

Original article

Impact of sandstorm and carnival celebrations on SARS-CoV-2 spreading in Tenerife and Gran Canaria (Canary Islands, Spain)

Laura Tomaino^{a,b,c}, Jaime Pinilla^{c,d}, Silvia Rodríguez-Mireles^{c,e}, Beatriz González López-Valcárcel^{c,d,f}, Patricia Barber-Pérez^{c,d}, Antonio Sierra^g, Carlo La Vecchia^b, Lluís Serra-Majem^{a,c,f,h,*}

^a Research Institute of Biomedical and Health Sciences (IUIBS), University of Las Palmas de Gran Canaria, Las Palmas, Spain

^b Department of Clinical and Community Sciences (DISCO), Università degli Studi di Milano, Milan, Italy

^c COVIDCAN, COVID-19 Study and Analysis Group, University of Las Palmas de Gran Canaria, Las Palmas, Spain

^d Department of Quantitative Methods in Economics and Management, University of Las Palmas de Gran Canaria, Las Palmas, Spain

^e Admission and Clinical Documentation Service, Hospital Universitario de Gran Canaria Dr. Negrín, Canary Health Service, Las Palmas, Spain

^f Scientific Advisory Group of the COVID-19 Committee of the Government of the Canary Islands, Las Palmas, Spain

^g Department of Preventive Medicine and Public Health, University of La Laguna, La Laguna, La Laguna, Santa Cruz de Tenerife, Spain

^h Preventive Medicine Service, Centro Hospitalario Universitario Insular Materno Infantil (CHUIMI), Canary Health Service, Las Palmas, Spain

ARTICLE INFO

Article history:

Received 3 June 2020

Accepted 8 September 2020

Available online xxx

Keywords:

Severe acute respiratory syndrome

coronavirus 2

COVID-19

Spain

Weather

ABSTRACT

Objective: We address the hypothesis that the extraordinary sandstorm occurred on 22-24 February 2020 might have a role in the different cumulated incidence of COVID-19 cases between the islands of Tenerife and Gran Canaria, since it obliged to reduce significantly air traffic and forced to suspend all major carnival street events in all most locations.

Method: We performed a retrospective analysis of COVID-19 cases as to 1 April 2020 according to symptoms onset, weather-related data and Carnival events in Tenerife and Gran Canaria.

Results: The sandstorm occurred on February 22-24, 2020, forced air traffic to close, reducing the influx of tourists to the Canary Islands and suspending carnival events in most places, except in Santa Cruz de Tenerife. Cumulated incidence as to 1 April was 132.81/100,000 in Tenerife, and 56.04/100,000 in Gran Canaria.

Conclusions: The suspension of Carnival events due to the sandstorm in the Canary Islands contributed to reduce differently the SARS-CoV-2 spread in Tenerife and Gran Canaria.

© 2020 SESPAS. Published by Elsevier España, S.L.U. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Impacto de una tormenta de arena y de los carnavales en la diseminación del SARS-CoV-2 en Tenerife y Gran Canaria (Islas Canarias, España)

RESUMEN

Objetivo: Investigar la hipótesis de que la extraordinaria tormenta de arena ocurrida el 22-24 de febrero de 2020 pudo tener un papel en la diferente incidencia acumulada de casos de COVID-19 entre las islas de Tenerife y Gran Canaria, en cuanto conllevó una reducción significativa del tráfico aéreo y la cancelación de las mayores celebraciones del carnaval en muchas poblaciones.

Método: Se realiza un análisis retrospectivo de los casos de COVID-19 hasta el 1 abril de 2020 según fecha de inicio de los síntomas, de los datos climáticos y de las celebraciones de carnaval en Tenerife y Gran Canaria.

