

## Contributions of the analysis of discarded cigarette packages in household waste in the Brazilian city of Rio de Janeiro, Brazil, to estimate the illegal market

Contribuições da análise de embalagens de cigarros descartadas nos resíduos domiciliares do Município do Rio de Janeiro, Brasil, para estimativa de mercado ilegal

Contribuciones del análisis de paquetes de cigarrillos desechados como residuos domiciliarios en el Municipio de Rio de Janeiro, Brasil, para estimar mercado ilegal

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### Abstract

*The illicit trade of tobacco products, by enabling access to cheaper cigarettes, favors smoking initiation and hinders its cessation, minimizing the effects of price policy and taxes on reducing the demand for tobacco. This is especially the case among populations with lower income and schooling, where smoking is concentrated. Its confrontation requires multisectoral actions, aligned with the World Health Organization Framework Convention on Tobacco Control, supported by estimates of the illicit trade magnitude and the analysis of its characteristics. This study analyzes, based on samples of household solid waste collected in 2018 in the city of Rio de Janeiro, Brazil, the conformity of discarded cigarette packages with criteria for their regular commercialization in Brazil, classifying them as legal or illegal. The evaluation was also carried out for the 15 Planning Areas (PA) of the municipality. The Social Progress Index (SPI) was chosen to represent heterogeneities among PA. The average percentage of illegal cigarette packs found was 26.79%, ranging from 3.36% to 46.29% among PA. The PAs with high illegality presented lower Social Progress Index and lower percentages of legal cigarette packages with a price equal to or greater than BRL 7.25. Among the illegal packages, 98.07% were manufactured in Paraguay. The study contributes methodologically to measure the consumption of illegal cigarettes in the second economic capital of Brazil, supporting the National Tobacco Control Policy in the struggle against illicit trade of tobacco products and in the effective implementation of the pricing and tax policy on these products.*

Tobacco Products; Tobacco Use Disorder; Health Policy

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## Introduction

Tobacco consumption and the exposure to its smoke are significant risk factors for chronic non-communicable diseases and health inequalities <sup>1</sup>, accounting annually for eight million deaths worldwide. It is estimated globally that approximately 80% of the 1.1 billion smokers live in low- and middle-income countries, where the burden of smoking-associated diseases is higher <sup>2</sup>.

The understanding of the great effects of active and passive smoking resulted in the negotiation in 2003 of the first international public health treaty: the World Health Organization Framework Convention on Tobacco Control (WHO-FCTC) <sup>3</sup>. The treaty proposes a broad set of intersectoral and cooperation-related measures aimed to reduce the demand and supply of tobacco products, and it is an significant instrument for protecting health with equity.

Brazil has been a Party State to the WHO-FCTC since 2005, when the treaty was ratified by the Brazilian National Congress <sup>4</sup>. Since then, the commitment to the internalization of its measures has become the map of the Brazilian National Policy for Tobacco Control (PNCT in Portuguese).

Thanks to the actions previously adopted by the country and the consequent implementation of measures foreseen in the WHO-FCTC <sup>5</sup>, Brazil stood out in the world scenario for the significant reduction in the prevalence of smoking between 1990 and 2015 <sup>6</sup>.

Despite the advances achieved, the absolute number of smokers in Brazil is high: 21.5 million <sup>7</sup>, which is reflected in high health, economic, social, and environmental burden to the country. Every year, smoking is responsible for the deaths of more than 156,000 Brazilians. In economic terms, the annual cost to Brazil due to medical expenses and loss of productivity attributable to smoking is approximately BRL 57 billion. On the other, the tax collection on the sale of cigarettes covers only 23% of the expenses caused by smoking in the country <sup>8</sup>.

Sustained tax policies to increase prices and taxes on tobacco products (Art. 6 of the WHO-FCTC) are recognized as the most cost-effective measures to reduce the prevalence of smokers, especially among young people and the population with lower income and schooling, where smoking is concentrated, besides contributing to the increase in tax collection <sup>9</sup>. However, it is recommended that these policies must be aligned with measures to decrease illicit trade of tobacco products (Art. 15 of the WHO-FCTC) <sup>10</sup>. The low prices of illegal cigarettes ease the access to the product, favoring the initiation of children and adolescents in smoking. Such prices also hinder smoking cessation by providing the regular legal cigarette smoker with a cheaper option. Therefore, they weaken the effect of tax policy on reducing the prevalence of smokers, contributing to the health inequities generated by smoking. Furthermore, illicit trade of tobacco products burdens public coffers considering the tax evasion and spending on security actions, including border control <sup>11</sup>.

It is estimated that 1/9 of the cigarettes consumed worldwide are illegal <sup>12</sup>, and the market is dominated by organized crime factions attracted by profitability and impunity resulting from lenient penalties imposed on illicit crime <sup>13</sup>. As part of the international agenda to combat the illegal market for tobacco products, the *Protocol to Eliminate Illicit Trade in Tobacco Products* <sup>14</sup> was negotiated between the Member States to the WHO-FCTC, which has as its central axes the control of the production chain and distribution of tobacco products, the adequacy of penalties to crimes related to illicit trade in tobacco products, and international cooperation for the exchange of information and assistance between the fighting forces against the illegal tobacco market. The country officially adhered to the protocol in 2018 <sup>15</sup>.

