ABSTRACT

Objective To evaluate if extensive use of tear gas during the Chilean social uprising of 2019 was associated with a higher frequency of respiratory emergencies and bronchial diseases in a residential vulnerable population.

Design Observational, longitudinal, repeated measures study.

Settings Six healthcare centres (one emergency department and five urgent care centres) in the city of Concepción, Chile during 2018 and 2019.

Participants This study was conducted on daily respiratory emergencies and diagnosis. Daily frequency of urgency and emergency visits are administrative data, publicly available and previously de-identified.

Primary and secondary outcome measures Absolute and relative frequency of daily respiratory emergencies in infants and older adults. A secondary outcome was the relative frequency of bronchial diseases (International Classification of Diseases 10th Revision, ICD-J20–J21; J40–J46) in both age groups. We finally measured the rate ratio (RR) of bronchial diseases above the daily grand mean, since the number of visits with these diagnoses in several days was zero. Tear gas exposure was assessed as the uprising period. Models were adjusted by weather and air pollution information.

Results Percentage of respiratory emergencies during the uprising rose by 1.34 percentage points (95% CI 1.26 to 1.43) in infants and 1.44 percentage points (95% CI 1.34 to 1.55) in older adults. In infants, the emergency department experienced a larger increment in respiratory emergencies (6.89 percentage points; 95% CI 1.58 to 2.28) than the urgent care centres (1.67 percentage points; 95% CI 1.46 to 1.90). The RR of bronchial diseases above the daily grand mean during the uprising period was 1.34 in infants (95% CI 1.15 to 1.56) and 1.50 in older adults (95% CI 1.28 to 1.75).

Conclusions The massive use of tear gas increases the frequency and probability of respiratory emergencies and particularly bronchial diseases in the vulnerable population; we recommend revising public policy to restrict its use.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Our study is an observational, longitudinal, repeated measures design, analysing the frequency and diagnosis of emergency visits over 2 years, in six public healthcare centres covering the population of Concepción, Chile (258,653 inhabitants).

⇒ This study adds information about potential effects of tear gas exposure on vulnerable populations: infants (1 year old or less) and older adults (65 years old or older), who by far do not participate in public demonstrations or protests.

⇒ Visits to healthcare centres may not represent distance to protest places from residency or staying in the residency during the time of the protests.

⇒ An important limitation of this study is the lack of an individual assessment that can account for frequency and intensity of tear gas exposure.

INTRODUCTION

Tear gas is known to produce acute and chronic respiratory injuries.™ During the social uprising of 2019 in Chile, the police extensively used tear gas in city centres causing concern about its potential health effects on inhabitants.

Tear gas is a toxicant dust that causes mostly respiratory symptomatology. When used for crowd-control purposes, gas dispersion can encompass an area from 60 to 300 m™; once spread, this chemical irritant makes demonstrators disperse by running away from its effects, thus leaving defenceless those unable to disperse by themselves from exposure.

Aerosolised tear gas in protests does not discriminate targets because it is impossible to manage the reach of the gas cloud; therefore, it is usual to have bystanders exposed. Additionally, it is a challenge to have evidence...
of long-term respiratory effects with incidental exposures. Two studies documented the effects of secondary exposure in adults; immediate and short-term reported symptoms included respiratory tract irritation, cough, shortness of breath and worsening symptoms of previous respiratory diseases. After 8–10 months of follow-up, some cases presented with persistent complaints and aggravated asthma.

Adult demonstrators directly and acutely exposed to tear gas have presented with persistent cough and symptoms of asthma, among other respiratory symptoms, and a higher risk of chronic bronchitis with repeated exposures. A report documented the case of a teacher who developed asthma after a dozen events of secondary occupational exposure to tear gas during a 1-year period. Occupational exposure in military personnel revealed cases of acute and transient pulmonary syndrome requiring hospitalisation. Frequent and large amount of exposure to tear gas can result in pulmonary oedema, pneumonitis or congestive heart failure, especially in patients with pre-existing respiratory diseases. These results suggest that people directly exposed to tear gas could develop acute and chronic respiratory diseases.

