**Effects of 2019’s Social Protests on Emergency Health Services Utilization and Case Severity in Santiago, Chile**

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# **Abstract**

Background: On October 18th, 2019, protestors gathered across Chile to call for social equality. The government responded by declaring a state of emergency and deploying the Chilean army and police, who utilized anti-riot shotguns and tear gas as a means of crowd control.

Aim: To quantify the effects of the October 2019 Chilean protests on emergency health services utilization and inpatient admission rates in public hospitals near the protest focal point in Santiago, Chile.

Methods: We used an interrupted time series analysis of aggregated weekly emergency department (ED) admissions (2015-2019). Data from three public hospitals located 3 km around the point of the main protest in Santiago, Chile. The exposure period was defined as the onset of social protests on October 18 to December 31, 2019. The number of weekly consultations and hospitalizations by trauma and respiratory causes, together with the rate of hospitalizations by 1,000 ED consultations, were the outcomes. We implemented Bayesian structural time series (*BSTS*) models to calculate absolute and relative differences between the observed outcomes and the counterfactual and their credible intervals (CrI).

Results: 148,141 ED consultations and 15,500 hospitalizations were observed in 2019. Health services utilization, assessed by ED consultations, were not affected by the social protests. In contrast, after social movement onset, trauma hospitalizations increased by 16% (95% CrI: 2.75, 29.82), and the proportion of hospitalizations by ED consultations increased by 38% for trauma (95% CrI: 9.16, 65.07) and 63% for respiratory causes (95% CrI: 31.15, 96.13).

Conclusion: Social movements affects population health. The October 2019 Chilean protest did not affect ED services utilization; however, a higher severity was observed at the ED presentation. Crowd-control protocols must be reviewed to avoid adverse effects on population health.

# **Introduction**

Throughout history, the world has continually witnessed social movements and civil unrest on the local, national, and global levels [1, 2]. Social movements are defined as organized efforts by a group (or groups) of people working toward a common goal [3, 4]. During a movement, participants may intentionally cause a public disturbance that violates the law, an act known as civil unrest [5]. In Chile in October of 2019, metro fare increase of 30 pesos (about USD 0.04) triggered protests that quickly began to encompass concerns stemming from historical injustices and social inequality. Protestors called for structural changes related to wealth distribution, rising costs of living, stagnant wages, access to and quality of basic public services (health, education, transport, and justice systems), and retirement pensions, among others [6-9]. Despite a lack of organized leadership, this social movement featured high attendance rates and strong national support. However, civil unrest occurred collaterally with the social protests, which led the government to declare a state of emergency characterized by restricted mobility, a curfew, and the deployment of armed soldiers and policemen to control street disturbances [10, 11].

Social movements have direct and indirect effects on health. Much of the current research linking social movements and health have focused on indirect effects of protest, demonstrations, and civil unrest. For instance, civil unrest and violence often expose people to stress, contributing to mental health burden [12-14]. Similarly, the shutdown of city streets, disruption of public transportation, and damage to public and private infrastructure could affect health services utilization by restricting patient access [15-17]. Emergency department (ED) consultations are heavily influenced by barriers to access [18-20] and serve as a measure of health services utilization.

Other mechanisms likely influence ED visits during civil unrest. Crowd control techniques such as pellet guns, tear gas, and other chemical irritants have been shown to have adverse effects on individual health, and the way these are used can impact the overall rate of ED consultations [21]. Rubber bullets have been cited for causing eye injuries, lacerations, contusions, and hematoma [22-25]. Burns and physical blows from batons, bottles, bricks, boots, and other objects also account for physical injury during protests [21, 24]. The use of tear gases —a subset of riot control agents that cause tears, eye pain, and difficulty keeping the eyes open— has been associated with short and long-term effects on the respiratory system [17, 21, 25-28][13, 18]. Thus, the more immediate and direct exposure consequences of crowd control techniques are dermatological (e.g., irritation, dermatitis, skin rashes), traumatological (injuries and disabilities), and respiratory (e.g., dyspnea, coughing, choking, and chest tightness) [29, 30][30].

