International Journal of Sustainable Development and Planning
Vol. 19, No. 12, December, 2024, pp. 4905-4918
Journal homepage: http://iieta.org/journals/ijsdp

Concentrations of Indoor $PM_{2.5}$ and PM_{10} Worldwide

Manuel Reategui-Inga[1*], José Kalión Guerra Lu[2], Wilfredo Alva Valdiviezo[2], Cecilia Antony Ninahuanca Tocas[3], Percy Rivera Tiza[1], Daniel Susanibar-Sandoval[4], Alizon Cisneros[5], Peter Coaguila-Rodriguez[2], Alberto Franco Cerna-Cueva[2], Ronald Panduro Durand[1], Daniel Álvarez-Tolentino[1]

[1] Escuela Profesional de Ingeniería Ambiental, Universidad Nacional Intercultural de la Selva Central Juan Santos Atahualpa, Chanchamayo 12855, Perú
[2] Facultad de Recursos Naturales Renovables, Universidad Nacional Agraria de la Selva, Tingo María 10131, Perú
[3] Escuela Académica Profesional de Ingeniería Ambiental, Universidad Continental S.A.C., Huancayo 12000, Perú
[4] Escuela Profesional de Ingeniería Electrónica, Facultad de Ingeniería Electrónica - Sistemas, Universidad Nacional de Huancavelica, Huancavelica 09001, Perú
[5] Escuela Profesional de Ingeniería Ambiental, Universidad Nacional de Ucayali, Pucallpa 25000, Perú

Corresponding Author Email: mreategui@uniscjsa.edu.pe

https://doi.org/10.18280/ijsdp.191238

Received: 7 October 2024
Revised: 4 December 2024
Accepted: 10 December 2024
Available online: 30 December 2024

Keywords:
air, indoor, particulate matter, PRISMA, VOSviewer

ABSTRACT

Indoor air pollution has gained importance in recent years due to its direct contact with humans and its greater potential for harm. In this context, the objective of the study was to compare indoor $PM_{2.5}$ and PM_{10} concentrations with the World Health Organization (WHO) guideline. The methodology of the PRISMA 2020 statement was used, the bibliographic review was in 5 digital databases. The annual growth rate of scientific production was determined using the digital calculator Calcuvio, while data analysis was carried out with Microsoft Office Excel and VOSviewer. Approximately 80% of studies did not exceed the WHO guideline; the most studied indoor environment and pollution sources were homes and road traffic/cigarette smoke. The year and country with the highest scientific output were 2014 and the United States, respectively, with an annual growth rate in scientific production (1984–2024) of 13.49%. The most frequently appearing keyword was "particulate matter." The study concludes that corrective measures should be implemented to reduce particulate matter indoors, given that humans spend the majority of their lives in these environments.

1. INTRODUCTION

Globally, the deterioration of air quality has become a major challenge to control due to the release of high concentrations of pollutant gases from motor vehicles and industrialization, as well as a lack of environmental awareness [1, 2]. Air pollution occurs both outdoors and indoors; the latter is a complex mixture of suspended particles with an aerodynamic diameter of less than 10 μm (PM_{10}) and 2.5 μm ($PM_{2.5}$) [3], as well as pollutant gases such as carbon dioxide (CO_2), carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2), and volatile organic compounds (VOCs) [4-10].

Rapid urbanization and lifestyle changes have led people to spend most of their day in indoor environments (homes, workplaces, and leisure spaces), consequently increasing their exposure to pollutants [11-14]. Anthropogenic activities contributing to indoor air pollution include smoking, cooking, burning candles, cleaning, construction materials, and the use of traditional heating methods (coal and wood) [15-17]. Additionally, outdoor pollutants that can infiltrate indoor environments are caused by motor vehicles, industrial facilities, road dust, and biomass burning [18, 19].

Air pollution predominantly affects the most vulnerable populations (pregnant women, children, and the elderly), compromising the immune system in patients with respiratory, asthmatic, and cardiovascular diseases. Furthermore, indoor air pollution is responsible for one million deaths worldwide, and the United Nations Environment Programme determined that in 2020 and 2021, it accounted for 3.2 million and 4 million premature deaths, respectively [20, 21].

The regulations applicable to both outdoor and indoor air quality are set by the WHO, which presents guidelines of an average of 15 μg/m³ and 45 μg/m³ for $PM_{2.5}$ and PM_{10}, respectively, over a 24-hour period [18].

Thus, the objective of the research was to compare the concentrations of $PM_{2.5}$ and PM_{10} indoors with the WHO guidelines. In this context, the following research questions (RQ) were posed:

RQ1: What proportion of studies exceed the WHO guideline?

RQ2: Which indoor environment and source of pollution were the most studied?

RQ3: In which year and country was there the highest scientific output?

RQ4: What is the annual growth rate of scientific production?

RQ5: What keywords appear most frequently?

2. MATERIAL AND METHODS

The methodology used was the review applying the PRISMA 2020 statement [22], which will aid in better preparing, understanding, and summarizing the review [23, 24].

2.1 Document eligibility

In the inclusion, the following were applied: (1) scientific research articles, (2) research in the world (all languages), (3) in all years up to September 2024, and (4) studies with $PM_{2.5}$ and PM_{10} results expressed in µg/m³. This was all aimed at covering a larger number of articles on the topic.

Regarding the exclusion criteria, the following were discarded: (1) duplicate articles among the search equations, (2) closed-access articles, (3) articles whose titles or abstracts did not meet the study's objectives, and (4) other types of scientific publications.

The criteria were used to delimit the research in depth and to obtain a greater number of articles for the review.

2.2 Origin of the information and search strategies

The information collected was in databases (Table 1), which began on June 3 and ended on September 23, 2024. The aforementioned databases were chosen because they have the largest number of journals in the world and in different fields of studies [25, 26]. Two search equations were used:

Table 1. Search strategies

Digital Databases	Search Equations
Taylor & Francis Scopus Wiley ScienceDirect EBSCO (Academic Search Ultimate, Biological & Agricultural Index Plus, Environment Complete, GreenFILE and Veterinary Source)	TITLE-ABS-KEY (“particulate matter” AND indoors) TITLE-ABS-KEY (PM AND indoors)

2.3 Choice and collection of information

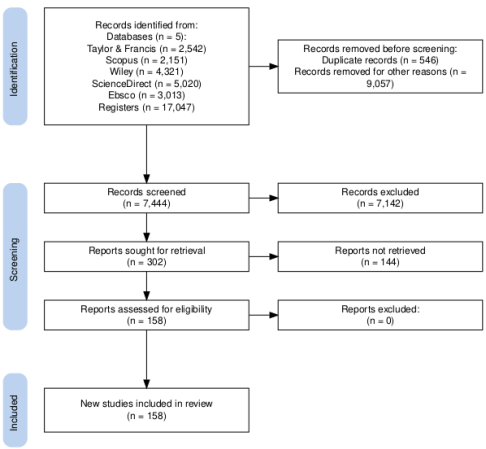

Figure 1. Flow diagram of article selection

In the selection of articles, 2 groups were formed (5 authors per group) so that each group searched for a search equation. The doubts that arose in the process were resolved at the end of the selection process. For the schematization of the selection of the articles, we used the online tool where the diagram was created (Figure 1) [27]. At the beginning, 17047 items were identified and by applying the criteria, 158 were subtracted.

2.4 Compound annual growth rate (CAGR)

Indicates the percentage of annual growth in scientific production (1984 to 2024), and with the help of an online calculator [28], the value was determined using the formula:

$$CAGR\ \% = 100 * \left(\left(\frac{V_f}{Vi}\right)^{\frac{1}{t}} - 1\right)$$

where, V_i = Initial value; V_f = Final value; t = Years.

2.5 Data analysis

The information was downloaded from the database in CSV format in order to determine the distribution of the investigations. For the analysis of keyword co-occurrence, VOSviewer 1.6.19 software [29] is useful in the scientific field to plot bibliometric networks in many colors to understand co-authorship, countries and keyword co-occurrence relationships [30, 31].

3. RESULTS AND DISCUSSIONS

Table 2 shows the 158 studies along with their respective particulate matter concentrations, of which 35 ($PM_{2.5}$) and 29 (PM_{10}) studies exceed the WHO guideline.

Table 2. Comparison of $PM_{2.5}$ and PM_{10} concentrations with WHO guideline

WHO 24 Hour Average		Refs.
$PM_{2.5}$ 15 µg/m³	**PM_{10} 45 µg/m³**	
11	X	[32]
X	78**	[33]
X	42	[34]
57.78**	106.19**	[35]
X	9840**	[36]
21.10**	28.90	[37]
19.52**	34.91	[38]
11.40	26.80	[39]
12.75	X	[40]
14	X	[41]
X	386**	[42]
X	32.60	[43]
13.50	X	[44]
22.50**	X	[45]
47**	X	[46]
15.45**	5.63	[47]
43.56**	X	[48]
X	1422.67**	[49]
X	24.50	[50]
2.60	X	[51]
13.45	X	[52]
111.31**	128.13**	[53]
35.83**	X	[54]
28.80**	X	[55]

82.65**	56.25**	[56]
8.40	13.95	[57]
8.60	X	[58]
12.10	18.50	[59]
241.05**	392.81**	[60]
X	90.83**	[61]
95**	X	[62]
X	68.25**	[63]
7	35	[64]
548**	2085**	[65]
6.90	X	[66]
37.40**	118.20**	[67]
7.30	X	[68]
34.15**	28.90	[69]
37.85**	19.20	[70]
X	81.50**	[71]
178**	X	[72]
88**	110**	[73]
93**	X	[74]
97.81**	X	[75]
5.80	X	[76]
204**	X	[77]
588**	X	[78]
151**	X	[79]
30.10**	35	[80]
X	15	[81]
61**	363**	[82]
109**	181**	[83]
88**	X	[84]
77**	X	[85]
X	33.67	[86]
X	77.20**	[87]
19**	53.70**	[88]
38.40**	18.10	[89]
33**	X	[90]
7	X	[91]
144.50**	X	[92]
20.90**	X	[93]
9.28	X	[94]
113**	X	[95]
23**	X	[96]
55.23**	X	[97]
71.90**	X	[98]
53**	X	[99]
97**	X	[100]
62**	X	[101]
68**	75**	[102]
X	54.60**	[103]
86.72**	X	[104]
343.33**	X	[105]
45.50**	X	[106]
70**	X	[107]
3.10	8.20	[108]
34.69**	50.94**	[109]
86.20**	320**	[110]
243**	X	[111]
34**	X	[112]
X	31.10	[113]
56**	X	[114]
112.51**	X	[115]
30**	X	[116]
201**	305**	[117]
55.20**	X	[118]
X	73.30**	[119]
503**	X	[120]
35.20**	27.40	[121]
71.70**	X	[122]
13.30	35.40	[123]
135.60**	X	[124]
112**	X	[125]
6.30	83.56**	[126]
12.80	X	[127]
56.33**	X	[128]
X	40	[129]
173**	153**	[130]
483**	X	[131]
36.42**	X	[132]
13.96	X	[133]
X	40	[134]
186.50**	X	[135]
212.01**	263.24**	[136]
177**	X	[137]
259**	X	[138]
7.71	X	[139]
253.45**	X	[140]
8.80	X	[141]
13	X	[142]
60.1**	93.20**	[143]
48.86**	X	[144]
41**	43	[145]
14.60	X	[146]
24.90**	X	[147]
20**	X	[148]
5.20	X	[149]
166.40**	X	[150]
5581**	X	[151]
14.10	27.50	[152]
29.50**	X	[153]
3.24	X	[154]
X	59.70**	[155]
53**	57**	[156]
7.50	X	[157]
17.30**	X	[158]
434.52**	X	[159]
34**	X	[160]
25.98**	31.02	[161]
35.95**	67.73**	[162]
52.20**	X	[163]
32.40**	X	[164]
78**	123.60**	[165]
795**	X	[166]
65.3**	92.90**	[167]
109**	X	[168]
203**	X	[169]
11.63	16.59	[170]
24**	24.90	[171]
10	15	[172]
41**	79.40**	[173]
40.72**	X	[174]
3.90	9.60	[175]
291.70**	X	[176]
10.80	X	[177]
10.40	X	[178]
75.30**	X	[179]
15.34**	X	[180]
X	50.30**	[181]
3869.98**	322.32**	[182]
49.60**	X	[183]
23.90**	X	[184]
142.30**	X	[185]
18.21**	25.53	[186]
18.10**	X	[187]
13.80	X	[188]
83**	X	[189]

