**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 a time series analysis of aggregated weekly emergency department (ED) admissions (2015-2019). Data included three public hospitals located within 3 km of the focal 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. We considered six outcomes, namely the number of weekly consultations and hospitalizations by trauma and respiratory causes, as well as the proportion of hospitalizations among consultants per 1,000. We implemented Bayesian structural time series models to calculate the absolute and relative effects and their 95% credible intervals (CrI).

*Results*: 28,155 ED consultations and 3,022 hospitalizations were observed in the ten week following the start of social protests. Health services utilization, assessed through ED consultations, declined by 15% (trauma; 95% CrI: -42.6, 12.1) and 46% (respiratory; 95% CrI: -95.3, 3.9) during the social protests. In contrast, trauma hospitalizations increased by 17% (95% CrI: 4.9, 29.1), and the proportion of hospitalizations among consultations increased by 41% for trauma (95% CrI: 11.1, 69.1) and 71% for respiratory causes (95% CrI: 36.5, 106.7).

*Conclusion:* The October 2019 Chilean protests appear to have affected the use of emergency health system services by lowering the number of consultations due to trauma and respiratory causes, while increasing the proportion of hopitalizations among consulting patients. Crowd-control protocols must be reviewed to prevent adverse effects of civil unrest on population health.

**Keywords:** social protests; civil unrest; emergency department; trauma, respiratory, Chile

# **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; non-authorized peaceful protests may also receive violent police response, also resulting in unrests (5). In Chile in October of 2019, a 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 (e.g. health, education, transport, and justice systems), and retirement pensions, among other structural processes (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).

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 may 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 as well. 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). 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).

Despite the burden on overall health and well-being, evidence regarding the effects of social movements on health is still lacking. Only a few studies have reported the number and patterns of injuries during periods of civil unrest (28, 31, 32). However, whether social movements and crowd control methods during civil unrest affect the admission rate and case severity of trauma and respiratory cases is still largely unknown.

In this study, 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 the protest's focal point in Santiago.

# **Methods**

*Design*

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 were gathered from 2015 to 2019 for both consultations and hospitalizations and aggregated into a weekly sum. The data were then refined to isolate cases from ages 15-64 (as most protesters were within this age range (21)), and cases were categorized 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”. The ED from the included hospitals are reference centers in the city, being among the biggest hospitals in the region with about 2 million of assignated adult population. The Hospital de Urgencia Asistencia Pública is a national referent center for severe trauma and burns.

*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, patients’ age, ICD-10 diagnosis at ED discharge, and hospital admission status. Data were deidentified and tabulated by each center and reported to the Ministry of Health, which then published the datasets containing the aggregated counts by cause (trauma, respiratory, circulatory system) and center. The dataset was freely available on the internet (<http://www.deis.cl>), thus no IRB approval was necesssary to conduct and publish this work.

*Variables*

Outcome. Health services utilization was measured as the weekly counts of ED consultations and hospitalizations for trauma and respiratory causes. We also looked at the rates of hospitalizations for each cause among those consulting for that cause per 1,000.

Exposure. We defined the exposure period as the onset of social protests from October 18 to December 31, 2019, as this period consisted of the majority of the protests’ milestones (see Supplemental Table 1 with a timeline of these milestones). Although protest continued during January and February (typically summer vacation months in Chile), they were far less in number and intensity than in previous months and the first two weeks of March, before Covid-19 pandemic started in Chile. Due to 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.

*Analysis*

To evaluate the effect of social protests on ED service utilization, we used Bayesian structural time series (BSTS) models (33) implemented using the *CausalImpact* R package (34) in R v4.0.2. This approach compares the observed trend of consultations and hospitalizations after the exposure, with an estimated average trend under the hypothetical scenario in which social protests did not occur (i.e., the counterfactual) (35). The estimated effect is then the difference between the counterfactual and the observed number of consultations and hospitalizations following the social protest of October 2019.

This method allowed flexibility in the inference of counterfactuals, temporal evolution, and incremental attributable impact. Its estimations were achieved by incorporating features such as level, trends, seasonality and regression to capture the time series dynamics (36). 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 (37). The selected models assumed a studentized distributed noise, which was robust against outliers and shocks, and included a random-walk that does not rely on an observable pattern or trend drift and has the advantage that adapts to local variation. Such approach was preferable for short-term predictions (38).