In vivo and in vitro studies have demonstrated that tear gas induced respiratory tract damage. The mechanism involves proteins related to hypersensitivity, hyperexcitability and inflammation that play an important role in the pathophysiology of asthma, chronic cough, among others, increasing the probability to develop respiratory diseases, particularly in vulnerable populations.

Older adults are considered vulnerable in the presence of respiratory toxicants. During the ageing process, a person presents multiple structural and physiological changes in the respiratory system. These changes include loss of elastic retraction of the lung, decreased compliance of the chest, reduced strength of the respiratory muscles, decreased mucociliary clearance and loss of perception of dyspnoea due to airway obstruction, which causes older adults to delay consulting for respiratory problems until more serious stages of bronchial obstruction. All these physiological changes would explain why older people’s respiratory systems have a greater susceptibility to air pollution.

Moreover, ageing causes an involution of physical capacities, which brings with it a reduction in general functionality and, therefore, a lower capacity for response and displacement in the face of sudden exposure to a harmful agent.

Children are of particular concern because of how vulnerable to chemical exposure they are, though only one case study has documented serious systemic effects of tear gas on an infant. To our knowledge, there is no report linking health effects of tear gas on either infants or older adult populations.

In Chile, on 18 October 2019, a civil uprising with protests, riots, barricades and looting in all major and some small cities began, as with the rest of the country; manifestations were sustained consistently until the end of December 2019. In repressing demonstrators, the use of crowd-control weapons such as rubber bullets, tear gas and pressurised water was massive and oftentimes outside regulations.

The use of tear gas in Chile is allowed for crowd dispersal. National regulations stipulate that tear gas use is restricted considering the presence of vulnerable populations (particularly children and infants) and/or proximity to places where they are or reside.

Chemicals commonly used as tear gas are o-chlorobenzylidene malonitrile (CAS no. 2698-41-1) and oloresin capiscum (CAS no. 8023-77-6), also known as CS and OC, correspondingly. Notwithstanding, information about what chemicals or mixture was used during this period in Chile has not been disclosed under the pretext of national security reasons.

Respiratory symptoms are a frequent cause for emergency department (ED) and urgent care centre (UCC) visits in infants. Treated ED and UCC emergencies (screened in, diagnosed and receiving healthcare) can be used to estimate health impacts of extended gas exposure. These healthcare emergencies may provide information on the occurrence of respiratory symptomatology in specific populations changed, or not, after an environmental exposure.

Worldwide, paediatric respiratory diseases represent a high economic burden for health systems. In Chile, lower respiratory tract infections are the third cause of death in children under 1 year of age and the first cause of hospitalisation in this age group.

In 2019, at a national level, there were a total of 15,521 hospital discharges for lower respiratory tract infection in children below 1 year of age, which translates into an estimated annual expenditure of US$8,214,180.

Excluding violence-related emergencies, a decrease in total emergencies to the ED and UCCs during a period of restriction of civil liberties is highly probable. Fear, transportation limitations, curfews and the secondary system-wide disorganisation may change the regular number of people requiring emergency care. Patients and/or their guardians who can wait out their symptoms if they do not seem severe would likely delay or give up visiting ED or UCCs.

In the possible scenario of decreased total number of urgency and emergencies, we hypothesise that during the social uprising, when the use of tear gas was massive, the relative frequency of infant (<1 year of age) and older adult (>65 years of age) ED and UCC visits due to respiratory reasons increased, particularly those related to bronchial diseases. We observed the relative frequencies because we assumed that, in infants and older adults, the request for healthcare would have outweighed the fear of going outside if their caregivers suspected a serious health outcome. During the social uprising, the absolute number of respiratory diseases would have been low for all age groups, compared with other periods; however, the relative frequency would have to go up in infants and older adults if they were more affected by the exposure.
METHODS
We conducted a longitudinal study in which the unit of observation was date (day) in all six public healthcare centres in the city of Concepción, Chile, during 2018 and 2019. We analysed the daily absolute and relative frequency of respiratory emergency and urgency visits in infants less than 1 year of age and older adults above 65 years of age.

