PLOS Global Public Health

RESEARCH ARTICLE

The illicit cigarette market in the Democratic Republic of the Congo (DRC): Findings from a cross-sectional study of empty cigarette packs

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OPEN ACCESS

Citation: Mdege ND, Tchoupé C, Pokothoane R, Mirindi DM, Miderho CC, Sams K, et al. (2025) The illicit cigarette market in the Democratic Republic of the Congo (DRC): Findings from a cross-sectional study of empty cigarette packs. PLOS Glob Public Health 5(6): e0003937. https://doi.org/10.1371/journal.pgph.0003937

Editor: Chandrashekhar T. Sreeramareddy, International Medical University, MALAYSIA

Received: October 24, 2024

Accepted: June 5, 2025

Published: June 25, 2025

Data availability statement: The datasets generated and/or analysed during the current study are available in the Zenodo repository, https://doi.org/10.5281/zenodo.12359650.

Funding: This work was supported, in whole or in part, by the Bill & Melinda Gates Foundation

Abstract

This study aimed to estimate the proportion of cigarettes consumed in the Democratic Republic of the Congo (DRC) that are illicit and the extent of cigarette tax evasion; and to identify the origins of and factors associated with illicit cigarettes. Data were collected from May 15 to June 9, 2023. Stratified, multistage sampling was used to select 32 health areas from which empty cigarette packs were collected. Each collected pack was examined and classified as licit if it complied, or illicit if it did not comply, with the DRC's tax stamp or written health warning requirements, or the requirements to have a notice indicating the prohibition of sale by/to minors or information on tar and nicotine content. We reported frequencies as numbers and percentages, and continuous variables as means or medians. We performed regression analysis and used adjusted odds ratios (aOR) and their 95% confidence intervals (CI) to measure associations. 8.6% (95% CI: 8.1, 9.2) of the 10622 empty cigarette packs collected were illicit, and had also evaded cigarette tax. 8.0% of the collected packs did not comply with written health warning requirements, 5.6% did not indicate the prohibition of sale by/to minors, and 4.5% did not have information on tar and nicotine content. Packs from low-income areas were more likely to be illicit than those collected from high-income areas (aOR 1.90; [95% CI: 1.48-2.43]). The likelihood of being an illicit cigarette increased with increasing susceptibility to armed conflict/insecurity. Packs from border provinces were less likely to be illicit than those from non-border provinces (aOR 0.48; [95% CI: 0.25-0.90]). All illicit cigarettes were

[Grant number INV-009670]. The conclusions and opinions expressed in this work are those of the author(s) alone and shall not be attributed to the Foundation. Under the grant conditions of the Foundation, a Creative Commons Attribution 4.0 License has already been assigned to the Author Accepted Manuscript version that might arise from this submission.

Competing interests: The authors have declared that no competing interests exist.

imports from other countries. There is, therefore, a need to secure the cigarette supply chain, strengthening border controls and enforcement and compliance monitoring, and strengthening political commitment by ratifying the Protocol to Eliminate Illicit Trade in Tobacco Products.

Background

In 2017–2018, 18% of men and 2% of women aged 15–49 years used tobacco in the Democratic Republic of the Congo (DRC), and 13% and <1% smoked cigarettes, respectively [1]. The DRC has progressively developed and implemented regulatory measures aimed at reducing the consumption of tobacco products over the past three decades. These include prohibiting the advertising, promotion and sponsorship of tobacco, tobacco products and their derivatives; banning smoking in public places; mandating written health warnings on tobacco products; and tobacco taxation, although this is at 38.7% of the retail price, and falls short of the recommended 75% [2].

In 2004, the country signed the World Health Organization Framework Convention on Tobacco Control (WHO FCTC) which provides evidence-based policy interventions to address the tobacco epidemic and its consequences, and ratified the treaty in 2005 [3]. In addition, the country also signed the Protocol to Eliminate Illicit Trade in Tobacco Products in 2013 in recognition of the importance of combating illicit trade in tobacco products by securing the supply chain, although this is yet to be ratified [4]. The illicit trade of tobacco products undermines tobacco control and public health by increasing access to the products, often cheaper ones, and thereby increasing consumption [5–8]. This exacerbates tobacco-related morbidity and mortality while depriving governments of substantial tax revenues through evasion. The Protocol to Eliminate Illicit Trade in Tobacco Products covers measures such as track and trace systems, licensing, due diligence, and issues related to internet- and telecommunication-based sales, tobacco product transactions in free zones and international transit, and duty-free sales [9].

The DRC shares its borders with nine countries: the Republic of Congo (Brazzaville), Uganda, Burundi, Rwanda, Tanzania, the Central African Republic, South Sudan, Zambia and Angola. The DRC has experienced persistent social and political instability throughout its recent history which contributes to porous borders and increases its susceptibility to the illegal importation of cigarettes from neighbouring countries. However, the extent of illicit cigarette trade in the DRC has not been investigated before, so its size, trend and characteristics are not documented or well understood. This hampers tobacco control decision making, and is particularly important because the tobacco industry often uses illicit tobacco trade as a reason to oppose effective tobacco control measures such as tax increases [10]. This study, therefore, aimed to 1) estimate the proportion of cigarettes consumed that are illicit, 2) estimate the extent of cigarette tax evasion, 3) identify the origins of illicit cigarettes, and 4) identify factors associated with illicit cigarettes.