The point effects of social protest and their 95% credible intervals (CrI) were generated as the differences between the estimated forecasts and the observed trends across each 30,000 Markov Chain Monte Carlo iterations, following a 10% burn-in period (33, 39, 40). The tail-area probability can be interpreted as the probability—across models iterations— of observing a response at least as extreme as the observed point estimate (41). Additional details on the modeling approach and statistics are described in the Supplemental Material.

Finally, we performed a sensitivity analysis through a traditional difference-in-differences model using historical controls from 2015 to 2018, expressing the observed trend for each outcome in the same three hospitals but in years in which social protest did not occur. The difference-in-differences model included year fixed-effects and a dummy variable for each month to capture seasonal variations in the outcome (42). Inferences were computed with robust standard errors to account for heteroscedasticity and autocorrelation (43) using the *xtscc* command (44) in Stata 16 (45).

Data and markdown with all software codes and outputs are available in https://fondecytacc.github.io/paperestallido/

# **Results**

A total of 28,155 ED consultations with 3,022 hospital admissions for ages 15 - 64 were registered in the exposure period (10 week following the start of the protests, from Octobe 21st to December 31st of 2019) in the three hospitals under study. Median weekly total consultations and hospitalizations during the etire pre-exposure period (January 2015 to October 2019) were 3,137 and 288, respectively (Table 1), while in the exposure period were 2,854 and 298. Overall, during 2015-2019 trauma cases represent the 26% of total consultation and 21% of total hospitalizations, and respiratory represents the 5% and 7%, respectively.

The weekly number of consultations and hospitalizations by trauma and respiratory causes are shown in Supplemental Figure 1. The number of respiratory ED consultations and hospitalizations show a clear seasonal pattern with a large increase in the winter months, although the relative severity of cases does not appear to present seasonal variation. The number of trauma ED consultations and hospitalizations were higher than respiratory cases; hopitalizations demonstrated fairly large variations throughout the time-series.

Differences between model predictions and the observed data in the pre and post-October protests are graphed in Figure 1. For ease of visualization, we only present pre-exposure differences for the last 10 weeks prior to the social protests. Overall, model predictions fit well to the observed pre-exposure data for all the outcomes (Supplemental Figure 1 and Figure 1). The absolute and cumulative differences between the predicted and the observed trend are shown in Figures 1 and 2. Consultations dropped following social protests along with the absolute number of respiratory hospitalizations. However, none of these three results were statistically distinguishable from the null in the Bayesian time series model. Nonetheless, the absolute number of trauma hospitalizations, as well as the relative severity of consultations (rate of hospitalizations per 1000 consultations), increased following the social protests. The number of trauma hospitalizations increased by 17% (95% CrI: 4.9, 29.1), while trauma hospitalizations per 1,000 consultations increased by 41%, relative to the counterfactual (95% CrI: 11.1, 69.1); respiratory hospitalizations per 1,000 consultations increased by 71% (95% CrI: 36.5, 106.7).

Sensitivity analysis with a frequentist “differences-in-differences” model showed consistent results in terms of both direction and magnitude of the effects, though confidence intervals were narrower. Social protest were associated with a 16% (95% CI: -25.5, -7.4) decline in trauma consultations and a 44% decline in respiratory consultation (95% CI: -72.8, -15.8). As with the Bayesian time-series approach, both trauma and respiratory hospitalizations per consultations showed increases in magnitude of 28% (95% CI: 17.9, 37.4) and 50% (95% CI: 37.5, 60.4), respectively, as well as trauma hospitalizations, which experienced an increase of 12% (95% CI 1.6,21.8) (Supplemental Table 3).

# **Discussion**

In this study, we aimed to quantify the effects of social protest and widespread crowd-control techniques on health service utilization within the Chilean context. Our findings suggest that, following the onset of the Chilean social movement on October 18, 2019, there was a decrease in consultations to ED services near the protest’s focal point. However, the severity of trauma and respiratory cases appeared to increase, which was particularly clear when we looked at the proportion of hospitalizations per 1,000 trauma/respiratory ED consultations. Hospitalizations among consultations for trauma were 41% higher than expected, while, for respiratory conditions, hospitalizations were 71% higher. These results provide novel insights on the impact of social movements and violence during civil unrest on health service utilization and population health.

The overall decline in ED consultations could likely be explained through access; during this period, individuals with non-severe or life-threatening emergencies who would generally visit emergency services might reasonably avoid these hospitals (15). In fact, public transportation was significantly disrupted throughout the time of the protests, particularly in the area surrounding the protest’s focal point. It is also known that incident cases due to police confrontations and exposure to crowd-control methods, particularly those with minor and mild injuries were treated on-site by volunteering health professionals, possibly lessening the ED burden from mild or non-life-threatening problems (9).