Emergency and urgency visits (referred as emergencies indistinctively, from here on) are recorded by the Chilean Department of Statistics and Health Information and made openly available. All data were publicly accessible and already unidentifiable35; thus, informed consent from patients was not needed.

From 1 January 2018 to 31 December 2019, the number of emergencies and their diagnoses were retrieved. The community healthcare centres covering the city were selected: five UCC units (SAR Tucapel, SAPU Juan Soto Fernández, SAR Víctor Manuel Fernández, SAPU Lorenzo Arenas, SAPU Santa Sabina) and the main regional hospital ED (Hospital Clínico Regional de Concepción Dr Guillermo Grant Benavente). These public healthcare centres cover the city of Concepción.

The diagnoses for those emergencies registered as ‘respiratory problems’ in the database are acute upper respiratory infections (International Classification of Diseases 10th Revision, ICD-10: J00–J06), influenza (J09–J11), pneumonia (J12–J18), acute bronchitis/acute bronchiolitis (J20–J21), obstructive bronchial crisis (J40–J46) and other respiratory causes (J22, J30–J39, J47, J60–J98).35

We computed the total number of respiratory emergencies and the total number of infant emergencies with respiratory diagnoses. For relative frequencies, we computed the proportion of infant emergencies with respiratory diagnoses out of all emergencies with respiratory diagnosis. The same absolute and relative frequencies were computed for older adults. Additionally, we processed daily amount of bronchial diagnosis, J20–J21 and J40–J46, above and below the daily grand mean for the period for both groups.

We classified exposure as a binary variable, absent or present, by using dates of protest events as proxy of tear gas usage. All 2018 days as well as all 2019 days before October 19 were considered as absent exposure. From 19 October to 31 December 2019 was regarded as the exposure period.

For the initial multivariable analyses using as outcome relative frequencies of respiratory emergencies, generalised linear models with repeated measures were performed. Lognormal link and distributions were used to model the data. Slopes for relative frequencies of respiratory emergencies in patients under 1 year and above 65 years of age were obtained having as reference the period with absent exposure.

As a second analysis, we transformed the relative frequency of bronchial emergencies for infants and old adults, into a grand mean above/below its 2 years of observation, obtaining a binary outcome variable. We modelled this outcome with generalised linear models with repeated measures using robust Poisson (0/1) distribution and a log link, obtaining rate ratios (RRs) of bronchial disease visits above the grand mean during the exposure period.

All multivariable models were adjusted by total number of emergency and urgency emergencies, healthcare centre level (ED compared with UCCs), and weather and air pollution information (source: Sistema de Información Nacional de Calidad del Aire35). Weather variables included maximum daily temperature in Celsius degrees and average relative humidity in percentage. Air pollution variables considered were particulate matter (PM) 2.5, PM 10, oxygen, sulfur dioxide, nitrogen dioxide and carbon monoxide. Weather and air pollution variables were centred in their median distribution.

Patient and public involvement
None.

RESULTS
A total of 728 days were analysed for each healthcare centre delivering urgent or emergency care. During 2018, the total amount of emergencies in the six healthcare centres included was 293,459 vs 302,372 in 2019. For the exposure period (19 October–31 December, both years), there was a 2018–2019 decrease of 5530 total emergencies or 9.3% (2018=59,242; 2019=53,712). These changes in absolute frequency support working with the outcome in relative frequencies.

Tables 1 and 2 display the relative frequencies (percentage) of respiratory emergencies in infants (table 1) and older adults (table 2) from the total number of respiratory emergency and urgency emergencies, in association with each predictive variable, and in two multivariable models: one controlled by PM 2.5 and another with PM 10. PM indicators were not included in the model together due to multicollinearity.