Resultados: La tormenta de arena ocurrida el 22-24 de febrero de 2020 obligó a cerrar el tráfico aéreo, reduciendo la llegada de turistas a Canarias, y a suspender las celebraciones de los carnavales en muchas poblaciones, excepto en Santa Cruz de Tenerife. El 1 abril de 2020, la incidencia acumulada de casos era de 132,81/100.000 en Tenerife y de 56,04/100.000 en Gran Canaria.

Conclusiones: La cancelación de las celebraciones de carnaval debido a la tempestad de arena en las Islas Canarias parece que contribuyó de manera diferente a la reducción de la incidencia del SARS-CoV-2 en Tenerife y Gran Canaria.

© 2020 SESPAS. Publicado por Elsevier España, S.L.U. Este es un artículo Open Access bajo la licencia CC BY-NC-ND (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Palabras clave:

Síndrome respiratorio agudo grave

por coronavirus 2

COVID-19

España

Clima

Introduction

SARS-CoV-2 spread rapidly from Wuhan, Hubei province, China, affecting nearly every country of the world. As of 1 April, 823,626 cases of COVID-19 were registered globally, with 72,736 deaths

* Corresponding author.

E-mail address: lluisserra@ulpgc.es (L. Serra-Majem).

<https://doi.org/10.1016/j.gaceta.2020.09.006>

0213-9111/© 2020 SESPAS. Published by Elsevier España, S.L.U. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Please cite this article in press as: Tomaino L, et al. Impact of sandstorm and carnival celebrations on SARS-CoV-2 spreading in Tenerife and Gran Canaria (Canary Islands, Spain). Gac Sanit. 2020. <https://doi.org/10.1016/j.gaceta.2020.09.006>

worldwide.¹ According to the World Health Organization (WHO) estimates as to 1 April, in Europe Italy presented the highest number of cases (105,792), followed by Spain (94,417).¹

Canary Islands are a Spanish archipelago located in the Atlantic Ocean in front of Morocco. They are the southernmost autonomous community of Spain and include eight islands: Tenerife, Gran Canaria, Lanzarote, Fuerteventura, La Palma, La Gomera, El Hierro, and La Graciosa. The population of the Canary Islands is 2,153,389 inhabitants (2019 figures), mostly concentrated in the two capital islands: around 43% in Tenerife (917,841) and 40% in Gran Canaria (851,231).²

Canary Islands' epidemic situation could have reached worrying levels as, while the pandemic was raging in Europe, the archipelago celebrated the carnival, attracting thousands of visitors. Moreover, a noteworthy sandstorm obliged to close Tenerife and Gran Canaria airports and forced the inhabitants to a lock-down of at least two days (22–24 February). Locally known as *calima*, it is a relatively frequent meteorological phenomenon in the Canary Islands, although in the last 40 years there has not been such an intense one as that of February 22–24, 2020. A warm or hot east-wind from the Sahara Desert, Africa, lifts up and transports to the archipelago clouds of sand and dust, with increasing warm and humid air. Often associated with fog and patchy drizzle, *calima* is also a contributing source of particulate matter (PM).³

According to the Spanish Health Ministry estimates, as to 1 April, the cumulative incidence of COVID-19 was higher in Tenerife than in Gran Canaria.⁴ In this paper we address the hypothesis that the extraordinary sandstorm occurred on 22–24 February 2020 might have a role in the different cumulated incidence of COVID-19 cases between the two islands, since it obliged to reduce significantly air traffic and forced to suspend all major carnival street events in most locations, but not so in Santa Cruz de Tenerife where, despite the *calima*, important carnival events took place. With this retrospective analysis, we aim to investigate the impact of environmental and weather characteristics of the Canary Islands, in addition to other confounding factors, on the COVID-19 epidemic.

