Impact of COVID-19 lockdowns on the number of residential fires in Catalonia

Òscar Saladié and Edgar Bustamante-Picón
Department of Geography, Universitat Rovira i Virgili, Vila-seca, Spain

Received 27 August 2023
Revised 1 February 2024
24 December 2024
25 February 2025
Accepted 22 March 2025

Abstract

Purpose – This article analyses how lockdowns during the COVID-19 pandemic impacted in residential fire numbers in 2020 in Catalonia, Spain, and how their temporal distribution changed throughout the year. The results stand to inform public authorities responsible for emergency prevention and to generate new streams of research on residential fires during the pandemic and beyond.

Design/methodology/approach – We compared the number of residential fires in 2020 with the number of fires in the two previous years (i.e. 2018 and 2019) and in 2021, both throughout full years and in five subperiods identified by analysing daily residential fire anomalies. We also analysed differences in the number of residential fires on weekdays versus weekends and in four daily time slots.

Findings – The results show a reduction of more than one-third in the first two weeks of the first lockdown in mid-March 2020 and of more than one-quarter in the first half of the second lockdown in autumn 2020. The pandemic's positive indirect impact was short-lived, even more so than the reduction in pollutants discharged into the atmosphere and the decrease in the number of traffic accidents and injuries.

Originality/value – To our knowledge, our study was the first to involve a temporal analysis of the incidence of residential fires in Catalonia as impacted by COVID-19 lockdowns.

Keywords COVID-19 pandemic, Lockdown, Residential fires, Temporal analysis, Catalonia

Paper type Research paper

1. Introduction

Every year, nearly 200,000 people die due to burns from flames or smoke, hot liquids or hot solids (World Health Organization, 2018), usually in the home or workplace (Fire Service Academy, 2018). Along with deaths, material damage, economic losses and injuries are other consequences of fires in buildings (Harvey *et al.*, 2020; Van Coile *et al.*, 2023).

Aside from intentional fires, the chief causes of accidental fires at home are cooking, heating equipment, electrical systems and electronic devices, smoking materials and candles (National Fire Protection Association, n.d.). Certain risk factors increase the probability of residential fires. In an extension of the model proposed by Jennings (1999), Corcoran *et al.* (2011b) developed a conceptual model of fires that includes seven factors—dwelling characteristics, physical environment, neighbourhood characteristics, weather conditions, calendar events, individual behaviour and group behaviour—and differentiated direct factors from mediating ones.

Moreover, following a comprehensive literature review, Jennings (2013) concluded that, according to research undertaken during the last third of the 20th century, the incidence of fires varied primarily according to residents' socioeconomic characteristics and secondarily according to housing and neighbourhood conditions. However, in light of research performed in the early 21st century, building and stock characteristics also now need to be considered.

We wish to thank Catalonia's Directorate-General of Fire Prevention, Extinction and Rescue for providing data about residential fires.

Funding: This work was supported by a grant (AGAUR 2021-SGR-00657).

International Journal of Emergency Services
Vol. 14 No. 2, 2025
pp. 198-210
Emerald Publishing Limited
e-ISSN: 2047-0908
p-ISSN: 2047-0894
DOI 10.1108/IJES-08-2023-0040

Most recently, Ghassempour *et al.* (2022) have grouped risk factors of residential fires and fatalities into four categories: fire circumstances, built environment, individual characteristics and socioeconomic conditions.

First, regarding fire circumstances, electrical failure, cooking-related activities, smoking materials and combustible items placed too close to heating systems can start residential fires (Ahrens, 2008; Xiong *et al.*, 2017). Second, regarding the built environment, the risk of fire is relatively high in dilapidated flats and apartments in multistorey buildings containing mattresses, bedding and upholstered furniture (Masoumi *et al.*, 2019; Thomas and Butry, 2016; Xiong *et al.*, 2015), especially in old neighbourhoods (Granda and Ferreria, 2019).

Third, regarding individual characteristics, the risk of residential fires is relatively higher for older and young people, men, unemployed individuals and people with a low level of education or alcohol and/or smoking addiction (Chikritzhs and Livingston, 2021; Corcoran *et al.*, 2011a; Harpur *et al.*, 2013; Jonsson and Jaldell, 2020; Nilson and Bonander, 2021; Runefors and Nilson, 2021; Taylor *et al.*, 2023; Untadi *et al.*, 2023). Fourth and finally, regarding socioeconomic conditions, the risk of residential fires and their health-related consequences is higher in more socioeconomically disadvantaged areas (Bispo *et al.*, 2023; Spatenková and Virrantaus, 2013; Vachuska, 2023), which can be more easily differentiated in urban areas than in rural ones (Hossain and Smirnov, 2023).

Certain temporal patterns also have to be taken into account when evaluating the risk of residential fires. By season, residential fires most often occur in the winter (Corcoran *et al.*, 2011b). By time of day, most residential fires occur during the evening in Finland (Spatenková and Virrantaus, 2013) but in the morning in India (Singh *et al.*, 2021).

Knowledge about all of those risk factors can aid public authorities in designing and implementing preventive measures to reduce the risk of residential fires and their consequences (Al-Hajj *et al.*, 2023) and thereby make urban communities more resilient (Dinić, 2023), at least under normal circumstances. However, on the global scale, neither governments nor citizens expected what began to unfold in China in late 2019 and later broke out worldwide during the first quarter of 2020: the COVID-19 pandemic.

To manage the health threats posed by the COVID-19 pandemic, national governments responded by imposing lockdowns that drastically altered the mobility of their populations (Benita, 2021). Although the lockdowns induced some short-term environmental improvements (Menut *et al.*, 2020), they also exerted a range of negative social and economic impacts (Ugur and Akbiyik, 2020). Lockdowns with especially severe restrictions also influenced the incidence of emergencies in, for example, the Indian city of Nagpur, Maharashtra (Singh *et al.*, 2021), and in the Canadian city of Vaughan, Ontario (Asgary *et al.*, 2023), some of which were residential fires (Solis *et al.*, 2021).

