International Journal of Sustainable Development and Planning
Vol. 19, No. 2, February, 2024, pp. 663-670
Journal homepage: http://iieta.org/journals/ijsdp

A Systematic Review of Fireworks Noise and Its Exceedance of WHO Outdoor Limits: Global Trends and Implications

Manuel Reategui-Inga[1*], Eli Morales Rojas[2], Geovany Vilchez Casas[3], José Kalión Guerra Lu[4], Wilfredo Alva Valdiviezo[4], Manuel Ñique Alvarez[5], Ronald Panduro Durand[1], Peter Coaguila-Rodriguez[4], Daniel Álvarez-Tolentino[6]

[1] Escuela Profesional de Ingeniería Ambiental, Universidad Nacional Intercultural de la Selva Central Juan Santos Atahualpa, Chanchamayo 12855, Perú
[2] Facultad de Ciencias Naturales y Aplicadas, Universidad Nacional Intercultural Fabiola Salazar Leguía de Bagua, Bagua 01721, Perú
[3] Escuela Profesional de Ingeniería Civil, Universidad Nacional Intercultural de la Selva Central Juan Santos Atahualpa, Chanchamayo 12855, Perú
[4] Facultad de Recursos Naturales Renovables, Universidad Nacional Agraria de la Selva, Tingo María 10131, Perú
[5] Departamento Académico de Agronomía, Universidad Nacional de Cañete, Lima 10131, Perú
[6] Escuela Académico Profesional de Ingeniería de Medio Ambiente y Desarrollo, Universidad Peruana Los Andes, Huancayo 12000, Perú

Corresponding Author Email: mreategui@uniscjsa.edu.pe

https://doi.org/10.18280/ijsdp.190223

Received: 5 October 2023
Revised: 15 January 2024
Accepted: 23 January 2024
Available online: 28 February 2024

Keywords:
festival, pyrotechnics, sound pressure levels, VOSviewer, WHO noise guidelines

ABSTRACT

Firework noise, generated in short bursts, poses health risks. The objective of the research was to compare the sound pressure levels generated by fireworks with the World Health Organization's (WHO) noise guidelines. The methodology employed was the 2020 PRISMA statement. The bibliographic review was conducted using digital databases such as Scopus, ScienceDirect, Taylor & Francis, Wiley, and EBSCO. To determine the annual growth of scientific production, a digital tool was utilized, and data analysis was performed with Microsoft Office Excel and VOS viewer. The annual growth of scientific production between 1975 and 2022 was 6.47%. The geographical distribution of studies by year and country was concentrated in 2013 and in India, with 3 and 13 publications, respectively. The festival where the most sound pressure levels were measured was Diwali, with 8 studies. The author with the highest number of citations was Overall K., with 161 citations, and the keyword with the highest number of occurrences was "fireworks" (18 instances). It is concluded that 100% (19) of the studies exceeded the WHO's desirable upper limit value for outdoor noise. This finding is concerning because it directly affects people's health. Consequently, governments should implement strategies to minimize the negative impacts generated by fireworks.

1. INTRODUCTION

Fireworks events, which often occur in an atmosphere of social or family harmony, can significantly deteriorate air quality within short periods [1, 2]. The festivals where fireworks are most frequently used include the Spring Festival in China, the Diwali festival, and New Year celebrations [2, 3]. Fireworks are low-explosive pyrotechnic devices [4] utilized in various countries for entertainment during political, sports, folkloric, and religious events, among others [5-7]. There are two types of fireworks: those that produce bright lights (luminous fires) and those that emit high-pitched noises momentarily (firecrackers) [8]. Both types contribute to atmospheric pollution; explosions generate noise, while the resulting smoke contains particles and toxic gases [9, 10].

Noise is an unwanted sound perceived in daily life that can cause harm to the health of people and wildlife, depending on its intensity [11, 12]. In this context, fireworks are considered sources of impulsive or intermittent noise [13, 14], a type of physical disturbance also known as noise pollution [15]. Prolonged exposure to noise pollution can lead to irreversible hearing loss [16, 17]. Fireworks can reach noise peaks of 160 dB(A), and cause tympanic membrane rupture [18] as well as anxiety, hypertension, hearing impairment, myocardial infarction and depression [7]. The sound pressure level is measured using a sound level meter with "A" weighting, which approximates noise perception in the human ear; the unit of measurement is the decibel (dB) [19, 20]. The World Health Organization (WHO) recommends a desirable upper noise limit of 55 dBA for outdoor environments to avoid harm to the human ear [21, 22].

No research exists that compares the noise generated by fireworks with the World Health Organization's (WHO) desirable upper limit value for outdoor noise, nor investigates which festivities contribute significantly to the noise problem. In this context, the following research questions were established: RQ1: What percentage of studies exceeds the WHO's desirable outdoor noise upper limit value? RQ2: What is the distribution of studies by year and country? RQ3: How has the annual scientific production on noise generated by fireworks evolved? RQ4: During which festivities were sound pressure levels measured? The objective of this research is to compare the sound pressure levels generated by fireworks with the WHO's desirable outdoor noise upper limit value.

2. MATERIAL AND METHODS

The 2020 PRISMA statement [23] was applied in the systematic review, which facilitates better preparation, synthesis and presentation of the study [24].