**: Exceeded;
X: Not Specified, that is to say, the information was not found in the article.

The indoor environments where $PM_{2.5}$ and PM_{10} concentrations were most frequently measured are homes and schools, with 96 and 30 studies (Figure 2), respectively. This can be attributed to the importance given to these types of environments, where people spend between 60% and 70% of

their time [190, 191] in their homes, with the highest percentage among the elderly [192, 193]. Additionally, in schools, particulate matter is often transported on students' shoes, which can increase concentrations under humid conditions due to wet soil [152, 194]. The concentration of particulate matter could potentially be reduced by changing footwear before entering the study environment [195].

Out of the 158 studies, 100 did not report the source of pollution. On the other hand, the most commonly reported sources of pollution were road traffic and cigarette smoke, each with 13 studies (Figure 3). The significance of studies on road traffic lies in the fact that adults spend approximately 1.5 hours per day in their cars [193], which represents critical exposure points to pollutants [192]. Furthermore, homes are generally built close to highways and other high-traffic routes [194, 195], significantly contributing to atmospheric pollution [196], as road dust is the type of dust that researchers often study worldwide [197-200].

Cigarettes contain nicotine, which is the main component of tobacco smoke. This toxic compound accumulates in the air or on surfaces (as dust) [201, 202], remaining in the environment for days or months [203]. Even six months after former smokers quit, homes can still be contaminated with tobacco smoke [204, 205]. In this regard, due to the detriment to indoor air quality and the health effects that it causes, there are several studies on cigarette smoke [206].

The years with the highest scientific output are 2014 and 2018, with 15 and 12 studies, respectively (Figure 4). On the other hand, the annual growth rate of scientific production is 13.49%, indicating slow but steady growth.

The countries with the highest scientific publications are the United States and China, with 32 and 22 studies, respectively (Figure 5). This coincides with the review of $PM_{2.5}$ and PM_{10} concentrations due to fireworks [207]. The United States is one of the countries with the highest number of premature deaths, with approximately 60000 annually [208]. Additionally, 40% of its population lives in areas affected by wildfires, and it has the highest number of vehicles per capita [209, 210]. In China, 17% of deaths are attributed to air pollution, with approximately 4400 daily deaths [211]. Furthermore, economic growth and urbanization have made it one of the countries with the highest $PM_{2.5}$ concentrations [212-214]. Additionally, the number of vehicles in China has been steadily increasing, reaching 372 million in 2020, making it a significant source of air pollution [215].

Figure 6 shows keywords with a minimum of 6 occurrences, and the ones with the largest number of appearances are "particulate matter" and "indoor air pollution," with 57 and 52 occurrences, respectively. Additionally, four clusters were formed (blue, yellow, green, and red).

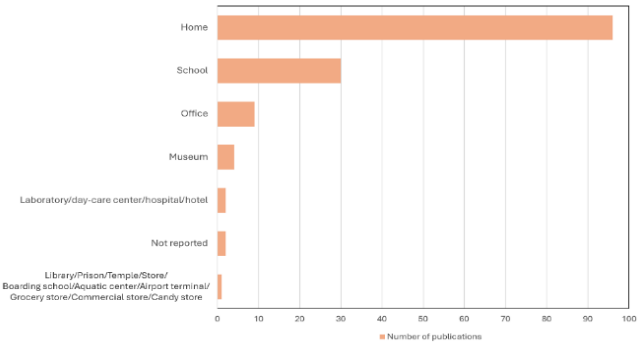

Figure 2. Indoors

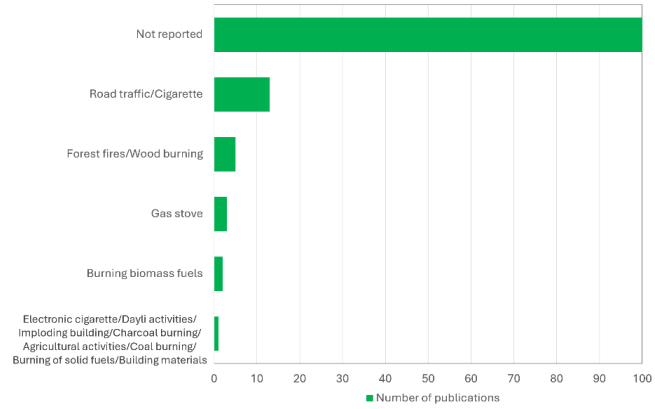

Figure 3. Sources of $PM_{2.5}$ and PM_{10} pollution

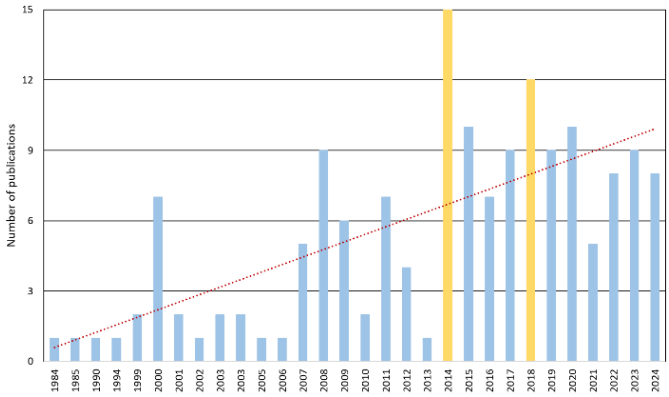

Figure 4. Evolution of scientific production per year

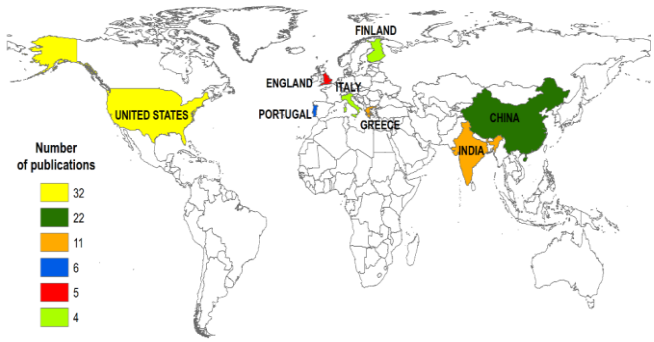

Figure 5. Evolution of scientific production per country

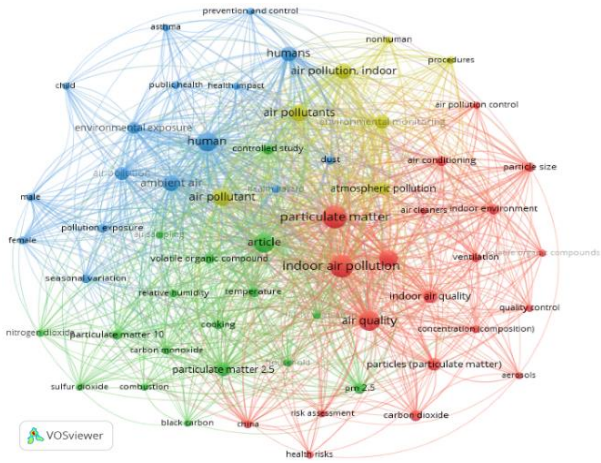

Figure 6. Keyword bibliometric network

4. CONCLUSIONS

In the studies reviewed, approximately 80% did not exceed the WHO guideline. In this context, it is necessary to implement targeted strategies for each type of indoor pollution activity to further reduce this percentage. The home and school were the locations with the highest number of studies conducted, as they are places where people spend most of their lives. This underscores the importance of implementing corrective measures to reduce particulate matter concentrations. Additionally, the primary sources of pollution identified were road traffic and cigarette smoke.

The United States and China are leaders in addressing this topic, as with most air pollution research. In contrast, South and Central America have fewer studies; most countries in this region are developing nations, which often lack stringent enforcement of environmental policies.

ACKNOWLEDGMENT

To the Universidad Nacional Intercultural de la Selva Central Juan Santos Atahualpa for its support in carrying out the study.