Methods

Study design

We conducted a national-level, cross-sectional study in which empty cigarette packs were collected [11, 12] from three types of collection points: stationary retailers, mobile retailers, and garbage bins/streets. Stationary retailers sell from the same location (e.g., shops, kiosks, and stalls), while mobile retailers are itinerant and sell cigarettes on the move. By law, the sale of single cigarette sticks is not prohibited in the DRC and is highly prevalent, which makes it possible to collect empty cigarette packs from retailers. We also collected average cigarette retail price information for each brand from retailers.

Study setting

The available resources meant that we could not collect data from all 26 provinces of the DRC. We, therefore, used stratified random sampling to select study locations based on the structure of the DRC health pyramid which spans from provinces, to health zones (HZs) within provinces, to health areas (HAs) within HZs. We stratified the 26 provinces of the DRC into four groups based on the level of porosity, i.e., border/non-border status and susceptibility to armed conflict/insecurity. Stratum 1 had two provinces with very high-porosity (i.e., at the border and highly susceptible to armed conflict); stratum 2 had one province with high-porosity (at the border and the capital); stratum 3 included 14 provinces with intermediate-porosity (i.e., border provinces that are not subject to armed conflicts); and stratum 4 consisted of nine provinces with low-porosity (i.e., non-border provinces with no particular security issues) (S1 Fig). We randomly sampled provinces from each stratum with the number of provinces to be drawn from each stratum being proportional to the weight of the stratum. The total number of provinces included in the study was eight: one province each from stratum 1 (Ituri) and 2 (Kinshasa), four provinces from stratum 3 (Haut-Katanga, Kasaï-Central, Kwango, Nord-Ubangui), and two provinces from stratum 4 (Tshopo and Sankuru).

For each sampled province, we grouped the HZs into two strata, i.e., urban and rural, and we randomly sampled one HZ from each of the strata. The third level of sampling involved randomly sampling two HAs from each participating HZ (S2 Fig). This yielded a total of 32 HAs as sites for data collection (S1 Text).

Criteria for identifying illicit empty cigarette packs

By law, there are a number of requirements regarding what should be on a cigarette pack sold in the DRC. These include a notice on the ban on the sale of tobacco to minors and by minors, written health warnings, brand identifiers, information on tar and nicotine content, and an affixed tax stamp. In addition, misleading names, words or logos, for example, those that are likely to create confusion or give the impression that a particular brand can promote fitness and well-being in general, are prohibited. We conducted semi-structured one-on-one discussions and workshops with key tobacco control stakeholders in the DRC, including the Programme National de Lutte Contre la Toxicomanie et les Substance Toxiques (National Program for the Control of Drug Addiction and Toxic Substances), Direction Générale des Douanes & Accises (Directorate-General of Customs and Excise), and the Société Industrielle et Commerciale des Produits Alimentaires (Industrial and Commercial Company of Food Products), to agree on the definition of an illicit cigarette pack. From consensus with these tobacco control stakeholders, an empty cigarette pack was classified as illicit if it met any of the following criteria:

- *cigarette tax evasion/non-compliance with tax stamp requirements* (i.e., no tax stamp, has a duty-free stamp but collected from a retailer who is unauthorised to sell duty-free cigarettes, or has the wrong stamp). Every cigarette pack in the DRC should have a tax stamp that is orange if for locally manufactured cigarettes that are intended for domestic consumption, grey for imported cigarettes, or green for cigarettes intended for duty-free shops.
- *non-compliance with written health warning requirements* (no written health warnings on the two main sides, or has written health warnings in a language other than French). Every pack of cigarettes must bear at least two of the following

four health warnings in French: “Smoking is harmful to health”, “Tobacco seriously harms your health”, “Be careful, smoking kills”, or “Smoking is highly addictive”.

- *absence of the notice indicating the prohibition of sale by/to minors*. By law, each pack of cigarettes must bear the words “Prohibited for sale to minors and by minors.” This notice must be printed in bold, indelible, and visible capital letters, with a height of at least two millimetres, on the top of the right side of the pack.
- *no information on tar and nicotine content.* Tar and nicotine content information should be on the right side of each pack, and cover at least 20% of the side.

During data collection, we found that some empty cigarette packs had a yellow tax stamp. This is an old stamp that was used for both imported and locally manufactured cigarettes, and according to the Direction Générale des Douanes & Accises, cigarettes imported after a transitional period of 60 days from April 15, 2022 should not bear this stamp. However, there was a lack of clarity on whether those manufactured in the DRC, or those imported before the transition period but are still on the shelves in the DRC could still have the yellow stamp. In addition, there was recognition from some key tobacco control stakeholders that the transition from yellow stamps is not yet complete.

Data collection

Data were collected from May 15 to June 9, 2023. We aimed to collect at least 10,000 empty cigarette packs in total from the eight provinces. This quantity was based on information from similar studies [12, 13]. Data were collected by a team of 40 data collectors and eight supervisors. The team was trained in the study protocol and data collection process, including the recruitment of retailers, and the collection of empty cigarette packs from retailers and garbage bins/streets. The team was also trained on the use of data collection instruments, in particular, the questionnaires that were programmed on tablets, and the Distance Meter application for measuring distance to ensure that the data were collected only from the demarcated data collection grid. Considering the size of the DRC, training took place in two phases: 1) the training of the eight supervisors (one supervisor per province) from April 3–6, 2023; and 2) the training of data collectors by the supervisors from April 10 to May 14, 2023. Data collection procedures and tools were piloted in each province after the completion of classroom training.

