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Review

Effects on Health of Passive Smoking and Vape on Terraces in the COVID-19 Pandemic: A Review

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A B S T R A C T

The health damage caused by passive smoking is well known in closed public spaces such as workplaces, inside homes and restaurants. However, at present, the number of smokers in open public spaces such as terraces has increased and consequently a loss of the quality of the air breathed, increasing the concentration of particles and other contaminating agents, affecting the health of workers and customers, of these spaces. Multiple studies show that high exposure to tobacco smoke in these environments augments the risk of developing cardiorespiratory diseases, especially in the vulnerable population, but also respiratory infections. Tobacco smoke can be an excellent vehicle for transmitting viral particles, favoring coronavirus disease 2019 (COVID-19).

Efectos sobre la salud del tabaquismo pasivo y el vapeo en terrazas durante la pandemia COVID-19: Una revisión

Palabras clave:
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R E S U M E N

Es bien conocido el daño sobre la salud que provoca el tabaquismo pasivo en espacios públicos cerrados como los lugares de trabajo, domicilios y restaurantes. No obstante, en la actualidad, el número de fumadores en espacios públicos abiertos como como terrazas ha aumentado y como consecuencia esto ha generado una pérdida de la calidad del aire respirado, incrementándose la concentración de partículas y otros agentes contaminantes, afectando la salud de trabajadores y clientes de estos espacios. Múltiples estudios muestran que la alta exposición al humo del tabaco en estos ambientes aumenta el riesgo de desarrollar enfermedades cardiorrespiratorias, especialmente en la población vulnerable, pero también de infecciones respiratorias. El humo del tabaco puede ser un excelente vehículo de transmisión de partículas virales, favoreciendo enfermedad por coronavirus 2019 (COVID-19).

Introduction

In recent years, there has been an increase in air pollution caused by tobacco in open environments such as the terraces of bars and restaurants on public roads. Currently, these spaces represent one

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of the places most used by smokers and vapers to use their products, reaching a prevalence of consumption in Spain of 88%.[1] In addition, for each person smoking on a terrace, ambient air pollution can increase by 30%.[2,3] All of this causes non-smokers to be exposed to significant concentrations of harmful gases and particles that come from the smoker's exhalation, cigarette combustion, butts or the mixture of these toxins from the smoker with gases from the atmosphere. These chemical agents present in these premises are maintained over time as they adhere to clothing, objects or other facility surfaces on the terraces. There is currently solid scientific evidence of the association between passive exposure to tobacco smoke and heart and respiratory diseases, tumors, respiratory infections or fetal disorders. There is no safety threshold for tobacco smoke concentrations in these environments, although the greatest damage is related to the shortest distance from the smoker or the duration and intensity of exposure. The most vulnerable populations are children, pregnant women, hospitality workers and patients with pre-existing chronic diseases.[4,5]

Besides, these open spaces favor the consumption of tobacco and electronic cigarettes (EC). In the midst of the COVID-19 pandemic, the relationship between this disease, tobacco and vaping is well known. Recently, a Spanish registry with 14,000 patients admitted for COVID-19 concluded that being a smoker is an independent factor for poor prognosis of this disease.[6,7] On the other hand, tobacco smoke or vaping present in these spaces can be an excellent vehicle for the SARS-CoV-2 viral particles responsible for the COVID-19 disease that is transmitted through aerosols.[8] Likewise, the behavior of smoking, the gestural patterns of the smoker or the less use of the mask on the terraces of smokers and non-smokers lead to a higher risk of infection.[9]

For all these reasons, it is necessary: (a) alerting about terraces where smoking and vaping are allowed as unsafe places that could increase SARS-CoV-2 infection in addition to favoring tobacco consumption in the midst of a pandemic, (b) urging health authorities to ban smoking and vaping in these places and maintain these measures permanently not only to protect non-smokers and smokers from COVID-19 but also to prevent other diseases associated with passive smoking.

The structure of this review consists of four aspects whose objective is to provide scientific evidence to the dangerous association between passive smoking and terraces. These aspects are:

- Passive smoking on terraces and health risk
- Tobacco, vaping and respiratory infections
- Tobacco, vaping and association with COVID-19
- Conclusions

Passive smoking on terraces and health risk

Concept and magnitude of the passive smoking

A report by the World Health Organization (WHO) alerted us to the significant impact tobacco has on the environment.[10] This impact begins with the cultivation of the plant, through curing, manufacturing, transport, consumption and what we could call post-consumption (second-hand tobacco [SHT], third-hand tobacco [THT] and fourth-hand tobacco [FHT, cigarette butts]).[11] For some years now, nicotine has been consumed using electronic nicotine delivery devices, the so-called electronic cigarettes (EC)[12] which also, it is now recognized, produce second-hand vapor (SHV) and thirdhand vapor (THV) and environmentally polluting residues, which could be called fourth-hand vapor (FHV) (12–15) Recently, tobacco heating devices (HnB) have also been recognized as indoor air pollutants, both as second-hand (SHHnB), thirdhand (THHnB) and fourth-hand (FHHnB)[13–17] We cannot forget the indoor and outdoor contamination of water pipes.[18]