However, data about the effects of social movements on health came mainly from case studies with a small sample size. To our knowledge, it has not yet been studied whether social movements and crowd control during civil unrest affects the admission rate or severity of the injury and respiratory cases at the population level.

We aimed to quantify the effects of the October 2019 Chilean protests and crowd-control techniques on emergency health system services utilization and inpatient admission rates in three large public hospitals near to the protest's focal point in Santiago.

# **Methods**

*Design and cases*

We used an interrupted time series analysis of aggregated weekly hospital ED admissions. The total daily emergency admission data of three major public hospitals in Santiago was gathered from 2015 to 2019 for both consultations and hospitalizations and aggregated into a weekly basis. The data was then refined to isolate cases from ages 15-64 (because most protesters were within this age range [21]), and cases were defined according to their primary cause of admission.

Chile’s capital, Santiago, was one of the most affected areas by the social protests in 2019, particularly around the historic focal point of social protest known as “Plaza Baquedano”, “Plaza Italia”, and more recently, “Plaza dignidad”. We included cases from tertiary public hospitals located within 3 kilometers of this focal point (Hospital de Urgencia Asistencia Pública, Hospital Del Salvador de Santiago, and Complejo Hospitalario San José). Two of these hospitals were within 1 kilometer of the “Plaza”.

*Data acquisition*

The data was obtained through the Chilean Department of Health Information and Statistics, which collects daily ED consultation and hospitalization from public health centers. Information from ED medical forms is used to obtain the consultation date, patient’s age, ICD-10 diagnosis at ED discharge, and hospital admission needing. Data is anonymized and tabulated by each center and reported to the Ministry of Health. The dataset is freely available on the web (http://www.deis.cl).

*Exposure, outcomes and covariates*

We defined the exposure period as the onset of social protests on October 18 to December 31, 2019. Because of the format of the data, we set the exposure period from October 21, 2019 (week number 43, according to ISO-8601). The pre-exposure period was from January 2015 to October 20, 2019.

We used two primary outcomes. Health services utilization was measured as the weekly counts of ED consultations and hospitalizations for trauma and respiratory causes. We also looked at the rate of hospitalizations for each cause among people admitted for the same causes per 1,000.

Also, we included the circulatory system causes as a control trend, assuming that most of these ED admissions were not directly related to most of the immediate consequences to health in users. This covariate isolates the effects related to confounding changes due to difficulties to access to health facilities.

*Statistics*

To evaluate the effect of social protests on ED service utilization, we used Bayesian structural time series (*BSTS*) models [31] implemented using the *CausalImpact* R package [32]. This approach compares the observed trend of consultations and hospitalizations after the event, with an estimated average trend under a hypothetical scenario in which social protests did not occur (i.e., the counterfactual) [33]. The estimated effect is then the difference between the counterfactual and the observed number of consultations and hospitalizations after the social protest of October 18, 2019.

This method allows flexibility in the inference of counterfactuals, temporal evolution, and incremental attributable impact. Its estimations are achieved by incorporating features such as level, trends, seasonality and regression to capture the time series dynamics [34].

We predefined additive monthly and yearly seasonal components. After estimating several models with different specifications, we selected those with lower cumulative absolute one step ahead errors. The selected models assumed a studentized distributed noise, robust against outliers and shocks, plus a random-walk that does not rely on an observable pattern or trend drift and adapts to local variation, making it desirable when constructing short-term predictions [35].

The point effects of social protest and its 95% credible interval were generated due to the difference between the estimated forecasts and the observed trend across each 30,000 Markov Chain Monte Carlo (MCMC) iterations [31, 36, 37]. The tail-area probability is the probability under the calculated posterior that the response is at least as extreme (away from the expected value) as the observed one [38]. Further details about the modeling approach and statistics are mostly described in the supplemental material.