Empty cigarette pack collection

Data collectors identified the centre of economic activity in an HA (e.g., the main market) to serve as the starting point for data collection. They then collected empty cigarette packs from consenting retailers and garbage bins/streets within a ~ 100m x 100m square grid (in urban areas) or a circle grid of ~800m in diameter (in rural areas) around the starting point [14]. For the collection of packs from retailers, data collectors approached retailers within the grid and informed them about the study. Those who were interested in study participation were provided with written study information and requested to provide verbal consent if they agreed to participate. Consenting retailers were supplied with a prelabelled bag the same day and asked to deposit all empty cigarette packs from single stick sales in the bag. The bags with empty packs were retrieved the following day. Each collection bag had a unique identifier to distinguish between retailers, HAs, HZs, provinces, and types of collection point (i.e., stationary retailers, mobile retailers, and garbage bins/streets). Collecting all empty packs from all garbage bins/streets and all consenting retailers within each collection grid enhanced the representativeness of the collected packs.

Data extraction from empty cigarette packs

Data were recorded using a questionnaire programmed in SurveyCTO [15]. We recorded area-level information including the province, porosity stratum, HZ, HA, rural/urban, and area-level income group. Retailer-level information included the type of retailer and total number of packs collected (including by brand). For each empty cigarette pack, we extracted information that included the brand name, manufacturer, and country of origin. We also recorded whether the pack had

a tax stamp, whether the tax stamp was a DRC mandated stamp, and the colour of the stamp. We recorded whether the pack had a written health warning, how many, the position and wording of each warning, the language; whether the health warnings were printed in bold capital letters, with black on a contrasting white background, and covered 30% of the two main presentation areas of the pack; and whether the background reserved for health warnings was framed by a distinctive black outline printed in bold. The collected information also included whether the nicotine and tar content were stated, the location of this information on the pack and whether it covered 20% of the side on which it was located. We also collected information on whether the pack had the phrase "PROHIBITED FOR SALE TO AND BY MINORS"; whether this was printed in bold capital letters, indelible and visible, and was at least 2 mm high on the top right side of the pack.

Quantitative survey with retailers

We used an interviewer-administered questionnaire to collect cigarette retail price data from those retailers who provided the empty cigarette packs. The questionnaire also collected information on where retailers source their cigarettes, the brands of cigarettes they sell, the sale and purchase prices of cigarettes, and the socio-demographic characteristics of the retailers. The questionnaire was also programmed in SurveyCTO [15].

The questionnaires used for this study were informed by literature reviews and guidelines/toolkits for measuring the illicit trade of tobacco products [14, 16]. The questionnaires were pretested before use and revised for clarity and relevance.

Data analysis

Our primary analysis considered packs with yellow stamps as legal if they did not meet any other 'illicit' criteria. This decision was made in consultation with key stakeholders in the DRC, based on the fact that there was a lack of clarity on whether cigarettes manufactured in the DRC, or those imported before the transition from yellow stamps could still have the yellow stamp; and that the transition from yellow stamps was recognised as not yet complete. We conducted descriptive statistics to estimate the overall proportion of empty cigarette packs (the proportion of cigarettes consumed) that was illicit, as well as by type of collection point, province, porosity stratum, rural/urban, area-level income group, imported/locally manufactured, brand and country of origin. Additionally, the proportion of illicit packs was calculated based on each of the specific criteria, i.e., cigarette tax evasion/ non-compliance with tax stamp requirements, non-compliance with written health warning requirements, absence of the notice indicating the prohibition of sale by/to minors and no information on tar and nicotine content. The extent of tax evasion was determined by focusing on the proportion of cigarette packs that did not have a tax stamp, had the wrong tax stamp or had a duty-free stamp but were obtained from a retailer that is not authorised to sell duty-free cigarettes. The frequencies were reported as numbers and percentages. We also calculated the average retail price for a cigarette pack by brand.

We used logistic regression to examine the factors associated with being an illicit cigarette pack, using adjusted odds ratios (aOR) and their 95% confidence intervals (CI) as measures of association. We considered the following independent variables based on literature that suggest their association with the prevalence of illicit cigarette consumption [17, 18]: border/non-border province, area-level income status (low/high), urban/rural health zone, collection point (stationary retailer/mobile retailer/garbage bin or street), porosity stratum, country of origin, province, cigarette manufacturer, cigarette brand, and whether the cigarettes were flavoured or not. Due to high multicollinearity between some explanatory variables, we dropped three independent variables: country of origin and province which were strongly correlated with porosity stratum, and cigarette brand which was strongly correlated with country of origin. High- and very high-porosity strata were combined into one category in the regression analysis. Statistical significance was set at the 0.05 level. The analyses were performed using STATA Version 17.0 [19].

We conducted sensitivity descriptive analyses in which we considered all imported packs with a yellow stamp to be illicit.

Ethics approval and consent to participate

Ethics approval was obtained from the National Health Ethics Committee of the Ministry of Health of the DRC on May 3, 2023 (approval number 443/CNES/BN/PMMF/2023). The participating retailers were provided with study information, including the study objectives, the procedures for participation, and the right to abstain from participation in the study or to withdraw consent to participate at any time without reprisals. They provided verbal informed consent to participate in the study before taking part.

Results

General characteristics of the empty cigarette packs

A total of 10,622 empty cigarette packs were collected, of which 67.0% (7,116) were from stationary retailers, 14.3% (1,522) were from mobile retailers and 18.7% (1,984) were from garbage bins/streets (Table 1). Kwango province contributed the highest proportion of packs collected at 17.1% (1,813) whilst the lowest was from Sankuru province at 5.5% (583). Very high-porosity provinces contributed 13.9% (1,479) of the packs collected, whilst high-porosity provinces contributed 16.4% (1,740), intermediate-porosity provinces contributed 53.7% (5,702) and low-porosity provinces contributed 16.0% (1,701).