A significant heterogeneity of estimates of illicit trade in tobacco products is observed in Brazil according to the agent-researcher and the methodology used. The tobacco industry, for example, presents analyses with trends in oversizing the consumption of illegal cigarettes in order to advocate the non-increase in taxation on its products <sup>16,17,18</sup>. On the other hand, government agencies have produced studies based on solid national research, with estimates lower than those presented by the tobacco industry <sup>19,20</sup>.

Based on this perspective of systematization of knowledge supported by statistically consistent research, this study analyzes – with samples of cigarette packets from household solid waste collected in 2018 in the city of Rio de Janeiro – the conformity of discarded packets with objective criteria established nationally for their commercialization and regular importation in the country, aiming to classify them as legal or illegal.

## Materials and methods

This is a cross-sectional study, using as probabilistic sample the household solid waste collected from January to November 2018, and its quantitative samples were selected proportionally to the collection of 15 Planning Areas (PA) of the municipality of Rio de Janeiro, composed of 16 PA. Due to the distribution of household solid waste collection in the city, two PA were aggregated (PA 5.3 and 5.4). These areas are composed of a set of neighborhoods and they have peculiarities related to their history of occupation, geographical and topographic characteristics, urban conformation, structure of the health care network, as well as distinct socioeconomic profiles (DataRio. Regiões de planejamento – indicadores 2016. <https://www.data.rio/datasets/regi%C3%B5es-de-planejamento-indicadores-2016/data>, accessed on 23/Jul/2020).

Cigarette packets collection and separation were performed by professionals from the Municipal Urban Cleaning Company (COMLURB – Companhia Municipal de Limpeza Urbana), in parallel to regular research on recycling behavior and characterization of household solid waste components generated in the city. The quantity and type of household solid waste are correlated with significant sociodemographic characteristics of the population (e.g., income and schooling)<sup>21</sup>.

Trucks were allocated to cover the most populous residential streets in each neighborhood, having followed a predetermined route and moved block by block until the defined household solid waste sample size was reached.

The sampling plan consisted of a probabilistic sample stratified with proportional allocation. The strata were the PAs. The sample was designed to be representative of the amount of household solid waste collected in the city of Rio de Janeiro. The total household solid waste collected in the city in 2018 was 144,875.01 tons. In terms of costs and logistics, a sample size of 24,000kg was established. The sample was distributed proportionally in the amount of household solid waste collected by neighborhood and PA. All districts of the PA had collection, except eight: two neighborhoods due to the low generation of household solid waste (Lapa and Grumari) and six neighborhoods due to difficulty in access (Paquetá, Rocinha, Maré, Jacarezinho, Cidade de Deus, and Complexo do Alemão) (Table 1).

The primary packages of cigarettes (packet or box) collected were separated according to the 15 PA in the city of Rio de Janeiro. The initial sample consisted of 2,720 packages. Out of these, nine had no record on the source PA; four were ineligible, and two were not eligible for evaluation due to the degree of destruction. Thus, 2,705 cigarette packs were analyzed (Table 1).

The Social Progress Index (SPI) was chosen to represent the heterogeneities among the 15 PAs, since it aggregates situations related to both household and people who live in it (e.g., percentage of permanent private households connected to the general distribution network, connected to the general sewage or rainwater network and with household solid waste collected directly by cleaning service or placed in a cleaning service bucket; average number of toilets per resident; percentage of illiteracy of residents from 10 to 14 years; per capita income of permanent private households; percentage of private households, with per capita household income up to one minimum wage and higher than 5 minimum wages)<sup>22</sup>.

The following information was collected from the direct observation of the cigarette packages discarded in the household solid waste: (i) content, size, and format of the health warnings (image and/or text) on the back, front and/or side faces of the packages; (ii) brand of cigarettes; (iii) “visibility” of a seal, produced or not by the Special Department of the Federal Revenue Service of Brazil, based on four classification options (“the package has a visible seal”, “only seal fragments are visible”, “there is no seal or fragment of seal, but it is possible to visualize traces of seal glue”, “there is no seal and no fragment of seal or trace of it is visible”); and (iv) the country of origin of manufacture of cigarette packages.

To classify cigarette package as legal, the objective criterion of presenting all attributes listed in (i) according to the specifications of Brazilian regulation was used, in addition to having the brand duly registered in the list of legal trademarks of the Brazilian National Agency of Sanitary Monitoring (Anvisa)<sup>23</sup> (criterion ii).

The proportions of illegal cigarette packages found were estimated for the total municipality of Rio de Janeiro and stratified by PA. The two PA with the lowest and with the highest proportions of illegal cigarette consumption were grouped and classified, respectively, as “very low” or “very high” illegality.