Additionally, we performed a sensitivity analysis using historical controls from 2015 to 2018 (i.e., we used the same outcomes, for the same period of the year, but in years without the exposure (2015-2018). This was done through a traditional difference-in-differences analysis with fixed-effects, similar to what was done in other articles that used this approach [39]. One distinction is that our inferences were computed using robust standard errors to account for heteroscedasticity and autocorrelation [40].

All analyses and graphics defined above were completed using R v 4.0.2. Sensitivity analyses were determined using the *xtscc* command [41] in Stata 16 [42].

# **Results**

A total of 148,141 ED consultations with 15,500 hospital admissions of ages between 15-65 were registered throughout 2019 in the three hospitals under study. Median weekly consultations and hospitalizations were 2,847 and 300, respectively. 19% of consultations and 19% of hospital admissions of the year occurred in the exposure period. More information about yearly outcomes is available in Table 1.

The weekly number of consultations and hospitalization by trauma and respiratory causes are shown in Figure 1, and specific seasonality patterns are observed for each cause. Differences between model predictions and the observed data in the pre and post-October protests are graphed in Figure 2. It is possible to note that model predictions fit the pre-exposure data for all the outcomes (Figure 2).

The effect of October's Social movement and crowd-control techniques on ED consultations and hospitalizations are displayed in Table 2 and Figure 2. Whereas weekly trauma consultations did not vary after social protests began, trauma hospitalizations increased by 16% (95% CrI: 2.75, 29.82; p= 0.010). Consequently, trauma hospitalizations per 1,000 consultations were 38% higher than predicted (95% CrI: 9.16, 65.07; p= 0.007). On the other hand, both weekly consultations by respiratory causes (95% CrI: -93.62, 12.57; p= 0.066) and respiratory hospitalizations (95% CrI: -54.70, 24.42; p= 0.218) remained essentially unchanged, although consultations shown increases while hospitalizations shown slight but nonsignificant decreases. However, respiratory hospitalizations per 1,000 consultations were 63% higher (95% CrI: 31.15, 96.13; p < 0.001). Cumulative differences for all the outcomes are shown in Figure 3.



Sensitivity analysis showed that trauma hospitalizations increased 8% but overlapping with null changes (95% CI: -5.49, 22.11). Respiratory Hospitalizations showed low and non-significant reductions of 3%, similar to the Bayesian approach (95% CI: -24.12, 17.93). Trauma and Respiratory Consultations, however, showed significant decreases of 13% (95% CI: -22.05, 3.51) and 32% (95% CI: -51.52, -12.07), respectively, that we did not find in the Bayesian approach. Nonetheless, Trauma and Respiratory Hospitalizations per Consultations showed significant increases of 32% (95% CI: 16.97, 47.15) and 53% (95% CI: 28.21, 77.64), similar to the Bayesian approach in terms of significance, direction, and magnitude.

# **Discussion**

Social movements resulting in civil unrest are far from being a Chilean or even a Latin American issue. Recent demonstrations have occurred for different reasons in countries such as Italy, France, Hong Kong, Syria, Colombia, Bolivia, Ecuador, Peru and the U.S. Furthermore, they are expected to expand due to the crisis derived from COVID-19 [43, 44];. For example, the recent killing of George Floyd in Minneapolis, Minnesota, triggered unrests in the U.S. and abroad. As in Chile, most of these protests resulted in the widespread use of anti-riot shotguns and tear gas as means of crowd control. The medical and public health community have raised concerns about the indiscriminate use of these methods and the potential harm to those involved in confrontation and surrounding areas (CITE AJPH and Lancet letters/editorials)[10, 16].