When considering urban/rural classification, this was 74.5% (7,918) and 25.5% (2,704) of the packs, respectively (Table 2). 67.1% (7,130) of the packs came from low-income areas and 32.9% (3,492) came from high-income areas. 45.5% (4,834) of the packs were of cigarettes manufactured in the DRC, and the rest were of imported cigarettes. Four brands, i.e., the Equateur, Monte Carlo, Master, and Pall Mall accounted for 66.6% of the packs collected. None of the collected cigarette packs had a duty-free stamp.

Proportion of empty cigarette packs that were illicit

Overall, 8.6% (95%CI: 8.1, 9.2) of the collected packs met at least one of the four criteria and were therefore classified as illicit (Table 1). 9.8% (95%CI: 9.1, 10.5) of packs from stationary retailers were illicit, and this was 2.2% (95%CI: 1.6, 3.1) of those collected from mobile retailers and 9.3% (95%CI: 8.1, 10.7) of those collected from garbage bins/streets. By province, the proportion of illicit cigarette packs ranged from 0.7% in Tshopo to 31.6% in Ituri. Very high-porosity provinces had the highest proportion of illicit cigarette packs of 31.6% (95%CI: 29.3, 34.1), whilst this was 5.2% (95%CI: 4.2, 6.4) for those from high-porosity provinces, 3.5% (95%CI: 3.0, 4.0) for those from intermediate-porosity provinces and 9.4% (95%CI: 8.0, 10.8) for those from low-porosity provinces. The geographical variation in the proportion of cigarette packs that were illicit is also shown in Fig 1 below.

8.1% of the packs collected in rural areas were illicit, whilst this was 8.8% for urban areas (Table 2). 7.8% of packs from low-income areas and 10.2% of those from high-income areas were illicit. All of the illicit packs were of imported cigarettes, meaning that 15.8% of imported packs were illicit. When considering the different brands, 0% of Elite, Equateur, Master and Portsman were illicit, whilst Supermatch and Oris had the highest proportions of illicit packs, at 52.0% and 71.4% respectively.

None of the packs originating from the DRC and Zimbabwe were illicit, whilst 100% of those originating from South Sudan and India were illicit (Table 2). This was 99.2% of those from Uganda, 52.4% of those from the United Arab Emirates, 2.8% of those from Angola, 1.2% of those from South Africa, 1.2% of those from Kenya and 0.6% of those originating from Tanzania.

All of the illicit packs did not comply with tax stamp requirements and were therefore classified as having evaded cigarette tax (Table 3). Approximately 8.0% of the collected packs did not comply with written health warning requirements. Of the 9,774 packs that complied with written health warning requirements, 0.3% (33) had the message *"Smoking is harmful to health"*, 31.7% (3,101) had *"Tobacco seriously harms your health"*, 73.1% (7,142) had *"Smoking is highly addictive"*, and none had the message *"Be careful, smoking kills."* 5.6% of all collected packs did not indicate the prohibition of sale by/to minors, and 4.5% did not have information on tar and nicotine content.

Table 1. Proportion of illicit empty packs by type of collection point, porosity and province.

	Type of collection point							
Porosity Province	**Stationary retailer**		**Mobile retailer**		**Garbage bins/ street**		**Total**	
	Illicit n % (95% CI)	**Total**	**Illicit n % (95% CI)**	**Total**	**Illicit n % (95% CI)**	**Total**	**Illicit n % (95% CI)**	**Total**
Very-high								
Ituri	428	1,333	0	29	40	117	468	1,479
	32.1 (29.6, 34.7)		0.0 (0.0, 11.9)		34.2 (25.7, 43.5)		31.6 (29.3, 34.1)	
High								
Kinshasa	49	918	10	524	32	298	91	1,740
	5.3 (4.0, 7.0)		1.9 (0.9, 3.5)		10.7 (7.5, 14.8)		5.2 (4.2, 6.4)	
Intermediate	**127**	**3,702**	**21**	**941**	**50**	**1,059**	**198**	**5,702**
	3.4 (2.9, 4.1)		**2.2 (1.4, 3.4)**		**4.7 (3.5, 6.2)**		**3.5 (3.0, 4.0)**	
Haut-Katanga	3	424	0	129	6	361	9	914
	0.7 (0.1, 2.1)		0.0 (0.0, 2.8)		1.7 (0.6, 3.6)		1.0 (0.5, 1.9)	
Kasaï-Central	12	878	3	326	3	183	18	1,387
	1.4 (0.7, 2.4)		0.9 (0.2, 2.7)		1.6 (0.3, 4.7)		1.3 (0.8, 2.0)	
Kwango	49	879	18	486	38	448	105	1,813
	5.6 (4.2, 7.3)		3.7 (2.2, 5.8)		8.5 (6.1, 11.5)		5.8 (4.8, 7.0)	
Nord-Ubangi	63	1,521	0	0	3	67	66	1,588
	4.1 (3.2, 5.3)		// (//)		4.5 (0.9, 12.5)		4.2 (3.2, 5.3)	
Low	**93**	**1,163**	**3**	**28**	**63**	**510**	**159**	**1,701**
	8.0 (6.5, 9.7)		**10.7 (2.3, 28.2)**		**12.4 (9.6, 15,5)**		**9.4 (8.0, 10.8)**	
Sankuru	90	387	3	10	58	186	151	583
	23.3 (19.1, 27.8)		30 (6.7, 65.3)		31.2 (24.6, 38.4)		25.9 (22.4, 29.7)	
Tshopo	3	776	0	18	5	324	8	1,118
	0.4 (0.1, 1.1)		0.0 (0.0, 18.5)		1.5 (0.5, 3.6)		0.7 (0.3, 1.4)	
Total	**697**	**7,116**	**34**	**1,522**	**185**	**1,984**	**916**	**10,622**
	9.8 (9.1, 10.5)		**2.2 (1.6, 3.1)**		**9.3 (8.1, 10.7)**		**8.6 (8.1, 9.2)**	**100**

