

Quantification of Cigarette Butts Littered to the Streets and Sidewalks in Dance Clubs and Pub Areas in Bogota D.C., Colombia

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Abstract: *The annual amount of cigarette butts discarded onto streets and sidewalks in the areas of bars and nightclubs in Bogota was determined by analyzing a random selection of 5 of the 27 nightlife areas registered in the city. Cigarette butts in each zone were counted Tuesday to Saturday from the evening until early hours of the next day, with 2 hours between counts and 4 simultaneous replicas of each count. The data obtained was analyzed through Dixon's Q Test for detecting and removing outliers. Concentration of littered cigarette butts was calculated per sampling area. The value peak was located between 9 p.m. and 10 p.m. from Tuesday until Friday, and about 11 p.m. on Saturday. The greatest and second-greatest generations of cigarette butts by day were Friday and Saturday, respectively, which corresponds to the days of greatest influx of customers to these types of establishment. Annually, 94.9 million cigarette butts (16 tons) are thrown away in Bogota to the streets and sidewalks of the areas of pubs and nightclubs, which represents between 13 and 19 percent of the cigarettes consumed in the city. This represents an alarming environmental impact, as smoked cigarette butts can lead to leachate of toxic heavy metals and harmful substances into urban water resources, affecting its quality.*

Keywords: *Bogota, cigarette butts, urban rivers, nightclubs and bars.*

1. INTRODUCTION

1.1. Cigarette Consumption in the World, in Colombia and in Bogota

There are 1,300 million smokers in the world [1]. In Colombia, the prevalence of cigarette smoking among adults 18 to 69 years of age has fallen from 21.4% in 1993 to 18.9% in 1998 and 12.8% in 2007. Only 7.4% of women are smokers, whereas, among men, this figure reaches 19.5%. In Bogota, the prevalence of cigarette smoking is estimated to be 15.9%. This is one of the highest in the country after the departments of Risaralda (17.3%), Vaupés (17.3%), Antioquia (17.2%) and Chocó (15.9%) [2].

About 18,000 billion cigarettes were sold in Colombia in 2008. In 2010, it was calculated that of the 5.1 million of the smokers who exist in Colombia, 1.2 million (23.5%) live in Bogota [3], or 14% of the estimated 2015 population of 8.6 million. However, Eriksen, Mackay & Ross (2012) [4], in The Tobacco Atlas, estimate that the number of smokers in Colombia is 9 million, which is markedly different to the one reported by the Colombian authorities. Despite this discrepancy, the most worrying factor is that nearly half of smokers are young university students, where the prevalence of cigarette smokers is close to 46%. This number is much greater than that of the United States, where the prevalence of university student smokers is near 20% [1, 3]. This is also the highest prevalence among the cities of Latin America, which is 29.9% among young people between 13 and 15 years [5].

In the 1° Foro Internacional Espacios Libres de Humo: Políticas, Impuestos y Prevención (First International Forum of Smoke-Free Spaces: Policies, Taxes, and Prevention), the District Secretary of Environment of Bogota showed that the average consumption, in Colombia, of every smoker older than 15 years is 600 cigarettes per year [6]. The American Cancer Society, Inc., in The Tobacco Atlas, determined this same indicator for Colombia in 412 cigarettes per year for each consumer [4], data that are relatively similar to each other.

1.2. Toxic Substances Associated with Cigarettes

The cigarette is composed of a mixture of crushed tobacco leaves wrapped in paper rolling. A filter is added to the end through which the cigarette is drawn that is sometimes accompanied by a thin layer of activated charcoal. This filter, which was initially made of cotton and later with cellulose-acetate fibers, is wrapped in waterproof paper [7].

Much of fungicides, herbicides, insecticides and pesticides used in the course of growing, processing and manufacturing cigarettes, as well as mainstream smoke and particulate matter derived from the combustion of a cigarette (which contains more than 4,000 chemicals, at least 50 of them carcinogens, including cyanide, hydrogen, nitrate, ammonium, acetaldehyde, formaldehyde, benzene, phenols, pyridines and carbon monoxide). These chemicals are trapped by the filter and tobacco remaining on the cigarette butts [8 – 11]. Some of the metals present in tobacco, smoke and, consequently, in the butt, are present in the same soil where the tobacco is cultivated and incorporated by the plant through its root system [12].