**Table 1**

Number of cigarette packages collected, excluded, and classified, according to the Planning Area (PA) of the municipality of Rio de Janeiro, Brazil, 2018.

PA	Neighborhood *	Collected	Excluded	Classified
		packages	packages	packages
		n	n	n
PA 1.1	Saúde, Gamboa, Santo Cristo, Caju, Centro, Lapa, Paquetá, Catumbi, Rio Comprido, Cidade Nova, Estácio, São Cristóvão, Mangueira, Benfica, Vasco da Gama, Santa Tereza	194	1	193
PA 2.1	Botafogo, Humaitá, Urca, Catete, Glória, Flamengo, Laranjeiras, Cosme Velho, Copacabana, Leme, Leblon, Gávea, Vidigal, Ipanema, Jardim Botânico, Lagoa, São Conrado, Rocinha	198	2	196
PA 2.2	Praça da Bandeira, Tijuca, Alto da Boa Vista, Maracanã, Vila Isabel, Andaraí, Grajaú	119	0	119
PA 3.1	Ramos, Olaria, Bonsucesso, Manguinhos, Maré	91	0	91
PA 3.2	Méier, Sampaio, Riachuelo, Cachambi, Todos os Santo, Lins de Vasconcelos, Engenho Novo, Rocha, São Francisco Xavier, Jacaré, Abolição, Piedade, Encantado, Engenho de Dentro, Água Santa, Pilares, Jacarezinho	244	0	244
PA 3.3	Irajá, Vila Kosmos, Vicente de Carvalho, Vila da Penha, Vista Alegre, Colégio, Madureira, Campinho, Quintino Bocaiúva, Cavalcanti, Engenheiro Leal, Cascadura, Vaz Lobo, Oswaldo Cruz, Bento Ribeiro, Turiaçu, Marechal Hermes, Honório Gurgel, Rocha Miranda	497	3	494
PA 3.4	Inhaúma, Engenho da Rainha, Thomás Coelho, Del Castilho, Maria da Graça, Higienópolis, Complexo do Alemão	108	0	108
PA 3.5	Penha, Penha Circular, Brás de Pina, Vigário Geral, Jardim América, Cordovil, Parada de Lucas	130	0	130
PA 3.6	Anchieta, Guadalupe, Parque Anchieta, Ricardo de Albuquerque, Pavuna, Coelho Neto, Acari, Barros Filho, Costa Barros, Parque Colúmbia	175	0	175
PA 3.7	Ribeira, Zumbi, Cacua, Pitangueiras, Praia da Bandeira, Cocotá, Bancários, Freguesia-Ilha, Jardim Guanabara, Jardim Carioca, Tauá, Moneró, Portuguesa, Galeão, Cidade Universitária	132	0	132
PA 4.1	Jacarepaguá, Tanque, Taquara, Praça Seca, Vila Valqueire, Pechincha, Anil, Gardênia Azul, Curicica, Freguesia, Cidade de Deus	183	0	183
PA 4.2	Barra da Tijuca, Itanhangá, Joá, Grumari, Camorim, Vargem Grande, Vargem Pequena, Recreio dos Bandeirantes	138	0	138
PA 5.1	Padre Miguel, Bangu, Gericinó, Senador Camará, Deodoro, Vila Militar, Campo dos Afonsos, Jardim Sulacap, Magalhães Bastos, Realengo	236	0	236
PA 5.2	Campo Grande, Cosmos, Inhoaíba, Santíssimo, Senador Vasconcelos	135	0	135
PA 5.3	Paciência, Santa Cruz, Sepetiba, Jesuíta, Guaratiba, Barra de Guaratiba, Pedra de Guaratiba	131	0	131
No definition	-	9	9	0
<b>Total</b>	-	<b>2,720</b>	<b>15</b>	<b>2,705</b>

\* No household solid waste samples were collected in eight neighborhoods: Lapa (PA 1.1) and Grumari (PA 4.2), due to low household solid waste generation; Rocinha (PA 2.1), Complexo do Alemão (PA 3.4), Jacarezinho (PA 3.2), Cidade de Deus (PA 4.1) Maré (PA 3.1) and Paquetá (AP 1.1), due to difficult to access.

Due to the quantities and names of the legal cigarette brands found in the PA, the average price paid for the legal cigarette in the municipality of Rio de Janeiro (BRL 7.25) <sup>24</sup> was estimated. The respective proportions of legal cigarette packages consumed, that presented a price equal to or higher than the average amount paid were estimated in order to better understand the behavior of smokers of legal cigarettes living in the “very low” or “very high” illegality of the municipality.

All analyses were performed using the Stata SE version 15.1 (<https://www.stata.com>) statistical package, where the sample weights were considered.

## Results

### Planning Area

The prevalence of illegal cigarette packs ranged from 3.36% (95%CI: 1.27-8.62) to 46.29% (95%CI: 39.03-53.71) among the PA of the municipality, with 26.79% (95%CI: 25.08-28.57) as the average percentage (Table 2).