REFERENCES

[1] Fallahi, S., Amanollahi, J., Tzanis, C.G., Ramli, M.F. (2018). Estimating solar radiation using NOAA/AVHRR and ground measurement data. Atmospheric Research, 199: 93-102. https://doi.org/10.1016/j.atmosres.2017.09.006

[2] Tzanis, C.G., Alimissis, A., Philippopoulos, K., Deligiorgi, D. (2019). Applying linear and nonlinear models for the estimation of particulate matter variability. Environmental Pollution, 246: 89-98. https://doi.org/10.1016/j.envpol.2018.11.080

[3] Li, Z., Wen, Q., Zhang, R. (2017). Sources, health effects and control strategies of indoor fine particulate matter (PM2.5): A review. Science of the Total Environment, 586: 610-622. https://doi.org/10.1016/j.scitotenv.2017.02.029

[4] Ishizaka, T.D., Kawashima, A., Hishida, N., Hamada, N. (2019). Measurement of total volatile organic compound (TVOC) in indoor air using passive solvent extraction method. Air Quality, Atmosphere and Health, 12: 173-187. https://doi.org/10.1007/s11869-018-0639-4

[5] Ielpo, P., Mangia, C., Marra, G.P., Comite, V., Rizza, U., Uricchio, V.F., Fermo, P. (2019). Outdoor spatial distribution and indoor levels of NO2 and SO2 in a high environmental risk site of the South Italy. Science of the Total Environment, 648: 787-797. https://doi.org/10.1016/j.scitotenv.2018.08.159

[6] Huang, Y., Yang, Z., Gao, Z. (2019). Contributions of indoor and outdoor sources to ozone in residential buildings in Nanjing. International Journal of Environmental Research and Public Health, 16(14): 2587. https://doi.org/10.3390/ijerph16142587

[7] Weichenthal, S., Dufresne, A., Infante-Rivard, C. (2007). Review: Indoor nitrogen dioxide and VOC exposures: Summary of evidence for an association with childhood asthma and a case for the inclusion of indoor ultrafine particle measures in future studies. Indoor and Built Environment, 16(5): 387-399. https://doi.org/10.1177/1420326X07082730

[8] Satish, U., Mendell, M.J., Shekhar, K., Hotchi, T., Sullivan, D., Streufert, S., Fisk, W.J. (2012). Is CO2 an indoor pollutant? Direct effects of low-to-moderate CO2 concentrations on human decision-making performance. Environmental Health Perspectives, 120(12): 1671-1677. https://doi.org/10.1289/ehp.1104789

[9] Azuma, K., Kagi, N., Yanagi, U., Osawa, H. (2018). Effects of low-level inhalation exposure to carbon dioxide in indoor environments: A short review on human health and psychomotor performance. Environment International, 121: 51-56. https://doi.org/10.1016/j.envint.2018.08.059

[10] Zhang, X., Wargocki, P., Lian, Z., Thyregod, C. (2017). Effects of exposure to carbon dioxide and bioeffluents on perceived air quality, self-assessed acute health symptoms, and cognitive performance. Indoor Air, 27(1): 47-64. https://doi.org/10.1111/ina.12284

[11] Mannan, M., Al-Ghamdi, S.G. (2021). Indoor air quality in buildings: A comprehensive review on the factors influencing air pollution in residential and commercial structure. International Journal of Environmental Research and Public Health, 18(6): 3276. https://doi.org/10.3390/ijerph18063276

[12] Faria, T., Martins, V., Correia, C., Canha, N., Diapouli, E., Manousakas, M., Eleftheriadis, K., Almeida, S.M. (2020). Children's exposure and dose assessment to particulate matter in Lisbon. Building and Environment, 171: 106666. https://doi.org/10.1016/j.buildenv.2020.106666

[13] Marć, M., Śmiełowska, M., Namieśnik, J., Zabiegała, B. (2018). Indoor air quality of everyday use spaces dedicated to specific purposes-A review. Environmental Science and Pollution Research, 25: 2065-2082. https://doi.org/10.1007/s11356-017-0839-8

[14] Vardoulakis, S., Kinney, P. (2019). Grand challenges in sustainable cities and health. Frontiers in Sustainable Cities, 1. https://doi.org/10.3389/frsc.2019.00007

[15] Adhikari, A., Hansen, A.J. (2018). Land use change and habitat fragmentation of wildland ecosystems of the North Central United States. Landscape and Urban Planning, 177: 196-216. https://doi.org/10.1016/j.landurbplan.2018.04.014

[16] Macneill, M., Kearney, J., Wallace, L., Gibson, M., Héroux, M.E., Kuchta, J., Guernsey, J.R., Wheeler, A.J. (2014). Quantifying the contribution of ambient and indoor-generated fine particles to indoor air in residential environments. Indoor Air, 24(4): 362-375. https://doi.org/10.1111/ina.12084

[17] Cincinelli, A., Martellini, T. (2017). Indoor air quality and health. International Journal of Environmental Research and Public Health, 14(11): 1286. https://doi.org/10.3390/ijerph14111286

[18] WHO. (2021). Particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. https://acortar.link/sYnGws/, accessed on Set. 20, 2024.

[19] Rivas, I., Fussell, J.C., Kelly, F.J., Querol, X. (2019). Indoor Sources of Air Pollutants. https://acortar.link/x92sAi/, accessed on Sep. 1, 2024.

[20] Zhang, Y., Zhao, B., Jiang, Y., Xing, J., Sahu, S.K., Zheng, H., Ding, D., Cao, S., Han, L., Yan, C., Duan, X., Hu, J., Wang, S., Hao, J. (2022). Non-negligible

contributions to human health from increased household air pollution exposure during the COVID-19 lockdown in China. Environment International, 158: 106918. https://doi.org/10.1016/j.envint.2021.106918

[21] Mata, T.M., Felgueiras, F., Martins, A.A., Monteiro, H., Ferraz, M.P., Oliveira, G.M., Gabriel, M.F., Silva, G.V. (2022). Indoor air quality in elderly centers: Pollutants emission and health effects. Environments - MDPI, 9(7): 86. https://doi.org/10.3390/environments9070086

[22] Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., Shamseer, L., Tetzlaff, J.M., Akl, E.A., Brennan, S.E., Chou, R., Glanville, J., Grimshaw, J.M., Hróbjartsson, A., Lalu, M.M., Li, T., Loder, E.W., Mayo-Wilson, E., McDonald, S., Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. The BMJ, 372: n71. https://doi.org/10.1136/bmj.n71

[23] Reategui-Inga, M., Valdiviezo, W.A., Lu, J.G., Coaguila-Rodriguez, P., Durand, R.P., Casas, G.V., Reategui-Inga, R., Cruz, A.C.D.la, Álvarez-Tolentino, D. (2024). A Systematic review of the behavioral and physiological effects of fireworks noise on domestic dogs. International Journal of Environmental Impacts, 7(1): 101-110. https://doi.org/10.18280/ijei.070112

[24] Posada, Z., Vasquez, 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] Bar-Ilan, J. (2010). Citations to the "Introduction to informetrics" indexed by WOS, Scopus and Google Scholar. Scientometrics, 82: 495-506. https://doi.org/10.1007/s11192-010-0185-9

[26] Vieira, E., Gomes, J. (2009). A comparison of Scopus and Web of science for a typical university. Scientometrics, 81: 587-600. https://doi.org/10.1007/s11192-009-2178-0

[27] Haddaway, N., Page, M., Pritchard, C., McGuinness, L. (2022). 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): 1230. https://doi.org/10.1002/cl2.1230

[28] Calcuvio. (2024). Calculadora de tasa de crecimiento anual compuesto o CAGR. https://www.calcuvio.com/crecimiento-anual/, accessed on Aug. 26, 2024.

[29] van Eck, N.J., Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics, 84: 523-538. https://doi.org/10.1007/s11192-009-0146-3

[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] Li, L., Wan, N., He, Y., Zhang, Y., He, X., Lu, L. (2023). A global bibliometric and visualized analysis of the status and trends of bone metastasis in breast cancer research from 2002 to 2021. Journal of Bone Oncology, 42: 100500. https://doi.org/10.1016/j.jbo.2023.100500

[32] Lebowitz, M.D., Corman, G., O'Rourke, M.K., Holberg, C.J. (1984). Indoor-outdoor air pollution, allergen and meteorological monitoring in an arid southwest area. Journal of the Air Pollution Control Association, 34(10): 1035-1038. https://doi.org/10.1080/00022470.1984.10465851

[33] Rowe, D.R., Nouh, M.A., Ai Dhowalia, K.H., Mansour, M.E. (1985). Indoor outdoor relationship of suspended particulate matter in riyadh Saudi Arabia. Journal of the Air Pollution Control Association, 35(1): 24-26. https://doi.org/10.1080/00022470.1985.10465880

[34] Lioy, P.J., Waldman, J.M., Buckley, T., Butler, J., Pietarinen, C. (1990). The personal, indoor and outdoor concentrations of PM-10 measured in an industrial community during the winter. Atmospheric Environment. Part B. Urban Atmosphere, 24(1): 57-66. https://doi.org/10.1016/0957-1272(90)90010-R

[35] Chih-Shan, L. (1994). Relationships of indoor/outdoor inhalable and respirable particles in domestic environments. Science of The Total Environment, 151(3): 205-211. https://doi.org/10.1016/0048-9697(94)90469-3

[36] Albalak, R., Frisancho, A.R., Keeler, G.J. (1999). Domestic biomass fuel combustion and chronic bronchitis in two rural Bolivian villages. Thorax, 54(11): 1004-1008. https://thorax.bmj.com/content/54/11/1004.

[37] Leaderer, B.P., Naeher, L., Jankun, T., Balenger, K., Holford, T.R., Toth, C., Sullivan, J., Wolfson, J.M., Koutrakis, P. (1999). Indoor, outdoor, and regional summer and winter concentrations of PM10, PM2.5, SO4(2)-, H+, NH4+, NO3-, NH3, and nitrous acid in homes with and without kerosene space heaters. Environmental Health Perspectives, 107(3): 223-231. https://doi.org/10.1289/ehp.99107223

[38] Kingham, S., Briggs, D., Elliott, P., Fischer, P., Lebret, E. (2000). Spatial variations in the concentrations of traffic-related pollutants in indoor and outdoor air in Huddersfield, England. Atmospheric Environment, 34(6): 905-916. https://doi.org/10.1016/S1352-2310(99)00321-0

[39] Quintana, P., Samimi, B., Kleinman, M., Liu, L., Soto, K., Warner, G., Bufalino, C., Valencia, J., Francis, D., Hovell, M., Delfino, R. (2000). Evaluation of a real-time passive personal particle monitor in fixed site residential indoor and ambient measurements. Journal of Exposure Science & Environmental Epidemiology, 10: 437-445. https://doi.org/10.1038/sj.jea.7500105

[40] Wigzell, E., Kendall, M., Nieuwenhuijsen, M. (2000). The spatial and temporal variation of particulate matter within the home. Journal of Exposure Science & Environmental Epidemiology, 10: 307-314. https://doi.org/10.1038/sj.jea.7500091

[41] Patterson, E., Eatough, D.J. (2000). Indoor/outdoor relationships for ambient PM2.5 and associated pollutants: Epidemiological implications in Lindon, Utah. Journal of the Air & Waste Management Association, 50(1): 103-110. https://doi.org/10.1080/10473289.2000.10463986

[42] Lee, S.C., Chang, M. (2000). Indoor and outdoor air quality investigation at schools in Hong Kong. Chemosphere, 41(1-2): 109-113. https://doi.org/10.1016/S0045-6535(99)00396-3

[43] Partti-Pellinen, K., Marttila, O., Ahonen, A., Suominen, O., Haahtela, T. (2000). Penetration of nitrogen oxides and particles from outdoor into indoor air and removal of

the pollutants through filtration of incoming air. Indoor Air, 10(2): 126-132. https://doi.org/10.1034/j.1600-0668.2000.010002126.x

[44] Ramachandran, G., Adgate, J., Hill, N., Sexton, K., Pratt, G., Bock, D. (2000). Comparison of short-term variations (15-minute averages) in outdoor and indoor PM 2.5 concentrations. Journal of the Air & Waste Management Association, 50(7): 1157-1166. https://doi.org/10.1080/10473289.2000.10464160

[45] Koistinen, K.J., Hänninen, O., Rotko, T., Edwards, R.D., Moschandreas, D., Jantunen, M.J. (2001). Behavioral and environmental determinants of personal exposures to PM2.5 in EXPOLIS – Helsinki, Finland. Atmospheric Environment, 35(14): 2473-2481. https://doi.org/10.1016/S1352-2310(00)00446-5

