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# Magnitude, structure and associated factors of illicit cigarette sales in Bangladesh: a pack analysis

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## ABSTRACT

**Introduction** Bangladesh's cigarette smoking prevalence remained unchanged (around 14%) between 2009 and 2017. Through tax evasion and regulatory non-compliance, illicit trade might have contributed to the status quo. Little is known about the magnitude of illicit cigarettes in Bangladesh.

**Methods** We analysed empty cigarette packs collected from retailers and street litter in eight districts in Bangladesh between December 2019 and January 2020. We examined tax stamps on packs to assess tax evasion and printed health warnings, retail prices, sales declarations, misleading descriptors, and duty-free signs to determine packaging law compliance. All but tax-paid and compliant packs were considered illicit. We examined associations between tax evasion and price or non-price factors. Sensitivity and specificity of packaging compliance were measured when used as a proxy for tax evasion.

**Results** Among 24 363 cigarette packs examined from sampled districts in Bangladesh (23 207 from shops and 1156 from litter), 5.32% (95% CI: 5.04% to 5.60%) evaded taxes, while only 0.77% (95% CI: 0.4% to 1.4%) were non-compliant with packaging laws, totalling 5.62% (95% CI: 4.3% to 7.1%) illicit share. This neither differed statistically significantly between packs collected from shops (5.47%; 95% CI: 4.2% to 7.0%) and those from litter (8.13%; 95% CI: 5.7% to 11.1%) nor between urban (5.15%; 95% CI: 3.5% to 7.3%) and rural (6.16%; 95% CI: 4.2% to 8.7%) areas. Low-price cigarettes (OR: 3.48; 95% CI: 2.10 to 5.75) and those sold in unconventional shops (OR: 1.99; 95% CI: 1.12 to 3.54) were more likely to be tax evaded than high-price cigarettes and those sold in formal shops, respectively. Packaging non-compliance was not a sensitive marker for detecting tax-evaded cigarettes.

**Conclusions** Bangladesh has a low share of illicit cigarette packs. While surveillance of the illicit cigarette trade is essential, the government should continue to enhance cigarette taxes without concern for its effect on the illicit trade.

### WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Illicit cigarette and tax evasion research is limited in Bangladesh. Research in other low-income and middle-income countries often used packaging compliance as an indirect measure of tax evasion. Specific factors contributing to tax evasion in Bangladesh remain unexplored. The specificity and sensitivity of packaging compliance in detecting cigarette tax evasion require exploration.

### WHAT THIS STUDY ADDS

⇒ Using the largest dataset of cigarette packs and objectively applying selected illicit criteria, we provided an updated estimate of illicit cigarette packs in Bangladesh.
⇒ Tax evasion was more likely in the low-price segment and unconventional shops, emphasising the necessity of obligatory licensing of retailers and focused market monitoring.
⇒ Assessment of the preciseness of packaging compliance in detecting evasion underscored the importance of explicit tax markers on packs.

### HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Cigarette packs in Bangladesh are mostly compliant with packaging and labelling requirements. The government can further increase cigarette tax without concern for its effect on illicit cigarettes.
⇒ Within the legal enforcement mechanism, enhanced regulatory oversight of informal cigarette retailers and cigarettes in the low-price segment would be critical for keeping the share of illicit cigarettes low.

## INTRODUCTION

Bangladesh is the eighth largest tobacco-consuming country globally.[1] While tobacco consumption consists of both smoking and smokeless forms, cigarettes have remained the most popular form of smoking in Bangladesh; cigarette smoking consumption remained constant around 14% between 2009 and 2017.[2] Of the 15 million cigarette-smoking adult population, around 98% are men (male prevalence 28.7%).[2] Accordingly, among men in Bangladesh, 25% of all deaths aged 25–69 years are attributable to smoking.[3] Furthermore, 61 000 children suffered from diseases attributable to passive smoking in 2018 in the country.[4] Alarmingly, a nationwide survey found that over 40% of students aged 13–15 years are around secondhand smoke in public places.[5] In some areas, 95% of primary school children were positive for recent secondhand smoking exposure.[6] Controlling the prevalence of smoking and hence the exposure to passive smoking is crucial for curbing the death and disability toll.