In the PA classified as “very low” illegality (PA 2.2 and PA 2.1), 81.2% (95%CI: 80.97-81.4) of legal cigarette packs had a price equal to or greater than BRL 7.25. On the other hand, in the PAs with “very high” illegality (PA 5.1 and PA 3.6), 49.06% (95%CI: 48.61-49.51) of the legal cigarette packages consumed had a price equal to or greater than BRL 7.25, that is, 32.14% fewer packages of legal cigarettes consumed with a price equal to or greater than BRL 7.25 compared to the PA “very low” illegal (Table 2).

It could be observed that the PA with higher SPI presented lower percentages of illegality, which are PA 2.2 (3.36%); PA 2.1 (8.21%), and PA 4.2 (10.14%). On the other hand, the PA with lower SPI presented higher percentages of illegality (Table 2).

The verification of the conformity of cigarette packages with the objective criteria used to assess their legality or illegality allowed the results described below.

### Registration of the brand of cigarettes in Anvisa

Among the packages of illegal cigarettes, the brand “Gift” <sup>25</sup> (96.7%; 95%CI: 95.0-97.9) prevailed, which also has a version duly registered with Anvisa and sold regularly in the country. Out of the 727 “Gift” packages found, most (92.22%; 95%CI: 89.93-94.03) were illegal and only 7.78% (95%CI: 5.97-10.07) were legal.

### Health warnings

All packages classified as legal cigarettes presented health warnings on the front, sides, and back sides in accordance with the Brazilian regulation. Out of these, 51.73% (95%CI: 49.47-53.98) presented health warnings in the back side with images corresponding to the third group of warnings <sup>26</sup> (in force between 2008 and May 2018) and 48.27% (95%CI: 46.02-50.53) with images corresponding to the fourth group <sup>27</sup> (effective from May 25, 2018, and the deadline has been extended to some companies, by legal decision, for 15th December of the same year <sup>28</sup>). Among the illegal cigarette packages, 43.61% (95%CI: 39.8-47.5) presented health warnings with images in the back side, however they were divergent from those established by the Brazilian regulation.

### Manufacturing country

Most legal cigarette packages (98.95%; 95%CI: 98.41-99.31) were as a manufactured in Brazil and 1.05% (95%CI: 0.69-1.59) were imported from Germany. On the other hand, 98.07% (95%CI: 96.69-98.88) of illegal cigarette packages indicated Paraguay as a manufacturing country and 0.39% (95%CI: 0.12-1.20) originated in the United Kingdom or Indonesia (Table 3).

**Table 2**

Distribution of illegal and legal cigarette packages with a price equal to or greater than BRL 7.25 in the Planning Areas (PA) of the municipality of Rio de Janeiro, Brazil, 2018.

PA	SPI	Packages of illegal cigarettes % (95%CI)	Packages of legal cigarettes with a price equal to or greater than BRL 7.25 * % (95%CI)	Classification of PA as to the degree of illegality
PA 2.2	0.688	3.36 (0.0127-0.0862)	81.20 (0.8097-0.8143)	Very low illegality
PA 2.1	0.722	8.21 (0.0509-0.1298)		
PA 4.2	0.676	10.14 (0.061-0.1641)		
PA 3.4	0.570	11.11 (0.0642-0.1856)		
PA 3.2	0.622	19.26 (0.1479-0.247)		Between low and high illegality
PA 3.7	0.627	21.97 (0.1571-0.2984)		
PA 1.1	0.600	22.28 (0.1696-0.2870)		
PA 4.1	0.597	23.32 (0.1773-0.3003)	58.04 (0.5751-0.5858)	
PA 3.3	0.597	28.28 (0.2449-0.3242)		Very high illegality
PA 5.2	0.562	30.37 (0.232-0.3864)		
PA 3.5	0.577	30.77 (0.2344-0.3922)		
PA 5.3	0.519	35.88 (0.2813-0.4444)		
PA 3.1	0.571	37.36 (0.2806-0.4771)		Very high illegality
PA 5.1	0.572	42.80 (0.3663-0.492)	49.06 (0.4861-0.4951)	
PA 3.6	0.562	46.29 (0.3903-0.5371)		
<b>Total</b>	0.609	26.79 (0.2508-0.2857)	-	

95%CI: 95% confidence interval; SPI: Social Progress Index.

\* This was the average price paid for the legal cigarette depending on the type and volume of legal brands consumed.

### Tax control seal

Among the legal cigarette packages, 55.97% (95%CI: 53.71-58.19) presented a visible seal, preserved and compatible with the fiscal control specifications of the Special Department of the Federal Revenue Service. On the other hand, among the illegal cigarette packages, 96.75% (95%CI: 94.88-97.96) did not have any type of seal, seal fragments or even traces of glue from some seal, which could be a falsified seal of the Special Department of the Federal Revenue Service or a seal of its own (Table 4).

**Table 3**

Country of origin of legal and illegal cigarette packages. Municipality of Rio de Janeiro, Brazil, 2018.