[46] Long, C.M., Suh, H.H., Catalano, P.J., Koutrakis, P. (2001). Using time- and size-resolved particulate data to ouantify indoor penetration and deposition behavior. Environmental Science and Technology, 35(10): 2089-2099. https://doi.org/10.1021/es001477d

[47] Geller, M.D., Chang, M., Sioutas, C., Ostro, B.D., Lipsett, M.J. (2002). Indoor/outdoor relationship and chemical composition of fine and coarse particles in the southern California deserts. Atmospheric Environment, 36(6): 1099-1110. https://doi.org/10.1016/S1352-2310(01)00340-5

[48] Adgate, J.L., Ramachandran, G., Pratt, G.C., Waller, L.A., Sexton, K. (2003). Longitudinal variability in outdoor, indoor, and personal PM2.5 exposure in healthy non-smoking adults. Atmospheric Environment, 37(7): 993-1002. https://doi.org/10.1016/S1352-2310(02)00978-0

[49] Beck, C.M., Geyh, A., Srinivasan, A., Breysse, P.N., Eggleston, P.A., Buckley, T.J. (2003). The impact of a building implosion on airborne particulate matter in an urban community. Journal of the Air and Waste Management Association, 53(10): 1256-1264. https://doi.org/10.1080/10473289.2003.10466275

[50] BéruBé, K.A., Sexton, K.J., Jones, T.P., Moreno, T., Anderson, S., Richards, R.J. (2004). The spatial and temporal variations in PM10 mass from six UK homes. Science of the Total Environment, 324(1-3): 41-53. https://doi.org/10.1016/j.scitotenv.2003.11.003

[51] Koistinen, K.J., Edwards, R.D., Mathys, P., Ruuskanen, J., Künzli, N., Jantunen, M.J. (2004). Sources of fine particulate matter in personal exposures and residential indoor, residential outdoor and workplace microenvironments in the Helsinki phase of the EXPOLIS study. Scand J Work Environ Health, 30(2): 36-46. https://acortar.link/9galoN

[52] Wallace, L., Williams, R. (2005). Use of personal-indoor-outdoor sulfur concentrations to estimate the infiltration factor and outdoor exposure factor for individual homes and persons. Environmental Science and Technology, 39(6): 1707-1714. https://doi.org/10.1021/es049547u

[53] Wang, X., Bi, X., Sheng, G., Fu, J. (2006). Hospital indoor PM10/PM2.5 and associated trace elements in Guangzhou, China. Science of the Total Environment, 366(1): 124-135. https://doi.org/10.1016/j.scitotenv.2005.09.004

[54] Balasubramanian, R., Sheng, S.L. (2007). Characteristics of indoor aerosols in residential homes in urban locations: A case study in Singapore. Journal of the Air and Waste Management Association, 57(8): 981-990. https://doi.org/10.3155/1047-3289.57.8.981

[55] Jędrychowski, W., Pac, A., Choi, H., Jacek, R., Sochacka-Tatara, E., Dumyahn, T.S., Spengler, J.D., Camann, D.E., Perera, F.P. (2007). Personal exposure to fine particles and benzo[a]pyrene. Relation with indoor and outdoor concentrations of these pollutants in Kraków. International Journal of Occupational Medicine and Environmental Health, 20(4): 339-348. https://pubmed.ncbi.nlm.nih.gov/18655236.

[56] Diapouli, E., Chaloulakou, A., Spyrellis, N. (2007). Indoor and outdoor particulate matter concentrations at schools in the Athens area. Indoor and Built Environment, 16(1): 55-61. https://doi.org/10.1177/1420326X06074836

[57] Jones, J., Stick, S., Dingle, P., Franklin, P. (2007). Spatial variability of particulates in homes: Implications for infant exposure. Science of the Total Environment, 376(1–3): 317-323. https://doi.org/10.1016/j.scitotenv.2007.01.060

[58] Johannesson, S., Gustafson, P., Molnár, P., Barregard, L., Sällsten, G. (2007). Exposure to fine particles (PM2.5 and PM1) and black smoke in the general population: Personal, indoor, and outdoor levels. Journal of Exposure Science and Environmental Epidemiology, 17: 613-624. https://doi.org/10.1038/sj.jes.7500562

[59] Lazaridis, M., Aleksandropoulou, V., Hanssen, J.E., Dye, C., Eleftheriadis, K., Katsivela, E. (2008). Inorganic and carbonaceous components in indoor/outdoor particulate matter in two residential houses in Oslo, Norway. Journal of the Air and Waste Management Association, 58(3): 346-356. https://doi.org/10.3155/1047-3289.58.3.346

[60] Kulshreshtha, P., Khare, M., Seetharaman, P. (2008). Indoor air quality assessment in and around urban slums of Delhi city, India. Indoor Air, 18: 488-498. https://doi.org/10.1111/j.1600-0668.2008.00550.x

[61] Triantafyllou, A.G., Zoras, S., Evagelopoulos, V., Garas, S. (2008). PM10, O3, CO concentrations and elemental analysis of airborne particles in a school building. Water, Air, and Soil Pollution: Focus, 8: 77-87. https://doi.org/10.1007/s11267-007-9132-z

[62] Proescholdbell, S.K., Foley, K.L., Johnson, J., Malek, S.H. (2008). Indoor air quality in prisons before and after implementation of a smoking ban law. Tobacco Control, 17(2): 123-127. https://doi.org/10.1136/tc.2007.022038

[63] Heudorf, U. (2008). Feinstaubbelastung in schulen - Untersuchungsergebnisse und lösungsansätze am beispiel der stadt Frankfurt am Main. Gesundheitswesen, 70(4): 231-238. https://doi.org/10.1055/s-2008-1077055

[64] Kingham, S., Durand, M., Harrison, J., Cavanagh, J., Epton, M. (2008). Temporal variations in particulate exposure to wood smoke in a residential school environment. Atmospheric Environment, 42(19): 4619-4631. https://doi.org/10.1016/j.atmosenv.2008.01.064

[65] Kurmi, O.P., Semple, S., Steiner, M., Henderson, G.D., Ayres, J.G. (2008). Particulate matter exposure during domestic work in Nepal. Annals of Occupational Hygiene, 52(6): 509-517. https://doi.org/10.1093/annhyg/men026

[66] Barn, P., Larson, T., Noullett, M., Kennedy, S., Copes, R., Brauer, M. (2008). Infiltration of forest fire and residential wood smoke: An evaluation of air cleaner effectiveness. Journal of Exposure Science and

Environmental Epidemiology, 18: 503-511. https://doi.org/10.1038/sj.jes.7500640
[67] Fromme, H., Diemer, J., Dietrich, S., Cyrys, J., Heinrich, J., Lang, W., Kiranoglu, M., Twardella, D. (2008). Chemical and morphological properties of particulate matter (PM10, PM2.5) in school classrooms and outdoor air. Atmospheric Environment, 42(27): 6597-6605. https://doi.org/10.1016/j.atmosenv.2008.04.047
[68] Johannesson, S., Bergemalm-Rynell, K., Strandberg, B., Sällsten, G. (2009). Indoor concentrations of fine particles and particle-bound PAHs in Gothenburg, Sweden. Journal of Physics: Conference Series, 151: 012006. https://doi.org/10.1088/1742-6596/151/1/012006
[69] Stranger, M., Potgieter-Vermaak, S.S., Van Grieken, R. (2009). Particulate matter and gaseous pollutants in residences in Antwerp, Belgium. Science of the Total Environment, 407(3): 1182-1192. https://doi.org/10.1016/j.scitotenv.2008.10.019
[70] McCormack, M.C., Breysse, P.N., Matsui, E.C., Hansel, N.N., Williams, D., Curtin-Brosnan, J., Eggleston, P., Diette, G.B. (2009). In-home particle concentrations and childhood asthma morbidity. Environmental Health Perspectives, 117(2): 294-298. https://doi.org/10.1289/ehp.11770
[71] Saliba, N.A., Atallah, M., Al-Kadamany, G. (2009). Levels and indoor-outdoor relationships of PM10 and soluble inorganic ions in Beirut, Lebanon. Atmospheric Research, 92(1): 131-137. https://doi.org/10.1016/j.atmosres.2008.09.010
[72] Kulshrestha, A., Bisht, D.S., Masih, J., Massey, D., Tiwari, S., Taneja, A. (2009). Chemical characterization of water-soluble aerosols in different residential environments of semi aridregion of India. Journal of Atmospheric Chemistry, 62: 121-138. https://doi.org/10.1007/s10874-010-9143-4
[73] Gaidajis, G., Angelakoglou, K. (2009). Indoor air quality in university classrooms and relative environment in terms of mass concentrations of particulate matter. Journal of Environmental Science and Health - Part A Toxic/Hazardous Substances and Environmental Engineering, 44(12): 1227-1232. https://doi.org/10.1080/10934520903139936
[74] Wichmann, J., Lind, T., Nilsson, M.A.M., Bellander, T. (2010). $PM_{2.5}$, soot and NO_2 indoor-outdoor relationships at homes, pre-schools and schools in Stockholm, Sweden. Atmospheric Environment, 44(36): 4536-4544. https://doi.org/10.1016/j.atmosenv.2010.08.023
[75] Nerín, I., Alayeto, C., Córdoba, R., López, M.J., Nebot, M. (2011). Measurement of fine breathable particles (PM2.5) as a marker of environmental smoke in catering establishments in Zaragoza. Archivos de Bronconeumologia, 47(4): 190-194. https://doi.org/10.1016/S1579-2129(11)70045-3
[76] Gioda, A., Fuentes-Mattei, E., Jimenez-Velez, B. (2011). Evaluation of cytokine expression in BEAS cells exposed to fine particulate matter ($PM_{2.5}$) from specialized indoor environments. International Journal of Environmental Health Research, 21(2): 106-119. https://doi.org/10.1080/09603123.2010.515668
[77] Wheeler, A.J., Wallace, L.A., Kearney, J., Van Ryswyk, K., You, H., Kulka, R., Brook, J.R., Xu, X. (2011). Personal, indoor, and outdoor concentrations of fine and ultrafine particles using continuous monitors in multiple residences. Aerosol Science and Technology, 45(9): 1078-1089. https://doi.org/10.1080/02786826.2011.580798
[78] Titcombe, M.E., Simcik, M. (2011). Personal and indoor exposure to PM2.5 and polycyclic aromatic hydrocarbons in the southern highlands of Tanzania: A pilot-scale study. Environmental Monitoring and Assessment, 180: 461-476. https://doi.org/10.1007/s10661-010-1799-3
[79] Saraga, D., Pateraki, S., Papadopoulos, A., Vasilakos, C., Maggos, T. (2011). Studying the indoor air quality in three non-residential environments of different use: A museum, a printery industry and an office. Building and Environment, 46(11): 2333-2341. https://doi.org/10.1016/j.buildenv.2011.05.013
[80] Diapouli, E., Eleftheriadis, K., Karanasiou, A.A., Vratolis, S., Hermansen, O., Colbeck, I., Lazaridis, M. (2011). Indoor and outdoor particle number and mass concentrations in Athens. Sources, sinks and variability of aerosol parameters. Aerosol and Air Quality Research, 11(6): 632-642. https://doi.org/10.4209/aaqr.2010.09.0080
[81] Wheeler, A.J., Dobbin, N.A., Lyrette, N., Wallace, L., Foto, M., Mallick, R., Kearney, J., Van Ryswyk, K., Gilbert, N.L., Harrison, I., Rispler, K., Héroux, M.E. (2011). Residential indoor and outdoor coarse particles and associated endotoxin exposures. Atmospheric Environment, 45(39): 7064-7071. https://doi.org/10.1016/j.atmosenv.2011.09.048
[82] Papanastasiou, D.K., Fidaros, D., Bartzanas, T., Kittas, C. (2011). Monitoring particulate matter levels and climate conditions in a Greek sheep and goat livestock building. Environmental Monitoring and Assessment, 183: 285-296. https://doi.org/10.1007/s10661-011-1921-1
[83] Massey, D., Kulshrestha, A., Masih, J., Taneja, A. (2012). Seasonal trends of PM10, PM5.0, PM2.5 & PM1.0 in indoor and outdoor environments of residential homes located in North-Central India. Building and Environment, 47: 223-231. https://doi.org/10.1016/j.buildenv.2011.07.018
[84] Cao, J.J., Huang, H., Lee, S.C., Chow, J.C., Zou, C.W., Ho, K.F., Watson, J.G. (2012). Indoor/outdoor relationships for organic and elemental carbon in PM2.5 at residential homes in Guangzhou, China. Aerosol and Air Quality Research, 12(5): 902–910. https://doi.org/10.4209/aaqr.2012.02.0026
[85] Mentese, S., Rad, A.Y., Arisoy, M., Güllü, G. (2012). Multiple comparisons of organic, microbial, and fine particulate pollutants in typical indoor environments: Diurnal and seasonal variations. Journal of the Air and Waste Management Association, 62(12): 1380-1393. https://doi.org/10.1080/10962247.2012.714717
[86] Majestic, B.J., Turner, J.A., Marcotte, A.R. (2012). Respirable antimony and other trace-elements inside and outside an elementary school in Flagstaff, AZ, USA. Science of the Total Environment, 435-436: 253-261. https://doi.org/10.1016/j.scitotenv.2012.07.020
[87] Abdel-Salam, M.M.M. (2013). Indoor particulate matter in urban residences of Alexandria, Egypt. Journal of the Air and Waste Management Association, 63(8): 956-962. https://doi.org/10.1080/10962247.2013.801374
[88] Hassanvand, M.S., Naddafi, K., Faridi, S., Arhami, M., Nabizadeh, R., Sowlat, M.H., Pourpak, Z., Rastkari, N.,