In infants (table 1), during the social uprising (exposure period), the percentage of emergencies rose from 5.74 to 6.98, a difference of 1.24 percentage points (95% CI: 1.13 to 1.36). In the fully controlled model, the difference rises slightly to 1.34 (model with PM 2.5) and 1.36 (model with PM 10) percentage points.

Similar results were observed for older adults (table 2), with a rise of 1.33 percentage points in respiratory emergencies (95% CI: 1.26 to 1.41) during the exposure period. Controlling for PM 2.5 and PM 10, 1.44 and 1.45 percentage points were the new slopes, respectively.

Air pollution and weather variables were significantly associated with infants’ and older adults’ outcomes (tables 1 and 2).

In the interaction between healthcare level and social uprising period (table 3), we observed a statistically significant increase on the relative frequency of respiratory emergencies by infants during the exposure period. In the case of respiratory ED visits, they rose by 1.67 percentage
points (95% CI: 1.46 to 1.90), while the respiratory UCC visits had an increment of 1.91 percentage points (95% CI: 1.58 to 2.28).

For bronchial diseases (acute bronchitis, acute bronchiolitis and obstructive bronchial crisis), the grand mean in infants was 0.85, while in older adults was 1.53 visits per day. For infants and older adults, the probability of bronchial diseases above their respective grand mean during the exposure period increased, 1.34 (95% CI 1.15 to 1.66), while in older adults, that probability is reduced to RR 0.11 (95% CI 0.09 to 0.14) (table 4).

DISCUSSION

In this study, we compared the relative frequency of respiratory emergencies in infants and older adults in ED and UCCs in the city of Concepción, Chile, during 2018 and 2019 to address the citizens’ concern about tear gas exposure during the social uprising of 2019.

We found an increment in the relative frequency of respiratory emergencies of approximately 1.4 percentage points in both age groups during the social uprising. This rise, if we consider the yearly average of respiratory emergencies in the period, could imply approximately 8000 more emergencies in this city.

We also found that bronchial diseases were more probable to rise above the grand mean during the social uprising in infants and older adults. These diagnoses were acute bronchitis, bronchiolitis and bronchial obstructive crisis, consistent with lower respiratory tract acute irritation documented in acute and chronic exposure to tear gas in adults.

To the best of our knowledge, no published literature can be interpreted as having findings not compatible with ours. Our results are consistent with the reports of chemical agents affecting the upper and/or lower respiratory tract, which at the same time are frequent causes for acute and long-term respiratory illness. Our results are also consistent with the findings related to direct and indirect exposure about tear gas developing respiratory symptomatology and similar to what was observed in occupational exposure. Though we did not analyse how many of the respiratory emergencies ended in hospitalisation, the increase in emergencies and diagnosis of lower respiratory tract illnesses during the period of exposure is suggestive of the repercussions that tear gas can have in respiratory health for vulnerable populations.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Univariable</th>
<th>Multivariable with PM 2.5 (intercept: 2.91; 95% CI 2.80 to 3.03)</th>
<th>Multivariable with PM 10 (intercept: 2.88; 95% CI 2.77 to 3.00)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Infants’ respiratory emergencies (%)</td>
<td>P value</td>
<td>Infants’ respiratory emergencies (%)</td>
</tr>
<tr>
<td>Social uprising</td>
<td>Yes</td>
<td>6.98 &lt;0.001</td>
<td>4.25 &lt;0.001</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>5.74 Ref</td>
<td>2.91 Ref</td>
</tr>
<tr>
<td>Healthcare level</td>
<td>ED</td>
<td>9.04 &lt;0.001</td>
<td>9.63 &lt;0.001</td>
</tr>
<tr>
<td></td>
<td>UCC</td>
<td>3.07 Ref</td>
<td>2.91 Ref</td>
</tr>
<tr>
<td>Total number of emergencies</td>
<td>1.01 &lt;0.001</td>
<td>1.00 0.01</td>
<td>1.00 0.01</td>
</tr>
<tr>
<td>PM 2.5†</td>
<td>1.00 0.07</td>
<td>1.00 0.02</td>
<td>— —</td>
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<tr>
<td>PM 10†</td>
<td>1.00 0.12</td>
<td>— —</td>
<td>— —</td>
</tr>
<tr>
<td>Ozone†</td>
<td>1.00 0.22</td>
<td>0.98 &lt;0.001</td>
<td>0.99 0.19</td>
</tr>
<tr>
<td>Sulfur dioxide†</td>
<td>1.00 0.94</td>
<td>0.99 0.19</td>
<td>0.99 0.24</td>
</tr>
<tr>
<td>Nitrogen dioxide†</td>
<td>1.00 0.12</td>
<td>1.00 0.09</td>
<td>1.00 0.11</td>
</tr>
<tr>
<td>Carbon monoxide†</td>
<td>1.05 0.43</td>
<td>1.10 &lt;0.001</td>
<td>1.10 &lt;0.001</td>
</tr>
<tr>
<td>Maximum temperature (°C)*</td>
<td>1.02 &lt;0.001</td>
<td>1.01 0.07</td>
<td>1.01 0.07</td>
</tr>
<tr>
<td>Relative air humidity (%)†</td>
<td>1.00 0.07</td>
<td>1.00 0.01</td>
<td>1.00 0.01</td>
</tr>
</tbody>
</table>

