What happens in Vegas, stays in your lungs: An assessment of fine particulate matter in casinos that prohibit and allow smoking in Las Vegas, NV

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Abstract

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Introduction

Despite progress in adoption of smoke-free policies, casinos are exempted in some smoke-free laws, including in Nevada. In 2020 for the first time, a resort-style casino in Las Vegas, Nevada prohibited smoking indoors. This study will be the first to assess air quality in this smoke-free casino and compare results with other Las Vegas casinos that continue to allow smoking.

Methods

A real-time personal aerosol monitor was used to evaluate particulate matter with a diameter <2.5 µm (PM2.5), a surrogate for secondhand smoke (SHS). PM2.5 was measured at 8 Las Vegas casinos, including the smoke-free casino. Each casino was visited twice, and PM2.5 was assessed in smoking-permitted gaming areas and casino areas where smoking is otherwise prohibited. A t-test assessed the differences in average PM2.5 levels for each casino type.

Results

Average PM2.5 in gaming areas was 164.9 $\mu g/m^3$ in casinos that allow smoking, compared to 30.5 $\mu g/m^3$ in the smoke-free casino. For areas of casinos where smoking is otherwise prohibited, average PM2.5 was 83.2 $\mu g/m^3$ in casinos which allowed smoking in gaming areas, compared to 48.1 $\mu g/m^3$ in the

smoke-free casino. Average PM2.5 levels were significantly higher in casinos that allow smoking, for both casino gaming areas and areas where smoking is otherwise prohibited (p=<0.05).

Conclusion

Despite robust evidence about the harms of SHS, tens of thousands of casino employees and tens of millions of tourists are exposed to high levels of SHS in Las Vegas casinos annually. PM2.5 levels in gaming areas of Las Vegas casinos that allow smoking are 5.4 times higher than the smoke-free casino. The only way to protect people from exposure to SHS is to prohibit smoking in all indoor areas.

Keywords: Secondhand Smoke, Smoke-free, Policy

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INTRODUCTION

Exposure to secondhand smoke (SHS) causes more than 41,000 deaths in the United States and 1.2 million global deaths each year.(1-3) Tobacco smoke contains more than 7,000 chemicals, of which 69 cause cancer.(2) SHS is sidestream smoke from burning tobacco products that is mixed with smoke that is exhaled.(1-4) There is no risk-free level of exposure to SHS, and even brief exposure can have immediate adverse effects on the cardiovascular system and can trigger an acute myocardial infarction among nonsmokers.(1, 2, 4) SHS also causes respiratory diseases, adversely affects the circulatory system, and causes lung cancer among adults who do not smoke.(1, 2)

The U.S. Surgeon General concluded that separating smokers from nonsmokers, cleaning the air, and ventilation cannot eliminate SHS exposure.(1) Prohibiting smoking in all indoor areas is the only way to eliminate involuntary exposure to SHS.(1) Currently, more than 60% of the U.S. population lives in a state or community with a comprehensive smoke-free law which prohibits smoking in all indoor areas of workplaces, restaurants, and bars.(5) Despite the progress in adoption of comprehensive state and local smoke-free laws in the last two decades, casinos are not always included in these state and local smoke-free policies.(6, 7)

Numerous studies have found that prohibiting smoking indoors eliminates SHS and substantially improves indoor air quality.(1, 2, 7-11) For example, a study of 32 countries found that those with national laws that prohibit smoking indoors had lower levels of particulate matter caused by SHS compared to countries without restrictions.(10) Similarly, a study of 128 pubs in 15 countries found particulate matter was 93% lower in locations where smoking was prohibited.(11) Overall, studies have

found declines in particulate matter that ranged from 71% to 99% after implementation of policies that prohibit smoking in all indoor areas of a setting.(8)

Studies specific to casinos have found that casinos that allow smoking have high levels of particulate matter, that particulate matter from smoke drifts from areas where smoking is allowed, and that ventilation does not eliminate exposure.(12-17) A study of Las Vegas-area casinos conducted from 2007 to 2008 found that casinos with higher levels of particulate matter in gaming areas also had higher levels of particulate matter in areas where smoking was not allowed, demonstrating that exposure risks can occur throughout casinos when smoking is allowed indoors.(14) And while casinos may promote ventilation as a method to mitigate SHS exposure, a multi-site study concluded that smoker density was the primary predictor of elevated particulate matter levels in casinos, and ventilation was not effective in eliminating exposure.(17) Also, studies examining biomarker data have documented elevated levels of nicotine and other chemicals from SHS, including carcinogens, among nonsmoking casino employees.(7, 13, 15)

Despite this evidence, some jurisdictions, including Nevada, continue to allow indoor smoking in casinos. Nevada's smoke-free law prohibits smoking in workplaces and restaurants but allows smoking in stand-alone bars and other certain areas where minors are prohibited, which include casino gaming areas.(14) While all casinos on the Las Vegas strip have allowed smoking indoors in gaming areas, the Park MGM casino became a smoke-free casino when it reopened on September 30, 2020, after having been closed due to the COVID-19 pandemic. With this new policy, the Park MGM is the only resort-style casino on Las Vegas Boulevard to prohibit smoking in all indoor areas, including in casino gaming areas.