Since ratifying the WHO Framework Convention on Tobacco Control (FCTC) in 2004, Bangladesh has implemented fiscal and regulatory measures to curb cigarette use.[7] However, research in other

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settings shows that the illicit sale of cigarettes, often through tax evasion and non-compliance with packaging laws, impedes tobacco control efforts,[8–12] which might have also been the case in Bangladesh. Understanding the magnitude and structure of the illicit cigarette trade is critical to designing more effective policies and preventive interventions. In Bangladesh, legitimate cigarette packs should display health warning labels (pictorial and textual), retail prices and sales declarations (printing 'sales only allowed in Bangladesh'), avoid misleading descriptors and duty-free signs, and carry an official tax stamp indicating tax payment.[13 14] Tax evasion of cigarettes can be related to price and non-price factors.[15–21] Evidence from other countries shows that cigarette tax evasion varies across administrative regions,[17–19] urban–rural geographical areas,[17] border proximity[16 18 21] and pack sizes.[15 16 18 19] Many such studies have used packaging non-compliance as a proxy to estimate cigarette tax compliance.[18 22–24] Despite having a significant smoking population, evidence on illicit cigarettes in Bangladesh is limited. Exploiting the year 2010 International Tobacco Control (ITC) Wave II data, Guindon *et al* found that 3.7% of cigarette packs in Bangladesh evaded taxes.[25] Sadiq *et al* relied on tobacco industry estimates and reported a 1.8% market share for illicit cigarettes in 2016–2017.[26] Furthermore, Brown *et al* estimated a median price disparity of 455% between illicit and licit cigarette packs in Bangladesh.[27]

Recent independent estimates of the share of illicit cigarettes are scarce in Bangladesh.[28] Moreover, previous studies in Bangladesh have not estimated the proportions of cigarette packs with invalid or absent tax stamps (a direct indicator of tax evasion) and those not compliant with the packaging laws, which may or may not have evaded taxes. We aimed to address this gap by estimating the magnitude of illicit cigarette packs sold in retail markets and analysing its composition concerning tax evasion and packaging non-compliance. We examined the association of price and non-price factors with cigarette tax evasion. Also, we explored the sensitivity and specificity of packs' compliance with packaging laws if used as a proxy for tax evasion. The findings will provide the magnitude and structure of illicit cigarettes in selected districts in Bangladesh and inform policy initiatives to combat the issue.

## METHODS

### Data and sample

We analysed the cross-sectional survey data obtained from a pack observational study conducted in Bangladesh under the Tobacco Control Capacity Programme.[28] Bangladesh comprises eight divisions (Barishal, Chittagong, Dhaka, Khulna, Mymensingh, Rangpur, Rajshahi and Sylhet; highest administrative unit) and 64 districts (second highest administrative unit). Except Dhaka and Barishal, all divisions share international borders with India or Myanmar. The study randomly selected eight districts (Comilla, Chapainawabganj, Dhaka, Maulavibazar, Mymensingh, Patuakhali, Satkhira and Thakurgaon) for cigarette pack collection. Together, they account for 22% of the total population and 15.12% of the country's total area.[29] Online supplemental table S1 compares the sociodemographics of these districts with the national average, revealing marginal differences. Districts were categorised as either 'border' or 'non-border' based on their proximity to international land border. Border districts were defined as those that share a land border with India or Myanmar, while non-border districts were selected from divisions where no district has international land border. Within these districts, 80 postcodes were randomly selected as primary sampling units (PSUs), evenly divided across eight districts with equal urban–rural stratification. The study protocol detailing the sampling design has been published elsewhere.[28]

Cigarette packs were collected in December 2019 and January 2020 from two sources: retail shops (1339 retailers) and street litter (online supplemental table S2). In practice, for each PSU, the enumerators selected a centre point or landmark (eg, a bus station, a government building or a marketplace). Within half kilometre distance from the centre point, all cigarette retailing shops (eg, ordinary/departmental stores, groceries, tea stalls, only tobacco shop, cart and others) on both sides of the streets were requested to hand over the empty cigarette packs generated from one business day of retailing. Online supplemental table S3 categorises the packs among retail shop types. Littered packs were collected from the streets around the cigarette retailing shops and from other streets with public gatherings.[28]