https://doi.org/10.1371/journal.pgph.0003937.t001

When considering all imported packs with yellow stamps as illicit, 51.5% of the collected packs met at least one of the four criteria and were therefore classified as illicit. All of the illicit packs did not comply with tax stamp requirements and were therefore classified as having evaded cigarette tax. The proportions that met the other criteria for illicit were similar to those found when considering all packs with yellow stamps as legal packs. The proportion of illicit cigarettes by source, province, province porosity stratum, urban/rural, area-level income group, brand, and country of origin for the sensitivity analyses are provided in S2 to S4 Text.

Cigarette pack retail prices

Cigarette pack retail price data were collected from 1,236 retailers. The median retail price of a pack of cigarettes by brand varied from 1,500–3,000 Congolese Francs (Table 4). Some brands that had a high proportion of illicit cigarette packs, such as Oris, had some of the highest median retail prices for a pack, whilst some where all packs were judged as legal, e.g., Elite, Equateur and Master, had some of the lowest median prices.

Table 2. Proportion of illicit empty packs by rural/urban, area-level income group, brand and country of origin.

	Total packs collected	Number of illicit packs	Proportion of illicit packs
Urban/rural			
Rural	2,704	219	**8.1**
Urban	7,918	697	**8.8**
Area-level income group			
High-income	3,492	357	**10.2**
Low-income	7,130	559	**7.8**
Brand			
Supermatch	894	465	**52.0**
Oris	532	380	**71.4**
Pall Mall	1,238	16	**1.3**
Monte Carlo	1,914	14	**0.7**
Stella	546	8	**1.5**
Business	147	8	**5.4**
Caesar	120	1	**0.8**
Ambassade	240	1	**0.4**
Elite	525	0	**0.0**
Equateur	2,109	0	**0.0**
Master	1,809	0	**0.0**
Portsman	262	0	**0.0**
Other brands	286	23	**8.0**
Country of origin			
DRC	4,834	0	**0.0**
Uganda	403	400	**99.3**
United Arab Emirates	743	389	**52.4**
South Sudan	64	64	**100.0**
Kenya	2,108	26	**1.2**
India	16	16	**100.0**
Tanzania	2,178	14	**0.6**
South Africa	162	2	**1.2**
Angola	36	1	**2.8**
Zimbabwe	72	0	**0.0**
Other country	6	4	**66.7**
Total	**10,622**	**916**	**8.6**

https://doi.org/10.1371/journal.pgph.0003937.t002

Factors associated with being an illicit cigarette pack

Empty cigarette packs from low-income areas were more likely to be illicit (aOR 1.90; [95 CI: 1.48 - 2.43]) than those collected from high-income areas (Table 5). Cigarette packs sold in intermediate-porosity (aOR 3.36; [95% CI: 1.72 - 6.57]) and high-porosity (aOR 17.15; [95% CI: 7.48 - 39.31]) strata were more likely to be illicit than those in the low-porosity stratum.

Cigarette packs from border provinces were less likely to be illicit (aOR 0.48; [95% CI: 0.25 - 0.90]) than those from non-border provinces. Cigarette packs collected from mobile retailers were less likely to be illicit (aOR 0.43; [95% CI: 0.28 - 0.68]), while those collected from the garbage bins/streets were more likely (aOR 1.86; [95% CI: 1.38 - 2.51]) to be illicit, than those collected from the stationary retailers. Cigarette packs that were flavoured were more likely to be illicit than

