**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 from Chile. | Thousands | (4, 5) |
| October 19-24 | Massive demonstrations spread through the country. Stores and buildings were looted and/or burned. State of emergency is proclaimed in Santiago and then to other major cities: military and police were displayed; curfew is declared. | Thousands | (6-14) |
| October 25 | Biggest peaceful march across “Plaza Italia” in Santiago. Big demonstrations occurred also through the whole 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 lost and deaths occurred. Human Rights organizations researched the events. Civil unrest, lootings and fires continued. | Unknown (probably thousands) | (17-26) |
| December 5 | “Las Tesis” feminist protest is peacefully done at the national stadium in Santiago. “A rapist in your part” is replicated worldwide | About 10.000 | (27-30) |
| December | Civil unrest and deaths in demonstrations continued, but more were allocated in 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 used Bayesian structural time series (BSTS) models (36) implemented using 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 protest of October 18, 2019. The general model can be written as follows:

One advantages of this method is that it allows 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 the noise and random disturbances, which allows to incorporate empirical priors on the parameter and transitory or cyclic components able to approximate volatility in the series. The second component () are 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., increase number of respiratory consultations during the winter season). The third component ( relates to other contemporaneous time-series that can be included as covariates via linear regression. We used as a covariate the circulatory hospitalizations when the outcome were hospitalizations,and consultations series when the outcome were consultations. Due to the length of the time-series, we used a dynamic framework which included the coefficients of time-varying regression, as a way to relax the assumption of stability of the model structure, and in which coefficients change over time according to a random walk process (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 that had lower errors assumed studentized distributions, which are robust against anomalies such as data outliers. These comparisons allowed us to choose the specified structure with the 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 was 30,000 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 the 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=210* | *N=52* |
| Total Consultations | 3183 [3003;3394] | 2846 [2678;2949] |
| Trauma Consultations | 792 [724;878] | 866 [779;944] |
| Respiratory Consultations | 140 [115;176] | 154 [104;198] |
| Circulatory Consultations | 100 [86.0;121] | 108 [95.8;134] |
| Total Hospitalizations | 284 [264;310] | 300 [286;315] |
| Trauma Hospitalizations | 57.0 [51.0;64.0] | 73.0 [65.0;77.5] |
| Respiratory Hospitalizations | 19.0 [15.0;23.0] | 22.0 [18.8;26.0] |
| Circulatory Hospitalizations | 29.0 [23.0;36.0] | 32.0 [27.5;37.0] |
| Trauma hospitalizations per 1,000 consultations | 72.0 [62.1;85.1] | 80.6 [72.8;96.8] |
| Respiratory hospitalizations per 1,000 consultations | 131 [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 for events in treated units, however, consensus on best practice 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 of years 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 models 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, in which the model with sine and cosine showed lower RMSEs. 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 a | -122.90 | -186.99,-58.80 | -16.45 | -25.47,-7.42 |
| Respiratory Consultations a | -55.74 | -85.64,-25.84 | -44.30 | -72.83,-15.78 |
| Trauma Hospitalizations b, c | 7.53 | 0.53,14.52 | 11.70 | 1.63,21.77 |
| Respiratory Hospitalizations b | 0.37 | -3.98,4.72 | 1.76 | -18.58,22.11 |
| Trauma hospitalizations per 1,000 consultationsd | 24.38 | 14.29,34.46 | 27.65 | 17.91,37.4 |
| Respiratory hospitalizations per 1,000 consultationsd | 86.55 | 60.30,112.79 | 48.94 | 37.5,60.37 |

Note: Each model included a fixed effect for years. Models also included the following time-varying covariates: a) Circulatory Consultations, b) Circulatory Hospitalizations, c) Seasonal effects were included using a sine and cosine term to represent the months; d) Circulatory Hospitalizations per 1000 Consultations;.

As seen in Supplemental Table 3, we found Trauma Hospitalizations did not show statistically significant differences even though it showed 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)**

Gráfico, Gráfico de barras, Histograma

Descripción generada automáticamente

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.

**References**

1. Baeza A. Evasión masiva de alumnos del Instituto Nacional en el Metro termina con denuncia en Fiscalía y medidas de contención: La Tercera; 2019, Octubre 11 [Available from: <https://www.latercera.com/nacional/noticia/evasion-masiva-alumnos-del-instituto-nacional-metro-termina-denuncia-fiscalia-medidas-contencion/857409/>.

2. Ciudadanía Inteligente. Chronology on Chile’s inequality crisis n.d. [Available from: <https://ciudadaniai.org/en/chile.html>.

3. Vega M. Grupo de 300 estudiantes invaden estación Pedro de Valdivia del Metro: protestan por alza de pasajes: Bío-Bío Chile; 2019, October 14 [Available from: <https://www.biobiochile.cl/noticias/nacional/region-metropolitana/2019/10/14/grupo-de-300-estudiantes-invaden-estacion-pedro-de-valdivia-del-metro-protestan-por-alza-de-pasajes.shtml>.

