12:331–5. <https://doi.org/10.1037/tra0000592>.
- [20] Czeisler MÉ, Lane RI, Petrosky E, Wiley JF, Christensen A, Njai R, et al. Mental Health, Substance use, and suicidal ideation during the COVID-19 pandemic - United States, June 24–30, 2020. *MMWR Morb Mortal Wkly Rep.* 2020;69:1049–57. <https://doi.org/10.15585/mmwr.mm6932a1>.
- [21] Ornell F, Moura HF, Scherer JN, Pechansky F, Kessler FHP, von Diemen L. The COVID-19 pandemic and its impact on substance use: implications for prevention and treatment. *Psychiatry Res.* 2020;289:113096. <https://doi.org/10.1016/j.psychres.2020.113096>.