2.1 Eligibility criteria

The inclusion criteria for the search encompassed: (1) scientific research articles indexed in Scopus, (2) studies conducted worldwide, (3) articles published in any language, and (4) publications available up to July 2023 without year restrictions.

The exclusion criteria were as follows: (1) duplicate articles, (2) articles not available via open access, (3) articles whose title and abstract were not related to the study's objective, (4) conference papers, reviews, conference reviews, book chapters, books, letters, notes, and short communications, and (5) articles that did not meet the objective of the study.

2.2 Information sources and search strategy

The information was collected from March 4 to July 25, 2023 in 5 digital databases: Scopus, ScienceDirect, Taylor & Francis, Wiley and EBSCO (Academic Search Ultimate, Biological & Agricultural Index Plus, Environment Complete and GreenFile) (Table 1). Regarding the search strategy, the following search terms were utilized:

Table 1. Search process

Digital Databases	Search Equations
Scopus	TITLE-ABS-KEY (fireworks AND noise)
ScienceDirect	TITLE-ABS-KEY (pyrotechnics AND noise)
Taylor & Francis	TITLE-ABS-KEY (fireworks AND decibels)
Wiley	TITLE-ABS-KEY (pyrotechnics AND
	decibels) TITLE-ABS-KEY (fireworks AND
EBSCO	"noise pollution") TITLE-ABS-KEY (festival
	AND noise)

2.3 Selection and extraction of information

The selection of articles was carried out in groups of 2 authors independently, who reviewed a digital database to extract the information (authors, title, DOI or link, country where the research was conducted, measurement equipment, sound pressure level, festival where it was measured, points and period of monitoring), disagreements were resolved by all authors democratically following the eligibility criteria as well as choosing the articles that contained all the necessary information. The systematization of the article selection strategy was carried out using a digital tool that allows the production of the PRISMA 2020 flow chart [25]. At the beginning, 19668 articles were identified and with the application of the exclusion criteria, 19 articles remained for the review (Figure 1).

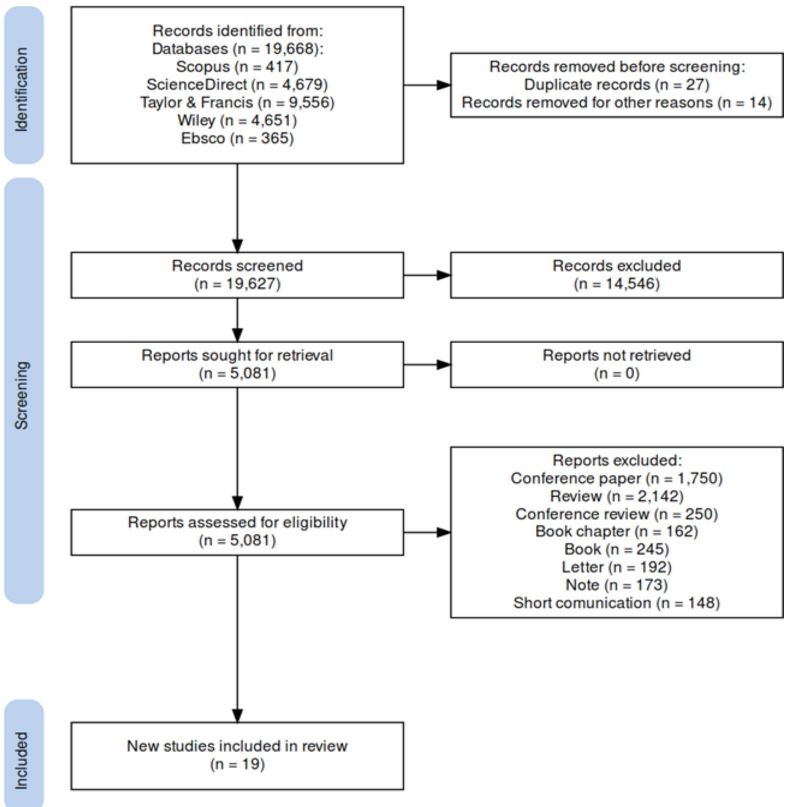

Figure 1. Item selection flowchart

2.4 Compound annual growth rate (CAGR)

The CAGR indicates the annual growth of a variable over a period of time exceeding one year [26] utilized the CAGR to determine the annual growth of scientific production from 1975 to 2022 with the aid of a digital tool [27], which was selected for its free availability, speed, and ease of use [28].

2.5 Data analysis

The data were downloaded in CSV format and processed using Microsoft Office Excel 2016. This facilitated the determination of the distribution of studies by year and country. The analysis was performed with VOSviewer version 1.6.19 a tool widely used in the scientific community to represent and visualize bibliometric networks. VOSviewer employs various colors to assist in understanding and discovering collaborative relationships (co-authorship) among authors (by number of documents or citations), institutions, countries, journals, and keyword co-occurrence [29, 30]. Accordingly, it was employed to analyze collaborations among authors based on citation counts and keyword co-occurrences.

3. RESULTS

All 19 studies, representing 100%, exceeded the WHO's recommended desirable upper limit for outdoor noise. Furthermore, most of the studies were based on measurements from a single monitoring point.