The purpose of this study is to measure fine particulate matter with a diameter <2.5 micrometers (PM2.5) inside resort-style casinos in Las Vegas, and to compare PM2.5 levels in a smoke-free casino with PM2.5 levels in a sample of similar casinos that continue to allow smoking indoors. PM2.5 has been used as a marker to assess SHS concentrations in multiple countries and settings, including in casinos.(7-

17) PM2.5 is produced in substantial amounts by cigarettes and can be inhaled deeply into the lungs.(9) To our knowledge, this is the first study to assess PM2.5 levels in a smoke-free casino in Las Vegas and compare findings to Las Vegas casinos that continue to allow smoking indoors.

METHODS

Study Design

This study assessed indoor air in resort-style casinos in Las Vegas, Nevada during a three-day period in the first calendar quarter of 2022. The study assessed respirable suspended particulates, specifically PM2.5, a non-unique marker of SHS in indoors environments, using methods similar to a previous study.(14) PM2.5 was evaluated in eight casinos in Las Vegas, including seven casinos that allow smoking and one smoke-free casino. Data collection occurred after February 10, 2022, after Nevada ended its COVID-19-related mask mandate.

Casino Sample

A purposeful sample of 8 casinos on the Las Vegas strip (i.e., located on Las Vegas Boulevard) was included in this assessment. Casinos were selected to be similar to and in the same vicinity of the smoke-free casino, and to allow for one person to visit up to 6 casinos each day during the study period.

Instrument

PM2.5 was measured using a SidePak AM520 Personal Aerosol Monitor (TSI Inc., St. Paul, MN). This style of instrument, a real-time dust monitor, is commonly used for this type of sampling, and previous instrument makes and models have been used in numerous studies published on SHS and PM2.5 worldwide, including in casinos.(7, 8, 10, 14) The SidePak was fitted with a PM2.5 size selecting inlet with an impactor disk prepared and inserted per manufacturer specifications. A new impactor disk was used each day. The instrument was set to a flow rate of 1.7 liters per minute. Before each use, the Sidepak was zeroed using a “zero cal filter,” following procedures in the instruction manual. The data-

logging interval for the SidePak was set to 1 minute, which averages the 1 second data collected by the instrument into 1-minute intervals. The Sidepak was factory-calibrated on December 13, 2021.

Procedures

Each casino was visited twice over a Thursday, Friday, and Saturday between approximately 1 p.m. and 11:30 p.m. each day, and no casino was visited more than once on the same day. During each visit, indoor air was assessed in the gaming area (where smoking is permitted for 7 of the casinos in the sample) and in an area within each casino where smoking is not otherwise permitted, such as a restaurant or sportsbook designated as nonsmoking. Sportsbooks are specific areas of casinos where visitors can wager on and watch live televised sporting events, and that often have seating areas and beverage services. Indoor air assessments occurred for at least 30 minutes in each area, for each visit. Because smoking is prohibited in all areas of the smoke-free casino, PM2.5 was assessed in a restaurant and sportsbook area as a comparison for “nonsmoking areas” in that casino. Outdoor air was also assessed for 10 minutes prior to entering each casino.

The SidePak was placed in a backpack and fitted with 1 meter of Tygon tubing, which was exposed to the environment at the level where a person breathes, called the breathing zone. This allowed for data to be collected discreetly, which was necessary to avoid changing the behavior of casino visitors and employees. A record was kept of the time when each area was entered and exited. Similar to a previous study, when walking through the casino gaming area, the observer avoided entering direct puffs of tobacco smoke or electronic cigarette emission.(14) Also, when outdoor air was assessed, the observer attempted to avoid sources of pollution, such as vehicle exhaust and tobacco smoke. The number of tobacco products being used in each casino was also observed and recorded. Estimates of gaming area size for casinos were collected from casino websites and media reports.

Statistical Analysis

Data from the SidePak were downloaded using TrakPro Data Analysis Software (v5.0.0.24, TSI Inc., St. Paul, MN) and imported into tables in Microsoft Excel (v2108, Redmond, WA). Statistical analyses were conducted using R (v4.1.0, Vienna, Austria). The first and last minute for each indoor area were excluded from the analysis to ensure that data from areas during transitions between areas were not include within the analysis. The mean PM2.5 concentration ($\mu g/m^3$) was then determined for each area where PM2.5 was assessed for each casino visit, for each casino overall, and for each casino type (i.e., smoke-free casino or casinos that permit smoking). A t-test was used to determine if differences in mean PM2.5 for areas within smoking-permitted casinos and the smoke-free casino were statistically significant, using a significance level of 0.05.

RESULTS

For the casino gaming areas, the average PM2.5 in casinos that permit smoking was 164.9 $\mu g/m^3$ compared to 30.5 $\mu g/m^3$ in the smoke-free casino (Table 1, Figure 1). For the areas of casinos where smoking is otherwise prohibited (i.e., nonsmoking areas), the average PM2.5 level was 83.2 $\mu g/m^3$ in casinos which permit smoking compared to 48.1 $\mu g/m^3$ in comparable areas in the smoke-free casino. Among the casinos that permit smoking, PM2.5 averages for each casino gaming area ranged from 95.3 to 306.5 $\mu g/m^3$ (Figure 2), while PM2.5 averages for each area in casinos where smoking is otherwise prohibited ranged from 49.2 to 103.5 $\mu g/m^3$ (Figure 3). Overall, the average PM2.5 levels were significantly higher in casinos that permit smoking when compared to the smoke-free casino, for both the casino gaming area ($p=0.002$), and in areas where smoking is otherwise prohibited ($p=0.003$).