Cigarette packages	Brazil	Paraguay	Another country	No mention of country	Total
	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)	%
Legais	98.95 (0.9841-0.9931)	0.00	1.05 (0.0069-0.0159)	0.00	100.00
Illegal	0.00	98.07 (0.9669-0.9888)	0.39 (0.0012-0.0120)	1.54 (0.0083-0.0285)	100.00
<b>Total</b>	72.41 (0.7062-0.7413)	26.31 (0.2461-0.2808)	0.87 (0.0059-0.0129)	0.41 (0.0022-0.0077)	100.00

95%CI: 95% confidence interval.

**Table 4**

Characterization of the presence or absence of tax control seal in the packages of legal and illegal cigarettes. Municipality of Rio de Janeiro, Brazil, 2018.

Cigarette packages	The package has a Federal Revenue Service of Brazil seal or other visible seal	Only seal fragments are visible	There is no seal or fragment of seal, but its possible to visualize traces of its glue	There is no seal and no fragment of seal or traces of its glue is visible	Total
	% (IC95%)	% (IC95%)	% (IC95%)	% (IC95%)	%
Legal	55.97 (0.5371; 0.5819)	31.16 (0.2910; 0.3329)	7.23 (0.0617; 0.0847)	5.65 (0.0467; 0.0681)	100.00
Illegal	2.03 (0.0114; 0.0356)	1.22 (0.0055; 0.0270]	0.00	96.75 (0.9488; 0.9796)	100.00
<b>Total</b>	41.54 (0.3964; 0.4346)	23.15 (0.2155; 0.2483)	5.30 (0.0451; 0.0621)	30.01 (0.2824; 0.3184)	100.00

95%CI: 95% of confidence interval.

## Discussion

In addition to the cartographic aspects, the PA with its heterogeneous arrangements and its socio-economic, cultural, and environmental diversities, as well as structural and organizational peculiarities, including the conformation of the health care network, available educational equipment, urban mobility, degree of social cohesion, support networks, etc., constitute distinct vivid territories, in constant historical and social movement, constituting themselves as spaces of life consisting of social and political subjects<sup>29</sup> who establish relationships and where health-illness processes are socially produced<sup>30,31</sup>.

The local specificities of each planning area contribute to the design of different consumption patterns of its resident population, even regarding tobacco products. Thus, estimates of illegal cigarettes consumed varied significantly according to PA, from 3.36% in PA 2.2 to 46.29% in PA 3.6. This heterogeneity can be influenced by the very local diversities mentioned that also encompass the characteristics of the local trade organization, including greater presence of informal market, and variables such as the state's surveillance presence, whether in health surveillance or public security issues.

Based on data on the legal production of cigarettes provided by the Special Department of the Federal Revenue Service and a continuous and integrated system of monitoring smoking of the Brazilian Ministry of Health, two adequate methodologies were developed to estimate the size of illegal cigarette market in the country<sup>20</sup> (DataRio. Regiões de planejamento – indicadores 2016. <https://www.data.rio/datasets/regi%C3%B5es-de-planejamento-indicadores-2016/data>, accessed on 23/Jul/2020). One of these methodologies is based on the purchase prices of cigarettes obtained from two household surveys conducted by the Brazilian government in 2008 and 2013 to estimate the consumption of illegal cigarettes that did not pay taxes (16.9% vs. 32.3%). In 2013, this consumption of illegal cigarettes was concentrated among individuals with incomplete primary education (42.1%) and among those living in border states (40.8%)<sup>20</sup>. More recently, a methodology based on the information available on official legal sales of cigarettes (Federal Revenue Service) was used, as well as on the consumption of cigarettes from an annual telephone survey of the Brazilian Ministry of Health<sup>32,33</sup>, allowing the finding that since 2013 the participation of illegal cigarettes in the total consumption of cigarettes has fluctuated: 28.6% (2012), 28.8% (2014), 42.8% (2016) (DataRio. Regiões de planejamento – indicadores 2016. <https://www.data.rio/datasets/regi%C3%B5es-de-planejamento-indicadores-2016/data>, accessed on 23/Jul/2020) and, more recently, 38.5% (2017)<sup>34</sup> and 31.4% (2018)<sup>35</sup>. Although the methodologies are not comparable, the estimate of our study (26.79%), for Brazil's second most populous capital does not differ from the national average for 2018.

On the other hand, the oversized estimates presented by the tobacco industry for the percentage of illegal cigarettes consumed in Brazil indicate an increase in consumption (48% in 2017 vs. 54% in 2018)<sup>36</sup>.

Since smoking is more prevalent in populations with lower education and lower income<sup>34</sup>, the presence of tobacco products in the daily consumption of these individuals compromises a significant portion of their monthly income. In order to balance the family budget, they would have as alternatives the search for treatments for smoking cessation or the migration to the consumption of cheaper cigarettes, such as illegal ones.