Scientific production has shown an increasing trend from 1975 to July 2023. The year 2013 marked the peak with 3 publications, making it the year with the highest number of publications (Figure 2a). The Compound Annual Growth Rate (CAGR) for scientific production between 1975 and 2022 is 6.47%. The studies are geographically concentrated, with India accounting for 13 publications (Figure 2b).

The festival most frequently studied is Diwali, with 8 publications. Additionally, 7 publications did not specify the festival during which sound pressure levels were measured (Figure 3).

The three authors with the highest number of citations are Overall K., with 161 citations; Blackwell E., with 118 citations; and Branson N., with 106 citations. These authors are represented by the large yellow nodes seen in Figure 4.

The keywords with the highest number of occurrences are "fireworks" with 18 (turquoise node), "fear" (violet node) and "dog" (violet node) both with 14, on the other hand, noise studies with "fireworks" started around 2016 as observed in the large turquoise node (Figure 5).

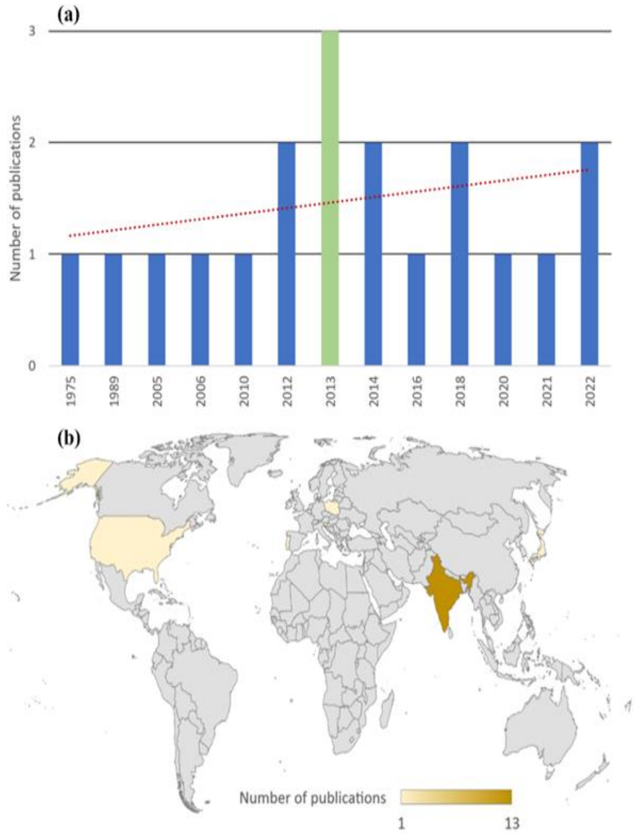

Figure 2. Distribution of studies (a) Per year (b) Per country

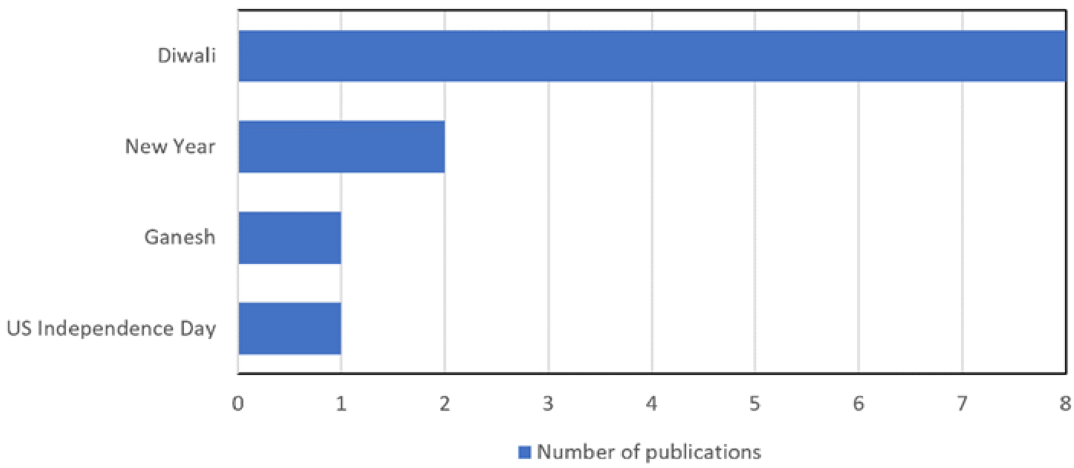

Figure 3. Research carried out for festivities

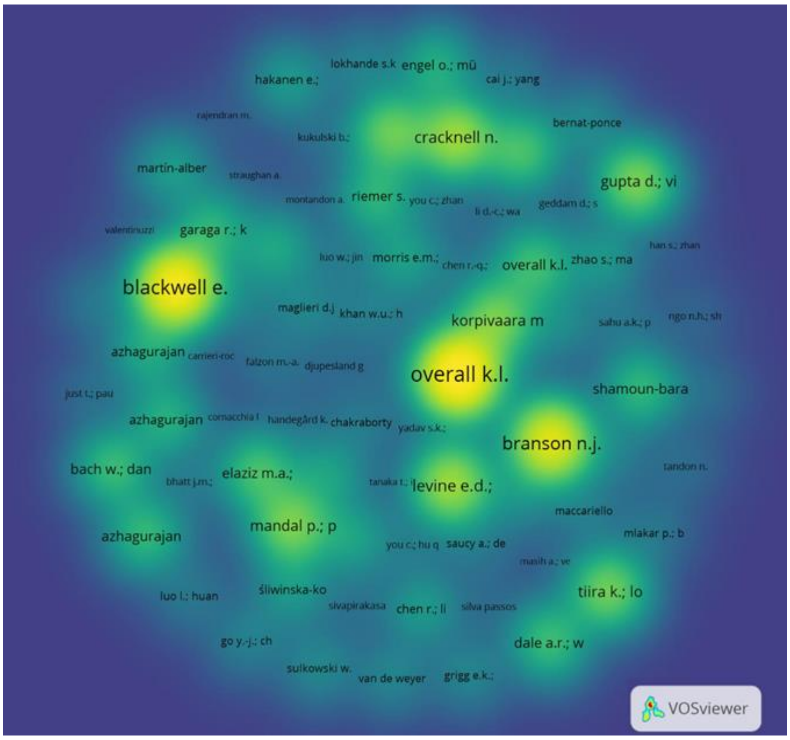

Figure 4. Co-authorship by author by number of citations

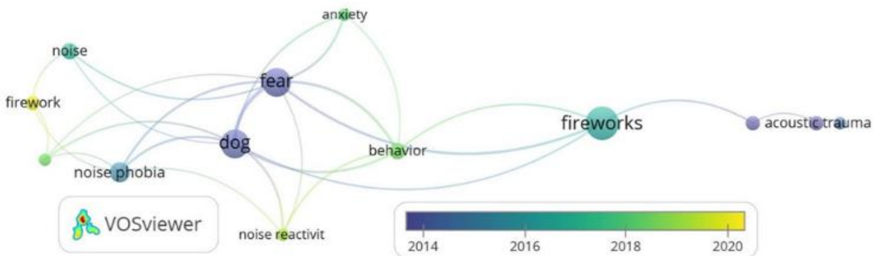

Figure 5. Cooccurrences by keyword

4. DISCUSSIONS

All recorded sound pressure levels exceeded the World Health Organization's (WHO) desirable upper limits for outdoor noise. This may be attributed to the existence of fireworks regulations that are not enforced, as there is resistance from people who consider the use of fireworks a part of their tradition and culture during these festivals [31, 32]. Nonetheless, higher education institutions should be encouraged to promote sustainability practices [33]. Moreover, the number of monitoring points is limited, inhibiting a comprehensive representation of the sound pressure levels in a given location, which is partly due to the high cost of monitoring equipment (Table 2).

Table 2. Sound pressure levels compared to the WHO desirable upper limit value for outdoor noise