Method

In this retrospective observational study, meteorological and weather-related data were obtained from the Canary Government website (*Red de Control y Vigilancia de la Calidad del Aire de Canarias*). A retrospective analysis of the cases who presented symptoms related to COVID-19 and tested positive to SARS-CoV-2 by polymerase chain reaction in Tenerife and Gran Canaria islands, as to 1 April 2020, was carried out. Data were collected and registered in ReVECa (*Red de Vigilancia Epidemiológica de Canarias*), a detailed database constantly updated. Moreover, aggregated epidemiological data are published daily by the Canary authorities detailing the situation of each island. Due to the anonymization process performed prior to data extraction from ReVECa database, no ethical issue is concurring in the present study. Independent samples z-test was performed. The two sample z-test approach is based on comparing the incidence rates on the natural log scale. Statistical analysis was performed with SPSS 23.0 software (IBM).

Results

Weather conditions and attendance to carnival events

According to the Spanish national weather service, winds of up to 120 km/h blown over the Canary Islands from Saturday 22 night until Monday 24 February. As shown in [Figure 1 in online Appendix](#), a noteworthy sandstorm was photographed by NASA's Terra and Aqua satellites on February 22 and 23, 2020. Gran Canaria,

Fuerteventura, and Lanzarote islands appeared to be hardest hit by the storm, which started abruptly on February 22 and continued until the 26th.⁵ Nevertheless, the state of alert was declared by the authorities from February 22 to 24.

[Table 1](#) shows weather data related Santa Cruz de Tenerife and Las Palmas de Gran Canaria over the period 20–29 February 2020. The cabins are located in the centre of the cities, in Santa Cruz (Tome Cano) and in Las Palmas (central market), respectively.⁶ On 22 February, PM₁₀ (<10 μm diameter) reached concentrations of 319 μg/m³ in Santa Cruz and 416 μg/m³ in Las Palmas, while the following day of 1238 μg/m³ and 1283 μg/m³, respectively.

From 22 to 24 February the adverse weather conditions (low visibility and strong winds that accompanied the intense *calima*), forced the Spanish national air authority to close the airspace on the Canary Islands. On 22 February, at 4:52 p.m., Gran Canaria airport was the first one to refuse incoming and outgoing air operations, diverting scheduled flights to other islands. At 7:07 p.m., Tenerife Norte and Tenerife Sur airports suspended arrival operations, resuming some operations at 10:14 p.m. On Sunday 23 the airports tried to restore normal traffic. However, since the weather conditions did not totally improve, the airports operated intermittently. Tenerife (North and South) and Gran Canaria airports cancelled a total of 354 flights, presenting Gran Canaria airport the highest number of cancellations (58.5% of the total).^{7,8}

On Sunday 23, following the advice of the Canarian Government due to the weather conditions, all celebrations were cancelled in Gran Canaria and some municipalities of Tenerife. However, the events in Santa Cruz de Tenerife took place as planned. Family day carnival (*Carnaval de día*), one of the most multitude-concentrating celebrations of Tenerife carnival, was held with thousands of people joining the events. According to the authorities, during these celebrations, around 55,800 vehicles entered the city of Santa Cruz. Also, the Tenerife tram, one of the most important public transport to access the city of Santa Cruz, registered a total of 32,614 passengers (being the average number of passengers on any other Sunday in February was around 19,000).

Gran Canaria and Tenerife data on confirmed COVID-19 cases

In Canary Islands, a total 1,515 confirmed cases of SARS-CoV-2 infection were detected as of 1 April 2020, corresponding to the 0.07% of the resident population (2,153,389; 2019 figures). Cumulated incidence of SARS-CoV-2 in Tenerife and Gran Canaria as of 1 April was 132.81/100,000 and 56.04/100,000 inhabitants respectively, as shown in [Figure 1](#). These differences were statistically significant ($z = -5.4168$; $p < 0.001$).