Based on this perspective, the local SPI, by incorporating indicators such as per capita income and illiteracy percentage, can contribute to possible correlations between characteristics of the population living in the different PA and its profile of illegal cigarette consumption.

Generally, it could be observed that in PA with lower SPI and, therefore, those PA that concentrate a population with lower per capita income and lower literacy degree, higher percentages of illegal cigarette packages were found. Smokers of these PA with lower SPI seem to be opting for cheaper illegal cigarettes, as well as the general consumption of legal brands with lower prices, since a higher percentage of legal cigarette packs with a price of less than BRL 7.25 (Table 2) were also found in them.

Considering that the price of cigarettes consumed is a significant predictor for smokers to think about quitting smoking, as well as to hinder young people's access to cheaper cigarettes, by preventing their initiation into smoking<sup>37</sup>, the populations of such PA could be particularly benefited with advances in the implementation of national policies and local actions aimed to reduce the supply and demand for cheaper illegal and legal cigarettes, in line with the measures of the WHO-FCTC, such as price increases and taxes on tobacco products, inspection actions, educational measures, expansion of the supply of treatment for smoking cessation in the public health network, among others.

Since the end of the 1980s, Brazil has implemented policies to increase taxes on cigarettes, generating successive increases in the prices of these products to the final consumer. From 1989 to 2010 the country experienced a reduction of approximately 46% in the prevalence of smoking, and almost half of this reduction was attributed to the policy of price increase on tobacco products implemented in the period<sup>38</sup>.

Subsequently, *Federal Law n. 12,546* of 2011 changed the system of taxation of the Tax on Industrialized Products (IPI in Portuguese) and instituted a policy of minimum prices for cigarettes. Both measures resulted in a significant increase in their retail sales prices and a substantial reduction in the prevalence of smokers. Furthermore, they generated an increase in the tax revenue of cigarettes<sup>39</sup>. However, when considering price differences of the best-selling cigarette brand in the world, it is observed that Brazilian cigarettes are still one of the cheapest<sup>40</sup>. The last increases in IPI rates, as well as an adjustment of the minimum price of cigarettes, occurred in 2016. Indicators suggest the need to

evaluate new adjustments in cigarette prices so that they return to function as an effective economic barrier against initiation and/or greater stimulus for smoking cessation<sup>34</sup>.

The success of macro policies to raise taxes on tobacco products – which can provide benefits to the populations of PA with high prevalence of illegal cigarette consumption and higher consumption of cheaper legal brands – requires that such measures be followed by coordinated multisectoral actions to combat illicit trade of cigarettes at the national and local level, because, otherwise, lower-income smokers will be able to migrate to cheaper illegal cigarettes, undermining the effect of increased health taxation, in addition to the tax evasion generated. These PA may have a lower level of organization of the local structure due to the lower presence of the state, which favors the circulation of illegal products, including cigarettes.

It is also essential that the public health system of PA guarantees individuals who smoke and wish to quit smoking timely and qualified access to the health care network of the Brazilian Unified Health System (SUS in Portuguese) and programs for smoking cessation in the basic health units (UBS in Portuguese) to which they are enrolled, or follow-up in other points of the health care network.

One of the requirements for classifying the packages of cigarettes as to the legality of the packaged product is the verification of the registration of the brand in Anvisa. In the sample analyzed, the presence of cigarette brands without registration in the agency implies that the packages correspond to products that do not meet the national regulatory requirements for their regular marketing in the country, therefore, they were classified as illegal.

Among the illegal cigarette packages found, 96.87% were “Gift” brand, meeting the reality of the municipality from information on seizures disclosed<sup>41,42</sup>, corroborating the accuracy of the criteria used to characterize – based on direct observation of the package – its illegality. Produced by the Paraguayan company, The Uriom, the illegal “Gift” in Brazil were classified as such by the absence of health warnings regulated by Anvisa. It is noteworthy that the brand “Gift” has regular registration in Anvisa and it is produced by two companies located in the municipality of Duque de Caxias, state of Rio de Janeiro: Cia Sulamericana de Tabacos S/A and Quality in Tabacos Ind. and Com. de Cigarros e Importação e Exportação Ltda (Consulta à registro: relação das marcas de cigarros. <http://portal.anvisa.gov.br/tabaco/consulta-a-registro>, accessed on 24/Jul/2020).

One of the significant measures for the reduction of smoking, established by the WHO-FCTC in article 11, is the use of packages as a form to communicate to the population about the several harms of smoking with health warnings, using the packages as a product advertising tool<sup>43,44</sup>.

In Brazil, the first sentences of sanitary warnings on cigarette packages date back to the 1980s. The insertion of warnings with images, proven to be more effective in motivating non-initiation and smoking cessation, occurred in the country from 2001, making Brazil the second country in the world to adopt the measure<sup>45</sup>.

The rotation of images ensures renewal of the content of sentences and photos, which become inefficient after a long period of delivery<sup>46</sup>. The collections in different PA occurred throughout 2018, precisely in the year that a transition between the third and fourth group of images of Brazilian health warnings was carried out. This fact was reflected in the circulation of the two groups of images in the analyzed sample.