Reference	Monitoring Points	Monitoring Period	Measuring Equipment	WHO (55 dbA)
[34]	One	NR	Calibrated magnetic tape recorder used in combination with a General Radio (GR) Octave Band Noise Analyzer fitted with a GR preamplifier microphone combination.	Over 117*
[35]	One	One day	Bruel and Kjaer sound level meters, filter, recorder, and microphone 1621, 2205, 2209, 2306, 4125, 4165; RION real time analyzer SA-24 and recorder LR-04	150*
[36]	One	23:00 and 1:00	NR	97*
[37]	One	NR	NR	112*
[38]	Two	06:00 and 00:00	Sound level meter	75.65* and 77.4*
[39]	One	2006, 2007 and 2008: One day	NR	80*, 79* and 75*
[40]	Two	8:30 and 21:30	Sound level meter TES-1350 A	87*, 96* and 74.27*

[41]	Ten	2010 and 2011: 16:30 to 19:00, 19:00 to 22:30 and 22:30 to 01:00	Sound level meter Model LUTREN, SL-4010	2010: 96.1*, 96.97*, 98.57*, 98.57*, 95.97*, 96.23*, 95.53*, 99.77*, 285.1* and 95.63* 2011: 87.37*, 93.3*, 92.07*, 91.7*, 88.27*, 93.5*, 92.67*, 91.83*, 93.53* and 96.2 *
[42]	One	NR	Four noise level Monitors using Model N°824L (Make: Larson and Davis, USA)	125*
[43]	One	Septembre-November 2012: One day	NR	96.23*
[44]	One	5 consecutive days	NR	72.71*
[45]	Four	16:00 to 16.30, 17:00 to 17:30, 18:00 to 18:30, 19:00 to 19:30, 20:00 to 20.30 and 21:00 to 21:30	Sound level meter of Lutron Electronics (Model number: - SL 4010)	57.67*, 81.5*, 83.5* and 81.67*
[46]	One	Jule 2013: 12:00 to 19:15 and 19:20 to 20:50	Precision sound level meter Model NA-27 (JIS C 1509-1: 2005 Class 1, RION Co., Ltd., Tokyo, Japan)	89*
[5]	Three	11:30 and 00:30	Sound level meters: SVAN 945A, SVAN 958 and SVAN 959	79.8*, 74.5* and 77.1*
[47]	One	November 11 to 14, 2015: 4 days at night	Sound level meter (Amprobe SM - 20 A)	101*
[8]	Three	18:00 to 23:00	Sound level meter-cumanalyzer (B & K make)	69.36*, 71.50* and 72.56*
[7]	Trece	One day	Sound level meter 01 dB type, was used with a measuring range of 40 to 140 dB	106*, 106.8*, 113.2*, 98.3*, 110*, 108.5*, 110.1*, 111.07*, 111.6*, 106.95*, 102.85*, 110.4* and 111.7*
[48]	One	One day	Sound level analyzer, Make: CASELLA, Model 63x	101*
[49]	Three	June 30 to July 8, 2020: 7 consecutive days	Cirrus Optimus Green Octave Band Analyzer CR171B (North Yorkshire, UK)	67*, 70* and 60*