Each healthcare centre was observed for at least 680 days for a total of n=4103 days in the PM 2.5 model and n=4133 days in the model with PM 10.

P values are presented for continuous measures.

*Centred on the distribution median.
†Daily average.
‡Approximately 684 days of observation for each healthcare centre.
§Approximately 689 days of observation for each healthcare centre.
AIC, Akaike Information Criteria; ED, emergency department; PM, particulate matter; UCCs, urgent care centres.
A major advantage of our research is its repeated measures design. Previous studies have reported the effects of tear gas using single-case studies or a small group of hospital patients.\textsuperscript{10,11,19} Another study mentions the increase of hospital visits related to tear gas exposure; however, their records were not compared with other periods or places without exposure.\textsuperscript{12} A case series with a follow-up of persistent symptoms after receiving emergency care due to tear gas exposure evidenced health consequences but did not have a comparison group either.\textsuperscript{8} Our study included a large population with a 2-year follow-up comparison period with and without exposure.

We reviewed two studies with an exposed and unexposed comparison group. One of them found no evidence of long-term effects of tear gas exposure but its comparison group was one of exposed bystanders, which potentially could have pushed results towards the null.\textsuperscript{7} The other study had a group of patients with and without exposure and studied long-term effects of tear gas, finding higher rates of deleterious effects in those exposed—significant even with a small sample size.\textsuperscript{8} We did...
not study long-term effects, but we did compare periods of exposure in bystanders (infants and older adults) and we found a detrimental effect to health, consistent with the findings in bystanders reported by Koul et al.6

Our study supports the hypothesis that massive use of tear gas can induce respiratory diseases. Especially, the CS component of tear gas has been demonstrated to have deleterious effects in the respiratory tract, affecting a mechanism associated with transient receptor potential ankyrin 1 channels that also are expressed in the nervous system, cardiovascular system and gastrointestinal tract, among other organs.13–15

The stratified results by healthcare level of the centre showed a higher increment in respiratory visits in ED than in UCCs in infants. Regardless of exposure status, infants and older adults tend to use the ED more than the UCCs, but during the exposure period, this tendency got potentiated in infants and not in older adults. One possible reason is that parents could have judged their infants’ respiratory problem as in need of more specialised care. This does not mean necessarily that the respiratory problems were more severe, since ED will rarely refuse to give care to a patient. However, in a low-risk-level emergency visit, the patient could experience an important delay in healthcare provision.