### Measures

#### Packaging and tax compliance of cigarette packs and operational definition of illicit

Online supplemental table S4 summarises cigarette packs' tax and packaging compliance based on Bangladesh's tobacco control laws. We considered a pack non-compliant if it lacked or had non-compliant pictorial or textual health warnings, retail price (MRP), or sales statements or if it displayed misleading descriptors or duty-free signs. While it makes cigarette packs illegal, packaging non-compliance does not automatically indicate tax evasion status (TES). As research considered the absence of tax stamps as a good indicator for TES,[30] we considered the packs with no or invalid tax stamps to have evaded tax. Tax stamps were invalid if they lacked the legitimate watermark or luminescent content that glows under ultraviolet light. We conceptualised the illicit phenomena by merging two aspects: tax evasion (paid vs evaded) and packaging compliance (compliant vs non-compliant). Legal cigarette packs were identified by valid tax stamps and compliant packaging. If either of these two were absent, the pack was considered illicit. Packs containing a tax stamp only could be counterfeit, and those with compliant packaging but no tax stamp could be tax evaded.

#### Outcome and exposures

In the descriptive analysis, we considered the illicit status of cigarette packs (illicit vs licit) as the outcome, whereas TES (paid vs evaded) served as the outcome in the analytical approach. Bangladesh has a segmented cigarette price structure.[31 32] Based on MRP in Bangladeshi Taka (BDT), cigarette packs were categorised into four segments (fiscal year 2019–20: premium (MRP>123 BDT), medium (MRP>93 BDT), high (MRP>63 BDT) and low (MRP>37 BDT)). Three different taxes are levied on cigarettes: value added tax (VAT), supplementary duty (SD) and health development surcharge (HDS). Regardless of the price segment, VAT and HDS are imposed equally at rates of 15% and 1%, respectively. In 2019–2020, for cigarettes in the low-price segment, the SD rate was 55%, while the other segments had an SD rate of 65%. Thus, the total tax share in price (or tax incidence defined as the sum of VAT, SD and HDS) for low price segments was 71%, whereas for the other segments it was 81%.[31] We considered price segments and tax share in price as price-related exposures. Along with districts, location (urban and rural) and proximity to Myanmar or Indian border (border and non-border areas), we used several other non-price exposures such as pack size (20 sticks pack and others), shop type (ordinary/departmental store, grocery, tea

stall, only tobacco shop, cart and others), pack source (retail shops and littered) and packaging compliance (compliant and non-compliant). Online supplemental table S5 details variable definitions and their roles.

## Statistical analysis

### Descriptive approach: sample description and structure of illicit cigarette packs

The descriptive analysis provided the proportional distribution of packs with their tax and packaging compliance. Accordingly, the distribution of the structure of illicit is generated. Stratifying the analysis by pack source, we described the sample and presented the overall proportion of illicit cigarette packs over price and non-price exposures. We also estimated and presented the overall proportion of illicit cigarettes by administrative district. We used robust standard errors (SEs) and presented the estimates of proportions with a 95% confidence interval (CI).

### Analytical approach: tax evasion of cigarette packs and the associated factors

We estimated five logistic regressions to analyse binary outcome (TES) and examine how different exposures affect adjusted odds ratios (AOR). Statistical specification of the multiple logistic regression is provided in online supplemental appendix S1. Model 1 included only the geographical variables (districts, location and border proximity) as exposures. Model 2 augmented model 1 with price and pack-related variables (price segment, pack size and pack source). In model 3, pack compliance was added as an additional exposure to model 2. Replacing the price segment with the tax share in the price of the cigarette pack in models 4 and 5, we re-estimated the parameters. In all models, we grouped districts a priori based on the regional concentration of illicit cigarette production and high tobacco prevalence to enhance model interpretability and reduce complexity while capturing overarching patterns. Statistical analysis was performed using STATA V.18.0.[33] AOR estimates were presented with 95% CI. Clustered robust SEs with PSUs as clusters were employed to address clustering effects. The Hosmer-Lemeshow test was employed to assess goodness of fit, while the Wald test evaluated overall significance.[34] The diagnostic ability of the models was assessed using the area under the receiver operating characteristic (ROC) curve. Bayesian information criterion (BIC) was reported for model selection.