*: Exceeded; NR: Not reported

Scientific production on this topic exhibits low growth, reflecting a lack of global interest in investigating the sound pressure levels caused by fireworks. This trend persists today, with India having the highest number of publications. This is likely because India is the most populous country in the world and the largest producer of fireworks for domestic consumption. Additionally, the fireworks industry is well-established within the country [50, 51].

Diwali, the most important religious festival in India, which dates back 2500 years [52-54], is celebrated annually in October or November over approximately 5 to 6 days [55-58]. Known for its fireworks displays [59, 60], it was estimated that in 2017, around 50,000 tons of fireworks were used [61, 62]. Consequently, Diwali has the highest number of publications related to this research area, due to the massive burning of fireworks and the scientific community's concern over noise pollution, particularly in densely populated countries.

5. CONCLUSIONS

All studies surpassed the WHO's desirable upper limit for outdoor noise levels, with most research featuring only a single monitoring point, inadequate for representing the sound pressure levels produced by fireworks. The year and country with the highest number of publications are 2013 and India, with three and thirteen publications, respectively. The annual growth rate of scientific production on noise generated by fireworks is 6.47%, indicating a sustained low interest, which is concerning given the potential health impacts of this anthropogenic activity. Diwali accounts for the most studies on sound pressure levels, with eight publications noted.

The noise pollution caused by fireworks is a significant contemporary issue that can affect health. Consequently, governments should implement and enforce environmental policies, laws, and stringent penalties, or seek alternatives to traditional fireworks that are less harmful.

ACKNOWLEDGMENT

The researchers would like to thank the Universidad Nacional Intercultural Fabiola Salazar Leguía de Bagua and the Universidad Nacional Intercultural de la Selva Central Juan Santos Atahualpa for facilitating the process of conducting this research.

REFERENCES

[1] Greven, F.E., Vonk, J.M., Fischer, P., Duijm, F., Vink, N.M., Brunekreef, B. (2019). Air pollution during New Year's fireworks and daily mortality in the Netherlands. Scientific Reports, 9(1): 4-11. https://doi.org/10.1038/s41598-019-42080-6

[2] Zhang, X., Shen, H., Li, T., Zhang, L. (2020). The effects of fireworks discharge on atmospheric PM2.5 concentration in the chinese lunar new year. International Journal of Environmental Research and Public Health, 17(24): 1-19. https://doi.org/10.3390/ijerph17249333

[3] Tanda, S., Ličbinský, R., Hegrová, J., Goessler, W. (2019). Impact of New Year's Eve fireworks on the size resolved element distributions in airborne particles. Environment International, 128: 371-378. https://doi.org/10.1016/j.envint.2019.04.071

[4] Russell. (2009). The Chemistry of Fireworks.

https://acortar.link/3sw6oM.

[5] Kukulski, B., Wszołek, T., Mleczko, D. (2018). The impact of fireworks noise on the acoustic climate in urban areas. Archives of Acoustics, 43(4): 697-705. https://doi.org/10.24425/aoa.2018.125163

[6] Liu, Z., Liu, Q., Cao, X., Zhang, X. (2022). Effects of residential customs on spatio-temporal pollution characteristics of fireworks burning during Chinese new year. Asia-Pacific Journal of Atmospheric Sciences, 58(2): 169-180. https://doi.org/10.1007/s13143-021-00246-1

[7] Silva Passos, R., da Rocha, C.A.A.C., de Carvalho, A.P.O., da Silva, L.B., da Silva, R.L.A. (2021). Environmental noise exposure assessment from fireworks at festivals and pilgrimages in Northern Portugal. Applied Acoustics, 181: 108143. https://doi.org/10.1016/j.apacoust.2021.108143

[8] Sahu, A.K., Pradhan, P.K., Mohanty, C.R., Pradhan, M. (2020). Analysis of noise and air pollution in Sambalpur City, India, during Diwali. Journal of Environmental Engineering and Science, 15(4): 172-179. https://doi.org/10.1680/jenes.20.00006

[9] Chatterjee, A., Sarkar, C., Adak, A., Mukherjee, U., Ghosh, S.K., Raha, S. (2013) Ambient air quality during diwali festival over Kolkata - A mega-city in India. Aerosol and Air Quality Research, 13(3): 1133-1144. https://doi.org/10.4209/aaqr.2012.03.0062

[10] Yang, L., Gao, X., Wang, X., Nie, W., Wang, J., Gao, R., Xu, P., Shou, Y., Zhang, Q., Wang, W. (2014). Impacts of firecracker burning on aerosol chemical characteristics and human health risk levels during the chinese new year celebration in Jinan, China. Science of the Total Environment, 476-477: 57-64. https://doi.org/10.1016/j.scitotenv.2013.12.110