In this way, a butt constituted by the filter and the last fraction of tobacco remnant is a trap of various toxic substances, among which are cadmium (Cd), lead (Pb), arsenic (As) and nickel (Ni); these compounds are bioaccumulative and along with the tar and nicotine, cause serious impacts on water sources [13, 14]. The post-use filter, along with the cigarette butt, is non-biodegradable [15] and its decomposition takes between one and two years [16]. Despite the fact that the cigarette butt disintegrates in small fractions over time, chemical contaminants and other trapped toxic substances are easily transferred, by leaching, into soil and water, causing severe deterioration of the environment and its ecosystems [17 – 21].

1.3. The Problem of Cigarette Butts

Cigarette butts are the most common form of urban litter in the world. In Australia, for example, between 24 and 32 trillion cigarette butts are discarded to the ground, of which 10% ends up in water bodies. In the world, this figure rises to more than 5.6 trillion [22 – 25], representing a global annual mass of 845,000 tons of cigarette butts [26]. In the United States, cigarette butts correspond to 30% of total waste that people throw onto beaches and into the bodies of water and soil [27]. This is figure is cause for concern when considering that 80% of the waste that enters the ocean originates on the continent [28].

With these precedents it is possible to conclude that the leaching of the cigarette butts has a high potential to cause highly harmful toxic effects on aquatic ecosystems and on animal life (including another type of animals such as dogs and birds) because of the traces of heavy metals trapped by the filter [18, 19, 29, 30]. Slaughter and collaborators [17] explained that, in laboratory conditions, leaching of a single cigarette butt in a liter of water is capable of causing death of half of some species of exposed fish. This argument suggests the possibility of considering cigarette butts as a hazardous waste [23]. In addition, these butts, when combined with the wastewater from sewage networks and other solids present there, are able to cause obstructions in the extent to which they can significantly increase its size [31].

In Colombia, in 2008, the Ministry of Social Security issued Resolución 1956 (Resolution 1956/2008) "*by which measures related to the consumption of cigarette and tobacco are adopted*" in which the second article says, "*Prohibit smoking in indoor or enclosed areas of places of work or public places*". The purpose of this standard, as well as other worldwide anti-tobacco laws, is to benefit the health of the population, to protect people from exposure to tobacco smoke, reduce health problems and avoid affecting the passive population, reducing lung problems [32]. However, the adoption of this norm had, for Lozano-Rivas and Franco [13] a negative effect on the environment, as the volume of cigarette butts discarded to the soil, streets in cities increased, especially in the areas of bars, clubs, and other establishments dedicated to the nightlife entertainment. This same problems generated by anti-tobacco laws had already been exhibited in other places of the world [15, 33].

The purpose of this research is to determine the annual amount of cigarette butts that are thrown into streets and sidewalks of the areas of pubs and nightclubs in Bogota. The fieldwork was carried out by

students of the Environmental Administration program of the College of Environmental Sciences in conjunction with the Semillero de Investigación en Gestión y Tecnologías del Agua (Student's Research Group in Management and Water Technologies) under the direction of Professor William Antonio Lozano-Rivas. This student's group is attached to the Grupo de Investigación en Ambiente y Sostenibilidad (Research Group on Environment and Sustainability - GUIAS) of the Piloto de Colombia University. These results correspond to the development of the first phase, which seeks to evaluate the impact on the urban river of the pollutant load from the leaching of the cigarette butts discarded to the streets and sidewalks in the nightlife areas of Bogota.

2. MATERIALS AND METHODS

The research conducted is quantitative in nature, carried out by an observational and cross-sectional study. The data presented were obtained through fieldwork carried out in 2013 and 2014.

2.1. Selection of Sampling Areas

There are 27 nightlife areas in Bogota, as recorded by ASOBARES (the Association of Bars in Bogota). For the quantification of the number of cigarette butts discarded on the streets and sidewalks in the nightlife areas, 10 of these 27 zones were selected using a type non-probability sampling run, considering the following criteria:

- Uniformity: exclusive or almost exclusive presence of night entertainment establishments in the area
- Safety: areas with low crime rates
- Knowledge of the area by any member of the team

Once the preliminary selection was complete, a random probability sample considering the total population (27 areas) of five nightlife areas were associated, in the order of choice, 4 days per week: Tuesday, Thursday, Friday and Saturday. Two zones were assigned to Saturday, with the aim of having at least two indicators of littered cigarette butt on the day with major nightlife activity. The sites selected and the counting days were Calle 116 (Tuesday); Calle 51 (Thursday); Los Héroes (Friday); Galerías (Saturday); Modelia (Saturday).