Discussion

Canary Islands, located 96.6 km off the coast of Morocco in Northwestern Africa, are one of the most popular tourist destinations in Europe during winter due to warm temperatures compared to the continent. Nevertheless, on 22–23 February 2020 temperature raised to 33 °C, tourists and residents were forced indoors due to an intensive sand and dust storm blowing in from the Sahara Desert, leading to all ports and airports closure. PM reached extraordinarily high peaks worsening the risk of respiratory and cardiovascular symptoms.⁴

Due to this extraordinary incidence, the state of alert was declared since 22 February at 4:00 p.m.,⁹ and all the eight airports of the archipelago were closed by the Spanish authority for the air traffic management being over 800 flights affected, especially in Gran Canaria, as visibility was reduced to less than 400 meters. Air traffic resumed on the morning of February 24, 2020. Also, the authorities

Table 1
PM_{2.5} and PM₁₀ concentrations in the cities of Santa Cruz de Tenerife and Las Palmas de Gran Canaria between February 20 and 29, 2020.

Date	Las Palmas de Gran Canaria		Santa Cruz de Tenerife	
	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)
2020-02-20	30	11	24	7
2020-02-21	19	7	15	6
2020-02-22	416	93	319	70
2020-02-23	1283	390	1238	363
2020-02-24	397	121	720	188
2020-02-25	109	35	143	49
2020-02-26	39	9	31	18
2020-02-27	23	7	19	7
2020-02-28	36	10	30	11
2020-02-29	23	6	21	8

PM₁₀: particulate matter < 10 µm; PM_{2.5}: particulate matter < 2.5 µm.

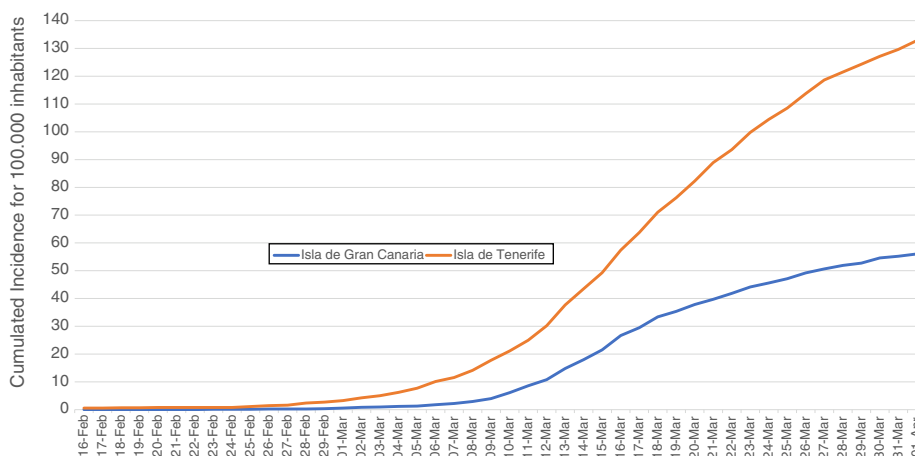


Figure 1. COVID-19 in Tenerife and Gran Canaria: cumulated incidence according to symptoms onset and island of declaration.

closed primary schools on Monday 24th and advised residents to stay indoors, particularly those with respiratory problems.

The carnival of Gran Canaria and Tenerife usually takes place each year between February and March. It usually lasts many weeks and various festivities and activities take place during the day and the night^{10,11} (Table I in online Appendix shows the program of the celebrations). Tenerife’s carnival started earlier than Gran Canaria’s, being the most important celebrations held on 21-24 February 2020, while the great carnival event in Las Palmas (the *Cabalgata*), was held on Saturday the 29th. Since the pandemic was still not perceived as a major problem in the archipelago nor in Spain, the decision whether suspending the celebrations were only made based on of the weather conditions of those days and the importance of the carnival event.

According to the WHO,¹² the incubation period for SARS-CoV-2 (time from exposure to symptom onset), lasts around 5-6 days, to a maximum of 14 days. So, the cancellation of important functions in Gran Canaria may be the explanation for the SARS-CoV-2 incidence delay between Gran Canaria and Tenerife. Indeed, these celebrations represented a way for COVID-19 spread, especially among young individuals who are more likely to be asymptomatic or present mild symptoms.