Momeniha, F., Kashani, H., Gholampour, A., Nazmara, S., Alimohammadi, M., Goudarzi, G., Yunesian, M. (2014). Indoor/outdoor relationships of PM_{10}, $PM_{2.5}$, and PM_1 mass concentrations and their water-soluble ions in a retirement home and a school dormitory. Atmospheric Environment, 82: 375-382. https://doi.org/10.1016/j.atmosenv.2013.10.048

[89] Prasauskas, T., Martuzevicius, D., Krugly, E., Ciuzas, D., Stasiulaitiene, I., Sidaraviciute, R., Kauneliene, V., Seduikyte, L., Jurelionis, A., Haverinen-Shaughnessy, U. (2014). Spatial and temporal variations of particulate matter concentrations in multifamily apartment buildings. Building and Environment, 76: 10-17. https://doi.org/10.1016/j.buildenv.2014.02.010

[90] Rivas, I., Viana, M., Moreno, T., Pandolfi, M., Amato, F., Reche, C., Bouso, L., Àlvarez-Pedrerol, M., Alastuey, A., Sunyer, J., Querol, X. (2014). Child exposure to indoor and outdoor air pollutants in schools in Barcelona, Spain. Environment International, 69: 200-212. https://doi.org/10.1016/j.envint.2014.04.009

[91] Escobedo, L.E., Champion, W.M., Li, N., Montoya, L.D. (2014). Indoor air quality in Latino homes in Boulder, Colorado. Atmospheric Environment, 92: 69-75. https://doi.org/10.1016/j.atmosenv.2014.03.043

[92] Taneja, A. (2014). Fine particles characterization in residential homes located in different microenvironment of India. Reviews on Environmental Health, 29(1-2): 135-138. https://doi.org/10.1515/reveh-2014-0033

[93] Habre, R., Coull, B., Moshier, E., Godbold, J., Grunin, A., Nath, A., Castro, W., Schachter, N., Rohr, A., Kattan, M., Spengler, J., Koutrakis, P. (2014). Sources of indoor air pollution in New York City residences of asthmatic children. Journal of Exposure Science and Environmental Epidemiology, 24: 269-278. https://doi.org/10.1038/jes.2013.74

[94] Szigeti, T., Kertész, Z., Dunster, C., Kelly, F.J., Záray, G., Mihucz, V.G. (2014). Exposure to PM2.5 in modern office buildings through elemental characterization and oxidative potential. Atmospheric Environment, 94: 44-52. https://doi.org/10.1016/j.atmosenv.2014.05.014

[95] Canha, N., Almeida, S.M., Freitas, M.D.C., Wolterbeek, H.T., Cardoso, J., Pio, C., Caseiro, A. (2014). Impact of wood burning on indoor PM2.5 in a primary school in rural Portugal. Atmospheric Environment, 94: 663-670. https://doi.org/10.1016/j.atmosenv.2014.05.080

[96] Challoner, A., Gill, L. (2014). Indoor/outdoor air pollution relationships in ten commercial buildings: $PM_{2.5}$ and NO_2. Building and Environment, 80: 159-173. https://doi.org/10.1016/j.buildenv.2014.05.032

[97] Alves, C.A., Urban, R.C., Pegas, P.N., Nunes, T. (2014). Indoor/Outdoor relationships between PM10 and associated organic compounds in a primary school. Aerosol and Air Quality Research, 14(1): 86-98. https://doi.org/10.4209/aaqr.2013.04.0114

[98] Custódio, D., Pinho, I., Cerqueira, M., Nunes, T., Pio, C. (2014). Indoor and outdoor suspended particulate matter and associated carbonaceous species at residential homes in northwestern Portugal. Science of the Total Environment, 473-474: 72-76. https://doi.org/10.1016/j.scitotenv.2013.12.009

[99] Buczyńska, A.J., Krata, A., Van Grieken, R., Brown, A., Polezer, G., De Wael, K., Potgieter-Vermaak, S. (2014). Composition of PM2.5 and PM1 on high and low pollution event days and its relation to indoor air quality in a home for the elderly. Science of the Total Environment, 490: 134-143. https://doi.org/10.1016/j.scitotenv.2014.04.102

[100] Amato, F., Rivas, I., Viana, M., Moreno, T., Bouso, L., Reche, C., Àlvarez-Pedrerol, M., Alastuey, A., Sunyer, J., Querol, X. (2014). Sources of indoor and outdoor PM2.5 concentrations in primary schools. Science of the Total Environment, 490: 757-765. https://doi.org/10.1016/j.scitotenv.2014.05.051

[101] Zhang, J., Chen, J., Yang, L., Sui, X., Yao, L., Zheng, L., Wen, L., Xu, C., Wang, W. (2014). Indoor PM2.5 and its chemical composition during a heavy haze-fog episode at Jinan, China. Atmospheric Environment, 99: 641-649. https://doi.org/10.1016/j.atmosenv.2014.10.026

[102] Gaidajis, G., Angelakoglou, K. (2014). Indoor mass concentrations of particulate matter in hospital environment. Global NEST Journal, 16(5): 832-839. https://doi.org/10.30955/gnj.001525

[103] Kovačević, R., Tasić, V., Živković, M., Živković, N., Đorđević, A., Manojlović, D., Jovašević-Stojanović, M. (2015). Mass concentrations and indoor-outdoor relationships of PM in selected educational buildings in niš, Serbia. Chemical Industry and Chemical Engineering Quarterly, 21(1-2): 149-158. https://doi.org/10.2298/CICEQ140207013K

[104] Abbas, M., Razzaq, S., Shahzadi, R., Rahman, A., Manzoor, F., Ali, Z. (2015). Determination of indoor and outdoor air quality under different ventilation conditions in a residential area of Lahore, Pakistan. The Journal of Animal and Plant Sciences, 25(3): 672-676. https://n9.cl/0492l.

[105] Aziz, K., Ali, Z., Nasir, Z.A., Colbeck, I. (2015). Assessment of airborne particulate matter (PM2.5) in university classrooms of varrying occupancy. The Journal of Animal and Plant Sciences, 25(3): 649-655. https://n9.cl/7c4ii.

[106] Abdel-Salam, M.M.M. (2015). Investigation of PM2.5 and carbon dioxide levels in urban homes. Journal of the Air and Waste Management Association, 65(8): 930-936. https://doi.org/10.1080/10962247.2015.1040138

[107] Zauli, S., Ricciardelli, I., Trentini, A., Bacco, D., Maccone, C., Castellazzi, S., Lauriola, P., Poluzzi, V., Harrison, R.M. (2015). Spatial and indoor/outdoor gradients in urban concentrations of ultrafine particles and PM2.5 mass and chemical components. Atmospheric Environment, 103: 307-320. https://doi.org/10.1016/j.atmosenv.2014.12.064

[108] Urso, P., Cattaneo, A., Garramone, G., Peruzzo, C., Cavallo, D.M., Carrer, P. (2015). Identification of particulate matter determinants in residential homes. Building and Environment, 86: 61-69. https://doi.org/10.1016/j.buildenv.2014.12.019

[109] Mainka, A., Zajusz-Zubek, E. (2015). Indoor air quality in urban and rural preschools in upper Silesia, Poland: Particulate matter and carbon dioxide. International Journal of Environmental Research and Public Health, 12(7): 7697-7711. https://doi.org/10.3390/ijerph120707697

[110] Elbayoumi, M., Ramli, N.A., Md Yusof, N.F.F. (2015). Spatial and temporal variations in particulate matter concentrations in twelve schools environment in urban and overpopulated camps landscape. Building and