2.2. Counting Procedure (Sampling Scheme)

During August, September and October 2013 and in February and March 2014, the procedure was carried out for five zones, on dry days (without rain) to avoid drag by rain or visual interference in observing butts thrown in the streets and sidewalks. The counts were performed on both sidewalks and ditches for 8 hours on Tuesday and Thursday (5 p.m. to 1 a.m), and for 10 hours for Friday and Saturday (5 p.m. to 3 a.m)., with intervals of 2 hours between every count. As many researchers, using manual counters, performed each reading 4 times simultaneously. Additionally, they were determined in situ areas of local bars and nightclubs (considering the number of plants of each establishment), defining the distances using the application for smartphones MotionX-GPS (V22.2 Build 4844R) and validating subsequently this information with Google Earth (7.1.2.2041). Monday and Sunday were not considered in the calculations because the influx of customers to these areas is significantly lower on those days.

2.3. Concentration Definition

A graph of increase for butts thrown for each nightlife area was developed where the area under the curve corresponds to the number of cigarette butts thrown in the sampling area. The area of establishments was calculated by a concentration indicator, which corresponds to the number of cigarette butts per square meter (number of butts/square meter), thrown to the streets and sidewalks in each sampling area during nightlife hours.

Since Saturday counts were made in two zones, a weighted average was calculated from the associated areas. Subsequently, mapping and information contained in the analysis document "Major conurbations of bars, restaurants and nightclubs in Bogota Distrito Capital 2014" [34], the total area of local bars and nightclubs in the city was estimated, considering Figure 1.

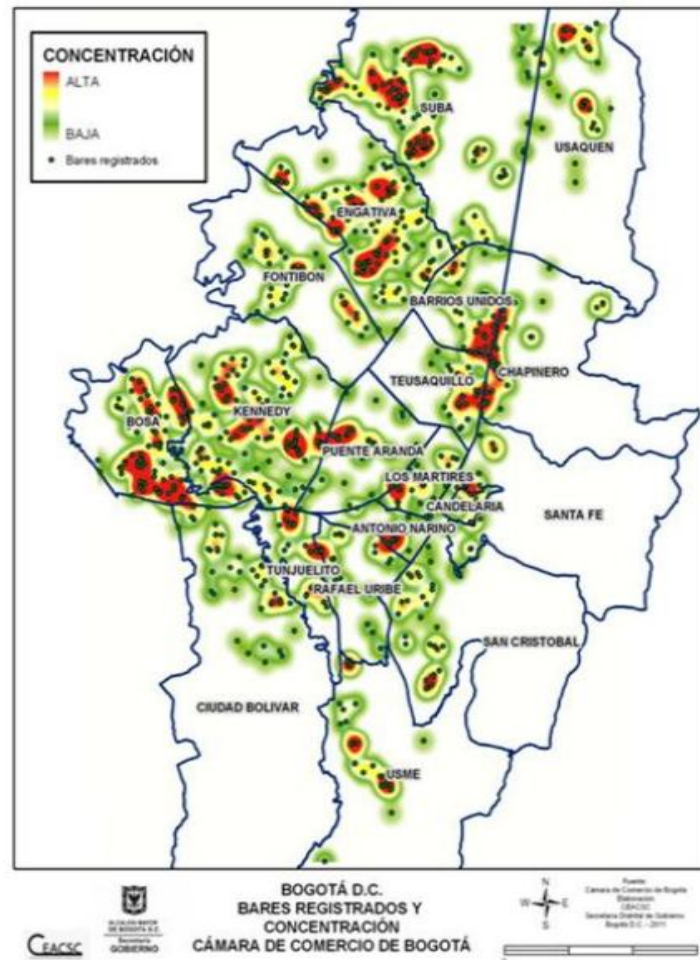


Fig1. Registered bars and its concentration around the city. Cámara de Comercio de Bogota. Secretaría Distrital de Gobierno. ASOBARES, 2014.