4. BBC News. Chile protests: Unrest in Santiago over metro fare increase: BBC News; 2019, October 19 [Available from: <https://www.bbc.com/news/world-latin-america-50106743>.

5. Bartlett J. Chile students' mass fare-dodging expands into city-wide protest: The Guardian; 2019, October 18 [Available from: <https://www.theguardian.com/world/2019/oct/18/chile-students-mass-fare-dodging-expands-into-city-wide-protest>.

6. Lara E. Chile crisis: 7 dead, curfew imposed in 14 cities as Government tries to face riots, looting, arson: Bío-Bío Chile; 2019, October 20 [Available from: <https://www.biobiochile.cl/noticias/biobiochile-english/english-chile/2019/10/20/chile-crisis-7-dead-curfew-imposed-in-14-cities-as-government-tries-to-face-riots-looting-arson.shtml>.

7. Associated Press. Chile: protests rage as president extends state of emergency: The Guardian; 2019, October 21 [Available from: <https://www.theguardian.com/world/2019/oct/20/chiles-president-reverses-fare-increase-as-unrest-continues>.

8. Bunyan R. 18 Killed as Hundreds of Thousands of Protestors Take to the Streets in Chile: Time; 2019, October 25 [Available from: <https://time.com/5710268/chile-protests/>.

9. Palacios-Valladares I. Chile's 2019 October Protests and the Student Movement: Eventful Mobilization? Rev cienc polít. 2020;40(2):215-34.

10. Laing A, Cambero F. Chile's deadly weekend of fire as youth anger ignites: Reuters; 2019, October 21 [Available from: <https://www.reuters.com/article/us-chile-protests-scenes/chiles-deadly-weekend-of-fire-as-youth-anger-ignites-idUSKBN1X009A>.

11. Reuters. Chilean state of emergency extended around country after deadly riots: France 24; 2019, October 21 [Available from: <https://www.france24.com/en/20191021-chile-extends-state-of-emergency-around-country-after-deadly-riots-1>.

12. Bonnefoy P, Krauss C. Chile Unrest Spreads, With 15 Deaths Reported in Violence: New York Times; 2019, October 20 [2021, January 19]. Available from: <https://www.nytimes.com/2019/10/20/world/americas/chile-protests-riots.html>.

13. Chesterman B. Chile president announces social measures to stem street violence: Yahoo News; 2019, October 23 [2021, January 14]. Available from: <https://sg.news.yahoo.com/chile-president-announces-social-measures-stem-street-violence-033315790.html>.

14. Deutsche Welle. Chile general strike goes ahead despite Pinera reforms: Deutsche Welle; 2019, October 24 [Available from: <https://www.dw.com/en/chile-general-strike-goes-ahead-despite-pinera-reforms/a-50958823>.

15. BBC News. Chile protests: One million join peaceful march for reform: BBC; 2019, October 26 [Available from: <https://www.bbc.com/news/world-latin-america-50191746>.

16. Sherwood D, Ramos N. One million Chileans march in Santiago, city grinds to halt: Reuters; 2019, October 25 [Available from: <https://www.reuters.com/article/us-chile-protests/one-million-chileans-march-in-santiago-city-grinds-to-halt-idUSKBN1X4225>.

17. Phillips T, Watts J, Franklin J. Chilean president cancels Apec and climate summits amid wave of unrest 2019, October 30 [Available from: <https://www.theguardian.com/world/2019/oct/30/chile-protests-president-sebastian-pinera-protest-unrest>.

18. Sepulveda M, Wissenstein M. Thousands march in Chile protest after summit cancellations: FOX 44 News; 2019, October 31 [Available from: <https://www.fox44news.com/news/thousands-march-in-chile-protest-after-summit-cancellations/>.

19. Deutsche Welle. Chile: Protesters burn university, loot church: Deutsche Welle; 2019, November 09 [Available from: <https://p.dw.com/p/3Sjav>.

20. McDonald B. A Bullet to the Eye Is the Price of Protesting in Chile: New York Times; 2019, November 19 [Available from: <https://www.nytimes.com/2019/11/19/world/americas/chile-protests-eye-injuries.html>.

21. Charner F. Beaten and blinded, Chile's protesters face "policy of punishment," says Amnesty International: CNN; 2019, November 22 [Available from: <https://edition.cnn.com/2019/11/22/world/amnesty-report-chile-protest-charner-intl/index.html>.

22. BBC News. Amnesty International: Chile using violence as a deterrent: BBC News; 2019, November 21 [Available from: <https://www.bbc.com/news/world-latin-america-50512093>

23. Bartlett J, Miller L. Chile security forces' crackdown leaves toll of death and broken bodies: The Guardian; 2019, November 25 [Available from: <https://www.theguardian.com/world/2019/nov/25/chile-protester-killed-mother-army-police-romario-veloz>.