The incidence of residential fires and fire injuries decreased during the COVID-19 restrictions in England compared with the previous year (Francis *et al.*, 2024). Suzuki and Manzello (2022a) also observed that residential fires declined in Tokyo and San Francisco and remained stable in number in London and New York. Because more people were at home, residential fires were prevented before calls to fire and rescue services were required (Francis *et al.*, 2024). By contrast, Suzuki and Manzello (2022b) concluded that residential fires increased at the beginning of the three lockdowns in London. Based on their results, they argued that residential fires increased in incidence during lockdowns precisely because more people were at home and spending more time cooking, which generally raises the risk of residential fires. They attributed the conflicting results between cities due to cultural differences and differences in the measures adopted during the lockdowns.

Considering all of the above, in our study we sought to examine how lockdowns during the COVID-19 pandemic influenced the number of residential fires in Catalonia, Spain. In our analysis, we compared the number of residential fires during several periods in 2020 with equivalent periods in a reference set of years, as well as on weekdays versus weekends and according to hourly distributions.

2. Context of the study

In response to the imminent COVID-19 pandemic, a state of alarm was decreed by the Spanish government on 14 March 2020 (Boletín Oficial del Estado, 2020). Although intended to be enforced for 15 days only (i.e. 16–29 March), the state of alarm was incrementally extended through 21 June 2020. Restrictions throughout the period varied, however. On 28 April 2020, for instance, the national government approved the "Plan for the Transition to a New Normal" (Ministerio de Sanidad, 2020).

The plan was based on several phases. The first, encompassing 4–10 May, was dedicated to maintaining general measures to minimise public health risks. The second, spanning from 11 May to 30 June, was dedicated to gradually reopening the economy. The third, dubbed the "new normal period" and involving the establishment of new social practices, began on 1 July and ended on 15 September. Last, at the beginning of the school year in mid-September, people had to engage in the new practices, now supported by modified security measures. However, owing to rising rates of infection over the summer, the government announced a new lockdown that entered into force on 25 October 2020 and ended on 9 May 2021, albeit with restrictions far less strict than the ones during the first lockdown.

The Directorate-General of Fire Prevention, Extinction and Rescue Services (DGPEIS) oversees the Catalan Fire Department, a public entity that responds to emergencies across the entirety of Catalonia except in Barcelona, a city with its own fire department. Despite its independent functioning, the Catalan Fire Department helps Barcelona's, and vice versa, when necessary.

Catalonia's Centre for Attention and the Management of Emergency Calls centralises all emergency calls received via the telephone number 112, classifies them according to the type of intervention required and, in turn, activates the appropriate resources according to the type of emergency. In urban areas, the Catalan Fire Department is committed to arriving at the site of the emergency in 20 min maximum upon receiving the emergency call (Bombers Generalitat de Catalunya, 2009). Such a response time helps to ensure the safety of lives and the protection of property (Manes and Rush, 2022).

3. Data and methods

The DGPEIS facilitated our collection of data regarding residential fires that occurred in Catalonia, excluding Barcelona, in 2018, 2019, 2020 and 2021. The data provided for each residential fire consisted of the date (i.e. day, month and year) and time when the fire was reported. We compared the number of residential fires in 2020 with those in the two previous years (i.e. 2018 and 2019) and the subsequent year (i.e. 2021). In addition, to determine subperiods with different patterns, whereas Solis *et al.* (2021), Suzuki and Manzello (2022b) and Asgary *et al.* (2023) analysed subperiods based upon public health measures introduced by governments, we calculated daily anomalies (i.e. number of residential fires on each day in 2020 minus the mean of the number of residential fires on the same day in 2018, 2019 and 2021) and detected breakpoints by using a temporal series that included cumulative sum charts and performing a bootstrapping analysis in the Change-Point Analyzer software package version 2.3 (Taylor Enterprises). That method has been thoroughly explained by Poblete *et al.* (2013) and employed by Saladié *et al.* (2023) to analyse traffic accidents.

Next, we analysed the temporal distribution of residential fires (i.e. daily, weekdays vs. weekends and the time when the Catalan Fire Department was activated) and differentiated four 6-hour homogeneous time slots: 06:01–12:00 (i.e. morning), 12:01–18:00 (i.e. afternoon), 18:01–00:00 (i.e. evening) and 00:01–06:00 (i.e. night).

The application of the D'Agostino-Pearson test shows that the shape of the distribution of residential fires is not similar to the shape of the normal distribution. We performed the non-parametric Kruskal–Wallis test (i.e. one-way ANOVA on ranks) to determine whether the differences were statistically significant. The test examines the null hypothesis that when selecting a value from each of n groups, each one of those groups will have an equal probability

of having the highest value. The Kruskal–Wallis test determines whether the difference between the ranks reflects a significant difference between the groups or is due to random noise within each group. We also performed Dunn's multiple comparison test (i.e. post hoc non-parametric test to be run after an ANOVA) to clarify whether the mean ranks of any of the six following pairs were significantly different: 2020 versus 2018, 2020 versus 2019, 2020 versus 2021, 2018 versus 2019, 2018 versus 2021 and 2019 versus 2021. Afterwards, we performed the chi-square test (χ^2) to analyse whether the differences in the distribution of residential fires were significant when weekdays were compared with weekends and when the various time slots were compared with each other.

4. Results

From 1 January to 31 December 2020, 4,218 residential fires—on average, 11.52 per day—occurred in Catalonia that involved the intervention of the Catalan Fire Department (Table 1). The number of residential fires in 2020, the year comprising the COVID-19 lockdowns, decreased by 11.04% compared with the daily mean of 12.95 fires per day in 2018, 2019 and 2021 combined. The figures within the reference period varied from 12.64 fires per day in 2018 to 13.24 fires per day in 2019, for an increase of 4.75%. The differences between the four year-based samples were statistically significant ($H = 27.5134$, $p < 0.01$). Nevertheless, when all of the possible pairs were analysed, the mean ranks were significantly different only when 2020 was in the pair (i.e. 2020 vs. 2018, 2020 vs. 2019 and 2020 vs. 2021).