When examining visits to casino gaming areas, among the casinos where smoking is permitted, Casino 2 had the highest average PM2.5 level observed on any of the casino gaming area observations, with an average of 306.5 $\mu g/m^3$, and had the highest average observed during a single visit (371 $\mu g/m^3$, visit 1). Casino 2 also had the highest combined average PM2.5 among areas where smoking is otherwise prohibited with an average of 103.5 $\mu g/m^3$ and had the highest average observed during a

single visit (149.2 μg/m^3). For the smoke-free casino, average PM2.5 for visits to the casino gaming area were 18 μg/m^3 and 42.9 μg/m^3, while average PM2.5 for each visit in comparable nonsmoking areas were 42.1 μg/m^3 and 53.9 μg/m^3. The average PM2.5 for outdoor areas was 12.5 μg/m^3 (range 6.4 to 22.8 μg/m^3), with individual observations ranging from 4.6 μg/m^3 (outside Casino 1, visit 2) to 38 μg/m^3 (outside Casino 6, visit 1).

A total of 534 tobacco products were also observed in use in the smoking-permitted casinos for all casino visits. (Table 2). Overall, 93% of the products that were observed were combustible tobacco products, such as cigarettes or cigars, and there were 0.68 products used per 1,000 square feet of gaming space, when both visits were combined (range 0.51-0.77). No tobacco-product use was observed in the nonsmoking areas of any casinos. No tobacco-product use was observed in any areas of the smoke-free casino. The smoke-free casino included electronic and non-electronic signs throughout the casino and at casino entrances that inform visitors that the casino is smoke-free.

DISCUSSION

This study finds that PM2.5 levels in casino gaming areas are 5.4 times higher in casinos that permit smoking compared to a smoke-free casino. Additionally, PM2.5 levels in areas where smoking is otherwise prohibited, such as restaurants and sportsbooks, are 72% higher in smoking-permitted casinos when compared to similar areas in a smoke-free casino. Despite the robust evidence about the harms of SHS, tens of thousands of Las Vegas-area casino employees and tens of millions of tourists who visit Las Vegas annually are exposed to dangerous levels of SHS in Las Vegas casinos (18, 19).

These findings demonstrate that the PM2.5 levels in Las Vegas casinos that permit smoking are high and continue to pose an exposure risk to employees and visitors in casinos. These data can be useful for public health practitioners and health departments as they identify strategic policy goals to eliminate SHS in casinos and can use these data to explain differences in PM2.5 levels in a smoke-free casino in Las Vegas to other area casinos. These findings can also be useful for casino employees and trade unions

who want to understand current levels of PM2.5 and occupational risks of exposure to SHS in Las Vegas casinos.

The number of people at risk of exposure to SHS in Las Vegas casinos is not inconsequential. The Las Vegas Convention and Visitor Authority reported that there were 32.3 million visitors to Las Vegas in 2021 (42.5 million in 2019)(18), and the University of Nevada Las Vegas reports that there were more than 64,000 casino employees on the Las Vegas Strip in 2021 (more than 96,000 in 2019)(19).

This study is also well timed, as it occurred soon after the first time a resort-style casino on the Las Vegas strip established a policy to prohibit smoking in all indoor areas. The findings that there are elevated PM2.5 levels throughout casinos that allow smoking, and that average PM2.5 levels in these casinos are significantly higher than a smoke-free casino, are expected. However, these findings remain important because they document that casino employees, tourists, and other visitors remain at risk of exposure to high levels of SHS in Las Vegas casinos, despite claims that ventilation can mitigate SHS.

In addition to conclusions by the U.S. Surgeon General that ventilation cannot eliminate exposure to SHS,(1) the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) also found that while ventilation can reduce odor and discomfort, ventilation cannot eliminate SHS exposure when smoking is allowed inside a building.(20) The only way to protect nonsmokers from involuntary exposure to secondhand smoke in casinos and other indoor settings is to prohibit smoking in all indoor areas.(1, 20).

While there are not national air-quality standards for indoor air, the U.S. Environmental Agency (EPA) has established air-quality standards for outdoor air, which includes a 24-hour standard for PM2.5 of less than or equal to 35 $\mu g/m^3$.(21) While this study did not assess data for 24-hours outdoors, the EPA standards for outdoor air can still be illustrative. The average PM2.5 for gaming areas of casinos that permit smoking in this study was 164.9 $\mu g/m^3$, which is substantially higher than the 24-hour

standard. Alternatively, the average PM2.5 in gaming areas of the smoke-free casino (Casino 4) was 30.5 $\mu g/m^3$, which is below the annual EPA 24-hour standard.

