**Supplementary material**

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

**Supplemental Table 1. Dates of highlighted protest and/or larger social unrest**

|  |  |  |  |
| --- | --- | --- | --- |
| **Date** | **Event** | **Estimated participants** | **Source** |
| October 07 | Instituto Nacional’s secondary students evade subway (“Metro”) access without pay tickets. Students began to protest in small groups at metro stations the following days. | 80 | 1,2 |
| October 14 | More secondary and undergraduate students follow Metro fare hikes. Hundreds of high school and university students evade Metro fares in six stations. | 300 | 3 |
| October 18 | Mass protests began (rioting, looting, attacks on almost all 164 metro stations) in Santiago and major cities in Chile. | Thousands | 4,5 |
| October 19-24 | Massive demonstrations occur throughout the country. Stores and buildings were looted and/or burned. A state of emergency is proclaimed in Santiago and then to other major cities: military and police were deployed; curfew is declared. | Thousands | 6-14 |
| October 25 | Largest peaceful march across “Plaza Italia” took place in Santiago. Substantial demonstrations also occurred throughout the country. | 1.200.000 in Santiago | 15,16 |
| November | Demonstrations continue in Santiago, with a major focus around “Plaza Italia” each weekend. Many severe civil injuries, ocular loss, and deaths occurred. Gustavo Gatica, a 21-year-old student, lost complete eyesight after being shot by rubber bullets by police. Human Rights organizations condemned the events. Civil unrest, lootings, and fires continued. | Unknown (probably thousands) | 17-26 |
| December 4 | “Las Tesis” feminist protest is peacefully conducted at the national stadium in Santiago. “A rapist in your path” is replicated worldwide | About 10.000 | 27-30 |
| December | Civil unrest continued, concentrated in Plaza Dignidad and downtown Santiago. | Unknown (probably thousands) | 31-35 |

**Note.** A more detailed timeline of historical events, including political and social milestones during this period could be consulted at:

* Rodríguez, Á., Peña, S., Cavieres, I. et al. Ocular trauma by kinetic impact projectiles during civil unrest in Chile. Eye (2020). Supplementary material available at: <https://bit.ly/36cO0V1>.
* Ciudadanía Inteligente. Chronology on Chile’s inequality crisis. Available at: <https://bit.ly/38UUklE>
* Estallido Social. Especial #18-O: los principales hitos del Estallido Social. <https://bit.ly/2XTyBnZ>
* Palacios-Valladares, Indira. Chile's 2019 October Protests and the Student Movement: Eventful Mobilization?.*Rev. cienc. polít*. 2020, 40(2):215-234.
* Human Rights Investigations Lab for the Americas & Human Rights Center, 2020, October 13. Human Rights Crisis in Chile: A Digital Inquiry. UC Santa Cruz & UC Berkeley; 2020. Available at: <https://bit.ly/2XZJAfz>.

**Bayesian Structural Time-Series Analysis**

To evaluate the effect of social protests on ED service utilization, we utilized Bayesian structural time series (BSTS) models 36 implemented through the *CausalImpact* R package 37. This approach compares the observed trend of consultations and hospitalizations after the event, with an estimated average change under a hypothetical scenario in which social protests did not occur (i.e., the counterfactual) 38. The estimated effect is then the difference between the counterfactual and the observed number of consultations and hospitalizations after the social protests of October 18, 2019. The general model can be written as follows:

An advantage of this method is the flexibility in the inference of counterfactuals, temporal evolution, and incremental attributable impact. This estimation is achieved by incorporating features such as level, trends, seasonality, and regression that capture the dynamics of the time series 39. Trends () describe how the hospitalizations and consultations are related to underlying states and how the latent state changes over time. It is referred to as the unobserved trend inherent in time-series data. It is associated with a probability distribution of noise and random disturbances, which allows for the incorporation of empirical priors on the parameter and transitory or cyclic components able to approximate volatility in the series. The second component () consists of the seasonal patterns that capture the associations between multiple fixed periodic events and the number of consultations and hospitalizations. We specified monthly and annual seasonal patterns based on theoretical backgrounds and the nature of admissions by its different causes (e.g., increased respiratory consultations during the winter season). The third component ( relates to other contemporaneous time-series that can be included as covariates via linear regression. Due to the length of the time-series, we used a dynamic framework, which included the coefficients of time-varying regression that change over time according to a random walk process, as a way to relax the assumption of stability of the model structure 37.