We also estimated the specificity and sensitivity of pack compliance in detecting TES. Online supplemental table S6 contains the (2×2) contingency structure for the analysis. Sensitivity (true tax evasion rate) was defined as the probability of detecting a tax-evaded cigarette pack when the pack was indeed evaded. Specificity (true tax-paid rate) was measured as the probability of detecting a tax-paid pack when the pack was certainly tax-paid.

# RESULTS

## Descriptive approach

### Pack collection summary and sample description

We analysed 24363 empty cigarette packs; 23207 packs from shops, and 1156 from street litter (online supplemental table S2). The low number of packs from the littered source is due to the high prevalence of loose or single sticks selling (about 81%) in Bangladesh.[35] Administrative districts and source-wise pack distribution are provided in online supplemental figure S1. Regardless of the collection source, the highest and lowest number of packs were collected from Patuakhali (3658; 15.01%) and Mymensingh (2326; 9.55%), respectively. Table 1 shows packs distributed across their features. Almost all the cigarette packs (99.67%; 95% CI: 99.4% to 99.8%) originated from Bangladesh, with 71.0% falling under low and medium price segments. Nearly all had legitimate pictorial and textual health warnings. Around 99.36% (95% CI: 98.7% to 99.7%) of the packs featured sale statements printed without misleading descriptors. For the tax marker, around 99.55% (95% CI: 99.3% to 99.7%) of the cigarette packs had affixed tax stamps. We found that 4.89% (95% CI: 3.7% to 6.3%) of the packs had invalid tax stamps. Those collected from shops had 4.80% (95% CI: 3.6% to 6.2%) and those from litter had 6.81% (95% CI: 4.7% to 9.4%) packs with invalid tax stamps.

### Tax evasion, packaging noncompliance and illicit cigarette packs

The overall share of tax-evaded cigarette packs was 5.32% (95% CI: 5.04% to 5.60%), while that of non-compliant packs was 0.77% (95% CI: 0.4% to 1.4%). Online supplemental table S7 contains the distribution of non-compliant packs over categories stratified by pack sources. There were 7.60% (95% CI: 5.2% to 10.7%) tax-evaded packs in the litter, compared with 5.20% (95% CI: 4.0% to 6.7%) in the shops. Nevertheless, the difference between these proportions was not statistically significant. There was also insufficient evidence that the share of non-compliant packs in shops (0.80%; 95% CI: 0.1% to 1.4%) and litter (1.00%; 95% CI: 0.4% to 1.8%) differed. Table 2 shows the share of illicit cigarette packs and their structural distribution concerning tax evasion and packaging non-compliance.

We estimated the combined share of illicit cigarette packs as 5.62% (95% CI: 4.3% to 7.1%). The proportion of illicit did not differ statistically significantly by pack source (shops: 5.47%; 95% CI: 4.2% to 7.0%; litter: 8.13%; 95% CI: 5.2% to 11.1%). We found the structure of the share of illicit packs consistent regardless of their source.

Regarding districts, Maulvibazar had the highest share of illicit cigarette packs (13.63%; 95% CI: 9.3% to 19.0%), followed by Patuakhali (6.56%; 95% CI: 1.8% to 16.0%) and Comilla (6.05%; 95% CI: 4.3% to 8.2%) (figure 1). Dhaka had the lowest share of illicit cigarette packs (2.73%; 95% CI: 1.4% to 4.7%). In urban and rural areas, it was 5.15% (95% CI: 3.5% to 7.3%) and 6.16% (95% CI: 4.2% to 8.7%), respectively (online supplemental table S8). Although not significant, districts next to the international border had a higher share (6.79%; 95% CI: 4.5% to 9.7%) than other districts (5.06%; 95% CI: 3.5% to 7.0%). We found in shops that the share of illicit cigarette packs is higher in rural and border areas than in urban and non-border areas (online supplemental table S8). However, the differences were not statistically significant. The share of illicit in the low-price segment was almost three times significantly higher (6.70%; 95% CI: 5.0% to 8.8%) than that in the premium segment (2.36%; 95% CI: 1.5% to 3.5%).