The PM2.5 levels in the comparable nonsmoking areas of the smoke-free casino are notable, as they were higher than expected during the first visit to this casino (53.9 $\mu g/m^3$). However, this location was a restaurant with open kitchens, and PM2.5 levels were likely impacted by cooking that was detected near where the observer was seated. Even with this impact, the combined average PM2.5 levels in the smoke-free casino remained in an expected range and were significantly lower than comparable areas in casinos that permit smoking, though this finding highlights how cooking, ventilation, and other factors can potentially impact PM2.5.

While nearly all casinos in Las Vegas continue to allow smoking indoors, this is counter to social norms related to smoking indoors. Most of the U.S. population lives in a state or community with a comprehensive smoke-free law, and smoke-free casinos are becoming more common. States and territories such as Colorado, Connecticut, Delaware, Florida, Illinois, Maine, Maryland, Massachusetts, New York, Ohio, Puerto Rico, and South Dakota all prohibit smoking in commercial, non-tribal casinos.(22) In 2021, the Navajo Nation passed legislation that prohibits commercial tobacco use on all tribal land and property, including casinos.(23)

Adult smoking in the U.S. has declined over several decades, and in 2020 only 12.5% of adults currently smoked cigarettes.(24) Previous research of smoking prevalence among Nevada gamblers finds that the percentage of gamblers who smoke was less than or the same as the U.S. population.(25) Additionally, a survey of adults in 2017 found that most adults favored smoke-free casino policies. This was true even for those who reported they visit casinos about once per year (74.1%), several times per year (75.3%), and at least once per month (74.2%).(26) Together, those findings show that allowing smoking in casinos is unfavorable among most adults and that casinos that continue to allow smoking

are placing a majority of people, including casino employees who do not smoke, at an increased health risk to accommodate a declining number of people who smoke.

Once businesses began to reopen after being closed during the initial phase of the COVID-19 pandemic in 2020, over 200 casinos reopened smoke-free, including New Jersey casinos and many tribal casinos.(27) But because these smoke-free policies are not mandated by state or local law, they could be changed by casino management and other decision makers, again exposing employees and visitors in these jurisdictions to SHS, a known and preventable health risk. For example, New Jersey temporarily prohibited smoking upon reopening, but smoking was permitted again in 2021, once certain emergency provisions in the state making casinos smoke-free expired. Public health practitioners and researchers could consider conducting similar PM2.5 studies in locations that have reopened smoke-free, to document the levels of PM2.5 and communicate any findings to casino operators, employees, and visitors. Such data can also be used as a baseline should casinos again allow smoking indoors.

Limitations and Strengths

This study has some limitations. First, factors other than tobacco smoke can impact PM2.5 levels, including ambient air pollution, cooking, room size, and ventilation. However, PM2.5 remains an accepted marker to identify SHS indoors, as tobacco smoke is the main source of elevated indoor levels of PM2.5 in areas where smoking is present.(1, 7, 28) Second, while some studies have used a standard calibration factor to adjust the real-time instrument's measurements to gravimetric measurements of tobacco smoke,(10-12) this study did not use a calibration factor because the experiments that arrived at this factor were from a previous-generation SidePak. Third, the room volumes or ceiling heights of the locations sampled could not be measured, and therefore smoking density was not estimated, though previous studies have well documented that smoking density is the primary determinant of PM2.5 in smoking areas of casinos.(17) This inability to determine smoking density combined with a lack of information about air exchange rates means that this study's findings may not be generalizable to all

casinos. Fourth, due to the size of Las Vegas casino gaming areas, it is likely that some tobacco-product use was not observed, though any estimates are likely conservative. Finally, due to the proximity of some casinos to streets and traffic, and because of the design of casino entrances, it was not always possible to avoid vehicles when sampling outdoor air, so vehicle emissions may have impacted PM2.5 levels. However, these data do reflect the real-time PM2.5 levels that individuals experience outside of casinos in Las Vegas, and this includes being exposed to vehicle emissions.

This study also has some strengths. First, this study used a monitor and methods that are commonly used in these types of evaluations, making this study easy to replicate for future research. Second, data collection occurred multiple times in each casino, with each casino being visited on different days, accounting for variability that could occur with different visits. Third, because this study period was over three consecutive days, these exposures may be similar to the SHS exposure a tourist who visits Las Vegas experiences when visiting multiple casinos over a weekend. Fourth, data collection was conducted by the same observer, ensuring that there were not variations in data-collection methods that could have otherwise occurred if there were multiple observers. Finally, this study occurred after the COVID-19-related mask mandate was lifted in Nevada in 2022.

CONCLUSION

This study demonstrates that decisions by casinos to continue to allow smoking indoors results in PM2.5 levels that are substantially higher than casinos that prohibit smoking completely, placing the health of nonsmoking tourists and employees at unnecessary risk. The only way to protect people from involuntary exposure to SHS is to prohibit smoking in all indoor areas, including in casinos.

What this paper adds (for journal submission)

What is already known on this topic

- Casinos in Las Vegas continue to allow smoking indoors. The only way to eliminate exposure to SHS is to completely prohibit smoking indoors.

What this study adds

- PM2.5 levels in Las Vegas casino gaming areas that allow smoking were 5.4 times higher than the casino gaming areas in a smoke-free casino.