[11] Merrall, E.S., Evans, K.L. (2020) Anthropogenic noise reduces avian feeding efficiency and increases vigilance along an urban-rural gradient regardless of species' tolerances to urbanisation. Journal of Avian Biology, 51(9): e02341. https://doi.org/10.1111/jav.02341

[12] Passchier-Vermeer, W., Passchier, W.F. (2000). Noise exposure and public health. Environmental Health Perspectives, 108: 123-131. https://doi.org/10.1289/ehp.00108s1123

[13] Młyński, R., Kozłowski, E., Usowski, J., Jurkiewicz, D. (2018). Evaluation of exposure to impulse noise at personnel occupied areas during military field exercises. Archives of Acoustics, 43(2): 197-205. https://bibliotekanauki.pl/articles/177458

[14] Sordello, R., Ratel, O., de Lachapelle, F.F., Leger, C., Dambry, A., Vanpeene, S. (2020). Evidence of the impact of noise pollution on biodiversity: A systematic map. Environmental Evidence, 9: 1-27. https://doi.org/10.1186/s13750-020-00202-y

[15] Lokhande, S.K., Pathak, S.S., Kokate, P.A., Dhawale, S.A., Bodhe, G.L. (2018). Assessment of heterogeneous road traffic noise in Nagpur. Archives of Acoustics, 43: 113-121. https://doi.org/10.24425/118086

[16] Smoorenburg, G.F. (1996). Risk of noise-induced hearing loss following exposure to Chinese firecrackers. International Journal for Consumer and Product Safety, 32(6): 137-146. https://doi.org/10.3109/00206099309071864

[17] Maassen, M., Babisch, W., Bachmann, K.D., Ising, H., Lehnert, G., Plath, P., Plinkert, P., Rebentisch, E., Schuschke, G., Spreng, M. (2001). Ear damage caused by leisure noise. Noise & Health, 4(13): 1-16. https://journals.lww.com/nohe/fulltext/2001/04130/ear_damage_caused_by_leisure_noise_.1.aspx

[18] Flamme, G.A., Liebe, K., Wong, A. (2009). Estimates of the auditory risk from outdoor impulse noise I: Firecrackers. Noise and Health, 11(45): 223-230. https://doi.org/10.4103/1463-1741.56216

[19] Naef, A.C., Knobel, S.E.J., Ruettgers, N., Jeitziner, M.M., Holtforth, M. grosse, Zante, B., Schefold, J.C., Nef, T., Gerber, S.M. (2022). Methods for measuring and identifying sounds in the intensive care unit. Frontiers in Medicine, 9: 1-12. https://doi.org/10.3389/fmed.2022.836203

[20] Risojević, V., Rozman, R., Pilipović, R., Češnovar, R., Bulić, P. (2018). Accurate indoor sound level measurement on a low-power and low-cost wireless sensor node. Sensors (Switzerland), 18(7): 2351. https://doi.org/10.3390/s18072351

[21] Erdélyi, K.H., Fuermaier, A.B.M., Tucha, L., Tucha, O., Koerts, J. (2023). Low-frequency noise: Experiences from a low-frequency noise perceiving population. International Journal of Environmental Research and Public Health, 20: 3916. https://doi.org/10.3390/ijerph20053916

[22] Silva, L.T., Oliveira, I.S., Silva, J.F. (2016). The impact of urban noise on primary schools. Perceptive evaluation and objective assessment. Applied Acoustics, 106: 2-9. https://doi.org/10.1016/j.apacoust.2015.12.013

[23] Page, M.J., McKenzie, J.E., Bossuyt, P.M., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. International Journal of Surgery, 88: 105906. https://doi.org/10.1016/j.ijsu.2021.105906

[24] Posada López, Z., Vasquez Lopez, C. (2022). Ejercicio físico durante la pandemia: Una revisión sistemática utilizando la herramienta PRISMA. Revista Iberoamericana de Ciencias de la Actividad Física y el Deporte, 11(1): 1-19. https://doi.org/10.24310/riccafd.2022.v11i1.13721

[25] Haddaway, N.R., Page, M.J., Pritchard, C.C., McGuinness. (2022). L.A. PRISMA2020: An R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimised digital transparency and open synthesis. Campbell Systematic Reviews, 18(2): 1-12. https://doi.org/10.1002/cl2.1230

[26] Bornmann, L., Haunschild, R., Mutz, R.(2021). Growth rates of modern science: A latent piecewise growth curve approach to model publication numbers from established and new literature databases. Humanities and Social Sciences Communications, 8: 224. https://doi.org/10.1057/s41599-021-00903-w

[27] Calcuvio. (2023). Calculadora de Tasa de Crecimiento Anual Compuesto o CAGR. https://www.calcuvio.com/crecimiento-anual, accessed on Apr. 10, 2023.