The cumulative numbers of residential fires in 2020 and in each of the three years in the reference period appear in Figure 1. As shown, the lines for all years follow a similar pattern until mid-March, when the state of alarm and several restrictions on mobility entered into effect in 2020. From that point, the line for 2020 shows a deceleration in the accumulation of fires compared with the reference years, which creates a gap between 2020 and the reference years that lasted until the end of the year.

Figure 2 depicts daily residential fires from Friday 3 January to Sunday 27 December 2020 and the mean for the reference period. To appropriately compare the plots (i.e. by starting and ending on the same weekday), we calculated the average values for 2018, 2019 and 2021 from Friday 5 January 2018, Friday 4 January 2019 and Friday 1 January 2021, respectively. Both series revealed the same general pattern. The number of daily residential fires peaked at the beginning of January and at the end of December—winter accounted for one-third of the total—and decreased until the end of spring. A slight upturn occurred in mid-summer, followed by a new decrease from August to the beginning of autumn. The lowest number of residential fires in the reference period occurred during the summer (21.27%) but in 2020 occurred in autumn (20.89%), and the figure for spring 2020 was only slightly higher than that for summer (22.35% vs. 22.17%).

However, Figure 2 does not depict subperiods with different patterns in relation to the period of lockdowns declared by the national government. Thus, we analysed the daily

Table 1. Annual and daily mean number of residential fires in 2020 compared with the reference period (i.e. 2018, 2019 and 2021)

Period	Total	Daily mean
2020	4,218	11.52
Reference period	4,727	12.95
2018	4,612	12.64
2019	4,833	13.24
2021	4,736	12.97

Source(s): Authors' own work

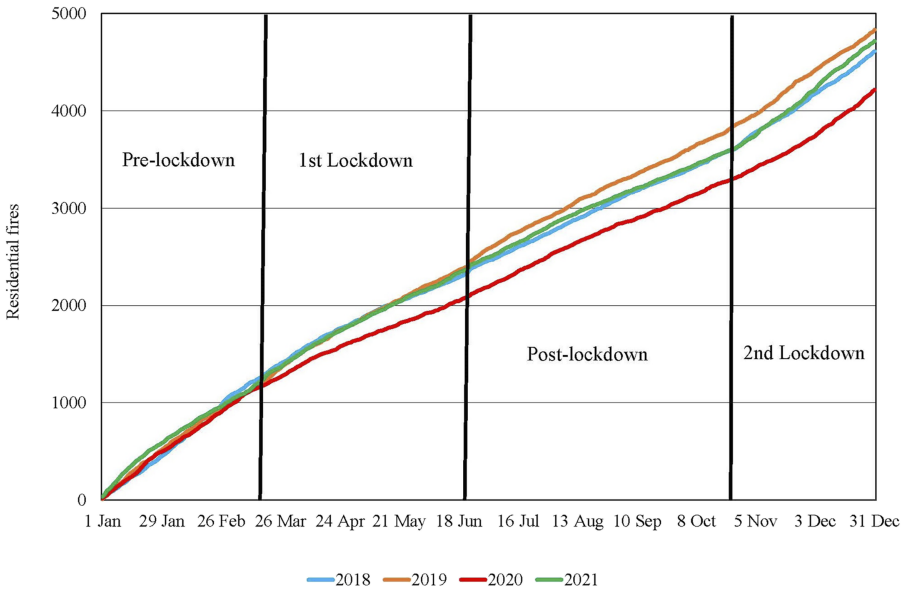

Figure 1. Cumulative number of residential fires in Catalonia in 2018, 2019, 2020 and 2021. Source: Authors' own work

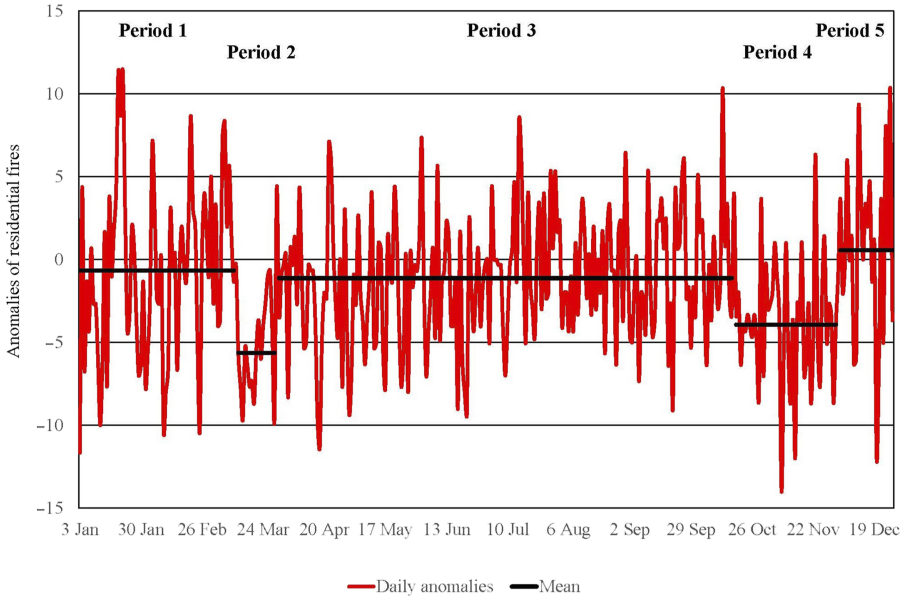

Figure 2. Daily residential fires in Catalonia for 2020 compared with an equivalent period in 2018, 2019 and 2021 combined. Source: Authors' own work

anomalies in 2020 in relation to values representing the reference period and detected four change points: 13 March (CL 100%), 30 March (CL 100%), 19 October (CL 100%) and 3 December (CL 100%). Subsequently, we defined five periods with different patterns, shown in Figure 3.