How this study might affect research, practice and/or policy

- These findings demonstrate the stark difference in particulate matter inside Las Vegas casinos that allow and prohibit smoking indoors.
- These findings can be used by casino employees who want to understand their potential exposure risk to SHS and by public health programs and other organizations that are working to inform people on the health risks of exposure to SHS in casinos.

Table 1. Mean levels of PM2.5 in eight casinos, by sampled area -- Las Vegas, Nevada, 2022.

	Casino Area Mean PM2.5 ($\mu g/m^3$)			**Nonsmoking* Area Mean PM2.5 ($\mu g/m^3$)**			**Outdoor Area Mean PM2.5 ($\mu g/m^3$)**		
Casino	Visit 1	Visit 2	Gaming Area Mean	Visit 1	Visit 2	Nonsmoking Area Mean	Visit 1	Visit 2	Outdoor Mean
Casino 1	123.8 n=29	157.1 n=32	**141.2** **n=61**	110.4 n=32	87.7 n=34	**98.7** **n=66**	8.1 n=10	4.6 n=10	**6.4** **n=20**
Casino 2	371 n=30	244 n=31	**306.5** **n=61**	56.3 n=30	149.2 n=31	**103.5** **n=61**	6.5 n=10	9.4 n=10	**8** **n=20**
Casino 3	103 n=29	88.9 n=35	**95.3** **n=64**	28.5 n=31	71.4 n=29	**49.2** **n=60**	13.1 n=10	7.2 n=10	**10.2** **n=20**
Casino 4**	18 n=30	42.9 n=30	**30.5** **n=60**	53.9 n=30	42.1 n=29	**48.1** **n=59**	27.7 n=10	13.2 n=10	**20.5** **n=20**
Casino 5	166.7 n=30	114.8 n=31	**140.3** **n=61**	94 n=32	98.8 n=37	**96.6** **n=69**	10.4 n=10	6 n=10	**8.2** **n=20**
Casino 6	107.3 n=30	144.7 n=32	**126.6** **n=62**	27.9 n=29	110.6 n=29	**69.1** **n=58**	38 n=10	7.6 n=10	**22.8** **n=20**
Casino 7	168.9 n=31	131.1 n=30	**150.3** **n=61**	68.8 n=30	90.8 n=32	**80.2** **n=62**	16.4 n=10	14.8 n=10	**15.6** **n=20**
Casino 8	216.2 n=31	176.1 n=38	**194.1** **n=69**	68.7 n=31	93.2 n=30	**80.7** **n=61**	7.8 n=10	9.1 n=10	**8.5** **n=20**
Smoking Casinos	180.3 n=210	150.7 n=229	**164.9** **n=439**	65.6 n=215	99.7 n=222	**83.2** **n=437**			
Smoke-free Casino	18 n=30	42.9 n=30	**30.5** **n=60**	53.9 n=30	42.1 n=29	**48.1** **n=59**			
							All Outdoor Areas		
							16 n=80	9 n=80	**12.5** **n=160**

*Nonsmoking areas are areas where smoking is prohibited either by The Nevada Clean Indoor Air Act or by the casino. The Nevada Clean Indoor Air Act exempts the casino gaming area from locations where smoking is prohibited.

**Casino 4 is smoke-free in all areas.

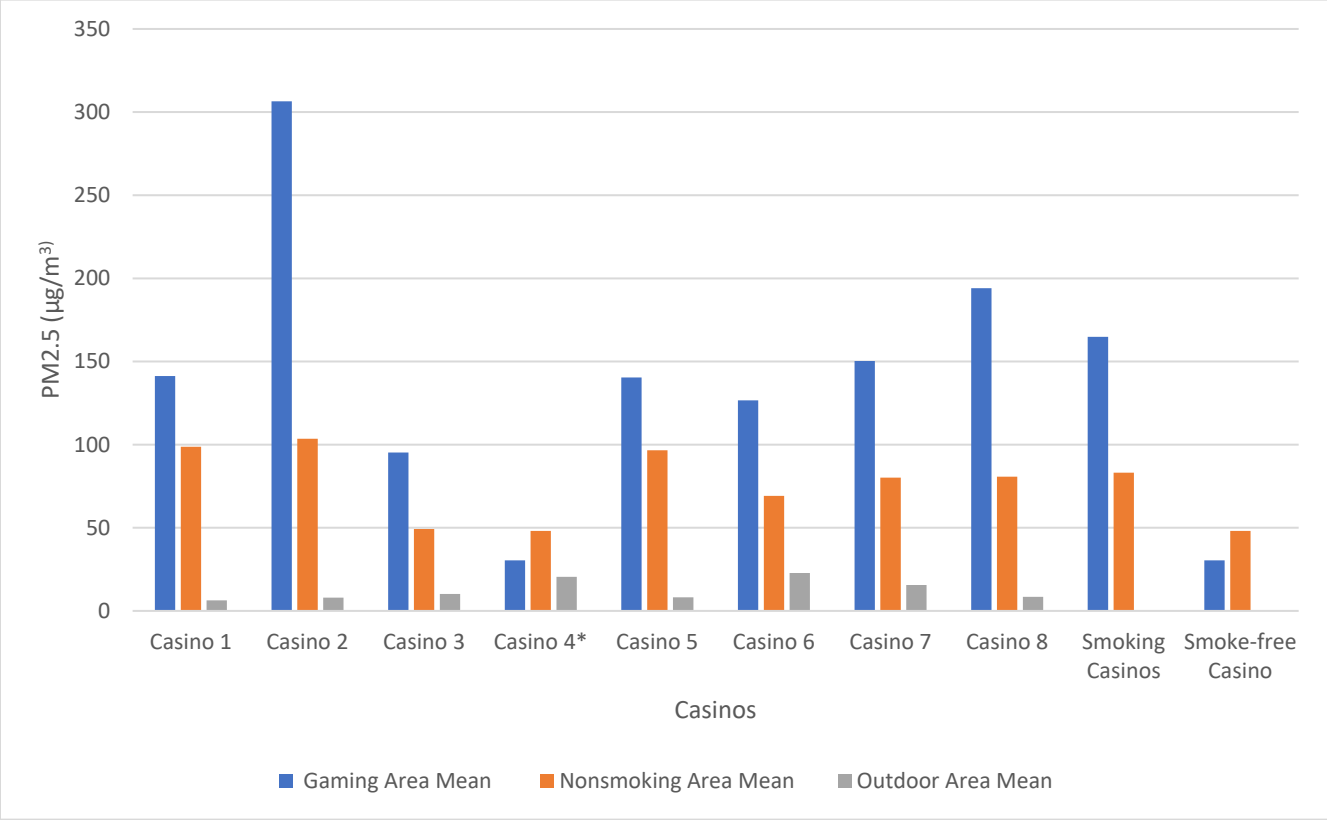
Table 2. Total number of tobacco products* observed being used in gaming areas of eight casinos -- Las Vegas, Nevada, 2022