2.4. Data Analysis

An analysis of outliers was made with a Dixon Q test for count data conducted by individual researchers in each time interval and area, eliminating test data considered an outlier. This test was performed using MS Excel 2013 software.

2.5. Sampling Error

Counts were conducted in five areas of bars and nightclubs in the city, of the 27 zones recorded by ASOBARES, dedicated to nightlife entertainment activities. Due to the lack of official data for the total area of bars and nightclubs in the city, this value was estimated by cartographic analysis. The indicators obtained from these *in situ* counts of cigarette butts were taken as an average of the amount of total butts littered, indicators for the total area of bars and clubs in Bogota. With this sample, considering a homogeneous population of 99%, 8% error for a confidence level of 95% ($\alpha = 0.05$) is presented.

3. RESULTS AND DISCUSSION

Individual values of increase in the number of cigarette butts thrown to streets and sidewalks were obtained from each of the five areas of bars and clubs selected. As can be seen in each of the graphs (Figures 2, 3, 4, 5 and 6), the data formed a parabolic curve that shows, during the first hours of night activity. A successive increase of the number of cigarette butts thrown (number of additional new butts counted with respect to the previous count value), corresponding to the highest value of cigarette butts thrown to the ground, the peak time in presenting the greatest influx people to these areas. This peak value is between 9 pm and 10 pm on weekdays and from 11 pm on Saturdays. After rush hour, an increasingly lower value is shown in the increase in the number of new butts thrown; at the end of the day, increased cigarette butts on the value of the immediately previous reading is almost zero.

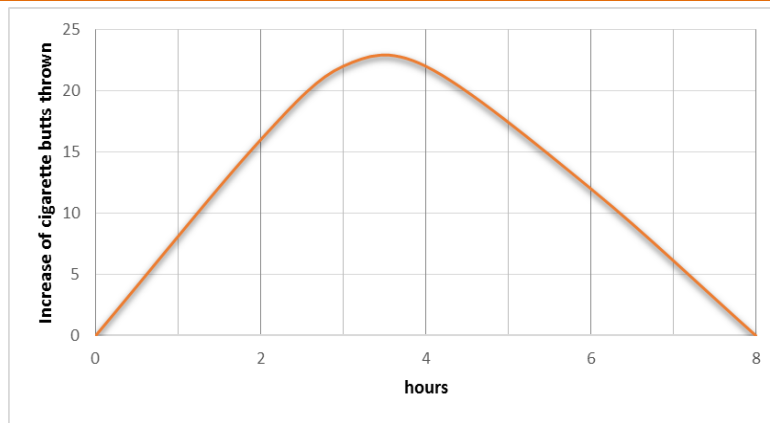


Fig1. Successive increase for butts thrown. Calle 116 Zone. Tuesday.