[28] Reategui-Inga, M., Rojas, E.M., Tineo, D., Araníbar-Araníbar, M.J., Valdiviezo, W.A., Escalante, C.A., Castre, S.J.R. (2023). Effects of artificial electromagnetic fields on bees: A global review. Pakistan Journal of Biological Sciences, 26(1): 23-32. https://doi.org/10.3923/pjbs.2023.23.32

[29] Castillo-Vergara, M., Alvarez-Marin, A., Placencio-Hidalgo, D. (2028). A bibliometric analysis of creativity

in the field of business economics. Journal of Business Research, 85: 1-9. https://doi.org/10.1016/j.jbusres.2017.12.011
[30] Veiga-del-Baño, J.M., Cámara, M.Á., Oliva, J., Hernández-Cegarra, A.T., Andreo-Martínez, P., Motas, M.(2023). Mapping of emerging contaminants in coastal waters research: A bibliometric analysis of research output during 1986-2022. Marine Pollution Bulletin, 194: 115366. https://doi.org/10.1016/j.marpolbul.2023.115366
[31] Kaur, B., Kaul, V.K. (2018). Consumers of fireworks and pollution in India: Implications for marketers and state policy. Indian Journal of Marketing, 48: 50-60. https://doi.org/10.17010/ijom/2018/v48/i5/123447
[32] Shali, P. (2017). Old Delhi' s fi recracker market protests Supreme Court ban, shops down shutters. India Today. https://www.indiatoday.in/india/story/financial-loss-to-fireworkers-shopkeepers-supreme-court-cracker-ban-1062508-2017-10-11, accessed on May. 19, 2023.
[33] Ocaña-Zúñiga, C.L., Tineo, M., Fernandez-Zarate, F.H., Quiñones-Huatangari, L., Huaccha-Castillo, A.E., Morales-Rojas, E., Miguel-Miguel, H.W. (2023). Implementing the sustainable development goals in university higher education: A systematic review. International Journal of Sustainable Development and Planning, 18(6): 1769-1776. https://doi.org/10.18280/ijsdp.180612
[34] Bach, W., Daniels, A., Dickinson, L., Hertlein, F., Morrow, J., Margolis, S., Dinh, V.D. (1975). Fireworks pollution and health. International Journal of Environmental Studies, 7(3): 183-192. https://doi.org/10.1080/00207237508709692
[35] Gupta, D., Vishwakarma, M. (1989). Toy weapons and firecrackers a source of hearing loss. The Laryngoscope, 99(3): 330-334. https://doi.org/10.1288/00005537-198903000-00018
[36] Čudina, M., Prezelj, J. (2005). Noise due to firecracker explosions. Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science, 219(6): 523-537. https://doi.org/10.1243/095440605X17036
[37] Sivapirakasam, S., Surianarayanan, M., Venkataratnam, G. (2006). Evaluation of noise levels of pyrotechnic fire crackers. Pollution Research, 25(2): 327-331. https://www.researchgate.net/publication/287015909_Evaluation_of_noise_levels_of_pyrotechnic_fire_crackers
[38] Sharma, V., Joshi, B.D. (2010). Assessment of noise pollution during Deepawali festival in a small township of Haridwar City of Uttarakhand, India. Environmentalist, 30(3): 216-218. https://doi.org/10.1007/s10669-010-9265-x
[39] Mandal, P., Prakash, M., Bassin, J.K. (2012). Impact of Diwali celebrations on urban air and noise quality in Delhi City, India. Environmental Monitoring and Assessment, 184(1): 209-215. https://doi.org/10.1007/s10661-011-1960-7
[40] Mahecha, G.S., Bamniya, B.R., Kapasya, V., Meena, R.S. (2012). Noise pollution monitoring during Diwali festival in Golden city Jaisalmer of Rajasthan, India. Environmentalist, 32(4): 415-419. https://doi.org/10.1007/s10669-012-9404-7
[41] Goswami, S., Swain, K., Mohapatra, H.P., Kumar Bal, K., Dalela, R.C. (2013). A preliminary assessment of noise level during Deepawali festival in Balasore, India. Journal of Environmental Biology, 34(6): 981-984. https://pubmed.ncbi.nlm.nih.gov/24555325/
[42] Selvakumar, N., Azhagurajan, A., Suresh, A. (2013). Experimental analysis on nano scale flash powder composition in fireworks manufacturing. Journal of Thermal Analysis and Calorimetry, 113(2): 615-621. https://doi.org/10.1007/s10973-012-2749-9
[43] Ambade, B., Ghosh, S. (2013). Characterization of PM10 in the ambient air during Deepawali festival of Rajnandgaon district, India. Natural Hazards, 69(1): 589-598. https://doi.org/10.1007/s11069-013-0725-8
[44] Masih, A., Verma, P., Lal, J.K., Taneja, A. (2014). Study of noise and atmospheric pollution during the festival of lights (deepawali) in the north central part of India—A case study. Advanced Science Letters, 20(7): 1666-1672. https://doi.org/https://doi.org/10.1166/asl.2014.5509
[45] Mule, P., Joshi, N., Bist, B., Joshi, A. (2014). Study of fluctuating noise levels in Palghar, Mumbai, India. Pollution Research, 33(2): 445-450. https://www.researchgate.net/publication/268801664_Study_of_fluctuating_noise_levels_in_Palghar_Mumbai_India
[46] Tanaka, T.I.A. (2016). Noise and low-frequency sound levels due to aerial fireworks and prediction of the occupational exposure of pyrotechnicians to noise. Journal of Occupational Health, 84(6): 1511-1518. https://doi.org/10.1134/s0320972519100129
[47] Garaga, R., Kota, S.H. (2018). Characterization of PM10 and impact on human health during the annual festival of lights (Diwali). Journal of Health and Pollution, 8(20): 1-12. https://doi.org/10.5696/2156-9614-8.20.181206
[48] Lokhande, S.K., Garg, N., Jain, M.C., Rayalu, S. (2022). Evaluation and analysis of firecrackers noise: Measurement uncertainty, legal noise regulations and noise induced hearing loss. Applied Acoustics, 186: 108462. https://doi.org/10.1016/j.apacoust.2021.108462
[49] Walker, E.D., Lee, N.F., Tieskens, K.F., Jay, J., Walker, L.J., Luse, M., Celestin, R., Smith, J., Mejia, J., Levy, J.I. (2022). Firework activity and environmental sound levels: Community impacts and solutions. Cities and Health, 6(3): 552-563. https://doi.org/10.1080/23748834.2021.1928857
[50] Mahilang, M., Deb, M.K., Nirmalkar, J., Pervez, S. (2020). Influence of fireworks emission on aerosol aging process at lower troposphere and associated health risks in an urban region of eastern central India. Atmospheric Pollution Research, 11(7): 1127-1141. https://doi.org/10.1016/j.apr.2020.04.009
[51] Nallathambi, I., Savaram, P., Sengan, S., Alharbi, M., Alshathri, S., Bajaj, M., Aly, M.H., El-Shafai, W. (2023). Impact of fireworks industry safety measures and prevention management system on human error mitigation using a machine learning approach. Sensors, 23. https://doi.org/10.3390/s23094365
[52] Khan, T., Lawrence, A., Dwivedi, S., Arif, S., Dwivedi, S., Upadhyay, A., Abraham, A., Roberts, V. (2022). Air pollution trend and variation during a mega festival of firecrackers (Diwali) in context to COVID-19 pandemic. Asian Journal of Atmospheric Environment, 16(3). https://doi.org/10.5572/ajae.2022.016
[53] Ravindra, K., Kumar, S., Mor, S. (2022). Long term assessment of firework emissions and air quality during Diwali festival and impact of 2020 fireworks ban on air