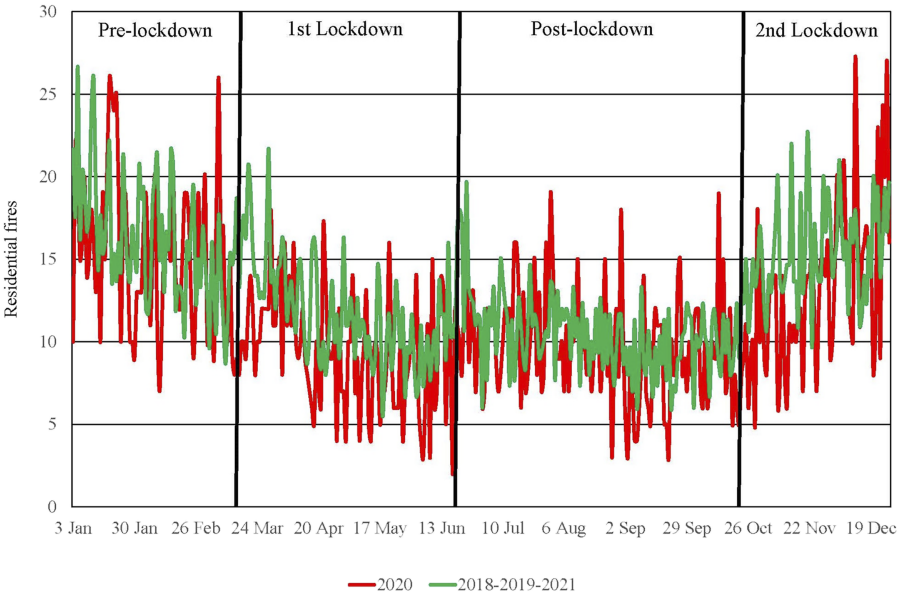

Figure 3. Daily anomalies of residential fires (i.e. 2020 minus the reference period) and periods with different patterns. Source: Authors' own work

During Period 1 (i.e. 3 January–12 March), the mean of anomalies was slightly less than 0, for a decline of 4.06% in the number of residential fires. The daily mean for the Period 1 was 16.20 in the reference period compared with 15.54 in 2020. The difference between the ranks reflects no significant difference between the four groups ($H = 1.864$, $p = 0.601$).

Period 2 (i.e. 13–29 March) was a short period with an abrupt 35.09% reduction in the number of residential fires. The daily mean for the Period 2 was 16.04 in the reference period compared with only 10.41 in 2020. The difference between the ranks reflects a significant difference in the dependent variable between the four years ($H = 21.6251$, $p < 0.01$). The mean ranks of three pairs that differed significantly all contained 2020.

In the long Period 3 (i.e. 30 March–18 October), the means of the anomalies remained below 0, and the number of residential fires for those 203 days in 2020 dropped by 10.50% in relation to the reference period. The daily mean for the Period 3 was 10.72 in the reference period compared with 9.59 in 2020. The difference between the ranks reflects a significant difference in the dependent variable between the four years ($H = 22.1969$, $p < 0.01$). Nevertheless, only the mean ranks of two pairs differed significantly: 2018 versus 2019 and 2019 versus 2020.

Next, in Period 4 (i.e. 19 October–2 December), a new sudden 27.02% reduction in number of residential fires occurred, with the mean of anomalies well below 0. The daily mean for the Period 4 was 14.56 in the reference period compared with only 10.62 in 2020. The difference between the ranks reflects a significant difference in the dependent variable between the four years ($H = 21.2646$; $p < 0.01$). Similar to Period 2, the mean ranks of the pairs that were significantly different were only the three containing 2020.

Last, in Period 5 (i.e. 3–27 December) the daily mean was 16.04 in the reference period compared with 16.60 in 2020. The mean of the anomalies slightly exceeded 0, for an increase of 3.49%. As in Period 1, the difference between the ranks reflects no significant difference between the four groups ($H = 5.927$; $p = 0.115$).

Table 2 shows the distribution of residential fires that occurred on weekdays versus weekends. The daily mean on weekdays for the whole year was 12.07 in the reference period

Table 2. Daily mean number and weekday versus weekend distribution of residential fires for several periods in 2020 and for equivalent periods within the reference period (i.e. 2018, 2019 and 2021)

	$\bar{x}$ reference period		2020	
	Weekday	Weekend	Weekday	Weekend
Period 1	14.64 (63.70%)	19.92 (36.30%)	14.43 (64.98%)	18.14 (35.02%)
Period 2	15.00 (58.68%)	17.79 (41.32%)	10.00 (62.15%)	11.17 (37.85%)
Period 3	10.35 (66.58%)	11.54 (33.42%)	9.65 (68.93%)	9.45 (31.07%)
Period 4	13.39 (65.39%)	17.44 (34.61%)	10.15 (70.08%)	11.92 (29.92%)
Period 5	14.91 (53.28%)	17.56 (46.72%)	15.33 (55.42%)	18.50 (44.58%)
Year	12.07 (64.09%)	14.65 (35.91%)	11.03 (66.36%)	12.22 (33.64%)

Source(s): Authors' own work

compared with 11.03 in 2020; during weekends, it was 14.65 in the reference period compared with 12.22 in 2020. The reduction in the number of residential fires in 2020 was thus greater on weekends than on weekdays. The greatest difference was observed when we compared residential fires (2020 vs. reference period) on weekends during Period 2 (−37.23%), when the daily mean fell from 17.79 to 11.17. The reduction in residential fires during weekdays was also notable (15 vs. 10).

Regarding changes in their distribution, the difference was not statistically significant ($\chi^2 = 10.5603$, $p = 0.454133$). The greatest difference (2020 vs. reference period) was also observed for weekends when we compared Period 4 (−31.65%). The change in distribution between weekends and weekdays in Period 4 was also not significant ($\chi^2 = 2.8233$, $p = 0.092904$).

The hourly distribution of residential fires is shown in Table 3. Three-quarters of the fires occurred in the afternoon and evening during the reference period. There was a decrease in the four time slots, with the highest drop in the morning (−19.32%). The afternoon and evening time slots accounted for the same proportion of fires in 2020 as in the reference period.