All packages classified as legal cigarettes presented frontal, lateral and back health warnings in accordance with the standards established by Anvisa: no divergences were found regarding their size in the respective face, regarding the language of the message (Portuguese) and the graphic pattern of the images.

Based on back side of the package (packet or box) of legal cigarettes, which contains the health warning image, it was observed that in 88.37% of the legal marks the side warnings prevailed on the left side of the package, regardless of the group of warnings used. Considering that the majority of the population is right-handed, it would be significant to develop studies that evaluate the patterns of handling the cigarette packages in order to determine in which of its lateral faces (right or left) the smoker would tend to view more frequently the warnings inserted there. As the Brazilian regulation does not establish on which side the warning should be placed, these studies could support regulatory changes in order to ensure greater effectiveness of lateral messages.

The packages corresponding to illegal cigarettes were non-compliant with the standards established by Anvisa for health warnings: when present, they were different from official images and with phrases in Spanish or another language. Also, among those packages that displayed images of health warning (43.6% of illegal ones), in addition to those regulated by the agency, presented proportion of the graphic set divergent from that stipulated by the Brazilian regulation. Thus, it was found that the manufacturers of these products did not “bother” to develop an “imitation” of Brazilian warnings, which could reduce the perception of illegality by the consumer. However, even the presence of images different from those recommended by national legislation can lead consumers to the erroneous perception of acquiring a legal product, whereas cigarette packages without health warning images are more easily identifiable as illegal.

Most illegal cigarette packages included Paraguay as the manufacturer country (98.07%). As there are no cigarette brands from this country registered with Anvisa and, therefore, authorized to be imported and regularly marketed in Brazil, the Paraguayan origin of the cigarette packet reiterates the data that indicate Paraguay as the main supplier of illegal cigarettes to Brazil.

Only 1.05% of the legal cigarette packages presented another country as a manufacturer (Germany), other than Brazil, indicating that the product was imported, since the German manufacturing brands found were registered with Anvisa ensuring their permission for importation, in addition to health warnings in accordance with Brazilian regulation.

In alignment with measures recommended by the *Protocol to Eliminate Illicit Trade in Tobacco Products*<sup>14</sup>, since 2007 Brazil has a System for Control and Tracking of Cigarette Production: SCORPIOS (Sistema de Controle e Rastreamento da Produção de Cigarros. <https://receita.economia.gov.br/interface/lista-de-servicos/regimes-e-registros-especiais/cigarros/acessar-scorprios>). The system reads, validates, and activates the security code of the tax control seals of the Special Department of the Federal Revenue Service, applied by the Brazil's Mint, consolidating information associated with them.

Only 55.97% of legal cigarette packages had a visible official seal. However, the presence of a seal of the Special Department of the Federal Revenue Service, compatible with the image available on its website, does not guarantee its authenticity. A mobile device in the end of the retail chain would be required to verify the validity of the code entered on a certain label. Moreover, a considerable percentage of legal cigarette packages did not have a perfectly characterized seal as the Special Department of the Federal Revenue Service, depending on the degree of destruction of the package or the fact that it was removed by the consumer. These aspects limit the use of the seal to classify the legality of the product in our methodology.

On the other hand, among the Paraguayan “Gift”, none had a seal or even any indication of its presence. This fact suggests that the presence of a seal, although falsified, does not seem to be in the scope of adulteration of the network that operates the illegal cigarette market in the municipality of Rio de Janeiro, which could burden the product and compromise its competitive advantage, which is precisely its low price to the final consumer.

## Limitations

One of the limitations of the study is the non-collection of household solid waste in neighborhoods of the municipality (communities) that have low SPI. However, these neighborhoods concentrate 5.5% of the total population of smokers in the municipality, which would not substantially change the results, although somewhat underestimated.

It is necessary to indicate an inverse correlation between daily cigarette consumption and the degree of physical activity: individuals who smoke 20 or more cigarettes per day (heavy smokers) tend to be more sedentary, which predisposes them to stay longer at home<sup>47</sup>. As heavy smokers tend to consume more illegal cigarettes – due to their lower price –, to be more sedentary and predisposed to stay longer at home, the prevalence of illegal packages in household solid waste may be overestimated. On the other hand, smokers and nonsmokers have been less exposed in recent years to secondhand smoke within their own homes due to increased denormalization of tobacco use and awareness about the damage related to exposure to their smoke. In this sense, light or heavy smokers would tend to

discard fewer legal or illegal packages at home.

Considering that intra-metropolitan commuting in Rio de Janeiro is more prevalent among people who receive up to five minimum wages <sup>48</sup>, a portion of lower-income smokers and more likely to consume illegal cigarettes would be outside home. In this case, the prevalence of illegal packages in household solid waste may be underestimated.

## Conclusions

Progress in the implementation of measures to combat the illegal market of tobacco products requires its measurement with clear methodology and replicable results, as well as evaluation of its behavior and historical trend by reliable statistics free of regulated sector interests.