quality over the states of Indo Gangetic Plains airshed in India. Atmospheric Environment, 285: 119223. https://doi.org/10.1016/j.atmosenv.2022.119223
[54] Saxena, P., Kumar, A., Mahanta, S.K., Sreekanth, B., Patel, D.K., Kumari, A., Khan, A.H., Kisku, G.C. (2022). Chemical characterization of PM10 and PM2.5 combusted firecracker particles during Diwali of Lucknow City, India: Air-quality deterioration and health implications. Environmental Science and Pollution Research, 29(58): 88269-88287. https://doi.org/10.1007/s11356-022-21906-3
[55] Ambade, B. (2018). The air pollution during Diwali festival by the burning of fireworks in Jamshedpur city, India. Urban Climate, 26: 149-160. https://doi.org/10.1016/j.uclim.2018.08.009
[56] Chhabra, A., Turakhia, T., Sharma, S., Saha, S., Iyer, R., Chauhan, P. (2020). Environmental impacts of fireworks on aerosol characteristics and radiative properties over a mega city, India. City and Environment Interactions, 7: 100049. https://doi.org/10.1016/j.cacint.2020.100049
[57] Chirmaie, N., Kapil, K., Singh, J.L., Singh, C.C., Singh, R.D. (2022). The aftermath of fireworks prohibition on Diwali festival due to COVID-19 situation: A case study of the air quality of metropolitan cities of India. Research Journal of Chemistry and Environment, 26(4): 105-114. https://doi.org/10.25303/2604rjce105114
[58] Garg, A., Gupta, N.C. (2020). Short-term variability on particulate and gaseous emissions induced by fireworks during Diwali celebrations for two successive years in outdoor air of an urban area in Delhi, India. SN Applied Sciences, 2(12): 1-14. https://doi.org/10.1007/s42452-020-03906-5
[59] Pope, R.J., Marshall, A.M., O'Kane, B.O. (2016). Observing UK bonfire night pollution from space: Analysis of atmospheric aerosol. Weather, 71(11): 288-291. https://doi.org/10.1002/wea.2914
[60] Singh, A., Pant, P., Pope, F.D. (2019). Air quality during and after festivals: Aerosol concentrations, composition and health effects. Atmospheric Research, 227: 220-232. https://doi.org/10.1016/j.atmosres.2019.05.012
[61] Chen, S., Jiang, L., Liu, W., Song, H. (2022). Fireworks regulation, air pollution, and public health: Evidence from China. Regional Science and Urban Economics, 92: 103722. https://doi.org/10.1016/j.regsciurbeco.2021.103722
[62] Praveen Kumar, R., Samuel, C., Raju, S.R., Gautam, S. (2022). Air pollution in five Indian megacities during the Christmas and New Year celebration amidst COVID-19 pandemic. Springer Berlin Heidelberg, 36(11): 3653-3683. https://doi.org/10.1007/s00477-022-02214-1