In this study, we aimed to quantify the effects of social protest and crowd-control techniques on population health, looking at the Chilean case. Our findings suggest that following the onset of the Chilean social movement on October 18, 2019, no effect was observed on ED services utilization; however, the severity of trauma and respiratory cases increased. Whereas trauma and respiratory consultations did not present statistical differences before and after the social movement onset, weekly trauma hospitalization increased. Also, the proportion of hospitalization per 1,000 trauma/respiratory ED consultations increased in the period with civil unrest. We estimated that hospitalization per ED trauma consultations was 38% higher than expected if the protests and crowd-control were not happened, reaching up to 63% in the case of respiratory causes. Inconsistencies between main and sensitivity analyses could be interpreted in light of the advantages of the Bayesian approach. Must take into account that the BSTS model could be better in capturing components such as growth and seasonality, providing more flexibility of the estimates over a time series than DiDs, even choosing the better term for capturing the effect of the month on changes in the outcomes. However, a studentized distribution of errors and a prior standard deviation of .1 adds a stringent criterion that can ignore the confusion resulting from cyclicity or other sources of noise in the time series and avoid over-optimistic inferences [31, 34].

Health services utilization, assessed by ED consultations, were not affected by the social movement. We hypothesized that during this protest period, individuals with non-severe or life-threatening emergencies who would generally visit emergency services might reasonably avoid these hospitals [15]; nevertheless, incident cases could also occur because of confrontations and mass-control. Although our results did not show any statistical effect on the number of ED consultations (Table 1), the absolute effect occurred in the expected direction (Figures 2 and 3). During confrontations observed between some civilians and policemen/soldiers, most minor and mild injuries were treated on-site by health professional volunteering, possibly decompressing ED from mild or non-life-threatening problems [9]. Also, as public transportation was significantly disrupted throughout the time of the protests, prospective patients may not have even been able to make it to these hospitals to receive care. Thus, even though severe cases increase, the effect on ED utilization seems to have been balanced by a lower or similar number of non-severe cases after the social movement onset.

In contrast, patients were presented with greater severity at ED after October 18 protests began. We observed more patients admitted by trauma and also more patients needing hospitalization by 1,000 trauma and respiratory consultations (Table2, Figure 2-3). It is likely that increases in violence during the social protests and widespread use of crowd control methods by the police and soldiers resulted in a larger number of severely injured patients requiring hospitalization [REF]. This is consistent with a previous study that evidenced an increment in severe ocular trauma by kinetic impact projectiles during this period [21] . However, our findings mildly relate to another previous study, which only observed increased levels of trauma but limited increase (peak) at the beginning of the social crisis, and no differences than in 2018 [45]. However, other explanations cannot be rejected at this point. For example, these shifts may also be due to a similar reason as the reduction in emergency services utilization. Patients may be avoiding care they need to resolve minor health issues, but in turn, the health issues become worse until the patient must be hospitalized with what is now a severe medical case [REF]. Anyway, whether the observed increase in disease severity was by crowd-control techniques in confrontations or by a later consultation, our sensitivity analysis confirmed changes in these numbers.

*Implications*

This study's results should be seen as a first step in better understanding the broader health effects of largescale social protests, like the Chilean protests, but may have several implications moving forward. First, our robust statistical approach provides health services with crucial information during times of civil unrest, making it useful to estimate the change in ED consultation patterns by trauma and respiratory causes, supporting decisions for resource reallocation. Second, and most importantly, this research should contribute as evidence to advocate for and advise policy change regarding law enforcement responses to civil unrest: authorities in Chile and worldwide must act now to reduce the broader negative health effects of social protests. This is the first study that provides epidemiological evidence that social movements negatively affect population health, and we hope it was the last.

*Limitations*

There were several limitations during the course of this study. The first and perhaps most crucial limitation was the difficulty in obtaining hospital data from private institutions near the focal point of the protests. Although more than 80% of the Chilean population have public health insurance [46] and likely use the public health system, there would be a fraction of the potential cases that could not be captured in our study. In addition, the degree of detail of emergency data in Chile is far from being ideal. We were only able to use the primary cause of admission; thus, contributory causes were not explored in the study. Finally, causes of admission were grouped in broad categories such as trauma or respiratory, but not in the specific code at admission. Nevertheless, our sensitivity analysis strength our results and conclusions.