Regarding the two subperiods with anomalous patterns, Period 2 showed a greater fall in the evening (−42.73%) than in the afternoon (−25.24%). The latter time slot accounted for

Table 3. Daily mean number and distribution of residential fires by time slots for several periods in 2020 and the equivalent periods within the reference period (i.e. 2018, 2019 and 2021)

$\bar{x}$ RP	06:01–12:00	12:01–18:00	18:01–00:00	00:01–06:00
Period 1	2.68 (16.52%)	5.76 (35.57%)	6.44 (39.77%)	1.32 (8.14%)
Period 2	2.31 (14.43%)	6.06 (37.77%)	6.47 (40.34%)	1.20 (7.46%)
Period 3	1.82 (16.99%)	4.00 (37.36%)	3.65 (34.03%)	1.24 (11.62%)
Period 4	2.36 (16.24%)	5.67 (38.93%)	5.26 (36.13%)	1.27 (8.70%)
Period 5	2.68 (16.71%)	5.97 (37.24%)	6.05 (37.74%)	1.33 (8.31%)
Year	2.14 (16.60%)	4.79 (37.16%)	4.69 (36.42%)	1.27 (9.82%)
2020	06:01–12:00	12:01–18:00	18:01–00:00	00:01–06:00
Period 1	2.61 (16.82%)	5.73 (36.86%)	6.06 (38.97%)	1.14 (7.35%)
Period 2	1.71 (16.39%)	4.53 (43.50%)	3.71 (35.59%)	0.47 (4.52%)
Period 3	1.40 (14.64%)	3.67 (38.21%)	3.33 (34.77%)	1.19 (12.38%)
Period 4	1.62 (15.27%)	4.09 (38.50%)	4.16 (39.12%)	0.76 (7.11%)
Period 5	2.04 (12.29%)	6.52 (39.28%)	6.72 (40.48%)	1.32 (7.95%)
Year	1.73 (15.13%)	4.36 (38.22%)	4.22 (37.00%)	1.10 (9.65%)

Source(s): Authors' own work

more than 43% of the residential fires, and it along with the evening accounted for nearly four-fifths of all fires, primarily due to the abrupt decrease in fires at night (−60.66%). In Period 4, the decrease in the numbers of residential fires was greater in the afternoon (−27.84%) than in the evening (−20.99%). The decreases in the morning and night were greater than in the afternoon and evening, but the two former time slots accounted for only one-quarter of the residential fires. Nevertheless, no change in the distribution of residential fires in the time slots was statistically significant.

5. Discussion

Our findings show that the lockdown declared by Spain's national government on 14 March 2020, as a measure to contain the spread of COVID-19, was responsible for a significant reduction in residential fires in Catalonia throughout 2020. It can be expected that, without extreme anomalies such as the pandemic, the number of residential fires varies from year to year, from season to season and between different times of day but not to any statistically significant degree. Indeed, we compared the number of residential fires for the three years within the reference period (i.e. 2018, 2019 and 2021), and their differences were not significant.

The numbers of residential fires in periods throughout the year can obscure various temporal behaviours. Abrupt changes occur due to global or regional anomalies, and, in 2020, one such anomaly was the COVID-19 pandemic or, more precisely, the related lockdowns. The decrease in the number of the residential fires at the beginning of the lockdown in March 2020 has been documented in the literature (Asgary *et al.*, 2023; Singh *et al.*, 2021; Solis *et al.*, 2021; Suzuki and Manzello, 2022a). Nevertheless, making quantitative comparisons is difficult due to differences at the beginning and over the course of the lockdowns, the rigour of restrictions announced by governments worldwide and the approaches adopted.

The change point in Catalonia occurred on 13 March 2020. From the beginning of the year to 12 March, the temporal pattern of residential fires can be considered to reflect normal behaviour for that part of the winter. The decrease in residential fires began one day before the national government decreed the lockdown and three days before it went into force. Some people began reducing their mobility by staying at home regardless of whether such a measure was recommended or enforced by public authorities. In that sense, it seems that, unlike outcomes observed in London (Suzuki and Manzello, 2022b), the number of residential fires decreases when people spend more time at home. As stated by Francis *et al.* (2024), more working-age adults could therefore notice when an accidental fire might start or had started. During lockdowns, urban mobility was limited to so-called essential workers and people working in economic sectors or for specific purposes other than leisure and tourism.

During 13–29 March 2020, the number of residential fires fell by more than one-third compared with the equivalent period within the reference period. Although the period falls within the winter, according to the Catalan Meteorological Service the anomalies in temperature in March 2020 were not colder than the anomalies in March 2018, 2019 or 2021 (Meteocat, 2023). The greater presence of people at home and thus cooking and using heating did not result in a greater increase of fires or, at least, of emergency calls. On the contrary, they decreased. The threat of some potential fires was resolved at an early stage precisely because people were at home, and those fires went unreported (Ghassempour *et al.*, 2021). The need for heating in Catalonia, especially in major urban areas located in or near the Mediterranean Sea, is not as high as in cities with more severe winters such as New York City, Tokyo and London (Suzuki and Manzello, 2022a). At the same time, cooking at home is a tradition rooted in Mediterranean cultures such as Catalonia's regardless of situations generated by lockdowns. That difference should be taken into account when comparing the results observed in other territories and cities.

The extremely short Period 2 (i.e. 17 days) was followed by a long Period 3 lasting 203 days, namely from 30 March to 18 October. The number of residential fires nevertheless

remained below the mean for the equivalent period in 2018, 2019 and 2021 combined. As mentioned, there was a significant difference in the dependent variable between the four years but only the mean rank of two of the three pairs that differed significantly contained 2020. The potential impact of the lockdown, which continued until the end of June, in the number of residential fires in Catalonia is blurred by interannual variability. Those results conflict with Saladié *et al.*'s (2023) findings in the case of traffic accidents in Catalonia; traffic accidents abruptly decreased at the beginning of the lockdown, with very low numbers during the so-called hard lockdown (i.e. 17 March–3 May), and achieved the numbers prior to the lockdown only at the beginning of September 2020. The first lockdown in Spain impacted traffic accidents, as well as mobility, more profoundly and for longer than residential fires.