The model selection process considered alternative specifications in the structure of the time-series for each outcome: Gaussian or studentized distributed noise (, different trend drifts such as a random-walk, a semi-local linear trend or a local linear trend, or the inclusion of cyclicity of autoregressive terms. We selected the model with lower cumulative absolute one-step ahead errors in the pre-intervention period for each outcome 40. The models with lower errors assumed studentized distributions, which are robust against anomalies such as data outliers. These comparisons allowed us to choose the specified structure with greater accuracy to match actual trends before social protests in order to strengthen causal inference 41.

Models were computed through Markov Chain Monte Carlo (MCMC) using Gibbs sampling. We ran 40,000 iterations following a 10% burn-in period. The point effect of social protest and its 95% credible interval was generated as the difference between the estimated forecasts and the observed trend across each iteration 42.

All analyses and graphics were completed using R v 4.0.2.

**Sensitivity analysis**

We used historical controls to contrast observed ED consultation and hospitalizations in the exposure period; that is, we used the same outcomes in the same hospitals, for the same time of the year, but in a different period (2015-2018).

**Supplemental Table 2. Median of hospitalizations and consultations 2015-2018 vs. 2019**

|  |  |  |
| --- | --- | --- |
| **Outcomes** | **2015-2018** | **2019** |
|  | *N=208* | *N=52* |
| Total consultations | 3192 [3018;3396] | 2842 [2678;2935] |
| Trauma consultations | 794 [726;878] | 859 [779;944] |
| Respiratory consultations | 140 [116;177] | 154 [104;198] |
| Circulatory consultations | 100 [86.8;121] | 108 [95.8;134] |
| Total hospitalizations | 285 [264;310] | 298 [282;315] |
| Trauma hospitalizations | 58.0 [51.0;64.2] | 72.5 [65.0;77.5] |
| Respiratory hospitalizations | 19.0 [15.0;23.0] | 22.0 [18.0;26.0] |
| Circulatory hospitalizations | 29.0 [23.0;36.0] | 32.0 [27.5;37.0] |
| Trauma hospitalizations per 1,000 consultations | 71.9 [62.0;85.2] | 82.0 [72.8;96.8] |
| Respiratory hospitalizations per 1,000 consultations | 132 [108;161] | 146 [108;187] |

Note. Percentiles 25 and 75 in brackets.

The main analytical approach is a novel technique for estimating the causal effect of events in treated units. However, consensus on best practices has not yet emerged. The way in which we used the observational data to identify the relationship of interest is always obtained at the cost of assumptions. For this reason, we changed the identification strategy in the sensitivity analysis 43. Here, we used the values of the outcomes and control variables from 2015 to 2018 as historical controls. Then, we compared the differences in weekly health services outcomes starting from the 43rd week, using a traditional fixed-effect difference-in-differences analysis (DiD).

For the inclusion of seasonal effects of the month in the DiD model, we chose the models with the lowest Root Mean Square Errors (RMSE) among those without monthly terms (1), month as a continuous variable (2), 11 dummy variables of the month (3), month as a quadratic term(4), and sine and cosine of the month scaled to the range 0,1π (5). The selected models for the outcomes were the models with the month as a dummy variable, except for Trauma Hospitalizations. This last variable showed lower RMSEs with month as sine and cosine. Finally, we computed robust standard errors to account for heteroscedasticity and autocorrelation 44 using the *xtscc* command 45 in Stata 16 46.

**Supplemental Table 3. Estimated effect of Social Protests in weekly Health Services Utilizations, from fixed effects difference-in-difference models**