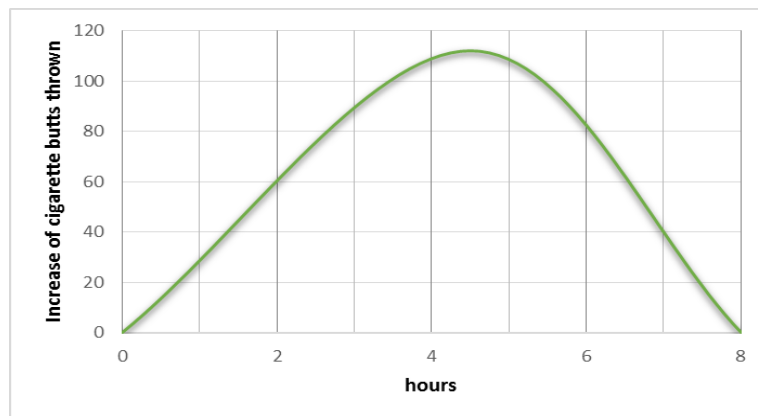


Fig2. Successive increase for butts thrown. Calle 51 Zone. Thursday

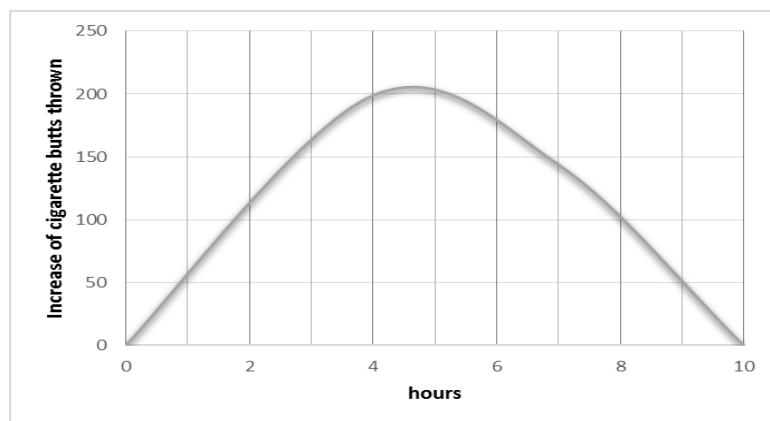


Fig3. Successive increase for butts thrown. Los Héroes Zone. Friday.

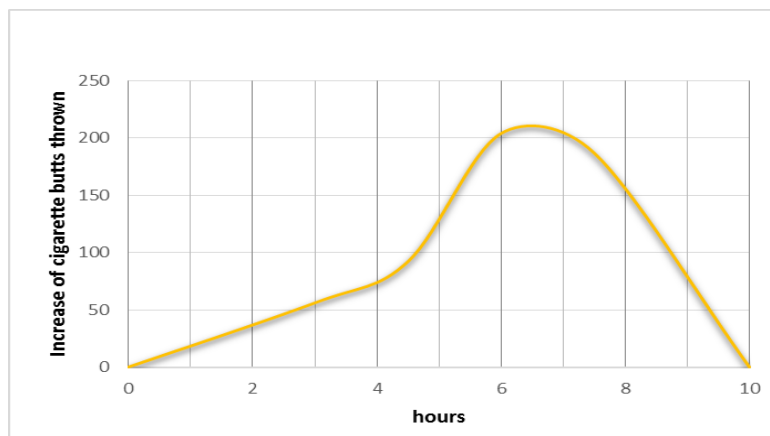


Fig4. Successive increase for butts thrown. Galerías Zone. Saturday

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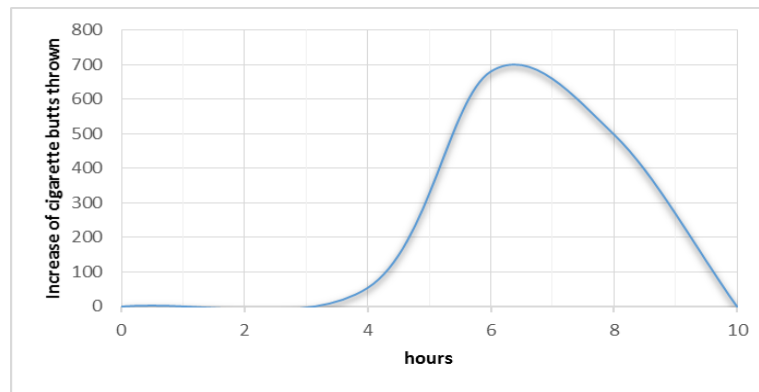


Fig5. Successive increase for butts thrown. Modelia Zone. Saturday.

As expected, the highest values of cigarette butts discarded to the streets of nightlife areas during sampling hours are presented on Saturday, while the number increases as the weekend nears Tuesday through Friday. Table 1 shows the estimated amounts of cigarette butts thrown during each day, the area monitored and the concentration of cigarettes butts.

Table1. Cigarette butts concentration in every sampling zone.

Day	Zone	Amount of cigarette butts thrown *	Sampling area (m ²)	Concentration of littered cigarette butts per sampling (butts/m ²)
Tuesday	Calle 116	92	1320	0.07
Thursday	Calle 51	448	3749	0.12
Friday	Los Héroes	995	800	1.24
Saturday	Galerías	1020	3000	0.34
	Modelia	3405	4719	0.72

*Estimated value from the area under the curve.

In the same way of the number of cigarette butts, a progressive increase was indicated in Table 1 from Tuesday leading to Saturday, with the highest value of concentration value on Friday, not Saturday, as expected. This high value on Friday corresponds to this day being the preferred day for social gathering activities in bars and, to a lesser extent, for dance club activities; the nature of this type of social gathering facilitates consumption of cigarette in contrast to the low consumption presented by customers dancing in nightclubs. Ruiz-Risueño, Juan Ruiz, & Zamarripa Rivera [35] confirmed this relationship between the consumption of liquor, night activities and cigarette smoking.