Environment, 90: 157-167. https://doi.org/10.1016/j.buildenv.2015.03.036
[111] Sidra, S., Ali, Z., Nasir, Z.A., Colbeck, I. (2015). Seasonal variation of fine particulate matter in residential micro–environments of Lahore, Pakistan. Atmospheric Pollution Research, 6(5): 797-804. https://doi.org/10.5094/APR.2015.088
[112] Meier, R., Eeftens, M., Phuleria, H.C., Ineichen, A., Corradi, E., Davey, M., Fierz, M., Ducret-Stich, R.E., Aguilera, I., Schindler, C., Rochat, T., Probst-Hensch, N., Tsai, M.Y., Künzli, N. (2015). Differences in indoor versus outdoor concentrations of ultrafine particles, PM2.5, PM absorbance and NO2 in Swiss homes. Journal of Exposure Science and Environmental Epidemiology, 25: 499-505. https://doi.org/10.1038/jes.2015.3
[113] Nascimento, G.C.D., Júnior, W.D.M., Peiter, F.S. (2016). Indoor environmental quality in a public library in Sao Carlos, SP, Brazil. OALib, 3(7): 1-9. https://doi.org/10.4236/oalib.1102685
[114] Patton, A.P., Calderon, L., Xiong, Y., Wang, Z., Senick, J., Allacci, M.S., Plotnik, D., Wener, R., Andrews, C.J., Krogmann, U., Mainelis, G. (2016). Airborne particulate matter in two multi-family green buildings: Concentrations and effect of ventilation and occupant behavior. International Journal of Environmental Research and Public Health, 13(1): 144. https://doi.org/10.3390/ijerph13010144
[115] Mohammed, M.O.A., Song, W., Ma, Y., Liu, L., Ma, W., Li, W.L., Li, Y.F., Wang, F., Qi, M., Lv, N., Wang, D., Khan, A.U. (2016). Distribution patterns, infiltration and health risk assessment of PM2.5-bound PAHs in indoor and outdoor air in cold zone. Chemosphere, 155: 70–85. https://doi.org/10.1016/j.chemosphere.2016.04.023
[116] Raysoni, A.U., Armijos, R.X., Weigel, M.M., Montoya, T., Eschanique, P., Racines, M., Li, W.W. (2016). Assessment of indoor and outdoor PM species at schools and residences in a high-altitude Ecuadorian urban center. Environmental Pollution, 214: 668-679. https://doi.org/10.1016/j.envpol.2016.04.085
[117] Massey, D., Habil, M., Taneja, A. (2016). Particles in different indoor microenvironments-its implications on occupants. Building and Environment, 106: 237-244. https://doi.org/10.1016/j.buildenv.2016.06.036
[118] Han, Y., Li, X., Zhu, T., Lv, D., Chen, Y., Hou, L., Zhang, Y., Ren, M. (2016). Characteristics and relationships between indoor and outdoor PM2.5 in Beijing: A residential apartment case study. Aerosol and Air Quality Research, 16(10): 2386-2395. https://doi.org/10.4209/aaqr.2015.12.0682
[119] Srithawirat, T., Latif, M., Sulaiman, F. (2016). Indoor PM10 and its heavy metal composition at a roadside residential environment, Phitsanulok, Thailand. Atmosfera, 29(4): 311-322. https://doi.org/10.20937/ATM.2016.29.04.03
[120] Soule, E.K., Maloney, S.F., Spindle, T.R., Rudy, A.K., Hiler, M.M., Cobb, C.O. (2017). Electronic cigarette use and indoor air quality in a natural setting. Tobacco Control, 26(1): 109-112. https://doi.org/10.1136/tobaccocontrol-2015-052772
[121] Segalin, B., Kumar, P., Micadei, K., Fornaro, A., Gonçalves, F.L.T. (2017). Size–segregated particulate matter inside residences of elderly in the Metropolitan Area of São Paulo, Brazil. Atmospheric Environment, 148: 139-151. https://doi.org/10.1016/j.atmosenv.2016.10.004
[122] Zhang, M., Zhang, S., Feng, G., Su, H., Zhu, F., Ren, M., Cai, Z. (2017). Indoor airborne particle sources and outdoor haze days effect in urban office areas in Guangzhou. Environmental Research, 154: 60-65. https://doi.org/10.1016/j.envres.2016.12.021
[123] Ragazzi, M., Rada, E., Zanoni, S., Passamani, G., Dalla Valle, L. (2017). Particulate matter and carbon dioxide monitoring in indoor places. International Journal of Sustainable Development and Planning, 12(6): 1032-1042. https://doi.org/10.2495/SDP-V12-N6-1032-1042
[124] Wang, J., Guinot, B., Dong, Z., Li, X., Xu, H., Xiao, S., Ho, S.S.H., Liu, S., Cao, J. (2017). PM2.5-bound polycyclic aromatic hydrocarbons (PAHs), oxygenated-pahs and phthalate esters (PAEs) inside and outside middle school classrooms in Xi'an, China: Concentration, characteristics and health risk assessment. Aerosol and Air Quality Research, 17(7): 1811-1824. https://doi.org/10.4209/aaqr.2017.03.0109
[125] Li, L., Ho, S.S.H., Chow, J.C., Watson, J.G., Lee, F.S.C., Cui, L., Gao, Y., Dai, W., Ho, K.F., Huang, Y., Cao, J. (2017). Characterization and health risk assessment of PM2.5-bound organics inside and outside of Chinese smoking lounges. Chemosphere, 186: 438-445. https://doi.org/10.1016/j.chemosphere.2017.08.006
[126] Vilcekova, S., Estokova, A., Burdova, E.K., Budaiova, Z. (2017). Investigation of particulate matter concentration in offices. Fresenius Environmental Bulletin, 26(2): 1225-1233. https://n9.cl/vdmm4.
[127] Zikova, N., Hopke, P.K., Ferro, A.R. (2017). Evaluation of new low-cost particle monitors for PM2.5 concentrations measurements. Journal of Aerosol Science, 105: 24-34. https://doi.org/10.1016/j.jaerosci.2016.11.010
[128] Shao, Z., Bi, J., Ma, Z., Wang, J. (2017). Seasonal trends of indoor fine particulate matter and its determinants in urban residences in Nanjing, China. Building and Environment, 125: 319-325. https://doi.org/10.1016/j.buildenv.2017.09.002
[129] Lazaridis, M., Katsivela, E., Kopanakis, I., Raisi, L., Mihalopoulos, N., Panagiaris, G. (2018). Characterization of airborne particulate matter and microbes inside cultural heritage collections. Journal of Cultural Heritage, 30: 136-146. https://doi.org/10.1016/j.culher.2017.09.018
[130] Jodeh, S., Hasan, A.R., Amarah, J., Judeh, F., Salghi, R., Lgaz, H., Jodeh, W. (2018). Indoor and outdoor air quality analysis for the city of Nablus in Palestine: seasonal trends of PM10, PM5.0, PM2.5, and PM1.0 of Residential homes. Air Quality, Atmosphere and Health, 11: 229-237. https://doi.org/10.1007/s11869-017-0533-5
[131] Cui, L., Duo, B., Zhang, F., Li, C., Fu, H., Chen, J. (2018). Physiochemical characteristics of aerosol particles collected from the Jokhang Temple indoors and the implication to human exposure. Environmental Pollution, 236: 992-1003. https://doi.org/10.1016/j.envpol.2017.10.107
[132] Yuan, Y., Luo, Z., Liu, J., Wang, Y., Lin, Y. (2018). Health and economic benefits of building ventilation interventions for reducing indoor $PM_{2.5}$ exposure from both indoor and outdoor origins in urban Beijing, China.

Science of the Total Environment, 626: 546-554. https://doi.org/10.1016/j.scitotenv.2018.01.119

[133] Tolis, E.I., Panaras, G., Bartzis, J.G. (2018). A comprehensive air quality investigation at an aquatic centre: Indoor/outdoor comparisons. Environmental Science and Pollution Research, 25: 16710-16719. https://doi.org/10.1007/s11356-018-1882-9

[134] Trompetter, W.J., Boulic, M., Ancelet, T., Garcia-Ramirez, J.C., Davy, P.K., Wang, Y., Phipps, R. (2018). The effect of ventilation on air particulate matter in school classrooms. Journal of Building Engineering, 18: 164-171. https://doi.org/10.1016/j.jobe.2018.03.009

[135] Xu, H., Li, Y., Guinot, B., Wang, J., He, K., Ho, K.F., Cao, J., Shen, Z., Sun, J., Lei, Y., Gong, X., Zhang, T. (2018). Personal exposure of $PM_{2.5}$ emitted from solid fuels combustion for household heating and cooking in rural Guanzhong Plain, northwestern China. Atmospheric Environment, 185: 196-206. https://doi.org/10.1016/j.atmosenv.2018.05.018

[136] Rohra, H., Tiwari, R., Khare, P., Taneja, A. (2018). Indoor-outdoor association of particulate matter and bounded elemental composition within coarse, quasi-accumulation and quasi-ultrafine ranges in residential areas of northern India. Science of the Total Environment, 631-632: 1383-1397. https://doi.org/10.1016/j.scitotenv.2018.03.095

[137] Okello, G., Devereux, G., Semple, S. (2018). Women and girls in resource poor countries experience much greater exposure to household air pollutants than men: Results from Uganda and Ethiopia. Environment International, 119: 429-437. https://doi.org/10.1016/j.envint.2018.07.002

[138] Militello-Hourigan, R., Miller, S. (2018). The impacts of cooking and an assessment of indoor air quality in Colorado passive and tightly constructed homes. Building and Environment, 144: 573-582. https://doi.org/10.1016/j.buildenv.2018.08.044

[139] Huang, S., Lawrence, J., Kang, C.M., Li, J., Martins, M., Vokonas, P., Gold, D.R., Schwartz, J., Coull, B.A., Koutrakis, P. (2018). Road proximity influences indoor exposures to ambient fine particle mass and components. Environmental Pollution, 243: 978-987. https://doi.org/10.1016/j.envpol.2018.09.046

[140] Volesky, K., Maki, A., Scherf, C., Watson, L., Van Ryswyk, K., Fraser, B., Weichenthal, S.A., Cassol, E., Villeneuve, P.J. (2018). The influence of three e-cigarette models on indoor fine and ultrafine particulate matter concentrations under real-world conditions. Environmental Pollution, 243: 882-889. https://doi.org/10.1016/j.envpol.2018.08.069

[141] Zhang, M., Garcia, A.D., Zamora, M., Anderson, I.A., Jativa, D.F. (2019). Exposure to secondhand tobacco smoke at airport terminals. Journal of Environmental and Public Health, 2019: 9648761. https://doi.org/10.1155/2019/9648761

[142] Yang, F., Lau, C.F., Tong, V.W.T., Zhang, K.K., Westerdahl, D., Ng, S., Ning, Z. (2019). Assessment of personal integrated exposure to fine particulate matter of urban residents in Hong Kong. Journal of the Air and Waste Management Association, 69(1): 47-57. https://doi.org/10.1080/10962247.2018.1507953

[143] Abdel-Salam, M. (2019). Investigation of indoor air quality at urban schools in Qatar. Indoor and Built Environment, 28(2): 278-288. https://doi.org/10.1177/1420326X17700948

[144] Cao, G., Bi, J., Ma, Z., Shao, Z., Wang, J. (2019). Seasonal characteristics of the chemical composition of fine particles in residences of Nanjing, China. International Journal of Environmental Research and Public Health, 16(6): 1066. https://doi.org/10.3390/ijerph16061066