Second-hand smoking

Definition: Exposure to second-hand smoke occurs when non-smokers breathe in smoke exhaled by smokers or smoke from burning other tobacco products. Terms such as passive smoking and involuntary smoking should be abolished as they suggest that involuntary or passive exposure is not acceptable, but that voluntary or active exposure to tobacco smoke is acceptable.[9] This is equally applicable to the use of EC, water pipes and HnB.[5,13–15]

Third-hand smoking

Definition: We define THT and THV as residual tobacco smoke pollutants that remain on indoor surfaces and in house dust after tobacco use, as well as in atmospheric particulate matter in outdoor environments. It re-emits to the gas phase and, reacts with other components of the environment to produce secondary pollutants.[15] It is equally applicable to HnB devices[17] and water pipes.[18]

Fourth-hand smoking

Definition: Tobacco clearly threatens many of the Earth's resources. Its impact goes beyond the effects of the smoke released into the air by the different tobacco products when consumed. This impact begins as early as the cultivation of the plant, through curing, manufacturing, transportation, consumption and so-called post-consumption (SHT, THT and FHT, butts]) (tobacco life cycle).[15] Tobacco generates waste and harms the environment throughout its life cycle.

Impact of passive smoking in open public spaces (terraces). Health effects of vaping and second-, third- and fourth-hand tobacco smoke

The latest Eurobarometer published shows the prevalence of observed consumption in terraces and outdoor leisure spaces (concerts, sporting events, etc.) in the 27 countries of the European Union plus Great Britain.[1] In Spain, this observed consumption reaches 88% on the terraces of bars, 78% at outdoor events and, with respect to the EC, 27% and 21% inside bars and restaurants, respectively.[1]

The question is, does this consumption in terraces and outdoor leisure areas affect air quality? Ruprecht et al.,[3] in a study carried out in Italy, in which they compared the air quality in the afternoon in a pedestrian area with a high density of terraces of bars and restaurants with a parallel area with high traffic density (they measured levels of particulate matter: PM1, PM2.5 and PM10) observed that the quality was worse in the pedestrian area, and correlated with the number of cigarettes smoked outdoors. Indeed, the presence of SHT is high in most outdoor areas in Europe, especially in countries with higher smoking prevalence and lower smoking control performance.[19] A recent study also found the consumption of EC in an outdoor setting in hospitality venues.[20]

The second question to ask is, does the pollution and poorer air quality of these open spaces affect the health of non-smokers? Indeed, it does: such pollution exposes non-smokers to substantial levels of particulate matter, carcinogens, carbon monoxide, polycyclic aromatic hydrocarbons, nitrosamines, aldehydes, volatile organic compounds and nitrogen oxides.[3,21–25] As in indoor environments, where exposure increases as one gets closer to lit cigarettes, the "proximity effect" also occurs outdoors.[21] Exposure to elevated levels of tobacco smoke usually occurs within two meters of smoke sources, and levels decrease beyond that distance; however, if there are many smokers, elevated levels may occur beyond two meters. There is also a dose-response relationship.[26] The complex composition of SHT smoke provides a number of components that can be measured in environmental samples (air, dust and surfaces forming the so-called THT) and thus used to assess the exposure of non-smokers to tobacco smoke.[25] Extensive scientific evidence supports the conclusion that SHT[27,28] and THT[29] cause disease.

As for cigarette butts (FHT), the basic problem lies not only in the length of time these residues will remain in the environment, but also in the toxicity they accumulate. The cigarette butt filter is designed to accumulate the components of tobacco, including the most harmful chemicals, which are released when they come into contact with water. Numerous substances are present in cigarette butts, including pesticides (present in the filter with a potential toxic effect on the environment, which can bio-accumulate in the human food chain), ethyl phenol (used as a flavoring agent, accumulates in the filter and is potentially lethal), nicotine (toxic to animals and humans), menthol (used as an additive), diethylene glycol (used as a humectant), various metals (Al, Ba, Cd, Cr, Cu, Cu, Fe, Mn, Ni, Pb, Sr, Ti, and Zn), tar and carcinogens: all highly toxic.[15]

It cannot be forgotten that EC also pollute the environment. Not only they do pollute the air around the user (SHV) (volatile organic compounds, aerosols, heavy metals, nicotine, flavorings, propylene glycol and glycerin), but they also produce residues that are deposited on surfaces, clothing, etc. (THV) and solid residues (batteries, plastic, metal, fabrics, glass, storage material and so-called e-waste (FHV) and liquids (nicotine derivatives and flavorings).[16,29] HnB have also been recognized as indoor air pollutants, both as second-hand (SHHnB), third-hand (THHnB) and fourth-hand (FHHnB)[13–17] (Table 1).