Our analysis revealed a new anomalous period (i.e. with numbers less than those in the reference period) spanning from 19 October to 2 December 2020, when the number of residential fires was more than one-quarter less than in the equivalent reference period. A second lockdown began on 25 October, six days later than our change point; however, as mentioned, the restrictions were not as severe as the ones in the first lockdown. The fact that people spent more time at home due to the second lockdown contributed to the decrease in residential fires. At the same time, we should highlight that November 2020 was warmer than November 2018, 2019 and 2021 (Meteocat, 2023). Added to that, the need for heating in October is limited to less densely populated areas located in the north at high altitudes above sea level. Moreover, the number of residential fires in Period 5 (i.e. December 2020) was equivalent to the number that occurred in the same period during the reference period.

The drop in the number of residential fires in 2020 was greater on weekends than on weekdays, especially at the beginning of the lockdown (i.e. Period 2). Regarding the time of the day when residential fires occur, our results show that, in a non-anomalous year, the distribution between the afternoon and evening time slots was quite similar. Nevertheless, there are generally more residential fires in the evening than in the afternoon during the winter (Spatenková and Virrantaus, 2013). That trend changed for Period 2 at the beginning of the first lockdown, when the greatest number of fires was documented in the afternoon. Both results underscore that when people spend more time at home, the number of reported residential fires drops. Citizens in Catalonia had limited opportunities to travel to other places for leisure or tourism on weekends, as well as in the evening. Nevertheless, differences in the temporal distribution (i.e. weekdays vs. weekends and hourly time slots) of residential fires between the various periods were not statistically significant.

Working from home during the COVID-19 lockdown meant spending more time at home, and the consequences included an increase in sedentary behaviour, a reduction in physical activity and a deterioration in physical (Wilms *et al.*, 2022) and mental health (Barone Gibbs *et al.*, 2021; Michinov and Michinov, 2023). An increase of accidental residential fires could be expected in relation to the aforementioned negative impacts. Nevertheless, such an increase did not occur in Catalonia. On the contrary, Hallman *et al.* (2021) have observed a potential health benefit of working from home—namely, that people spent more time sleeping the days working from home during the lockdown than the days working at the office.

6. Conclusions

Our results show that lockdowns during the COVID-19 pandemic, especially the first one in mid-March 2020, induced a drop in the number of residential fires in Catalonia. Nevertheless, the pandemic's positive, indirect impact was fleeting and limited to the beginning of the lockdown. It was even more fleeting than the other positive, indirect impacts of COVID-19's outbreak, including the reduction in pollutants discharged into the atmosphere and the decrease in the number of traffic accidents and injuries. Those improvements cannot be equated to the pandemic's negative effects by any means. The disease caused hundreds of thousands of deaths, while the lockdowns caused widespread bankruptcies and unemployment.

Our findings provide new evidence of the COVID-19 pandemic's disruptive effect on residential fires and may be of interest for public authorities in Catalonia. Facilitating telework for public sector employees and encouraging private companies to do the same, with or without a pandemic, can help to reduce the number of residential fires and their consequences, including deaths, injuries and economic loss. Nevertheless, many jobs, by their very nature, do not allow telework.

Our findings encourage new streams of research on residential fires in Catalonia, particularly the spatial distribution of residential fires instead of their temporal distribution, which should allow overcoming some of our study's limitations. A spatial analysis could be conducted to identify the existence of different patterns in the incidence of residential fires while taking into account the socioeconomic conditions of the areas where fires have occurred and the characteristics of the buildings. Such analyses can enable public authorities to increase their efforts in prevention and policymaking when it comes to residential fires, as a means to reduce the number of times that emergency services have to be activated and the effort needed to recover from fires once they are extinguished. However, the chief limitation of our study was our inability to access the database containing sensitive information due to reasons of privacy and confidentiality.

Last, our research aligned with the UN Sustainable Development Goal 11 to "make cities and human settlements inclusive, safe, resilient and sustainable".

References

Ahrens, M. (2008), "Home smoke alarms: the data as context for decision", *Fire Technology*, Vol. 44 No. 4, pp. 313-327, doi: 10.1007/s10694-008-0045-9.

Al-Hajj, S., Thomas, L., Morris, S., Clare, J., Jennings, C., Biantoro, C., Garis, L. and Pike, I. (2023), "Community fire risk reductions: longitudinal assessment for homesafe fire prevention program in Canada", *International Journal of Environmental Research and Public Health*, Vol. 20 No. 14, p. 6369, doi: 10.3390/ijerph20146369.

Asgary, A., Solis, A.O., Khan, N., Wimaladasa, J. and Sabet, M.S. (2023), "Spatiotemporal analysis of emergency calls during the COVID-19 pandemic: case of the city of Vaughan", *Urban Science*, Vol. 7 No. 2, p. 62, doi: 10.3390/urbansci7020062.

Barone Gibbs, B., Kline, C.E., Huber, K.A., Paley, J.L. and Perera, S. (2021), "Covid-19 shelter-at-home and work, lifestyle and well-being in desk workers", *Occupational Medicine*, Vol. 71 No. 2, pp. 86-94, doi: 10.1093/occmed/kqab011.

Benita, F. (2021), "Human mobility behavior in COVID-19: a systematic literature review and bibliometric analysis", *Sustainable Cities and Society*, Vol. 70, 102916, doi: 10.1016/j.scs.2021.102916.

Bispo, R., Vieira, F.G., Bachir, N., Espadinha-Cruz, P., Lopes, J.P., Penha, A., Marques, F.J. and Grilo, A. (2023), "Spatial modelling and mapping of urban fire occurrence in Portugal", *Fire Safety Journal*, Vol. 138, 103802, doi: 10.1016/j.firesaf.2023.103802.