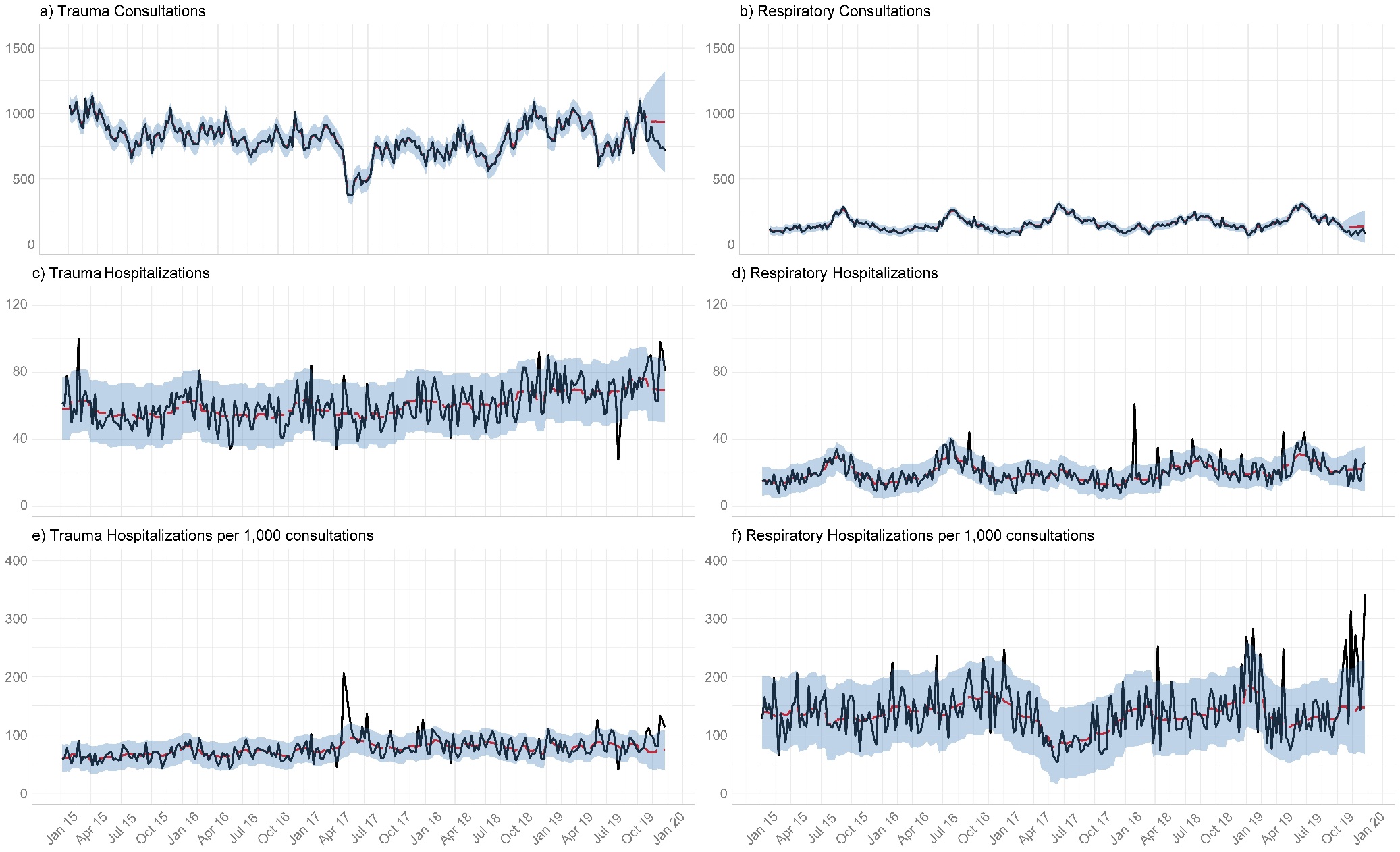
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Coef** | **95% CI** | **Relative Effect (%)** | **95% CI** |
| Trauma consultations | -115.65 | -178.89,-52.41 | -15.40 | -24.2,-6.59 |
| Respiratory consultations | -52.60 | -83.31,-21.90 | -41.23 | -69.73,-12.73 |
| Trauma hospitalizations | 7.46 | 0.54,14.37 | 11.59 | 1.63,21.55 |
| Respiratory hospitalizations | 0.34 | -3.80,4.48 | 1.65 | -17.73,21.02 |
| Trauma hospitalizations per 1,000 consultations | 23.02 | 13.78,32.27 | 26.26 | 17.22,35.3 |
| Respiratory hospitalizations per 1,000 consultations | 81.48 | 53.19,109.77 | 46.57 | 33.81,59.32 |

Note: Each model included a fixed effect for years.

As seen in Supplemental Table 3, we found that Trauma Hospitalizations show statistically significant differences as well as the same trend of increment posterior to social protests. For Respiratory Hospitalizations, we found no statistical differences. Notably, we found an association between trauma and respiratory consultations and social protests, which were associated with a significant decrease in the number of respiratory consultations; these decreases were not statistically significant in our primary analysis using the Bayesian Time Series Analysis.

Two main issues may explain the discrepancies in the significance of respiratory consultations between the two methods. First, the DiD model does not account for potential unobserved confounders over time. Second, the Bayesian Time-Series Analysis can capture more complexities than the difference-in-difference approach; therefore, it uses more stringent criteria to qualify a coefficient as a statistically significant change in trauma and respiratory consultations.

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



Note: black lines are the observed trend for each outcome, red lines are the estimated trends through Bayesis structural times-series model, and blue areas are the 95% credible interval from estimates.

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