Passive smoking, vape and respiratory infections

Exposure to second and third-hand tobacco smoke is associated with an increased risk of respiratory infections. In a Spanish study, those patients over 65 years of age exposed to tobacco smoke indoors had a higher risk of community-acquired pneumonia (CAP).[30]

Likewise, a meta-analysis concludes that passive exposure to tobacco smoke in adults is associated with a 13% increased risk of CAP, with those over 65 years having a 64% higher risk of CAP (grouped OR 1.64, 95% CI 1.17–2.30, $n = 2$ studies).[31] Another meta-analysis of nine case-control studies also showed that indoor secondhand smoke exposure in children under 5 years of age increases the risk of pneumonia. (OR = 2.15; 95% CI = 1.25–3.68; $p = 0.005$).[32] Likewise, the risk of tuberculosis transmission is two times higher in those patients with exposure to secondhand tobacco smoke hand indoors.[33,34]

Although there is little scientific evidence on the frequency of respiratory infections as a result of exposure to second-hand and third-hand tobacco smoke in open public spaces such as terraces, there are several reasons that suggest this statement. (A) High concentrations of particles such as PM (2.5) have been shown in these spaces at concentrations comparable to environments with high traffic density.[3] (B) There is a relationship between increased short-term exposure to PM2.5 and increased risk of symptomatic acute respiratory infections among adults.[35]

Tobacco, vape and association with COVID-19

Several meta-analyses have demonstrated that smoking cigarette can produce not only a worse evolution of COVID-19 but also an increase in respiratory complications from this disease. A meta-analyses carried out in Spain in 2021 included a total of 19 studies and found that being a smoker or former smoker was shown to be a risk factor for worse progression of COVID-19 (OR 1.96, 95% CI, 1.36–2.83) and a greater probability of presenting a more critical condition (admission to intensive care unit, ICU, mechanical ventilation, and more mortality) (OR 1.79 95% CI, 1.19–2.70).[6] The most recent meta-analyses found 109 articles involving 517,020 patients. The results showed a statistically significant association between smoking history and COVID-19 severity, the pooled OR was 1.55 (95%CI: 1.41–1.71). Smoking was significantly associated with the risk of admission to ICU (OR = 1.73, 95%CI: 1.36–2.19), increased mortality (OR = 1.58, 95%CI: 1.38–1.81), and critical diseases composite endpoints (OR = 1.61, 95%CI: 1.35–1.93).[36]

The relationship between vaping and COVID-19 has also been investigated in several studies. One study was conducted on a well-characterized patient cohort collected at Mayo Clinic. Among the 1734 eligible patients, 289 patients reported current vaping. The cohort of vapers ($N = 289$) was age and gender matched to 1445 COVID-19 positive patients who did not vape. A logistic regression analysis was performed separately for each symptom using generalized estimating equations (GEE). Patients who vaped and developed COVID-19 were more likely to have chest pain or tightness (16% vs 10%, vapers vs non vapers, $p = .005$), chills (25% vs 19%, vapers vs non vapers, $p = .0016$), myalgia (39% vs 32%, vapers vs non vapers, $p = .004$), headaches (49% vs 41% vapers vs non vapers, $p = .026$), anosmia/dysgeusia (37% vs 30%, vapers vs non vapers, $p = .009$), nausea/vomiting/abdominal pain (16% vs 10%, vapers vs non vapers, $p = .003$), diarrhea (16% vs 10%, vapers vs non vapers, $p = .004$), and non-severe light-headedness (16% vs 9%, vapers vs non vapers, $p < .001$).[37]

There are several reasons that explain why smokers and vapers are more likely to get infection by SARS-CoV-2 than no smokers: (a) during the past MERS-CoV epidemic it was found that smokers had more probability to be infected by this coronavirus and this virus is the same family of SARS-CoV-2,[38] (b) viral and bacterial infection is more frequent among smokers because they have alteration of their immune system[39] and (c) movement hand/mouth has been identified as a mechanism of viral transmission in COVID-19 disease. This movement is more frequent in smokers and vapers than in no smokers.[40] Moreover, a study by Takagi et al. analysing the relationship between the prevalence of smoking and the prevalence of COVID-19 in different Japanese regions found that the univariate meta-regression line was significantly positive (coefficient, 0.319; 95% confidence interval [CI] 0.148–0.490; $p < 0.001$), which indicated that COVID-19 prevalence increased significantly as smoking prevalence increased. This result was also significantly positive (coefficient, 0.321; 95% CI 0.093–0.549; $p = 0.006$) even in multivariable meta-regression including all 22 covariates together.[41] Taken together all these findings, we can conclude that smoking or vaping can facilitate infection by SARS-CoV-2.