[145] Lv, Y., Zhou, Y., Wang, H., Zhao, T., Liu, T., He, X., Zhang, L., Liu, J. (2019). Study on the multivariate prediction model and exposure level of indoor and outdoor particulate concentration in severe cold region of China. Ecotoxicology and Environmental Safety, 170: 708-715. https://doi.org/10.1016/j.ecoenv.2018.12.031

[146] Isiugo, K., Jandarov, R., Cox, J., Ryan, P., Newman, N., Grinshpun, S.A., Indugula, R., Vesper, S., Reponen, T. (2019). Indoor particulate matter and lung function in children. Science of the Total Environment, 663: 408-417. https://doi.org/10.1016/j.scitotenv.2019.01.309

[147] Oh, H., Kim, J., Sohn, J.R., Kim, J. (2019). Exposure to indoor-outdoor particulate matter and associated trace elements within childcare facilities. Air Quality, Atmosphere and Health, 12: 993-1001. https://doi.org/10.1007/s11869-019-00718-4

[148] Sharma, R., Balasubramanian, R. (2019). Assessment and mitigation of indoor human exposure to fine particulate matter (PM2.5) of outdoor origin in naturally ventilated residential apartments: A case study. Atmospheric Environment, 212: 163-171. https://doi.org/10.1016/j.atmosenv.2019.05.040

[149] Carrion-Matta, A., Kang, C., Gaffin, J., Hauptman, M., Phipatanakul, W., Koutrakis, P., Gold, D.R. (2019). Classroom indoor PM2.5 sources and exposures in inner-city schools. Environment International, 131: 104968. https://doi.org/10.1016/j.envint.2019.104968

[150] Fang, W., Song, W., Liu, L., Chen, G., Ma, L., Liang, Y., Xu, Y., Wang, X., Ji, Y., Zhuang, Y., Boubacar, A.H., Li, Y. (2020). Characteristics of indoor and outdoor fine particles in heating period at urban, suburban, and rural sites in Harbin, China. Environmental Science and Pollution Research, 27: 1825-1834. https://doi.org/10.1007/s11356-019-06640-7

[151] Adhikari, S., Mahapatra, P.S., Pokheral, C.P., Puppala, S.P. (2020). Cookstove smoke impact on ambient air quality and probable consequences for human health in rural locations of southern Nepal. International Journal of Environmental Research and Public Health, 17(2): 550. https://doi.org/10.3390/ijerph17020550

[152] Leppänen, M., Peräniemi, S., Koponen, H., Sippula, O., Pasanen, P. (2020). The effect of the shoeless course on particle concentrations and dust composition in schools. Science of the Total Environment, 710: 136272. https://doi.org/10.1016/j.scitotenv.2019.136272

[153] Tofful, L., Perrino, C., Canepari, S. (2020). Comparison study between indoor and outdoor chemical composition of PM2.5 in two Italian areas. Atmosphere, 11(4): 368. https://doi.org/10.3390/ATMOS11040368

[154] Othman, M., Latif, M., Yee, C., Norshariffudin, L., Azhari, A., Halim, N., Alias, A., Sofwan, N., Hamid, H., Matsumi, Y. (2020). PM2.5 and ozone in office environments and their potential impact on human health. Ecotoxicology and Environmental Safety, 194: 110432. https://doi.org/10.1016/j.ecoenv.2020.110432

[155] Tran, T., Nguyen, P., Nghiem, D., Le, T.H., Tu, M.B., Alleman, L., Nguyen, V., Pham, D., Ha, N., Dang, M., Van Le, C., Van Nguyen, N. (2020). Assessment of air quality in school environments in Hanoi, Vietnam: A focus on mass-size distribution and elemental composition of indoor-outdoor ultrafine/fine/coarse particles. Atmosphere, 11(5): 519. https://doi.org/10.3390/atmos11050519

[156] Madureira, J., Slezakova, K., Costa, C., Pereira, M.C., Teixeira, J.P. (2020). Assessment of indoor air exposure among newborns and their mothers: Levels and sources of PM10, PM2.5 and ultrafine particles at 65 home environments. Environmental Pollution, 264: 114746. https://doi.org/10.1016/j.envpol.2020.114746

[157] Singer, B., Chan, W., Kim, Y., Offermann, F., Walker, L. (2020). Indoor air quality in California homes with code-required mechanical ventilation. Indoor Air, 30(5): 885–899. https://doi.org/10.1111/ina.12676

[158] Xu, R., Qi, X., Dai, G., Lin, H., Shi, J., Tong, C., Zhai, P., Zhu, C., Wang, L., Ding, A. (2020). A comparison study of indoor and outdoor air quality in Nanjing, China. Aerosol and Air Quality Research, 20(10): 2128-2141. https://doi.org/10.4209/aaqr.2019.10.0496

[159] Kabera, T., Bartington, S., Uwanyirigira, C., Abimana, P., Pope, F. (2020). Indoor PM2.5 characteristics and CO concentration in households using biomass fuel in Kigali, Rwanda. International Journal of Environmental Studies, 77(6): 998-1011. https://doi.org/10.1080/00207233.2020.1732067

[160] Barkjohn, K., Norris, C., Cui, X., Fang, L., Zheng, T., Schauer, J.J., Li, Z., Zhang, Y., Black, M., Zhang, J., Bergin, M.H. (2021). Real-time measurements of PM2.5 and ozone to assess the effectiveness of residential indoor air filtration in Shanghai homes. Indoor Air, 31(1): 74-87. https://doi.org/10.1111/ina.12716

[161] Phongphetkul, P., Mangkang, S., Praditsmanont, A., Intrachooto, S., Choruengwiwat, J., Treesubsuntorn, C., Thiravetyan, P. (2021). Evaluation of indoor air quality in high-rise residential buildings in Bangkok and factor analysis. Environmental Monitoring and Assessment, 193: 23. https://doi.org/10.1007/s10661-020-08792-3

[162] Parmaksiz, K., Rastgeldi Dogan, T., Yesilnacar, M.I. (2021). Exposure of indoor air quality in office environment to workers and its relationship to health. El-Cezeri Journal of Science and Engineering, 8(1): 231-244. https://doi.org/10.31202/ecjse.824204

[163] Ezani, E., Brimblecombe, P., Asha'ari, Z.H., Fazil, A.A., Ismail, S.N.S., Ramly, Z.T.A., Khan, M.F. (2021). Indoor and outdoor exposure to PM2.5 during covid-19 lockdown in suburban Malaysia. Aerosol and Air Quality Research, 21(3): 1-12. https://doi.org/10.4209/aaqr.2020.07.0476

[164] May, N.W., Dixon, C., Jaffe, D.A. (2021). Impact of wildfire smoke events on indoor air quality and evaluation of a low-cost filtration method. Aerosol and Air Quality Research, 21(7): 210046. https://doi.org/10.4209/aaqr.210046

[165] Ferreira, A., Barros, N. (2022). COVID-19 and lockdown: The potential impact of residential indoor air quality on the health of teleworkers. International Journal of Environmental Research and Public Health, 19(10): 6079. https://doi.org/10.3390/ijerph19106079

[166] Huang, A., Murphy, M., Jacob, P., Schick, S. (2022). PM2.5 concentrations in the smoking lounge of a cannabis store. Environmental Science & Technology Letters, 9(6): 551-556. https://doi.org/10.1021/acs.estlett.2c00148

[167] Abdel-Salam, M. (2022). Indoor exposure of elderly to air pollutants in residential buildings in Alexandria, Egypt. Building and Environment, 219: 109221. https://doi.org/10.1016/j.buildenv.2022.109221

[168] Anand, A., Yadav, S., Phuleria, H.C. (2022). Chemical characteristics and oxidative potential of indoor and outdoor PM2.5 in densely populated urban slums. Environmental Research, 212: 113562. https://doi.org/10.1016/j.envres.2022.113562

[169] Dwivedi, S., Tewari-Singh, N., Masih, J., Taushiba, A., Lawrence, A. (2022). Evaluation of indoor particulate matter and associated PAHs during the winter season in Northern India: A comprehensive impact of regional appearances. Journal of Hazardous Materials Advances, 8: 100195. https://doi.org/10.1016/j.hazadv.2022.100195

[170] Popescu, L.L., Popescu, R.S., Catalina, T. (2022). Indoor particle's pollution in bucharest, romania. Toxics, 10(12): 757. https://doi.org/10.3390/toxics10120757

[171] Baptista, T., Almeida-Silva, M., Silva, D., Diogo, C., Canha, N. (2022). Indoor air quality assessment in grocery stores. Applied Sciences (Switzerland), 12(24): 12940. https://doi.org/10.3390/app122412940

[172] Duong, V.M., Hoang, A.L. (2022). Characterization of indoor and ambient air quality in modern commercial and recreational complex buildings in Hanoi. Atmospheric Environment, 291: 119405. https://doi.org/10.1016/j.atmosenv.2022.119405

[173] Khumukcham, R., Khoiyangbam, R. (2023). Determination of particulate matter fractions PM2.5, PM10 and CO2 in urban schools in Imphal, India. Holistic Approach to Environment, 13(1): 22-31. https://doi.org/10.33765/thate.13.1.3

[174] Kalisa, E., Kuuire, V., Adams, M. (2023). Children's exposure to indoor and outdoor black carbon and particulate matter air pollution at school in Rwanda, Central-East Africa. Environmental Advances, 11: 100334. https://doi.org/10.1016/j.envadv.2022.100334

[175] Bousiotis, D., Alconcel, L., Beddows, D., Harrison, R., Pope, F. (2023). Monitoring and apportioning sources of indoor air quality using low-cost particulate matter sensors. Environment International, 174: 107907. https://doi.org/10.1016/j.envint.2023.107907

[176] Muteti-Fana, S., Nkosana, J., Naidoo, R. (2023). Kitchen characteristics and practices associated with increased PM2.5 concentration levels in zimbabwean rural households. International Journal of Environmental Research and Public Health, 20(10): 5811. https://doi.org/10.3390/ijerph20105811

[177] Zhang, G., Li, W., Cheng, Q., Zhou, Z., Wang, Q., Peng, Z. (2023). Source identification and characterization of indoor particulate matter in potala palace museum. Buildings, 13(9): 2138. https://doi.org/10.3390/buildings13092138

[178] Walker, E., Stewart, T., Jones, D. (2023). Fine particulate matter infiltration at western montana residences during wildfire season. Science of the Total Environment, 896: 165238. https://doi.org/10.1016/j.scitotenv.2023.165238

[179] Ma, Z., Huang, J., Wang, X., Wei, Y., Huang, L. (2023). Estimation of infiltration efficiency of ambient

PM2.5 in urban residences of Beijing during winter. Urban Climate, 52: 101677. https://doi.org/10.1016/j.uclim.2023.101677

[180] Tepeneu, A., Lupitu, A., Surdea-Blaga, T., Moisa, C., Chambre, D., Copolovici, D.M., Copolovici, L. (2023). Variability of air pollutants in the indoor air of a general store. Applied Sciences (Switzerland), 13(23): 12572. https://doi.org/10.3390/app132312572