The influence in emergencies due to environmental air pollutants has been previously documented. Outdoor air pollutants such as PM 2.5 and ozone are directly associated with emergencies in ED due to respiratory symptoms. This association varies by age, with ozone and fine PM having an important association in children.35

Other possible explanations for the increase in respiratory emergencies in infants and older adults were controlled in the statistical models. Nonetheless, data suggest that in cities where weather does not greatly vary between seasons, respiratory emergencies are not impacted by temperature and relative air humidity.26 We included these variables in the model because they improved precision and adjustment.

Our analysis included the period of seasonal respiratory infections and allergy season corresponding to the southern hemisphere for years 2018 and 2019. The respiratory infection season starts in April–May, lasts until July–August and tends to have large variations from 1 year to the other, while the allergy season is usually from September to October. To account for the possible effect of these variations, we included all days in the previous year and analysed the data with a repeated measures design. Consistently, in our analysis, we did not see an increase in infectious or in higher respiratory tract diseases during the exposure period. Even having information from both years, the comparison between 2 years might have overestimated or underestimated the association between tear gas use and emergencies with respiratory diseases.

If the increase in respiratory emergencies in infants were to be induced by parents’ fear or anxiousness for the context, all causes for emergencies should have increased too, but this was not the case. In older adults, this was also

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Bronchial diseases in infants (intercept: 0.167; 95% CI 0.153 to 0.182) AIC=5334</th>
<th>Bronchial diseases in older adults (intercept: 0.137; 95% CI 0.123 to 0.152) AIC=5815</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RR</td>
<td>P value</td>
</tr>
<tr>
<td>Social uprising</td>
<td>Yes 1.34 &lt;0.001 1.145 to 1.563</td>
<td>No 1.00 Ref —</td>
</tr>
<tr>
<td>Healthcare level</td>
<td>ED 1.40 &lt;0.001 1.190 to 1.656</td>
<td>UCC 1.00 Ref —</td>
</tr>
<tr>
<td>Total emergency department emergencies</td>
<td>1.00 &lt;0.001 1.003 to 1.004</td>
<td>1.01 &lt;0.001 1.009 to 1.010</td>
</tr>
<tr>
<td>PM 2.5*</td>
<td>1.00 0.49 0.997 to 1.007</td>
<td>1.00 0.34 0.998 to 1.007</td>
</tr>
<tr>
<td>Ozone*</td>
<td>1.00 0.90 0.989 to 1.010</td>
<td>1.00 0.85 0.990 to 1.008</td>
</tr>
<tr>
<td>Sulfur dioxide*</td>
<td>0.98 0.14 0.947 to 1.008</td>
<td>0.98 0.27 0.954 to 1.013</td>
</tr>
<tr>
<td>Nitrogen dioxide*</td>
<td>0.99 0.25 0.979 to 1.006</td>
<td>1.00 0.56 0.991 to 1.016</td>
</tr>
<tr>
<td>Carbon monoxide*</td>
<td>0.89 0.18 0.742 to 1.059</td>
<td>0.75 &lt;0.001 0.632 to 0.878</td>
</tr>
<tr>
<td>Maximum temperature (°C)*</td>
<td>0.93 &lt;0.001 0.910 to 0.939</td>
<td>0.92 &lt;0.001 0.909 to 0.936</td>
</tr>
<tr>
<td>Relative air humidity (%)*</td>
<td>1.00 0.25 0.998 to 1.006</td>
<td>1.00 0.63 0.997 to 1.005</td>
</tr>
</tbody>
</table>

Results expressed in RRs from multivariable robust Poisson GLMs. *Centred on the distribution median.
AIC, Akaike Information Criteria; ED, emergency department; GLMs, generalised linear models; PM, particulate matter; RRs, rate ratios; UCC, urgent care centre.
the only health problem that was more frequent during the exposure period. In contrast with the infants’ situation, older adults can often decide for themselves if their health situation requires attention or not. The specificity of the exposure and diagnoses make us feel confident that the observed increase was produced by tear gas exposure, limiting other possible explanations, in concordance with systematic reviews that had concluded that the use of this chemical is hard to control and unsafe for respiratory health in populations.3–5