Casino	Visit 1	Visit 2	Total	Gaming Area (Sq Feet)	Tobacco products per 1000 Sq Feet (combined visits)
Casino 1	11	24	35	50,000	0.70
Casino 2	43	49	92	120,000	0.77
Casino 3	37	26	63	84,000	0.75
Casino 4**	NA	NA	NA	102,000	NA
Casino 5	53	27	80	156,000	0.51
Casino 6	30	56	86	125,000	0.69
Casino 7	31	34	65	95,000	0.68
Casino 8	54	59	113	170,000	0.66
Average	37	39	76		0.68
Total	259	275	**534**		

*Electronic tobacco products were included in the total and were observed in each visit respectively at the following casinos: Casino 1 (0,0); Casino 2 (5,4); Casino 3 (0,4); Casino 5 (3,1); Casino 6 (0,10); Casino 7 (2,2); Casino 8 (3,3).

**Casino 4 is smoke-free in all areas. No tobacco products were observed in Casino 4, and it is not included in the average.

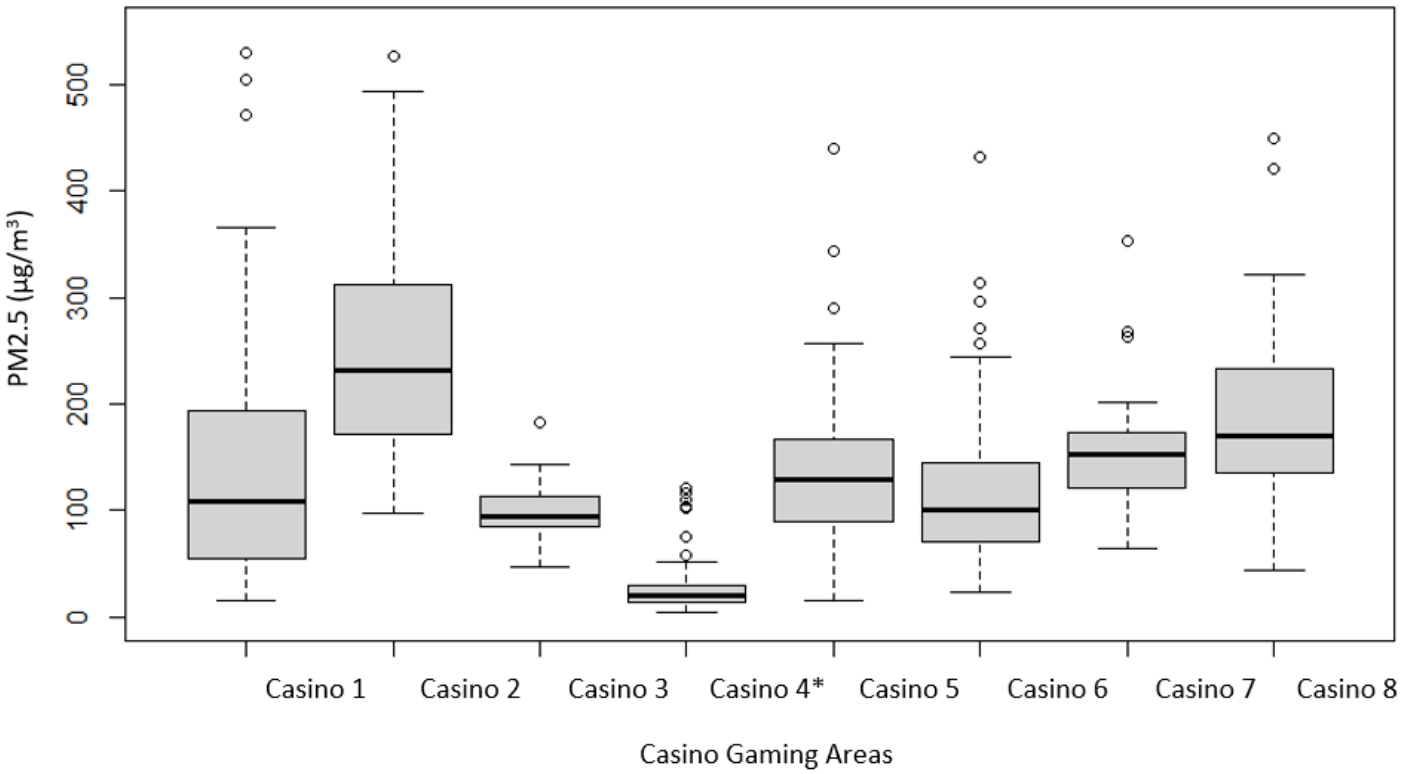
Figure 1. Mean levels of PM 2.5 (µg/m^3) for eight casinos by area and overall, and for areas outside casinos – Las Vegas, Nevada, 2022.