## Analytical approach

### Cigarette tax evasion and associated factors

Table 3 shows the AOR estimation using multivariate tax evasion models. In model 1, which solely considered administrative and geographical factors, the odds of tax evasion of cigarettes were 2.64 (95% CI: 1.71 to 4.08) times higher in Maulvibazar, Patuakhali and Comilla than in the other districts included in the sample. The odds for border and urban areas were 1.82 (95% CI: 0.68 to 4.88) and 1.13 (95% CI: 0.42 to 3.05) times higher than non-border and rural areas, respectively. Administrative districts emerged as a statistically significant predictor of tax evasion concerning cigarette packs, while the geographical characteristics (ie, urban–rural or border–non-border) did not. After adjusting for the price and pack-related factors in model 2, pack size was statistically insignificant, while pack source emerged as a significant predictor of TES. Tax evasion was 1.52 (95% CI: 1.09 to 2.13) times more likely in littered

**Table 1** Proportional distribution of cigarette packs over their packaging features and collection source

| Pack features | Pack collection source | | |
|---|---|---|---|
| | Retail shop (N=23 207) n (%) (95% CI) | Littered (N=1156) n (%) (95% CI) | Total (N=24 363) n (%) (95% CI) |
| Pack size (sticks) | | | |
| 5 | 9 (0.04) (0.0 to 0.2) | – | 9 (0.04) (0.0 to 0.2) |
| 10 | 7950 (34.26) (26.3 to 42.9) | 418 (36.16) (27.1 to 46.0) | 8368 (34.35) (26.5 to 42.9) |
| 12 | 535 (2.31) (1.6 to 3.3) | 21 (1.82) (0.9 to 3.3) | 556 (2.28) (1.5 to 3.3) to 3.2) |
| 16 | 19 (0.08) (0.0 to 0.2) | 1 (0.09) (0.0 to 0.5) | 20 (0.08) (0.0 to 0.2) |
| 20 | 14 694 (63.32) (54.4 to 71.6) | 716 (61.94) (52.2 to 71.0) | 15 410 (63.25) (54.4 to 71.5) |
| Retail price (MRP) printed on pack (yes) | 23 138 (99.70) (99.4 to 99.9) | 1152 (99.65) (98.9 to 99.9) | 24 290 (99.70) (99.4 to 99.9) |
| Retail price (MRP) segment | | | |
| Premium (MRP 123 BDT or higher) | 5972 (25.82) (23.1 to 28.7) | 268 (23.26) (19.1 to 27.8) | 6240 (25.70) (23.0 to 28.5) |
| High (MRP 93 BDT or higher) | 740 (3.20) (2.6 to 3.9) | 61 (5.30) (3.7 to 7.3) | 801 (3.30) (2.7 to 4.0) |
| Medium (MRP 63 BDT or higher) | 2202 (9.52) (7.8 to 11.5) | 125 (10.85) (8.0 to 14.2) | 2327 (9.58) (7.9 to 11.5) |
| Low (MRP 37 BDT or higher) | 14 217 (61.46) (58.6 to 64.3) | 698 (60.59) (55.6 to 65.5) | 14 915 (61.42) (58.5 to 64.2) |
| Name and address of manufacturer (yes) | 8735 (37.64) (34.6 to 40.8) | 434 (37.54) (33.0 to 42.3) | 9169 (37.76) (34.6 to 40.7) |
| Country of origin | | | |
| Bangladesh | 23 131 (99.67) (99.4 to 99.9) | 1152 (99.65) (98.9 to 99.9) | 24 283 (99.67) (99.4 to 99.8) |
| Others | 76 (0.33)(0.1 to 0.6) | 4 (0.35) (0.1 to 1.1) | 80 (0.33) (0.2 to 0.6) |
| Pictorial health warning (PHW) | | | |