Mechanism of transmission of COVID-19 through tobacco smoke and vaping

Models of viral particle transmission through respiratory emissions

Pathogen transmission through respiratory emissions between hosts is based on two models described more than 100 years ago. First, Carl Flügge, in 1897, described the presence of pathogens in “droplets” from a subject’s expiration that could be deposited around a second host. Later, in 1930, William F. Wells described the presence of “large and small droplets”, larger droplets are deposited before evaporating, while smaller ones, when exhaled into the environment, evaporate and form residual particles of dry material that we call aerosols that can be inhaled.[42] To this day we continue to use this classification of respiratory emissions in droplets or aerosols.

Table 1
Effects on health of passive smoking.

Title	Reference	Participants	Measures	Objectives	Design	Outcomes	Other considerations	Limitations
1. Secondhand smoke exposure (PM2.5) in outdoor dining areas and its correlates.	Cameron et al.[2]	Five shopping or retail areas within a 6-km radius of Melbourne city center. The baseline level of exposure (PM2,5): a 5-minute area on the footpath away from crowds and smokers. Researchers looked for a patron sitting in an outdoor dining area who was either currently smoking a cigarette within 1 m of where they were sitting. Researchers continued collecting data at the venue for 10 min after the target cigarette was extinguished.69 visits to 54 unique outdoor dining areas.	Examine the relation between the two outcome measures (total time and cigarette time exposure) and the predictor variables expected to influence exposure levels (number of target cigarettes; number of other lit cigarettes; overhead cover).	This study assessed the magnitude of secondhand smoke (SHS) exposure when people smoke in outdoor dining areas and explored conditions influencing exposure levels.	Observational prospective.	The overall mean baseline PM2.5 exposure was 8.4 mg/m^3 (95% CI 6.6–10.2; GM = 6.1 mg/m3, 95% CI 5.0–7.3). The mean total time exposure was 17.6 mg/m^3 (95% CI 14.0–21.2; GM = 12.7 mg/m^3, 95% CI 10.4–15.4). The mean cigarette time exposure was 27.3 mg/m^3 (95% CI 21.2–33.4; GM = 17.6 mg/m^3, 95% CI 13.9–22.2). The number of target cigarettes significantly predicted exposure levels at the multivariate level, with every one unit increase in the number of target cigarettes increasing total time exposure by 34% (95% CI 10–63%; $p = 0.004$), and cigarette time exposure by 34% (95% CI 2–75%; $p = 0.037$). Being situated underneath an overhead cover increased total time exposure by 51% (95% CI 9–109%; $p = 0.014$), and cigarette time exposure by 71% (95% CI 9–167%; $p = 0.020$).	During the times that target cigarettes were lit (cigarette time), the mean 30-s peak concentration across venues was 115.2 mg/m^3, while the maximum 30-s peak concentration was 483.9 mg/m^3.	-The recorded levels may not be representative of those present in outdoor dining venues across the state. -SHS is not the only source of PM2.5 particles. -Not obtain an adequate measure of wind conditions. -Not capture the exposure levels that would be experienced during the average shift of a hospitality employee.
2. Outdoor second-hand cigarette smoke significantly affects air quality.	Ruprecht et al.[3]	A pedestrian-only area with a high number of outdoor restaurants and bars, and the parallel high-traffic area of similar architectural design.	It compares the environmental pollution of a high-traffic area to that of a pedestrian-only area by measuring particulate matter (PM1, PM2.5, PM10) and vapour nicotine levels.	The contribution of SHS to environmental pollution in comparison with vehicular traffic	Observational prospective.	PM1 concentration levels were similar in the two streets during the morning hours. In the evening, PM1 was significantly elevated in the pedestrian area compared with the high traffic street (2.1 ± 0.03 versus 1.00 ± 0.03 $\mu g\,m^{-3}$; $p < 0.01$). PM2.5 and PM10 were also more elevated in the evening in the pedestrian area compared with the high traffic street (15.2 ± 1.1 versus 67.2 ± 8.9 $\mu g\,m^{-3}$ and 13.00 ± 1.1 versus 59.70 ± 5.5 $\mu g\,m^{-3}$, respectively; both $p < 0.05$).	After midnight, as the restaurants and bars closed, PM2.5 and PM10 were significantly elevated in the high traffic street compared with the pedestrian area. Vapour nicotine was present in the pedestrian (0.07 $\mu g\,m^{-3}$) but not in the vehicular area.	-The reduced ventilation is likely to have contributed to the experimental findings. -It may not apply to streets with a different layout

Table 1 (*Continued*)