Note: Average PM 2.5 (µg/m^3) concentration is presented for each casino by area and overall, and for areas outside casinos. The Nevada Clean Indoor Air Act exempts the casino gaming area from locations where smoking is prohibited. Nonsmoking areas are areas where smoking is prohibited either by The Nevada Clean Indoor Air Act or by the casino, such as restaurants or sportsbooks. Outdoor areas are areas outside of each casino.

* Casino 4 is smoke-free in all areas. Areas that are comparable to nonsmoking areas in other casinos were assessed in Casino 4 and are included in this category.

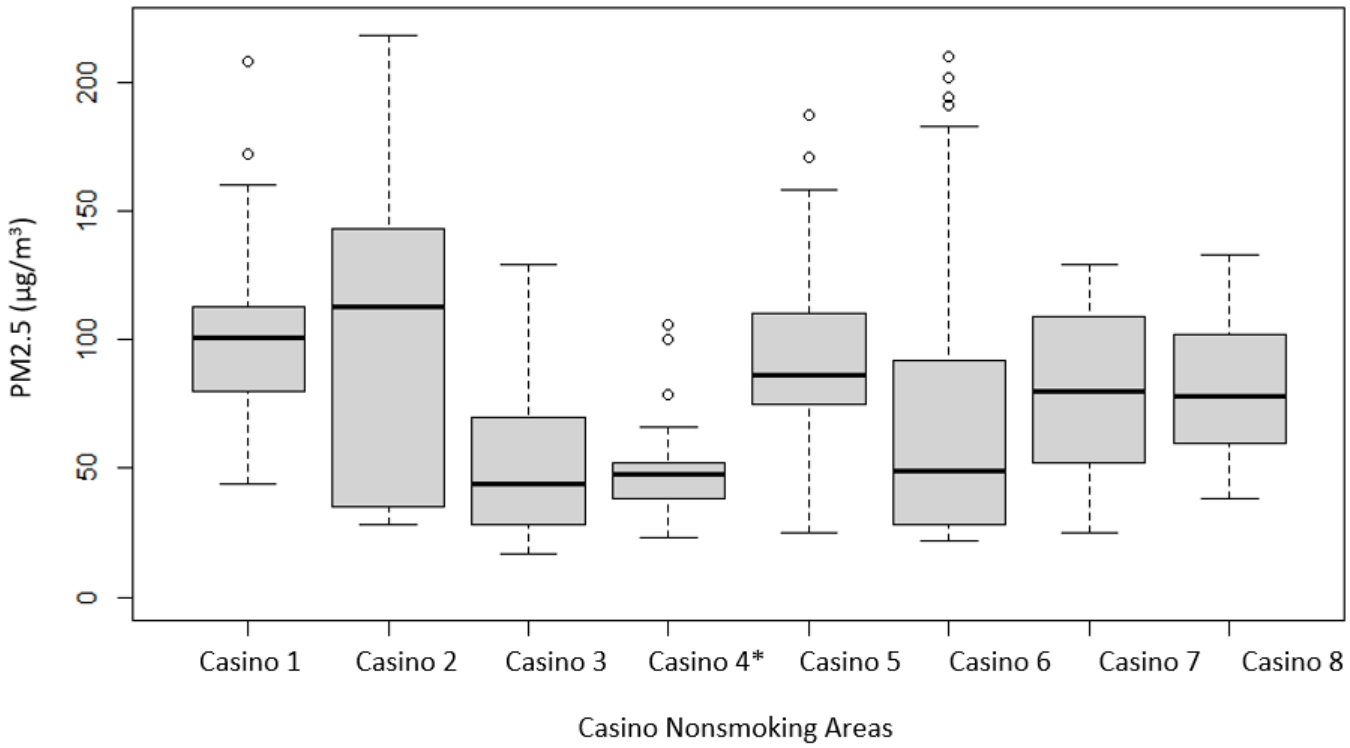
Figure 2. Boxplot of average PM2.5 (µg/m^3) levels in eight casino gaming areas, by casino – Las Vegas, Nevada, 2022.