The increase in the number and proportion of trauma hospitalizations during the social protest period suggests that confrontations and police brutality resulted in an increased number of civilians injured that needed medical attention. This is consistent with a previous study that evidenced an increase in severe ocular trauma by kinetic impact projectiles during this period (21) as well as another study that demonstrarted increased levels of trauma at the beginning of the social crisis in the south-east area of Santiago (fairly far from the protests’ focal point), though the authors found no unambiguous differences compared with 2018 (46). Moreover, because access issues, patients with trauma and also those with respiratory diseases could also have delayed their ED consultations during this period, worsening the disease severity at ED presentation. In other words, the observed increase in disease severity of trauma and respiratory consultations could be explained by the widespread use of crowd-control techniques in confrontations between the police and protesters and a late consultation due to access barriers during this period.

Social movements resulting in civil unrest are far from being merely a Chilean or even Latin American issue. Recent demonstrations have occurred for different reasons in countries such as France, Hong Kong, Syria, and the U.S. Many authors have suggested that social movements are expected to increase in the near future due to the crisis derived from COVID-19 (47, 48). One notorious example is the recent killing of George Floyd in Minneapolis, Minnesota, which triggered civil unrests in the U.S. and abroad, or the protest in the US capitol building on January 6th 2021 in which at least 5 people died and there was extensive use of chemical irritants and many blunt force injuries. As in Chile, many 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 the confrontation and surrounding areas (10, 16, 49, 50).

*Implications*

The results of this study should be seen as a first step in better understanding the broader health effects of largescale social movements. We believe that our rigorous analytical approach may help to anticipate changes in ED consultation and hospitalization patterns and disruptions in healthcare access during periods of widespread violence in surrounding areas in order to allocate efforts and resources accordingly. Second, and most importantly, we hope this study will be used to advise and advocate for policy change regarding police responses to civil unrest in order to prevent escalates of violence and harm among protesters, the police fource, and the people in surroundin areas.

*Limitations*

The results of this study should be seen in light of the following limitations. 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 around 75% of the Chilean population have public health insurance (51) and likely use the public health system, there was a still fraction of the population that was not included in our study, which limits the generalizability of our findings. In addition, the degree of detail for emergency data in Chile is far from being ideal. We were only able to use the grouped primary cause of admission; thus, contributory causes were not explored in the study. Finally, the precision of our main results was fairly poor, limiting our possibilities to generate robust conclusions on effect estimates for trauma and respiratory consultations. This is largely because the Bayesian structural time-series model is a fairly conservative approach as a consequence of its flexibility. However, the most consistent results using a more traditional difference-in-difference model give us confidence in our interpretation and final conclusions.

# **Conclusions**

The October 2019 Chilean protests appear to affect the use of emergency health system services by lowering the number of consultations due to trauma and respiratory causes, while increasing the proportion of hospitalizations among admitted patients. It is necessary to implement policy changes regarding law enforcement actions and the use of crowd control measures during civil unrest in order to avoid negative effects on population health.

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**Table 1. Median of emergency department weekly consultations and hospitalizations, pre and post October’s 2019 social protests in Chile**

|  |  |  |
| --- | --- | --- |
|  | **Previous to social protests** | **During social protests** |
|  | *N=252 weeks* | *N=10 weeks* |
| 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] |
| Trauma hospitalizations per 1,000 consultations | 73.0 [64.0; 86.2] | 102 [84.2; 113] |
| Respiratory hospitalizations per 1,000 consultations | 131 [107; 160] | 233 [189; 270] |