Boletín Oficial del Estado (2020), "Real Decreto 463/2020, de 14 de marzo, por el que se declara el estado de alarma para la gestión de la situación de crisis sanitaria ocasionada por el COVID-19", available at: https://www.boe.es/buscar/doc.php?id=BOE-A-2020-3692 (accessed 28 July 2023).

Bombers Generalitat de Catalunya (2009), "Carta de Serveis", available at: interior.gencat/wb/.contgent/home/010_el_departament/carta_de_serveis/docs_bombers/document_integre_cs.pdf (accessed 23 August 2023).

Chikritzhs, T. and Livingston, M. (2021), "Alcohol and fire risk", *Nutrients*, Vol. 13 No. 8, p. 2777, doi: 10.3390/nu13082777.

Corcoran, J., Higgs, G. and Higginson, A. (2011a), "Fire incidence in metropolitan areas: a comprehensive study of Brisbane (Australia) and Cardiff (United Kingdom)", *Applied Geography*, Vol. 31 No. 1, pp. 65-75, doi: 10.1016/J.APGEOG.2010.02.003.

Corcoran, J., Higgs, G., Rohde, D. and Chhetri, P. (2011b), "Investigating the association between weather conditions, calendar events and socio-economic patterns with trends in fire incidence: an Australian case study", *Journal of Geographical Systems*, Vol. 13 No. 2, pp. 193-226, doi: 10.1007/s10109-009-0102-z.

Dinić, J.M. (2023), "Quantification of fire resilience in urban communities: evidence from the city of Novi Pazar, Serbia", *Polish Journal of Environmental Studies*, Vol. 832 No. 4, pp. 3525-3533, doi: 10.15244/pjoes/165893.

Fire Service Academy (2018), *Fatal Residential Fires in Europe. A Preliminary Assessment of Risk Profiles in Nine European Countries*, Institute for Safety, Arnhem.

Francis, H., Taylor, M., Fielding, J., Oakford, G. and Appleton, D. (2024), "Comparison of fire injuries during and pre-COVID-19 restrictions", *Fire Safety Journal*, Vol. 143, 104074, doi: 10.1016/j.firesaf.2023.104074.

Ghassempour, N., Tannous, W.K., Avsar, G., Agho, K.E. and Harvey, L.A. (2021), "Estimating the total number of residential fire-related incidents and underreported residential fire incidents in New South Wales, Australia by using linked administrative data", *International Journal of Environmental Research and Public Health*, Vol. 18 No. 13, p. 6921, doi: 10.3390/ijerph18136921.

Ghassempour, N., Tannous, W.K., Agho, K.E., Avsar, G. and Harvey, L.A. (2022), "Comparison of causes, characteristics and consequences of residential fires in social and non-social housing dwellings in New South Wales, Australia", *Preventive Medicine Reports*, Vol. 28, 101860, doi: 10.1016/j.pmedr.2022.101860.

Granda, S. and Ferreria, T.M. (2019), "Assessing vulnerability and fire risk in old urban areas: application to the historical centre of Guimaraes", *Fire Technology*, Vol. 55 No. 1, pp. 105-127, doi: 10.1007/s10694-018-0778-z.

Hallman, D.M., Bergamin Januario, L., Mathiassen, S.E., Heiden, M., Svensson, S. and Bergström, G. (2021), "Working from home during the COVID-19 outbreak in Sweden: effects on 24-h time-use in office workers", *Public Health*, Vol. 21 No. 1, 528, doi: 10.1186/s12889-021-10582-6.

Harpur, A., Boyce, K.E. and McConnell, N. (2013), "An investigation into the circumstances surrounding fatal dwelling fires involving very young children", *Fire Safety Journal*, Vol. 61, pp. 72-82, doi: 10.1016/j.firesaf.2013.08.008.

Harvey, L.A., Ghassempour, N., Whybro, M. and Tannous, W.K. (2020), "Health impacts and economic costs of residential fires (RESFIRES study): protocol for a population-based cohort study using linked administrative data", *British Medical Journal Open*, Vol. 10 No. 9, e037709, doi: 10.11836/bmjopen-2020-037709.

Hossain, M.R. and Smirnov, O. (2023), "Analysing the risk factors of residential fires in urban and rural census tracts of Ohio using panel data analysis", *Applied Geography*, Vol. 151, 102863, doi: 10.1016/j.apgeog.2020.102863.

Jennings, C.R. (1999), "Socioeconomic characteristics and their relationship to fire incidence: a review of the literature", *Fire Technology*, Vol. 35 No. 1, pp. 7-34, doi: 10.1023/A:1015330931387.

Jennings, C.R. (2013), "Social and economic characteristics as determinants of residential fire risk in urban neighborhoods: a review of the literature", *Fire Safety Journal*, Vol. 62, pp. 13-19, doi: 10.1016/j.firesaf.2013.07.002.

Jonsson, A. and Jaldell, H. (2020), "Identifying sociodemographic risk factors associated with residential fire fatalities: a matched case control study", *Injury Prevention*, Vol. 26 No. 2, pp. 147-152, doi: 10.1136/injuryprev-2018-0403062.

Manes, M. and Rush, D. (2022), "A comprehensive investigation of the impacts of discovery time and fire brigade response on life safety and property protection in England", *Indoor and Built Environment*, Vol. 32, pp. 242-361, doi: 10.1177/1420326X221141404.

Masoumi, Z., van, L., Genderen, J. and Maleki, J. (2019), "Fire risk assessment in dense urban areas using information fusion techniques", *International Journal of Geo-Information*, Vol. 8 No. 12, p. 579, doi: 10.3390/ijgi8120579.

Menut, L., Bessagnete, B., Siour, G., Mailler, S., Pennel, R. and Cholokian, A. (2020), "Impact of lockdown measures to combat Covid-19 on air quality over western Europe", *Science of the Total Environment*, Vol. 741, 140426, doi: 10.1016/j.scitotenv.2020.140426.