24. Cuffe S. One month on: Protests in Chile persist despite gov’t concessions: Aljazeera; 2019, November 19 [Available from: <https://www.aljazeera.com/news/2019/11/19/one-month-on-protests-in-chile-persist-despite-govt-concessions>.

25. Deutsche Welle. Chile protests: 'Serious' human rights violations by police, says HRW: Deutsche Welle; 2019, November 27 [Available from: <https://p.dw.com/p/3ToXB>.

26. Human Rights Watch. Chile: Police Reforms Needed in the Wake of Protests 2019, November 26 [Available from: <https://www.hrw.org/news/2019/11/26/chile-police-reforms-needed-wake-protests>.

27. Human Rights Investigations Lab for the Americas , Human Rights Center. Human Rights Crisis in Chile: A Digital Inquiry: UC Santa Cruz & UC Berkeley; 2020, October 13 [Available from: <https://storymaps.arcgis.com/stories/1ee6a10615944aeab3be4fce51c03989>.

28. ABC News. UN calls for Chile to prosecute police over human rights violations against protesters 2019, December 14 [Available from: <https://www.abc.net.au/news/2019-12-14/un-says-chile-police-committed-human-rights-violations/11800610>.

29. Abrahimovic P. 'The rapist is you': Chile anthem against sexual violence goes viral: ABS-CBN News; 2019, December 06 [Available from: <https://news.abs-cbn.com/overseas/12/06/19/the-rapist-is-you-chile-anthem-against-sexual-violence-goes-viral>.

30. McGowan C. Chilean anti-rape anthem becomes international feminist phenomenon: The Guardian; 2019, December 06 [Available from: <https://www.theguardian.com/world/2019/dec/06/chilean-anti-rape-anthem-becomes-international-feminist-phenomenon>.

31. Ramos N, Laing A. Chile's Pinera inks law for vote on new constitution: Reuters; 2019, December 23 [Available from: <https://www.reuters.com/article/us-chile-protests-constitution/chiles-pinera-inks-law-for-vote-on-new-constitution-idUSKBN1YR1S8>.

32. Egypt Independent. Violent clashes in new round of Chile protests: Egypt Independent; 2019, December 28 [Available from: <https://egyptindependent.com/violent-clashes-in-new-round-of-chile-protests/>.

33. Agence France-Presse. Protesters clash with police as Chile unrest enters 50th day: New Straits Times; 2019, December 7 [Available from: <https://www.nst.com.my/world/world/2019/12/545665/protesters-clash-police-chile-unrest-enters-50th-day>.

34. Agence France-Presse. Chile convulsed by new round of violent clashes: The New Strait Times; 2019, December 28 [Available from: <https://www.nst.com.my/world/world/2019/12/551468/chile-convulsed-new-round-violent-clashes>.

35. Cooperativa.cl. Chile entra en su novena semana de protestas: Cooperativa; 2019, December 13 [Available from: <https://www.cooperativa.cl/noticias/pais/manifestaciones/chile-entra-en-su-novena-semana-de-protestas/2019-12-09/061301.html>.

36. Scott SL, Varian HR. Predicting the present with bayesian structural time series. International Journal of Mathematical Modelling and Numerical Optimisation. 2014;5(1-2):4-23.

37. Brodersen KH, Gallusser F, Koehler J, Remy N, Scott SL. Inferring causal impact using Bayesian structural time-series models. Ann Appl Stat. 2015;9(1):247-74.

38. Pinilla J, Negrín M, González-López-Valcárcel B, Vázquez-Polo F-J. Using a Bayesian Structural Time–Series Model to Infer the Causal Impact on Cigarette Sales of Partial and Total Bans on Public Smoking. Jahrbücher für Nationalökonomie und Statistik. 2018;238(5):423.

39. Harvey AC, Trimbur TM, Van Dijk HK. Trends and cycles in economic time series: A Bayesian approach. Journal of Econometrics. 2007;140(2):618-49.

40. Koopman SJ, Durbin J. Time series analysis of non-Gaussian observations based on state space models from both classical and Bayesian perspectives. (With discussion). Journal of the Royal Statistical Society Series B. 2000;62:3-56.

41. Scott SL. bsts: Bayesian Structural Time Series. R package version 0.9.5 ed2020.

42. Fragoso TM, Bertoli W, Louzada F. Bayesian Model Averaging: A Systematic Review and Conceptual Classification. International Statistical Review. 2018;86(1):1-28.

43. Keele L. The Statistics of Causal Inference: A View from Political Methodology. Political Analysis. 2015;23(3):313-35.

44. Driscoll J, Kraay AC. Consistent covariance matrix estimation with spatially dependent data. Rev Econ Stat. 1998;80:549-60.

45. Hoechle D. Robust Standard Errors for Panel Regressions With Cross-Sectional Dependence. Stata Journal. 2007;7:281-312.

46. StataCorp. Stata Statistical Software. In: LLC. S, editor. TX: College Station; 2019.