Title	Reference	Participants	Measures	Objectives	Design	Outcomes	Other considerations	Limitations
3. Comparative Indoor Pollution from Glo, Iqos,and Juul, Using Traditional Combustion Cigarettes as Benchmark: Evidence from the Randomized SUR-VAPES AIR Trial)	Peruzzi et al.[13]	SUR-VAPES AIR (Sapienza University of Rome-VascularAssessment of Proatherosclerotic Effects of Smoking Ambient Indoor). 7 current smokers were assigned one of the products to smoke to a 2-block set of 15 sessions each, for a total of 30 sessions (thus, yielding 15 device/flavoring combinations repeated twice). The 7 subjects recruited for the experiments were smokers of traditional cigarettes that converted to dual smoking.	Emissions of PM10,PM4,PM2.5,PM1 were continuously measured in real use conditions 5 min before, during, and 5 min after smoking each product in a room of 53 m^3	Comparison of aggregate MRP, as well as different flavors of each MRP type	Randomized trial	MRP yielded significantly lower levels of indoor PM in comparison to TCC. Median TCC PM levels rose to >1000 g/m^3, median MRP PM levels lower than 100 g/m^3 irrespective of the flavor. Iqos lower burden of emissions, and Glo more polluting, Levels of PM of different MRP are different due to different flavors.	Substantial individual variability	-Cannot provide a consistent explanation concerning between-flavor variability -differences in exhaled aerosols from different smokers -the small sample size -the focus on only three MRP. -Healthy volunteers participated in the trial, and the results cannot be considered immediately applicable to patients with cardiopulmonary disease
4. Secondhand smoke presence in outdoor areas in 12 European countries	TackSHS Project investigators, Henderson et al.[19]	Data were drawn from the TackSHS survey ($N = 11{,}902$).	SHS presence in the last visit (last 6 months) to different outdoor settings	To investigate SHS presence in outdoor areas from 12 European countries and its association with country-level characteristics.	Cross-sectional study	Among all outdoor settings, children's playgrounds had lower SHS presence (39.5%; 95% CI: 37.6–41.3%),whereas, beaches had higher SHS presence (72.8%; 95% CI: 71.4–74.1%). Strong inverse correlation between the overall SHS presence rank score and the TCS overall score ($r = 0.62$; $p < 0.001$); a moderate inverse association between the rank scores and the SDI values ($r = 0.56$; $p < 0.001$); a moderate inverse association between the rank scores and the GDP per capita ($r = 0.47$; $p < 0.001$), and a strong direct association between the rank scores and the country's national smoking (men and women combined) prevalence ($r = 0.64$; $p < 0.001$). In countries with higher smoking prevalence had greater SHS presence ($p < 0.05$). In most settings, SHS presence estimates were lowest in the Northern region ($p < 0.05$).	Outdoor areas in hospitality venues and public transport stops were amongst the settings with the highest SHS presence.	-The self-reported data and the 6-months recall window, both prone to information bias. -The sampling methodology and the participant's age ranges as they slightly differed among countries.

Table 1 (*Continued*)

Title	Reference	Participants	Measures	Objectives	Design	Outcomes	Other considerations	Limitations
5. How widespread is electronic cigarette use in outdoor settings? A field check from the TackSHS project in 11 European countries How widespread is electronic cigarette use in outdoor settings? A field check from the TackSHS project in 11 European countries	Beladenta et al.[20]	Within the framework of the TackSHS Project from March 2017 to October 2018, in major cities of 11 European countries	200 school entrances, 200 children's playgrounds, and 220 outdoor hospitality venues to describe e-cigarette use outdoors, A trained data collector recorded at the beginning (0 min), at 15 min, and at the end (30 min) of the observation period	To describe e-cigarette use in outdoor settings frequented by children or by large numbers of people, in 11 European countries.	A cross-sectional study	School entrances with e-cigarette use were observed four times (18.0% vs. 4.0%; $p = 0.002$) more frequently in countries with higher ($\geq$1.4%) national prevalence of e-cigarette use than in countries with lower prevalence. Outdoor hospitality venues with e-cigarette use were more frequently observed in countries with a higher national prevalence of e-cigarette use (26.7% vs. 15.0%, $p = 0.036$).		-Small simple size. -Difficult identification of e-cigarette use because of its similarity to other handheld items. -Limited duration of observation
6. Outdoor air pollution in close proximity to a continuous point source	Klepeis et al.[21]	103 separate outdoor monitoring experiments during 52 different days at a 2-story Redwood City, California residence in the morning and evening hours in the spring, summer, and fall months of 2004. Most experiments lasted 1 h, although a number of experiments lasted either 0.5 h or 2 h.	Carbon monoxide (CO) on a residential backyard patio with similar dimensions as patio cafe's in nearby towns.	To better understand outdoor exposure to tobacco smoke from cigarettes or cigars, and exposure to other types of outdoor point sources, it was released CO as a tracer gas.	Observational descriptive	Particle emissions from a single cigarette smoker could result in particle concentrations close to 100 mg m^{-3} within 0.5 m of the source, but they would diminish to background levels more than 2 m from the source. Exposure to outdoor tobacco smoke particles could cause the server's total 24-h exposure to exceed the U.S. EPA 24-h standard for fine particles of 35 mg m^{-3} . Levels dropped by approximately half the distance from the source was doubled. Air speeds smaller than 0.2 m s^{-1} were associated with the highest pollutant concentrations.	When the source was stopped, outdoor levels returned to background concentrations almost instantaneously in contrast to indoor locations where levels can persist for hours	Not described.