Indicators on Wednesday, in which no count was done, and Saturday, in which two areas were monitored, were obtained by the following considerations: the ultimate indicator of concentration for the day on Saturday is 0.57 butts per square meter, which corresponds to the average, about the area of the indicators obtained for the zones of Galerías and Modelia. The concentration value for Wednesday is 0.08 butts per square meter, which is the moving average of the values obtained between Tuesday and Thursday.

From the information provided by ASOBARES of Bogota and cartographic analysis, it was determined that the approximate total area of establishments engaged in night activities in the city, represented by bars and nightclubs, is 88 hectares, or 0.88 square kilometers. This value is equivalent to 120 football or soccer fields or about the area of Parque Central Simón Bolívar in Bogota. Whereas the Concentration of littered cigarette butts values obtained from the sample areas correspond to the average value of discarded cigarette butts in all areas of bars and clubs in Bogota, the amount of cigarette butts thrown into streets and sidewalks in these areas was calculated for the whole city (Table 2).

As shown in Table 2, it is estimated that, annually, nearly 95 million cigarette butts are thrown to the streets and sidewalks in nightlife areas of Bogota. With the average weight of a cigarette close to 0.17g, this amount of butts has an estimated weight of about 16 tons per year that can be considered as toxic waste.

Table2. Amount of cigarette butts that are thrown to the streets and sidewalks in nightlife areas of Bogota.

Day	Concentration of littered cigarette butts (butts/m ²)	Approximate total area of bars and nightclubs in Bogota (m ²)	Weekly littered cigarette butts	Monthly littered cigarette butts	Annual littered cigarette butts
Tuesday	0.07	880,000	61,600	246,400	2,956,800
Wednesday	0.08		66,000	264,000	3,441,240
Thursday	0.12		105,600	422,400	5,505,984
Friday	1.24		1,091,200	4,364,800	56,895,168
Saturday	0.57		501,600	2,006,400	26,153,424
TOTAL				1,826,000	7,304,000

The annual consumption of cigarettes in Colombia is between 412 and 600 per smoker, and there are 1.2 million smokers in Bogota [3]. Given that, it can be estimated that the city generated between 494.4 and 720 million cigarette butts a year (between 84 and 122 tons), of which between 13 and 19%, approximately, are thrown into the streets and sidewalks in areas of bars and nightclubs.

These 95 million cigarette butts generated in the areas of bars and nightclubs in Bogota represent 16 tons weight, generating a significant environmental impact on water sources and urban rivers. Almost all rainwater in the city is carried by the sewer system to urban rivers either directly or through relief structures discharging to wetland or tributary rivers Tunjuelo, Salitre and Fucha and Torca [36]. These discarded cigarette butts, when they come into contact with storm water leach several highly polluting substances as heavy metals with a high potential to cause toxic effects and highly harmful on aquatic ecosystems and on the animal life [17 – 19, 29, 30].

This situation is more critical considering that the city of Bogota has an average rainfall of about 920 mm/year and nearly 200 days of rain, according to data reported by the meteorological station of El Dorado International Airport between 1944 and 2014. In table 3, find a summary of the number and weight of cigarette butts calculated in this study, for the city of Bogota, and its area of bars and nightclubs.

Table3. Amount and weight of cigarettes butts calculated for Bogota

Area	Amount of cigarettes butts littered	Weight (tons) of cigarettes butts littered
Bars and nightclubs in Bogota	94,952,616	16
Total estimated average for Bogota	607,200,00	103

4. CONCLUSIONS

It was estimated that 94.9 million cigarette butts, with a weight of 16 tons, are annually dropped on streets and sidewalks of the nightlife areas of Bogotá. These butts are washed away by the rains, leaching toxic substances and harming water ecosystems, directly or indirectly, together with the underground water (through the sewage network) in urban rivers and wetlands.

Fridays and Saturdays present the largest amount of discarded cigarette on streets and sidewalks and correspond with the hours of greatest influx of people to bars and nightclubs. Peak cigarette butt concentration, occurs on Friday because this day is preferred for gathering activities, in which smoking is greater, as opposed typical Saturday activities, which typically involve more dancing and less consumption of tobacco.

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