[181] ElSharkawy, M. (2024). Indoor air quality in Saudi residential homes. Indoor and Built Environment, 33(3): 583-600. https://doi.org/10.1177/1420326X231205192

[182] Neumann, M., Dlamini, W.N., Sallah-Ud-Din, R., Berekute, A.K., Siregar, S., Getnet, M.E., Maulana, M., Pan, W.C., Lung, S.C.C., Yu, K.P. (2024). Assessment of air pollution emitted during cooking using biomass and cleaner fuels in the Shiselweni region of Eswatini (Swaziland). Clean Technologies and Environmental Policy, 303: 3003-3020. https://doi.org/10.1007/s10098-024-02786-2

[183] Stampfer, O., Zuidema, C., Allen, R.W., Fox, J., Sampson, P., Seto, E., Karr, C.J. (2024). Practical considerations for using low-cost sensors to assess wildfire smoke exposure in school and childcare settings. Journal of Exposure Science & Environmental Epidemiology. https://doi.org/10.1038/s41370-024-00677-8

[184] Tutsak, E., Alfoldy, B., Mahfouz, M.M., Al-Thani, J.A., Yigiterhan, O., Shahid, I., Isaifan, R.J., Koçak, M. (2024). Chemical composition of indoor and outdoor PM2.5 in the eastern Arabian Peninsula. Environmental Science and Pollution Research, 31: 49589-49600. https://doi.org/10.1007/s11356-024-34482-5

[185] Thakur, A., Patel, S. (2024). Characterization of particulate matter in a multizonal residential apartment: Transport, exposure, and mitigation. Environmental Science: Atmospheres, 4: 1026. https://doi.org/10.1039/d4ea00080c

[186] Gilbey, S.E., Zhao, Y., Lee, A., Rumchev, K.B. (2024). Is poor air quality in day-care centres' affecting our children's health? A study of indoor air quality in childcare facilities located in Perth, Western Australia. Air Quality, Atmosphere and Health, 17: 295-313. https://doi.org/10.1007/s11869-023-01445-7

[187] Krebs, B., Neidell, M. (2024). Wildfires exacerbate inequalities in indoor pollution exposure. Environmental Research Letters, 19: 024043. https://doi.org/10.1088/1748-9326/ad22b8

[188] Wang, Y., Koutrakis, P., Michanikou, A., Kouis, P., Panayiotou, A.G., et al. (2024). Indoor residential and outdoor sources of PM2.5 and PM10 in Nicosia, Cyprus. Air Quality, Atmosphere and Health, 17: 485-499. https://doi.org/10.1007/s11869-023-01460-8

[189] Huda, R.K., Kumar, P., Gupta, R., Sharma, A.K., Toteja, G.S., Babu, B.V. (2024). Air quality monitoring using low-cost sensors in urban areas of Jodhpur, Rajasthan. International Journal of Environmental Research and Public Health, 21(5): 623. https://doi.org/10.3390/ijerph21050623

[190] Klepeis, N., Nelson, W., Ott, W., Robinson, J., Tsang, A., Switzer, P., Behar, J., Hern, S., Engelmann, W. (2001). The national human activity pattern survey (NHAPS): A resource for assessing exposure to environmental pollutants. Journal of Exposure Science & Environmental Epidemiology, 11: 231-252. https://doi.org/10.1038/sj.jea.7500165

[191] Schweizer, C., Edwards, R.D., Bayer-Oglesby, L., Gauderman, W.J., Ilacqua, V., Juhani Jantunen, M., Lai, H.K., Nieuwenhuijsen, M., Künzli, N. (2007). Indoor time-microenvironment-activity patterns in seven regions of Europe. Journal of Exposure Science and Environmental Epidemiology, 17: 170-181. https://doi.org/10.1038/sj.jes.7500490

[192] Brasche, S., Bischof, W. (2005). Daily time spent indoors in German homes - Baseline data for the assessment of indoor exposure of German occupants. International Journal of Hygiene and Environmental Health, 208(4): 247-253. https://doi.org/10.1016/j.ijheh.2005.03.003

[193] Leech, J.A., Nelson, W.C., Burnett, R.T., Aaron, S., Raizenne, M.E. (2002). It's about time: A comparison of Canadian and American time-activity patterns. Journal of Exposure Analysis and Environmental Epidemiology, 12: 427-432. https://doi.org/10.1038/sj.jea.7500244

[194] Schneider, T. (2008). Dust and fibers as a cause of indoor environment problems. SJWEH Supplements, 4: 10-17. https://www.sjweh.fi/article/1200.

[195] Morawska, L., Ayoko, G.A., Bae, G.N., Buonanno, G., Chao, C.Y.H., et al. (2017). Airborne particles in indoor environment of homes, schools, offices and aged care facilities: The main routes of exposure. In Environment International, 108: 75-83. https://doi.org/10.1016/j.envint.2017.07.025

[196] Silva, L.T., Pinho, J.L., Nurusman, H. (2014). Traffic air pollution monitoring based on an air–water pollutants deposition device. International Journal of Environmental Science and Technology, 11: 2307-2318. https://doi.org/10.1007/s13762-014-0625-9

[197] Al-Khashman, O.A. (2007). The investigation of metal concentrations in street dust samples in Aqaba city, Jordan. Environmental Geochemistry and Health, 29: 197-207. https://doi.org/10.1007/s10653-006-9065-x

[198] Kong, S., Ji, Y., Lu, B., Chen, L., Han, B., Li, Z., Bai, Z. (2011). Characterization of PM10 source profiles for fugitive dust in Fushun-a city famous for coal. Atmospheric Environment, 45(30): 5351-5365. https://doi.org/10.1016/j.atmosenv.2011.06.050

[199] Leung, A.O.W., Duzgoren-Aydin, N.S., Cheung, K.C., Wong, M.H. (2008). Heavy metals concentrations of surface dust from e-waste recycling and its human health implications in southeast China. Environmental Science and Technology, 42(7): 2674-2680. https://doi.org/10.1021/es071873x

[200] Yongming, H., Peixuan, D., Junji, C., Posmentier, E.S. (2006). Multivariate analysis of heavy metal contamination in urban dusts of Xi'an, Central China. Science of the Total Environment, 355(1-3): 176-186. https://doi.org/10.1016/j.scitotenv.2005.02.026

[201] Winickoff, J.P., Friebely, J., E.tanski, S., Sherrod, C., E.matt, G., Hovell, M.F., McMillen, R.C. (2009). Beliefs about the health effects of "thirdhand" smoke and home smoking bans. Pediatrics, 123(1): e74-e79. https://doi.org/10.1542/peds.2008-2184

[202] Becquemin, M.H., Bertholon, J.F., Bentayeb, M., Attoui, M., Ledur, D., Roy, F., Roy, M., Annesi-Maesano, I., Dautzenberg, B. (2010). Third-hand smoking: Indoor measurements of concentration and sizes of cigarette

smoke particles after resuspension. Tobacco Control, 19(4): 347-348. https://doi.org/10.1136/tc.2009.034694

[203] Matt, G.E., Quintana, P.J.E., Hovell, M.F., Bernert, J.T., Song, S., Novianti, N., Juarez, T., Floro, J., Gehrman, C., Garcia, M., Larson, S. (2004). Households contaminated by environmental tobacco smoke: Sources of infant exposures. Tobacco Control, 13(1): 29-37. https://doi.org/10.1136/tc.2003.003889

[204] Matt, G.E., Quintana, P.J.E., Zakarian, J.M., Hoh, E., Hovell, M.F., Mahabee-Gittens, M., Watanabe, K., Datuin, K., Vue, C., Chatfield, D.A. (2017). When smokers quit: Exposure to nicotine and carcinogens persists from thirdhand smoke pollution. Tobacco Control, 26(5): 548-556. https://doi.org/10.1136/tobaccocontrol-2016-053119

[205] Matt, G.E., Quintana, P.J.E., Zakarian, J.M., Fortmann, A.L., Chatfield, D.A., et al. (2011). When smokers move out and non-smokers move in: Residential thirdhand smoke pollution and exposure. Tobacco Control, 20: e1. https://doi.org/10.1136/tc.2010.037382

[206] Wang, C., Collins, D., Hems, R., Borduas, N., Antiñolo, M., Abbatt, J. (2018). Exploring conditions for ultrafine particle formation from oxidation of cigarette smoke in indoor environments. Environmental Science and Technology, 52(8): 4623-4631. https://doi.org/10.1021/acs.est.7b06608

[207] Reategui-Inga, M., Valdiviezo, W., Lu, J., Durand, R., Coaguila-Rodriguez, P., Reategui-Inga, R., Casas, G.V., Álvarez-Tolentino, D., Cueva, A. (2024). $PM_{2.5}$ and PM_{10} airborne concentrations resulting from fireworks during festivities: A systematic review. International Journal of Sustainable Development and Planning, 19(4): 1307-1318. https://doi.org/10.18280/ijsdp.190409

[208] Saini, J., Dutta, M., Marques, G. (2020). Indoor air quality prediction systems for smart environments: A systematic review. Journal of Ambient Intelligence and Smart Environments, 12(5): 433-453. https://doi.org/10.3233/AIS-200574

[209] Zhao, Y.B., Gao, P.P., Yang, W.D., Ni, H.G. (2018). Vehicle exhaust: An overstated cause of haze in China. Science of the Total Environment, 612: 490-491. https://doi.org/10.1016/j.scitotenv.2017.08.255

[210] Rappold, A., Reyes, J., Pouliot, G., Cascio, W., Diaz-Sanchez, D. (2017). Community vulnerability to health impacts of wildland fire smoke exposure. Environmental Science & Technology, 51(12): 6674-6682. https://doi.org/10.1021/acs.est.6b06200

[211] Rohde, R., Muller, R. (2015). Air pollution in China: Mapping of concentrations and sources. Plos One, 10(8): e0135749. https://doi.org/10.1371/journal.pone.0135749

[212] Liu, Q., Wang, S., Zhang, W., Li, J., Dong, G. (2019). The effect of natural and anthropogenic factors on PM 2.5: Empirical evidence from Chinese cities with different income levels. Science of the Total Environment, 653: 157-167. https://doi.org/10.1016/j.scitotenv.2018.10.367

[213] Li, H., Shahbaz, M., Jiang, H., Dong, K. (2021). Is natural gas consumption mitigating air pollution? Fresh evidence from national and regional analysis in China. Sustainable Production and Consumption, 27: 325-336. https://doi.org/10.1016/j.spc.2020.11.010

[214] Wang, G., Leng, W., Jiang, S., Cao, B. (2021). Long-term variation in wintertime atmospheric diffusion conditions over the Sichuan basin. Frontiers in Environmental Science, 9: 763504. https://doi.org/10.3389/fenvs.2021.763504

[215] Luo, Z., Wang, Y., Lv, Z., He, T., Zhao, J., Wang, Y., Gao, F., Zhang, Z., Liu, H. (2022). Impacts of vehicle emission on air quality and human health in China. Science of the Total Environment, 813: 152655. https://doi.org/10.1016/j.scitotenv.2021.152655