Exposure misclassification is highly probable since we used a time proxy for tear gas assessment, resulting in the exposure measurement being the period in which the social uprising occurred, and this should have brought the effect towards the null value. However, significant results in the expected direction were found. Data from six healthcare departments delivering urgent and emergency care, all at different locations covering the downtown area of the same city, were used during the analysis. There are no bases to surmise that all neighbourhoods included had the same or even similar levels of exposure on a day-to-day basis. The decision to consider this proxy as exposure came from anecdotal information and was used due to the absence of alternatives21 24, and evidence showing that measuring changes in the burden of disease across cities or time can be very informative about respiratory-damaging exposures.37 This simple counterfactual model showed significant increases of respiratory emergencies in studied populations of the city during the social uprising period. It would have been ideal to compare the exposure period with the period after, when protests subside, but that period overlaps with the beginning of the SARS-CoV-2 pandemic.

To perform a similar comparison of the respiratory diagnosis attendance rate in the October–December 2019 period among hospitals in places exposed to tear gas versus other unexposed, further research would be relevant and significant.

The low number of visits during some days makes it more difficult to detect a significant association between exposure and outcome because of increased SE size. Nonetheless, our results were significant.

The use of emergency records from six facilities is a strong independent measurement of respiratory diseases in all ages. These diagnoses are recorded in cases after an initial screening process classifying cases as low, medium or high-risk level. All patients attended received medical care, and physical and laboratory examinations to determine the diagnosis. Therefore, the diagnostic process is consistent across cases, facilities and time. In case a patient needs specialised care, the patient will be transferred from a UCC to the ED without going through the screening process again, thus avoiding duplicate records.

CONCLUSIONS

Acute and chronic respiratory injuries due to tear gas exposure have been described in the adult population with acute and intense exposure to tear gas. During weeks of political unrest between October and December of 2019 in Chile, the police extensively used tear gas in residential areas to disperse multitudes in demonstrations against social injustice. Residents, not necessarily demonstrators, were exposed, and multiple symptoms were reported by news organisations and social media.

Our study supports an increase in short-term respiratory emergencies due to tear gas use in residential areas. The long-term impact is yet unknown. We recommend modifying public policy to severely restrict or ban the use of tear gas to protect vulnerable populations.

Respiratory diseases can lead to chronic conditions, worsen chronic illness and decrease quality of life in both groups and their families. The use of tear gas during protests causes involuntary exposure, which increases the burden of diseases for local public health organisations/facilities. This cause of diseases is preventable and completely within the reach of local and national governments to be reduced or even eliminated.

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Contributors PAH, MC, MG and TU-A are responsible for the main research idea, design, manuscript writing, data analysis and data interpretation, drafting and reviewing the main document, and approval of the final version to be published, and are accountable for the accuracy and integrity of the work presented. PAH is responsible for the overall content as the guarantor.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Ethics approval This study involves human participants and IRB approval was obtained from Regis College (study number 20202021-9) and from Universidad de Concepción (Proyecto IRID no 202000133MUL). Data are publicly available and de-identified. They were extracted from the registry of emergency visits to public healthcare centres; for each visit, sex, age group (<1, 1–4, 5–14, adults 15–64, and older adults 65 years and above), date, healthcare centre and diagnosis (ICD-10) are recorded. These records are kept by a governmental agency and can be downloaded for research and public policy endings at http://cognos.deis.cl. Data about air quality conditions are publicly available and may be obtained from the National Information System of Air Quality (SINCA) in the web page: https://sinca.mma.gov.cl/.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. All data about UCC and ED visits are publicly available and previously de-identified, and may be obtained from the Chilean governmental agency Departamento de Estadísticas e Información en Salud DEIS in the web page: http://cognos.deis.cl. Data about air quality conditions are publicly available and may be obtained from the National Information System of Air Quality (SINCA) in the web page: https://sinca.mma.gov.cl/.
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