The identification of the most relevant criteria for the characterization of cigarette packages as to the legality or not of the product will benefit future analyses, besides being able to support its recognition in inspection actions.

The measurement of the prevalence of illegal cigarette packages among the different PA contributes to the local dimensioning of the problem, which can direct strategies for its mitigation. The implementation of local actions, associated to fiscal, regulatory, and public security policies, including combating organized crime, aligned with the WHO-FCTC and its Protocol to eliminate illicit trade in tobacco products, will contribute to reduce the inequities generated by smoking and consequent advances in the PNCT.

## Contributors

A. T. Machado, R. M. Iglesias, F. L. Mendes and A. S. Szklo participated on the conception and design of the study, analysis and interpretation of the data, writing and relevant critical review of intellectual content of the article, and approval of the final version to be published. L. F. L. Martins, A. P. L. Teixeira, T. M. Cavalcante, A. L. F. M. Conde and S. O. Cordeiro contributed on the study project, analysis and interpretation of data, writing and relevant critical review of intellectual content of the article. A. R. R. Cardoso and L. M. Almeida collaborated on the data analysis and interpretation, writing and relevant critical review of intellectual content of the article. All authors are responsible for all aspects of the work in ensuring the accuracy and integrity of the work.

## Additional informations

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## Resumo

O comércio ilícito de produtos de tabaco, ao possibilitar acesso a cigarros mais baratos, favorece a iniciação do tabagismo e dificulta sua cessação, minimizando os efeitos da política de preços e impostos sobre a redução da demanda por tabaco, sobretudo entre populações de menor renda e escolaridade, onde se concentra o tabagismo. Seu enfrentamento requer ações multissetoriais, alinhadas à Convenção-Quadro para o Controle do Tabaco da Organização Mundial da Saúde e seus protocolos, e respaldadas em estimativas de sua magnitude e na análise de suas características. O estudo pretende analisar, por meio de amostras de resíduos sólidos domiciliares coletados em 2018 no Município do Rio de Janeiro, Brasil, a conformidade das embalagens de cigarros descartadas com critérios para a sua comercialização regular no país, classificando-as como legais ou ilegais. A avaliação foi feita também para as 15 Áreas de Planejamento (AP) do município. Escolheu-se o Índice de Desenvolvimento Social (IDS) para representar as heterogeneidades entre as AP. O percentual médio de embalagens de cigarros ilegais encontrado foi de 26,79%, variando de 3,36% a 46,29% entre as AP. As AP com alta ilegalidade apresentavam menores IDS e menores percentuais de embalagens de cigarros legais com preço igual ou superior a R\$ 7,25. Dentre as embalagens ilegais, 98,07% apresentavam o Paraguai como país fabricante. O estudo contribui metodologicamente para dimensionar o consumo de cigarros ilegais na segunda capital econômica do Brasil, subsidiando a Política Nacional de Controle do Tabaco no combate ao comércio ilícito de produtos de tabaco e na efetiva implementação da política de preços e impostos sobre estes produtos.

*Produtos do Tabaco; Tabagismo; Política de Saúde*

## Resumen

El comercio ilícito de productos del tabaco, al possibilitar el acceso a cigarrillos más baratos, favorece la iniciación del tabaquismo y dificulta la interrupción de su consumo, minimizando los efectos de la política de precios e impuestos sobre la reducción de la demanda de tabaco, sobre todo entre poblaciones de menor renta y escolaridad, donde se concentra el tabaquismo. Su combate requiere acciones multisetoriales, alineadas con la Convención-Marco para el Control del Tabaco de la Organización Mundial de la Salud, y sus protocolos, y respaldadas en estimaciones de su magnitud y en el análisis de sus características. El estudio pretende analizar, mediante muestras de residuos sólidos domiciliarios, recogidos en 2018 en el Municipio de Rio de Janeiro, Brasil, la conformidad de los paquetes de cigarrillos tirados a la basura con criterios para su comercialización regular en el país, clasificándolos como legales o ilegales. La evaluación se realizó también para las 15 Áreas de Planificación (AP) del municipio. Se escogió el Índice de Desarrollo Social (IDS) para representar heterogeneidades entre las AP. El porcentaje medio de paquetes de cigarrillos ilegales encontrado fue de un 26,79%, variando de 3,36% a 46,29% entre las AP. Las AP con alta ilegalidad presentaban menores IDS y menores porcentajes de paquetes de cigarrillos legales con un precio igual o superior a BRL 7,25. Entre los embalajes ilegales, un 98,07% presentaban Paraguay como el país fabricante. El estudio contribuye metodológicamente para dimensionar el consumo de cigarrillos ilegales en la segunda capital económica de Brasil, apoyando la Política Nacional de Control del Tabaco en el combate al comercio ilícito de productos del tabaco y en la efectiva implementación de la política de precios e impuestos sobre estos productos.

*Productos de Tabaco; Tabaquismo; Política de Salud*

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