Among the variables that may have played a role in the incidence differences between the two islands, the number of tourists and their nationality needs to be taken into account. In fact, according to the Canary Institute of Statistics, during the month of February 2020, a total of 387,431 tourists entered in Gran Canaria by airway. Of these, 33% (128,276) came from Nordic Countries, 21% (81,126) from Germany, 15% (56,873) from United Kingdom, 2% (7,104) from Italy and 1,5% (5,883) from Belgium. Spanish residents who entered in Gran Canaria in February 2020 were 10%

(37,738). During the same month, a number of 528,872 airway passengers entered in Tenerife. Of these 35% (184,208) from United Kingdom, 16% (84,332) from Germany, 12% (63,872) came from Northern Countries, 3% (17,297) from Italy and 3% (17,979) from Belgium, while Spanish residents who entered in Tenerife were 9% (49,853).¹³ Considering absolute numbers, these figures show that Tenerife received higher rates of tourists coming from Belgium, Italy and the United Kingdom (by then already presenting high rates of COVID-19) if compared to Gran Canaria.

On 14 March, a lockdown was compulsory in the whole country. It has been one of the hardest interventions to control the epidemic¹² and included a strict limitation to travel among provinces. These measures played a critical role in the contention of COVID-19 spread, as proven by literature.¹⁴ In fact, in Spain, the estimated number of cases sharply increased until the lockdown, then it showed a slow down followed by a decrease after the full quarantine was implemented.^{15,16} Since 19 March 2020 Canary airports start operating at minimum levels.

Conclusions

In conclusion, the cancellation of carnival celebrations due to the sandstorm occurred 22-24 February 2020 in the Canary Islands, together with the different flow and origin of tourists visiting Tenerife and Gran Canaria, contributed to the differences of SARS-CoV-2 cumulated incidence between the two islands. Thus, it is likely that the “worst *calima* in the last 40 years” differentially affected COVID-19 spread through the Canary Islands, in particular during carnival celebrations involving multitudes of people.

What is known about the topic?

While the origin of tourists and participants to carnival celebrations that took place in Tenerife and Gran Canaria can be easily related to SARS-CoV-2 spread, little is known about the impact of the sandstorm that affected the archipelago on 22-24 February 2020 and its direct and indirect consequences on the pandemic evolution in the Canary Islands.

What does this study add to the literature?

This study furthers knowledge in the areas of public health related to COVID-19. It helps to deepen the knowledge about the virus spread and, in the light of different touristic flow between the islands of Tenerife and Gran Canaria, to understand the reason why the islands presented differences in terms of cumulated incidence of COVID-19. It shows that the decision of suspending carnival events had positive consequences on the virus spread.

Editor in charge

Miguel Ángel Negrín Hernández.

Transparency declaration

The corresponding author on behalf of the other authors guarantee the accuracy, transparency and honesty of the data and information contained in the study, that no relevant information has been omitted and that all discrepancies between authors have been adequately resolved and described.

Authorship contributions

L. Tomaino and L. Serra-Majem had the original idea, conceptualization, and developed the investigation hypothesis. L. Tomaino wrote and redacted the first draft of the manuscript. J. Pinilla and P. Barber-Pérez carried out the statistical analysis, and prepared tables and figures. S. Rodríguez-Mireles, B. González López-Valcárcel, C. La Vecchia and A. Sierra, together with the rest of the authors, contributed substantially to the reviewing and editing, and to the supervision and validation of the final version of the manuscript. All results were discussed among the authors. All co-authors have read and approved the final version of the manuscript.

Acknowledgments

The authors desire to express their gratitude to the precious contribution of Lourdes Ribas-Barba (CIBER de Fisiopatología de la Obesidad y Nutrición [CIBERObn], Spain) and Domingo Núñez-Gallo (representing the Canary Government's Public Health Direction, Santa Cruz de Tenerife, Spain).

Funding

None.

Conflicts of interest

None.