Meteocat (2023), "Anomalies de la temperatura mitjana període de referència 1961-1990", available at: meteo cat/wpweb/climatología/butlletins-i-episodis-meteorologics/historic-de-cartografia-climatica/historic-de-mapes-de-temperatura-mensual (accessed 24 August 2023).

Michinov, E. and Michinov, N. (2023), "Stay at home! When personality profiles influence mental health and creativity during the COVID-19 lockdown", *Current Psychology*, Vol. 42 No. 7, pp. 5650-5661, doi: 10.1007/s.12144-021-01885-3.

Ministerio de Sanidad (2020), *Plan para la transición hacia una nueva normalidad*, Gobierno de España, available at: https://www.lamoncloa.gob.es/consejodeministros/resumenes/Documents/2020/PlanTransicionNuevaNormalidad.pdf (accessed 28 July 2023).

National Fire Protection Association (n.d.), "Top fire causes", available at: https://nfpa.org/Public-Education/Fire-causes-and-reisks/Top-fire-causes (accessed 12 August 2023).

Nilson, F. and Bonander, C. (2021), "Societal protection and population vulnerability: key factors in explaining community-level variation in fatal fires involving older adults in Sweden", *Fire Technology*, Vol. 57 No. 1, pp. 247-260, doi: 10.1007/s10694-020-00997-9.

Poblete, A.G., Minetti, J.L. and Borbore, C.A. (2013), "Recursos cuantitativos para la identificación de cambios abruptos en las series de tiempo geográficas", *Contribuciones Científicas GAEA*, Vol. 26, pp. 207-220.

Runefors, M. and Nilson, F. (2021), "The influence of sociodemographic factors on the theoretical effectiveness of fire prevention interventions on fatal residential fires", *Fire Technology*, Vol. 57 No. 5, pp. 2433-2450, doi: 10.1007/s10694-021-01125-x.

Saladié, O., Domínguez-Mallafré, M., Domènech, A. and Gutiérrez, A. (2023), "Back to the past: the decline and rebound in traffic accident numbers in Catalonia in the context of COVID-19 lockdown and post-lockdown", *Norwegian Journal of Geography*, Vol. 77 No. 2, pp. 78-97, doi: 10.1080/00291951.2023.2217818.

Singh, P.P., Sbnani, C.S. and Kapse, V.S. (2021), "Hotspot analysis of structure fires in urban agglomeration: a case of Nagpur City, India", *Fire*, Vol. 4 No. 3, p. 38, doi: 10.3390/fire4030038.

Solis, A.O., Wimaladasa, J., Asgary, A., Shafiei Sabet, M. and Ing, M. (2021), "Shifting patterns of emergency incidents during the COVID-19 pandemic in the city of Vaughan, Canada", *International Journal of Emergency Services*, Vol. 11, pp. 1-37, doi: 10.1108/IJES-05-2021-0024.

Spatenková, O. and Virrantaus, K. (2013), "Discovering spatio-temporal relationships in the distribution of building fires", *Fire Safety Journal*, Vol. 62, pp. 49-63, doi: 10.1016/j.firesaf.2013.07.001.

Suzuki, S. and Manzello, S.L. (2022a), "The Influence of COVID-19 Stay at Home Measures on Fire Statistics Sampled from New York City, London, San Francisco, and Tokyo", *Fire Technology*, Vol. 58 No. 2, pp. 679-688, doi: 10.1007/s10694-021-01177-z.

Suzuki, S. and Manzello, S.L. (2022b), "Effect of three lockdowns in London: Case study for residential fires", *Public Health in Practice*, Vol. 3, 100264, doi: 10.1016/j.puhip.2022.1002264.

Taylor, M., Francis, H. and Fielding, J. (2023), "Old age and fire injury", *Journal of Fire Sciences*, Vol. 41 Nos 1-2, pp. 16-31, doi: 10.1177/07349041231153040.

Thomas, D.S. and Butry, T. (2016), *Identifying Residential Fires Involving Upholstered Furniture within the National Fire Incident Reporting System*, National Institute of Standards and Technology, US Department of Commerce, doi: 10.6028/NIST.TN.1845.

Ugur, N.G. and Akbiyik, A. (2020), "Impacts of COVID-19 on global tourism industry: a cross-regional comparison", *Tourism Management Perspectives*, Vol. 36, 100744, doi: 10.1016/j.tmp.2020.10074.

Untadi, A., Li, L.D., Li, M. and Dodd, R. (2023), "Modeling socioeconomic determinants of building fires through backward elimination by robust final prediction error criterion", *Axioms*, Vol. 12 No. 6, p. 524, doi: 10.3390/axioms12060524.

Vachuska, K. (2023), "Neighborhood racial and economic composition predicts incidence of various emergency services responses", *Socius: Sociological Research for a Dynamic World*, Vol. 9, pp. 1-15, doi: 10.1177/23780231231157679.

Van Coile, R., Lucherini, A., Chaudhary, R.K., Ni, S., Unobe, D. and Gernay, T. (2023), *Economic Impact of Fire: Cost and Impact of Fire Protection in Buildings*, Fire Protection Research Foundation, Quincy.

Wilms, P., Schröder, J., Reer, R. and Scheit, L. (2022), "The impact of 'home office' work on physical activity and sedentary behavior during the COVID-19 pandemic: a systematic review", *Environmental Research and Public Health*, Vol. 19, 12344, doi: 10.3390/ijerph191912344.

World Health Organization (2018), "Burns", available at: who.int/new-room/fact-sheets/details/burns (accessed 10 August 2023).

Xiong, L., Bruck, D. and Ball, M. (2015), "Comparative investigation of 'survival' and fatality factors in accidental residential fires", *Fire Safety Journal*, Vol. 73, pp. 27-47, doi: 10.1016/j.firesaf.2015.02.003.

Xiong, L., Bruck, D. and Ball, M. (2017), "Unintentional residential fires caused by smoking-related materials: who is at risk?", *Fire Safety Journal*, Vol. 90, pp. 148-155, doi: 10.1016/j.firesaf.2017.04.020.

Corresponding author
Òscar Saladié can be contacted at: oscar.saladie@urv.cat