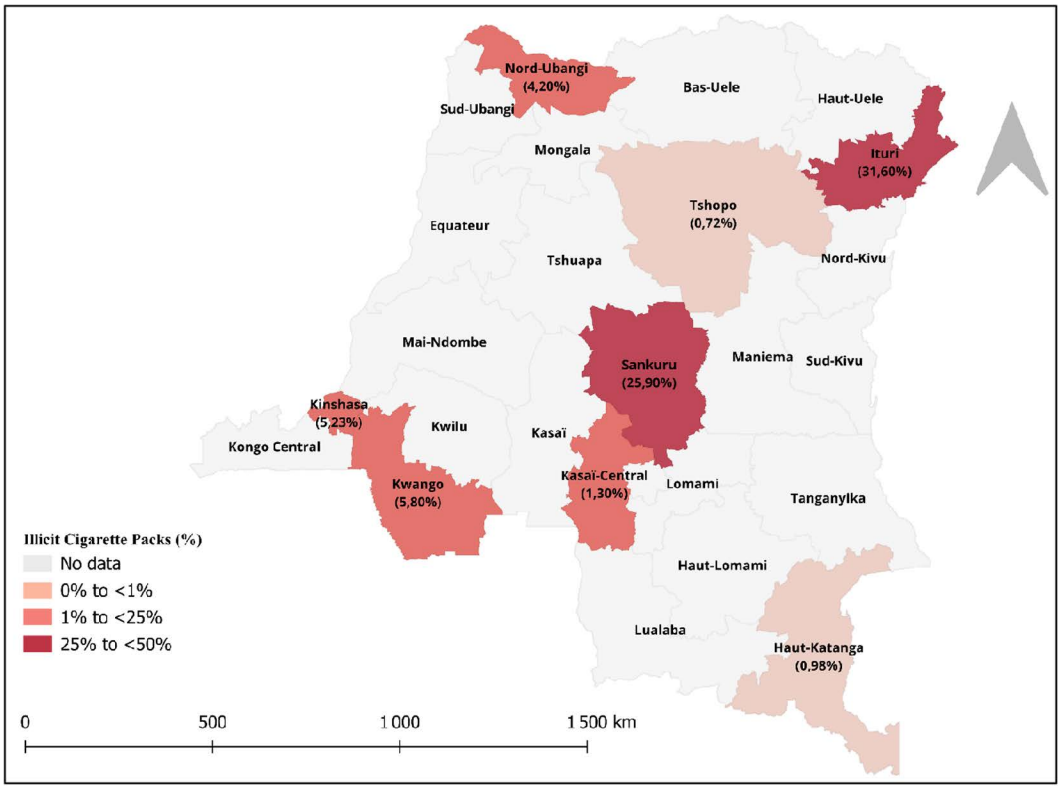

Fig 1. Geographical variation in the proportion of cigarette packs that were illicit by province.

https://doi.org/10.1371/journal.pgph.0003937.g001

Table 3. Proportion of illicit empty packs by type of collection point and illicit criteria.

	Type of collection point							
	Stationary retailer		Mobile retailer		Garbage bins/streets		Total	
Criteria	Illicit n (%)	Total	Illicit n (%)	Total	Illicit n (%)	Total	Illicit n (%)	Total
Tax stamp requirements	697	7,116	34	1,522	185	1,984	916	10,622
	(9.8)		(2.2)		(9.3)		(8.6)	
Written health warning	656	7,116	29	1,522	163	1,984	848	10,622
	(9.2)		(1.9)		(8.2)		(8.0)	
Notice of prohibition of sale to and by minors	505	7,116	6	1,522	87	1,984	598	10,622
	(7.1)		(0.4)		(4.4)		(5.6)	
Tar and nicotine content	435	7,116	0	1,522	47	1,984	482	10,622
	(6.1)		(//)		(2.4)		(4.5)	

https://doi.org/10.1371/journal.pgph.0003937.t003

those that were not flavoured (aOR 1.84; [95% CI: 1.22 - 2.77]). There was no statistically significant difference between those collected from urban and rural HZs with regard to the likelihood of being illicit (aOR 1.19; [95% CI: 0.88 - 1.61]). The odds of being illicit when considering the different cigarette manufacturers are also shown in Table 5.

The relationships between each of the independent variables and three of the illicit criteria (i.e., cigarette tax evasion/non-compliance with tax stamp requirements, non-compliance with written health warning requirements, or absence of the notice indicating the prohibition of sale by/to minors) were similar to those between the each of the independent variables

Table 4. Median retail price of a pack of cigarettes by brand.

	Median (interquartile range) in Congolese Francs
Brand	
Oris	3,000 (2,500-4,000)
Ambassade	2,500 (2,100-3,000)
Stella	2,000 (2,000-2,500)
Business	2,000 (2,000-2,000)
Caesar	2,000 (1,500-2,000)
Pall Mall	2,000 (1,700-2,000)
Portsman	2,000 (2,000-2,000)
Supermatch	1,850 (1,000-2,000)
Monte Carlo	1,800 (1,500-2,000)
Master	1,500 (1,200-2,000)
Equateur	1,500 (1,300-2,000)
Elite	1,000 (1,000-1,500)
Other brands	1,800 (1,200-2,500)

https://doi.org/10.1371/journal.pgph.0003937.t004

Table 5. Factor associated with illicit cigarette packs.

	Overall Illicit Cigarette	
Variables	**Adjusted Odds Ratio**	**95% Confidence Interval (CI)**
Area-level income group (reference: high income)		
Low income	1.90	(1.48 - 2.43)
Rural/urban (reference: rural)		
Urban	1.19	(0.88 - 1.61)
Porosity stratum (reference: low-porosity)		
Intermediate-porosity	3.36	(1.72 - 6.57)
High-porosity	17.2	(7.48 - 39.3)
Border/non-border province (reference: non-border)		
Border	0.48	(0.25 - 0.91)
Collection point (reference: stationary retailer)		
Garbage bins/streets	1.86	(1.38 - 2.51)
Mobile retailer	0.43	(0.28 - 0.68)
Manufacturer (reference: other manufacturers)		
British American Tobacco (BAT)	0.02	(0.01 - 0.03)
Congo Tobacco Company Sarl (CTC)	0.00	(0.00 - 0.00)
Oriental General Trading Inc	4.60	(3.17 - 6.68)
Tanzania Cigarette Public Limited Company	0.01	(0.00 - 0.01)
Cigarette flavour (reference: no)		
Yes	1.84	(1.22 - 2.77)

https://doi.org/10.1371/journal.pgph.0003937.t005

and overall illicit classification in both magnitude and direction (Table 6). The only differences were for 1) rural/urban HZs where packs from urban HZs were more likely not to have the notice indicating the prohibition of sale by/to minors than those from rural HZs (aOR 2.93; [95% CI: 2.02 - 4.24]); and 2) for porosity stratum where the association was stronger for high-porosity stratum (aOR 278.9; [95% CI: 81.66 - 952.5]).