Appendix. Supplementary data

Supplementary data associated with this article can be found, in the online version, at [doi:10.1016/j.gaceta.2020.09.006](https://doi.org/10.1016/j.gaceta.2020.09.006).

References

1. WHO Coronavirus Disease 2019 (COVID-19) Situation Report – 72. (Accessed 22-05-2020.) Available at: https://www.who.int/docs/default-source/coronavirus/situation-reports/20200401-sitrep-72-covid-19.pdf?sfvrsn=3dd8971b_2.
2. Real Decreto 743/2019, de 20 de diciembre, por el que se declaran oficiales las cifras de población resultantes de la revisión del Padrón municipal referidas al 1 de enero de 2019. BOE, 27 December 2019. Retrieved 20 February 2020. (Accessed 22-05-2020.) Available at: https://www.boe.es/diario_boe/txt.php?id=BOE-A-2019-18604.
3. World Health Organization, Regional Office for Europe. Health effects of particulate matter. Policy implications for countries in eastern Europe, Caucasus and central Asia. 2013. (Accessed 20-05-2020.) Available at: www.euro.who.int.
4. Centro Nacional de Epidemiología. (Accessed 22-05-2020.) Available at: <https://covid19.isciii.es>.
5. NASA Earth Observatory images by Joshua Stevens, using MODIS data from NASA EOSDIS/LANCE and GIBS/Worldview. Story by Michael Carlowicz. (Accessed 13-05-2020.) Available at: <https://earthobservatory.nasa.gov/images/146337/dust-blankets-the-canary-islands>.
6. Red de Control y Vigilancia de la Calidad del Aire de Canarias. Formulario de datos históricos. (Accessed 13-05-2020.) Available at: <https://www3.gobiernodecanarias.org/medioambiente/calidaddelaire/datosHistoricos.do>.
7. Aeropuertos Españoles y Navegación Aérea (AENA) twitter social network account (@aena). (Accessed 25-06-2020.)
8. Flights, airplanes, airports and timetables search. (Accessed 25-06-2020.) Available at: <https://spotterlead.net>.
9. Gobierno de Canarias. El Gobierno de Canarias declara la situación de alerta por calima en Canarias. February 22, 2020. (Accessed 21-05-2020.) Available at: <https://www3.gobiernodecanarias.org/noticias/el-gobierno-de-canarias-declara-la-situacion-de-alerta-por-calima-en-canarias/>.
10. Carnaval de Tenerife. (Accessed 4-05-2020.) Available at: <http://carnavaldetenerife.com/calendario-carnaval-2020/>.
11. Carnaval de Las Palmas de Gran Canaria. (Accessed 4-05-2020.) Available at: <http://pacarnaval.com/es/programa/year.listevents/2020/05/04/>.
12. World Health Organization. Coronavirus disease 2019 (COVID-19). Situation Report – 73. (Accessed 25-06-2020.) Available at: https://www.who.int/docs/default-source/coronavirus/situation-reports/20200402-sitrep-73-covid-19.pdf?sfvrsn=5ae25bc7_6.
13. Instituto Canario de Estadística (ISTAC). (Accessed 20-05-2020.) Available at: <http://www.gobiernodecanarias.org/istac/>.
14. Lau H, Khosrawipour V, Kocbach P, et al. The positive impact of lockdown in Wuhan on containing the COVID-19 outbreak in China. J Travel Med. 2020;27. <http://dx.doi.org/10.1093/jtm/taaa037>, taaa037.
15. Hyafil A, Moriña D. Analysis of the impact of lockdown on the reproduction number of the SARS-Cov-2 in Spain. Gac Sanit. 2020. <http://dx.doi.org/10.1016/j.gaceta.200.05.003>.
16. Siqueira CADS, Freitas YNL, Cancela MC, et al. The effect of lockdown on the outcomes of COVID-19 in Spain: an ecological study. PLoS One. 2020;15. <http://dx.doi.org/10.1371/journal.pone.0236779>, e0236779.