# **Conclusions**

This is the first study that probes the effects of a social movement on population health. October 2019 Chilean protests and crowd-control techniques did not affect emergency health system services utilization by trauma and respiratory causes; however, greater severity of patients admitted at ED was observed after social movement onset. It is necessary to implement policy changes regarding law enforcement action on civil unrest in order to avoid the adverse effects of social protests on population health.

# **Figures and Tables**

**Figure 1.** Trends of emergency department consultations and hospitalizations (2015-2019)

Imagen que contiene Calendario

Descripción generada automáticamente

Figure 2. Differences between model predictions and observed outcomes in the pre and post-exposure periods

Imagen que contiene Gráfico

Descripción generada automáticamente

Figure 3. Cummulative difference between expected and observed outcomes

Gráfico

Descripción generada automáticamente

Table 1. Summary descriptive table of Hospitalizations and Consultations, Pre-Civil Unrest vs. Post-Civil Unrest

|  |  |  |
| --- | --- | --- |
|  | **Previous to Civil Unrest** | **Civil Unrest** |
|  | *N=252* | *N=10* |
| Total Consultations | 3137 [2924;3361] | 2854 [2754;2898] |
| Trauma Consultations | 802 [728;888] | 786 [752;801] |
| Respiratory Consultations | 143 [120;183] | 96.0 [77.5;103] |
| Circulatory Consultations | 102 [87.0;125] | 90.5 [87.5;95.8] |
| Total Hospitalizations | 288 [268;311] | 298 [281;332] |
| Trauma Hospitalizations | 60.0 [52.0;67.0] | 81.5 [77.5;89.8] |
| Respiratory Hospitalizations | 19.5 [15.0;23.2] | 22.0 [15.5;24.0] |
| Circulatory Hospitalizations | 29.0 [23.0;36.0] | 35.5 [30.5;42.0] |
| Rate of Trauma Hospitalizations per Trauma Consultations (x1,000 population) | 73.0 [64.0;86.2] | 102 [84.2;113] |
| Respiratory Hospitalizations per Respiratory Consultations (x1,000 population) | 131 [107;160] | 233 [189;270] |

Note. Median, and percentiles 25 and 75 in brackets. Total weeks (n=262).

Table 2. Estimated effects of October social movement on the outcomes of interest a

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Outcome of Interest | Average Effect | Credible Interval | P-Value | Relative Effect (%) | Credible Interval (%) |
| Trauma Hospitalizationsb | 11.30 | 1.92, 20.91 | 0.010 | 16.11 | 2.75, 29.82 |
| Respiratory Hospitalizationsb | -3.73 | -13.25, 5.92 | 0.218 | -15.38 | -54.70, 24.42 |
| Trauma Consultationsc | -99.00 | -357.47, 160.75 | 0.220 | -10.93 | -39.46, 17.74 |
| Respiratory Consultationsc | -63.27 | -144.80, 19.45 | 0.066 | -40.91 | -93.62, 12.57 |
| Trauma Hospitalizations per Trauma Consultations (x 1,000 population)d | 28.06 | 6.77, 48.13 | 0.007 | 37.93 | 9.16, 65.07 |
| Respiratory Hospitalizations per Respiratory Consultations (x 1,000 population)d | 88.98 | 44.13, 136.20 | <0.001 | 62.80 | 31.15, 96.13 |

a Each model had a structure of studentized distribution of errors, and a conservative prior standard deviation of .1

bModels also included circulatory hospitalizations as a control variable.

cModels also included circulatory consultations as a control variable.

dModels also included the proportion of circulatory hospitalizations of circulatory consultations (x 1,000 population) as a control variable.

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