Table 6. Factors associated with illicit cigarettes by criteria.

	Non-compliance with tax stamp requirements	Non-compliance with written health warning requirements	Absence of the notice indicating the prohibition of sale by/to minors
Variable	Adjusted Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)
Area-level income group (reference: high income)			
Low income	1.90 (1.49 - 2.44)	1.89 (1.46 - 2.45)	2.12 (1.65 - 2.71)
Rural/urban (reference: rural)			
Urban	1.20 (0.89 - 1.63)	1.29 (0.93 - 1.78)	2.93 (2.02 - 4.24)
Porosity stratum (reference: low-porosity)			
Intermediate-porosity	3.43 (1.74 - 6.73)	4.53 (2.04 - 10.08)	6.30 (2.21 - 17.93)
High-porosity	17.64 (7.64 - 40.77)	28.27 (10.94 - 73.03)	278.9 (81.66 - 952.5)
Border/non-border province (reference: non-border)			
Border	0.47 (0.24 - 0.89)	0.34 (0.16 - 0.72)	0.01 (0.00 - 0.04)
Collection point (reference: stationary retailer)			
Garbage bins/streets	1.87 (1.39 - 2.53)	1.75 (1.28 - 2.37)	1.02 (0.72 - 1.44)
Mobile retailer	0.44 (0.28 - 0.69)	0.47 (0.29 - 0.75)	0.12 (0.05 - 0.32)
Manufacturer (reference: other manufacturers)			
British American Tobacco (BAT)	0.02 (0.01 - 0.03)	0.01 (0.00 - 0.02)	0.01 (0.00 - 0.01)
Congo Tobacco Company Sarl (CTC)	–	0.00 (0.00 - 0.00)	–
Oriental General Trading Inc	4.60 (3.17 - 6.71)	3.59 (2.46 - 5.25)	0.76 (0.53 - 1.10)
Tanzania Cigarette Public Limited Company	0.01 (0.00 - 0.01)	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.01)
Cigarette flavour (reference: no)			
Yes	1.88 (1.25 - 2.85)	2.52 (1.57 - 4.07)	1.68 (0.97 - 2.94)

https://doi.org/10.1371/journal.pgph.0003937.t006

Discussion

From our primary analysis, in the DRC, illicit cigarettes constitute approximately 8.6% of the total cigarette market base. All of the illicit packs did not comply with tax stamp requirements and were therefore classified as having evaded cigarette tax. 8.0% of the collected packs did not comply with written health warning requirements. 5.6% of all collected packs did not indicate the prohibition of sale by/to minors, and 4.5% did not have information on tar and nicotine content. The chance of being an illicit cigarette pack was higher for packs collected from low-income neighbourhoods than those from high-income neighbourhoods, and increased with increasing level of province porosity (i.e., susceptibility to armed conflict/insecurity). Flavoured cigarette packs were more likely to be illicit than those for unflavoured cigarettes. Packs that were collected from garbage bins/streets were more likely, whilst those collected from mobile retailers were less likely, to be illicit than those collected from stationary retailers. Those collected from border provinces were less likely to be illicit than those collected from non-border provinces. There was no statistically significant difference in the likelihood of being an illicit pack between those collected from urban HZs and those from rural HZs.

Global estimates suggest that on average, the illicit cigarette trade market share is ~17% for low-income countries [10]. Our study findings are consistent with a study which established that illicit cigarettes constituted 8.6% of the cigarette market in the Gambia [20]. Other Sub-Saharan African countries, however, have reported higher illicit trade market shares, for example Zambia (12.2%) [21], Ghana (20%) [11], Ethiopia (45.4%) [22] and South Africa (54%) [23]. This could be because, in these countries, illegal cigarettes are on average cheaper than legal purchases, whereas we found that some brands with the highest proportions of illicit cigarettes had the highest median retail price, whilst a number of brands where none of the packs were illegal had the lowest median prices. This might suggest an opposite trend in the DRC with illegal cigarettes being more expensive on average than legal cigarettes, potentially because most of them are imported.

However, this needs further investigation before definitive conclusions can be made. In addition, contrary to findings from other Sub-Saharan African country studies [11, 22], packs that were collected from border provinces were less likely to be illicit than those collected from non-border provinces. The concentration of illegal cigarettes in non-border provinces could be a reflection of the traders' perceptions of smoking pattens across different provinces and therefore where they are more likely to make the most profit; or perceptions of where they are less likely to be caught, potentially due to weaker enforcement and compliance monitoring of retailers once the cigarettes are in the DRC.

Cigarette packs collected from mobile retailers were about 60% less likely to be illicit, while those collected from the garbage bins/streets were ~2 times more likely to be illicit, than those collected from the stationary retailers. This might be because of international travellers coming to the DRC with illicit cigarettes in their luggage which is not examined upon arrival, and upon consumption, they discard the packs in the trash. On the other hand, consequences of not abiding by the law might dissuade stationary retailers from selling illicit cigarettes.

We also found that the yellow stamp, an old stamp that was used for both imported and locally manufactured cigarettes, which should have been phased out in 2022, is currently still being used in the DRC. If all imported packs with the yellow stamps are considered illicit, 51.5% of the cigarette market base becomes illicit.

The majority of the packs carried the written health warning *"Smoking is highly addictive"*, whilst none had the message "*Be careful, smoking kills*." Well-designed health warnings and messages on tobacco product packages reduce tobacco consumption by increasing public awareness of the negative health effects of tobacco use. However, the tobacco industry is known to undermine the effectiveness of health warnings in many ways, including through the use of weak message content and opposing strengthened warnings [24].