Note: The Nevada Clean Indoor Air Act exempts the casino gaming area from locations where smoking is prohibited. Y-axis for Figure 2 is set to 500 µg/m^3 to show detail, because Casino 2 has individual observations >2000 µg/m^3. See supplemental figure for unadjusted boxplot.

*Casino 4 is smoke-free in all areas.

Figure 3. Boxplot of average PM2.5 (µg/m^3) levels in eight casino areas where smoking is otherwise prohibited, by casino – Las Vegas, Nevada, 2022.



Note: Nonsmoking areas are areas where smoking is prohibited either by The Nevada Clean Indoor Air Act or by the casino, such as restaurants or sportsbooks.

*Casino 4 is smoke-free in all areas. Areas that are comparable to nonsmoking areas in other casinos were assessed in Casino 4 and are included in this category.

Contributors: MT conceptualized the study. MT, MC, and JH designed the study. MT collected the data, conducted the analysis, and interpreted the data. MC and JH provided input on the analysis and interpretation of data. All authors contributed to editing manuscript drafts and MT prepared the final manuscript. JH provided supervision.

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Competing interests: None declared.

Ethics statement: This study was exempt from the University of Washington Institutional Review Board review.

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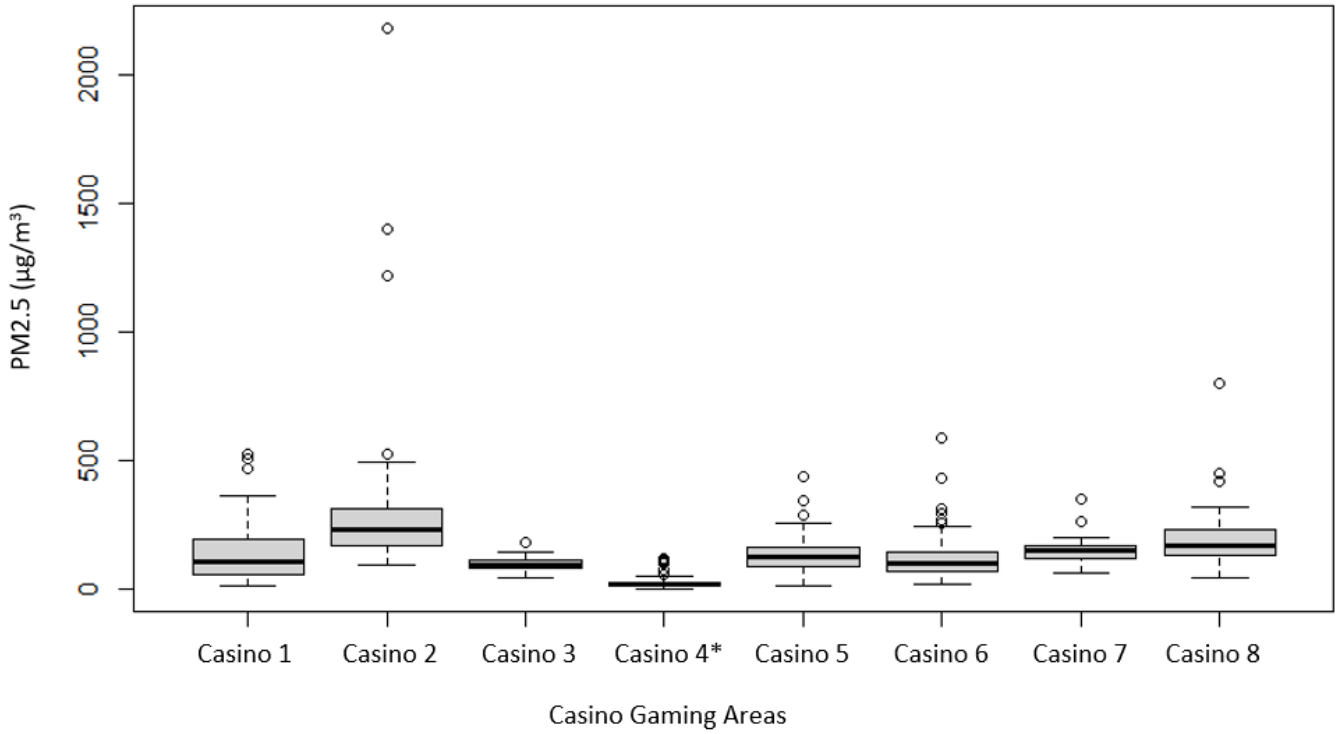
Supplemental Figure. Boxplot of average PM2.5 (µg/m^3) levels in eight casino gaming areas, by casino – Las Vegas, Nevada, 2022.



Note: These are the same data from Figure 2 with Y axis unadjusted to show all observations in casino gaming areas. Boxplot of average PM2.5 (µg/m3) levels in casino gaming areas, by casino. The Nevada Clean Indoor Air Act exempts the casino gaming area from locations where smoking is prohibited.

*Casino 4 is smoke-free in all areas.