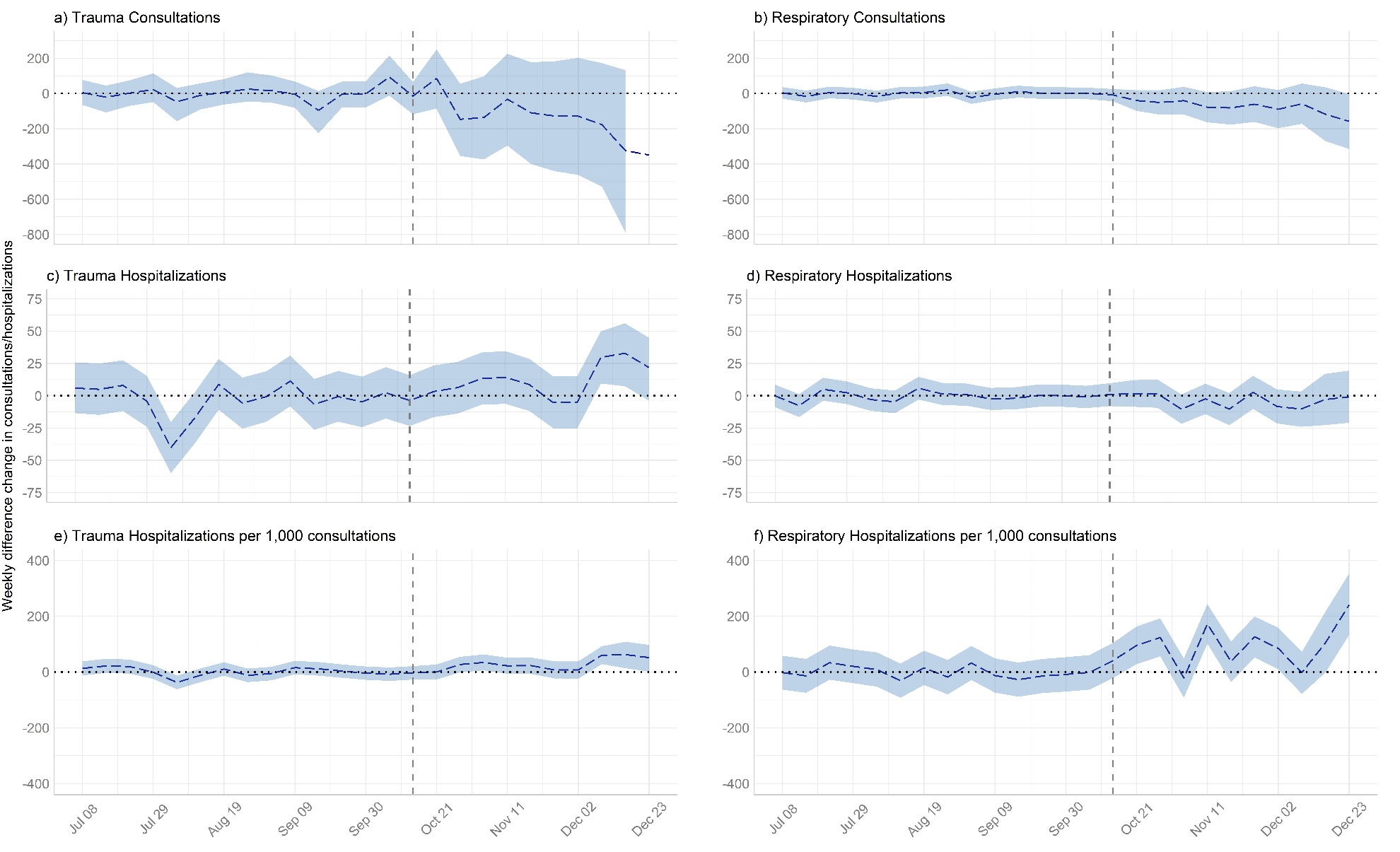
Note. Percentiles 25 and 75 in brackets.

**Table 2. Estimated effects of October’s 2019 social protests on trauma and respiratory emergency department consultation and hospitalization**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Average Effecta** | **95%Credible Interval** | **Relative Effect (%)** | **95% Credible Interval** |
| Trauma consultations | -144.58 | -405.43, 114.89 | -15.19 | -42.61, 12.08 |
| Respiratory consultations | -77.62 | -161.06, 6.60 | -45.92 | -95.29, 3.90 |
| Trauma hospitalizations | 11.95 | 3.39, 20.23 | 17.21 | 4.89, 29.13 |
| Respiratory hospitalizations | -4.00 | -13.62, 5.53 | -16.33 | -55.60, 22.56 |
| Trauma hospitalizations per 1,000 consultations | 29.49 | 8.03, 50.12 | 40.65 | 11.08, 69.10 |
| Respiratory hospitalizations per 1,000 consultations | 96.10 | 49.05, 143.53 | 71.41 | 36.45, 106.66 |

aEstimated as the change in expected events per week during the exposure period.

**Figure 1. Weekly differences between predicted and observed outcomes in the 10 weeks pre and post exposure periods**



**Figure 2. Cumulative difference between predicted and observed outcomes in the 10 weeks post exposure period**