Table 1 (*Continued*)

Title	Reference	Participants	Measures	Objectives	Design	Outcomes	Other considerations	Limitations
7. Particulate Matter (PM2.5) and Carbon Monoxide From Secondhand Smoke Outside Bars and Restaurants in Downtown Athens, Georgia.	Gideon et al.[22]	The study was conducted in downtown Athens, Georgia, a city of about 102,000 people, during two weekends in July 2006. Bar and restaurant sites were selected based on the significant number of outdoor smokers at these sites. The bar and restaurant sites varied from being fully open air to being partially enclosed on two or three sides by walls and a roof. An open-air control site (SW) was located on a sidewalk on the north campus of the University of Georgia, separated from the bars by a four-lane street. No smokers were expected at the control site	The average concentration of PM2.5 and CO emitted from burning tobacco products during normal bar and restaurant operating hours.	To measure PM2.5 and carbon monoxide (CO) in outdoor waiting areas and patios of restaurantsand bars in downtown Athens, Georgia, and to investigate whether the measured concentrations are directly associated with the number of cigarettes lit (as a proxy for SHS) in these settings	Observational descriptive	Carbon monoxide levels outside the restaurant and bar sites did not differ significantly from the control and ranged from 1.2 to 1.6 ppm. The average PM2.5 recorded at the majority of the bars and restaurants was three times higher than the control site, $20.4 \pm 3.4\,mg/m^3$. A linear increase in PM2.5 and CO concentrations as the number of smokers increase, more pronounced between PM2.5 and smokers than CO and smokers.	The approximately 12-h average levels of PM2.5, especially at bars, exceed the 24-hour U.S. EPA protective standard of $35\,mg/m^3$ Carbon monoxide levels at no point reached close to or exceeded the U.S. EPA standard.	-The venues sampled were not necessarily representative of venues throughout Athens, Georgia. -Some sites were fully open air while others were open or only one side facing the road and had a roof. -PM2.5 and CO are also influenced by cooking, especially grilling that were not measured. -It was not collected meteorological data such as wind speed, temperature, and humidity,
8. Second hand smoke in alfresco areas.	Stafford et al.[26]	12 cafes and 16 pubs located in eight local government areas in metropolitan Perth and Mandurah where smoking was permitted, in outdoor seating areas between December 2008 and February 2009.	If smoking affected PM2.5 concentrations controlling for other factors	To determine potential exposure of patrons to SHS in outdoor areas of eating and drinking venues.	Observational descriptive	Particulate concentrations were statistically significantly higher during the 'smoker present' periods (median = $8.32\,\mu g/m^3$) compared to the 'no smoking' periods (median = $2.56\,\mu g/m^3$, $p < 0.001$). The number of smokers (zero, one, or two or more) remained a significant predictor of PM2.5 level, explaining 24.3% of the variance in PM2.5 level	PM2.5 decreased in windier conditions, increased when the covering increased, and increased with the number of patrons, on busy roads and with the amount of traffic.	-It was not always possible to record exactly when smokers stopped smoking in the hospitality venues -in the analyses it has not been accounted for the distance and the position of smokers relative to the sampling equipment.

Table 1 (*Continued*)