Policy and practice implications

Our main analysis suggests that illicit cigarette trade in the DRC is low. However, there is still a need to secure the cigarette supply chain to counter the supply of illicit cigarettes in the DRC. In particular, there is a need to strengthen border controls, resolve the issue of the old yellow stamp, establish a secured track and trace system for cigarettes, and strengthen enforcement and compliance monitoring both centrally and at the provincial level. Romania, for example, was able to lower the illicit cigarette market from ~30% of the total cigarette market in 2010 to ~11% in 2013 through strategies that included better legislation, and strengthening border security, the customs department's administrative capacity and interinstitutional collaboration [24]. The DRC should also strengthen its political commitment to combating illicit cigarette trade by ratifying the Protocol to Eliminate Illicit Trade in Tobacco Products. In addition, there is a need to strengthen health warning requirements by ensuring strong message content on all cigarette packs.

Implications for future research

There is a need to continuously monitor illicit cigarette trade over time in the DRC in order to facilitate timely action, and enable the evaluation of the impact of any new tobacco control measures (e.g., tax and price measures), where necessary. Regular monitoring can, for example, help counter the tobacco industry's narrative that increasing taxes result in considerable increases in illicit cigarette trade. Our study suggests that non-compliance with cigarette tax stamp requirements is a good indicator of whether a cigarette pack is legal/illicit in the DRC. This means that, if the required data are available, regular monitoring could be more efficiently achieved by measuring the difference between consumption and tax paid sales (i.e., gap analysis) [14].

Different health warnings are applicable to, and resonate with, different people [25]. It is therefore important to investigate the effectiveness of the different health warnings that are being used in the DRC to ensure that those that are used are the most effective. This should include the evaluation of their effectiveness in deterring young people from initiating smoking, and motivating those who smoke to quit.

Strengths and limitations

This study is the first of its kind to estimate the illicit cigarette market share in the DRC. Although our study was limited to eight out of the 26 provinces of the DRC, we employed stratified, multistage random sampling to enhance the representativeness and generalizability of the findings. Our study relied on retailers providing us with empty cigarette packs, and it is possible that some retailers did not provide us with all their illegal packs, leading to underestimation of the illicit cigarette market share [11]. We tried to mitigate this by concealing our specific interest in illicit cigarette packs: at informed consent, we told retailers that we were interested in the characteristics of the packs. We also compensated retailers with 2,000 Congolese Francs for the time they spent gathering the cigarette packs. These procedures were approved by the ethics committee. Our reporting followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for cross-sectional studies (S1 STROBE Checklist) [26], and the data used in the writing of this article is publicly available [27]. We also adhered to high standards for research ethics and authorship (S1 Checklist).

Conclusions

Our study found that 8.6% of the cigarette packs collected were illicit, and all of the illicit cigarette packs were imported from other countries. There is a need to secure the cigarette supply chain to counter the supply of illicit cigarettes in the DRC. This includes strengthening border controls and enforcement and compliance monitoring, and establishing a secured track and trace system for cigarettes. Ratifying the Protocol to Eliminate Illicit Trade in Tobacco Products will strengthen the DRC's political commitment to combating illicit cigarette trade. This is also applicable to other similar low- and middle-income countries (LMICs). There is a need to continuously monitor illicit cigarette trade over time, and to evaluate the impact of tobacco control measures on illicit trade in the DRC and other LMICs.

Supporting information

S1 Fig. Provinces by strata.
(TIFF)

S2 Fig. Illustration of sampling provinces, health zones and health areas by stratum.
(TIFF)

S1 Text. Participating health zones and health areas by province and urban/rural classification.
(DOCX)

S2 Text. Proportion of illicit empty packs by type of collection point, porosity and province with all imported yellow stamps as illicit.
(DOCX)

S3 Text. Proportion of illicit empty packs by rural/urban, area-level income group, brand and country of origin with all imported yellow stamps as illicit.
(DOCX)

S4 Text. Proportion of illicit empty packs by type of collection point and illicit criteria with all imported yellow stamps as illicit.
(DOCX)

S1 STROBE Checklist. Checklist of items that should be included in reports of cross-sectional studies.
(DOCX)

S1 Checklist. Inclusivity in global research.
(DOCX)

Acknowledgments

This research was carried out within the framework of the Tobacco Control Data Initiative (TCDI). TCDI is a project that encompasses six African nations (the Democratic Republic of the Congo, Ethiopia, Kenya, Nigeria, South Africa, and Zambia). Its objective is to comprehend the tobacco-related data requirements of these countries, assess existing data, pinpoint gaps in available tobacco data, gather new data to address those gaps, and create tools to assist policymakers in utilising crucial data more effectively for shaping tobacco policies. The initiative is spearheaded by Development Gateway: an IREX Venture (DG), a global nonprofit organisation specialising in data-driven development, in collaboration with the University of Cape Town's Research Unit on the Economics of Excisable Products (REEP). We would like to express our deep gratitude to the Ministère de la Santé Publique, Hygiène et Prévoyance Sociale of the DRC and, specifically, the Programme National de Lutte Contre la Toxicomanie et les Substance Toxiques for their exceptional commitment to the realisation of this study. We also thank the cigarette retailers who collected and provided us with the cigarette packs that were analysed in this study; and the field investigators who collected them from the retailers and examined them to extract the study data. Our gratitude also goes to members of the Study Steering Committee for their guidance and advice throughout the study

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