Title	Reference	Participants	Measures	Objectives	Design	Outcomes	Other considerations	Limitations
9. Impact of Electronic Alternatives to Tobacco Cigarettes on Indoor Air Particular Matter Levels	Protano et al.[14]	Three volunteers who were already smokers. 2-block set of 15 sessions each, for a total of 30 sessions. Use of 6 different flavors forIQOS®, 4 different flavors for GLO® and 4 different flavors for JUUL®, plus 2 sessions using Tobacco cigarettes for control purposes. For each experiment, the measurement was performed from five minutes before until one hour after the end of the vaping session	Levels of PM10,PM4, PM2.5 and PM1 emissions of IQOS®, JUUL® and GLO® were assessed in real use conditions, the same experiment was performed also with a traditional cigarette (Marlboro® gold).	To evaluate the levels of different size fractions of PM emitted into indoor air during the use of IQOS®, JUUL® and GLO®, testing different sticks for IQOS® and GLO®and pods for JUUL®	An open-label randomized Study.	A statistically significant difference in concentrations of PM1 measured, before and during the vaping/smoking session was found. The highest levels of PM1 were measured during smoking of the traditional cigarette (median value equal to 3430.0 $\mu g\,m^{-3}$). In general, a relevant worsening of air quality in terms of PM pollution occurred for all the tested combinations.	PM values considerably higher than those recommended by WHO, up to 100 time higher for electronic devices and more than 1000 times higher for conventional cigarette.	-Not perform a systematic assessment of all commercially available EATCs. -The results were probably influenced in part by the individual way of smoking/vaping
10. Children's Exposure to Secondhand and Thirdhand Smoke Carcinogens and Toxicants in Homes of Hookah Smokers.	Kassem et al.[18]	Data from 24 households with hookah only smokers ($n = 19$): (daily hookah smokers [$n = 8$], weekly/monthly hookah smokers [$n = 11$]), and nonsmokers ($n = 5$), living with a healthy child 5 years old or younger.	Three child urine samples and 2 air and surface samples from the living room and the child bedroom of nonsmokers and hookah-only smokers.	It examined homes of hookah-only smokers and nonsmokers for levels of indoor air nicotine (a marker of secondhand smoke) and indoor surface nicotine (a marker of thirdhand smoke), child uptake of nicotine, the carcinogen 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), and the toxicant acrolein acid(3-HPMA).	A cross-sectional nonequivalent group comparison Study.	Air nicotine levels: the GM air nicotine levels in the living room and in the child bedrooms were higher in daily hookah homes compared to the nonsmoker homes and weekly/monthly hookah smoker homes. In weekly/monthly hookah smoker homes, GM air nicotine levels were 3 times higher than those found in nonsmoker homes(living room and child bedrooms). Surface nicotine levels:the GM Surface nicotine in living rooms and in the child bedrooms living room were higher in daily hookah smoker homes, compared to the nonsmoker homes and weekly/monthly hookah smoker homes. In week/monthly hookah smoker homes, GM surface nicotine levels were significantly higher than those found in the living rooms of nonsmoker homes(living room 11.4/childbedrooms 24.5). GM urine cotinine levels, urine total NNA, urine 3-HPMA in children living in daily hookah smoker homes were also higher than those found in children living in nonsmoker homes and than in children living in weekly/monthly hookah smoker homes.	It found significant positive correlations between the child urinary cotinine and total NNAL levels, and number of hookah heads smoked and number of hours the child was exposed to hookah tobacco SHS per week. Urinary total NNAL levels were negatively correlated with child age. Urinary 3-HPMA levels were negatively correlated with the number of bedrooms in homes.	-Small sample size. -mixed indoor and outdoor results -hookah smoking participants were almost exclusively Middle Easterners and the nonsmokers were non-Middle Easterner Whites.

PM1: particles ≤1 μm aerodynamic diameter; PM2.5:particles ≤2.5 μm in aerodynamic diameter; PM4:particles ≤4 μm in aerodynamic diameter; PM10: particles ≤10 μm in aerodynamic diameter; SHS: secondhand smoke; GM: Geometric means; TCC: traditional combustion cigarettes; EVC: electronic vaping cigarettes; HNBC: heat-not-burn cigarettes; MRP: modified risk products; EATCs new forms of electronic alternatives to tobacco cigarettes; NNK: 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone; NNAL: 4(methylnitrosamino)-1-(3-pyridyl)-1-butanol; total NNAL: NNAL-glucuronides: 3-HPMA: 3hydroxypropylmercapturic acid; TCS: score in the Tobacco Control Scale; GDP: gross domestic product; SDI: socio-demographic index.

However, more recent studies have shown that respiratory emissions are composed of a multiphase turbulent gas cloud in which droplets of different sizes are entrained by the ambient air, delaying their evaporation. This allows them to stay in the air for much longer and to travel much greater distances.[42,43]

The transmission capacity of respiratory emissions depends on environmental conditions such as temperature and humidity, as well as the flow of exhaled air and, of course, the composition of both the exhaled droplets and the ambient air.[42] In this sense, the presence of particles in suspension in the atmosphere will influence this transmission capacity.[43] In addition to other particulate materials related to air pollution, environmental tobacco smoke[44,45] (ETS) and vapor from EC[46,47] are one of the main sources of particle emissions, mainly particles smaller than 2.5 μm (PM2 .5) which are the ones that remain suspended in the air the longest and the ones that have the greatest deposit in the respiratory tract when inhaled.

There is multiple evidence that particulate matter, mainly PM2.5, can act as a vector for the transmission of pathogens, especially viruses, such as respiratory syncytial virus.[48] (RSV), measles[49,50] influenza or hemorrhagic fever.[51] Some explanations that justify this relationship may be the formation of particle aggregates, which facilitates long-range transport, or the protective effect of the particles against solar radiation that inactivates viruses.[52,53] In addition, specifically in relation to the HAT, the exit through the respiratory tract produces an increase in the temperature and humidity of the emissions that increases the adherence of the particles.[44]

Hypotheses of transmission of COVID-19 through exhalation of tobacco smoke and vaping

Knowing the routes of transmission of respiratory infections is crucial to be able to make recommendations that minimize the risk of contracting them. In the case of coronavirus disease 2019 (COVID-19), the routes of infection are complex,[54] but airborne transmission has been considered to represent the dominant route of infection.[55]

In this way, since the beginning of the pandemic, recommendations have been issued on what the safe distance should be in order not to contract COVID-19. The World Health Organization recommended a distance of 1 meter to health personnel while the Centers for Disease Control and Prevention suggested a separation of 2 meters.[56] These values are based on estimates that have not considered the possible multiphase turbulent gas cloud that transports droplets over long distances. Separations of 1–2 m may not be enough, especially in places where tobacco smoke is present.

Aerosols and smoke generated by cigarettes and electronic devices can be sources of COVID-19.[57,58] This is explained because the 0.1 μm diameter of the SARS-CoV-2(55) virus particles can adhere to the particles and droplets of tobacco aerosols that have a larger diameter, between 0.2 and 0.5 μm.[57] in such a way that aerosols loaded with the virus can travel up to distances of 7–8 m,[42] increasing the contagious range beyond the 1 or 2 m that are usually considered safe. In addition to reaching greater distances, when associated with tobacco aerosols, they can be deposited and survive for hours, even days, on surfaces.[59]

This peculiarity of adherence to exhaled smoke from conventional tobacco and electronic devices, such as vehicles to reach greater distances, makes smoking and vaping a risk for virus infection both in homes and in public places. In any case, new epidemiological studies are needed to confirm these hypotheses.

Terraces as a favorable environment for COVID-19 infections

Currently, terraces are open spaces with a high concentration of tobacco smoke and its particles could maintain the SARS-CoV-2 virus in these places for longer, in addition to reaching greater distances.[42,52,53] Likewise, the behavior of smoking and the gestural patterns of the smoker favor a greater transmission of viral particles. On the other hand, smokers and non-smokers stay on the terraces for a longer time without masks, with the risk of transmission being greater.[9] All this makes these places could be unsafe for the spread of COVID-19.

Nevertheless, there are other factors that can also influence the risk of transmission of COVID-19 on terraces such as the concentration of smokers, the time of exposure to this smoke, the concentration of particles or ventilation. That's why it is essential to carry out new studies that analyze this risk in those who have been exposed to passive smoking and vaping for many hours, such as hospitality workers.

Conclusions

One of the five inalienable measures proposed by the Spanish Society of Pulmonology and Thoracic Surgery (SEPAR) in view of a reform of the current Anti-Smoking Law is the extension of the smoking ban to open public spaces such as terraces. From our scientific society we urge Public Administrations to declare terraces as smoke-free environments due to the need to:

a) Defending non-smokers from the toxic agents of tobacco and electronic devices.
b) Avoiding the transmission of SARS-CoV-2 virus particles through tobacco smoke in both smokers and non-smokers, preventing contagion.
c) Protecting hospitality employees from the consequences of exposure to tobacco smoke and the toxins released by electronic devices.
d) Promoting quit attempts in smokers, which would increase their chance of quitting smoking, preventing complications associated with tobacco, such as the greater severity of COVID-19.
    1. Terraces free of tobacco smoke and toxic substances released by electronic devices could prevent COVID-19 and other respiratory infections in the Spanish population.
    2. This measure of prohibiting smoking and vaping on terraces should be maintained over time and not just circumstantial, as it could not only prevent SARS-CoV-2 infections, but also other respiratory infections and tobacco-related diseases, improving the health of Spaniards.

Authors' contribution

Dr. Carlos Rábade Castedo is the author of the correspondence and has collaborated in the preparation, review and approval of the manuscript.

Dr. José Ignacio de Granda Orive has collaborated in the preparation, review and approval of the manuscript.

Dr. Carlos A Jiménez Ruiz has collaborated in the process of preparing, reviewing and approving the manuscript.

Dr. Inma Gorordo has collaborated in the process of drafting and revising the manuscript.

Dr. Eva de Higes Martínez has collaborated in the process of preparing and revising the manuscript.

Dr. Eva Cabrera César has collaborated in the process of preparing the manuscript.

Dr. Raúl Sandoval Contreras has collaborated in the review process of the manuscript.

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