| PHW status (any size) (yes) | 23 138 (99.70) (99.4 to 99.9) | 1152 (99.65) (98.9 to 99.9) | 24 290 (99.70) (99.4 to 99.9) |
| PHW covers 50% of the Principal Display Area (PDA) (yes) | 23 131 (99.67) (99.4 to 99.9) | 1152 (99.65) (98.9 to 99.9) | 24 283 (99.67) (99.4 to 99.8) |
| Colourful PHW (yes) | 23 137 (99.69) (99.4 to 99.9) | 1152 (99.65) (98.9 to 99.9) | 24 289 (99.70) (99.4 to 99.9) |
| Proper quality of PHW (yes) | 23 105 (99.56) (99.2 to 99.8) | 1147 (99.22) (98.4 to 99.7) | 24 252 (99.54) (99.2 to 99.8) |
| PHW appears on both sides of the pack (yes) | 23 138 (99.70) (99.4 to 99.9) | 1152 (99.65) (98.9 to 99.9) | 24 290 (99.70) (99.4 to 99.9) |
| PHW getting covered tax stamp (no) | 23 206 (99.99) (99.9 to 100.0) | 1156 (100.0) (100.0 to 100.0) | 24 362 (99.99) (99.0 to 100.0) |
| PHW recommended by NTCC (yes) | 23 131 (99.67) (99.4 to 99.9) | 1152 (99.65) (98.9 to 99.9) | 24 283 (99.67) (99.4 to 99.8) |
| Textual health warning (THW) | | | |
| THW status (yes) | 23 198 (99.96) (99.9 to 100.0) | 1155 (99.91) (99.5 to 100.0) | 24 353 (99.96) (99.9 to 100.0) |
| THW written in Bengali (yes) | 23 130 (99.67) (99.4 to 99.9) | 1152 (99.65) (98.9 to 99.9) | 24 282 (99.67) (99.5 to 99.9) |
| THW printed in white on black background (yes) | 23 138 (99.70) (99.4 to 99.9) | 1152 (99.65) (98.9 to 99.9) | 24 290 (99.70) (99.4 to 99.9) |
| PHW to THW ratio 6:1 (yes) | 23 131 (99.67) (99.4 to 99.9) | 1152 (99.65) (98.9 to 99.9) | 24 283 (99.67) (99.4 to 99.8) |
| Sale statement printed and no misleading descriptors (yes) | 23 056 (99.35) (98.7 to 99.7) | 1150 (99.48) (98.8 to 99.8) | 24 206 (99.36) (98.7 to 99.7) |
| Contains duty free sign (yes) | 3 (0.01) (0.0 to 0.1) | – | 3 (0.1) (0.0 to 0.1) |
| Tax stamps | | | |
| Affixed tax stamp (yes) | 23 107 (99.57) (99.3 to 99.8) | 1146 (99.13) (98.1 to 99.7) | 24 253 (99.55) (99.3 to 99.7) |
| Authenticity of tax stamps | | | |
| Valid | 20 562 (88.99) (86.9 to 90.9) | 925 (80.72) (76.9 to 84.2) | 21 487 (88.60) (86.5 to 90.5) |
| Invalid | 1108 (4.80) (3.6 to 6.2) | 78 (6.81) (4.7 to 9.4) | 1186 (4.89) (3.7 to 6.3) |
| Removed | 1437 (6.22) (4.6 to 8.1) | 143 (12.48) (9.3 to 16.2) | 1580 (6.51) (4.9 to 8.4) |

The proportions under MRP segment used 23 131 for shops and 1152 for littered (packs originated in Bangladesh) as the denominator. Because the price segment for the packs originated in other countries is not disclosed explicitly in the packs. Proportions under 'Authenticity of Tax Stamps' used 23 107 for shops and 1146 for littered (number of packs that affixed tax stamps) as the denominator. Tax stamps were considered 'invalid' if they did not contain the legitimate watermark or luminescent content that glows under ultraviolet light. Tax stamps were labelled 'removed' if the tax stamps were removed or destroyed while retailers or consumers opened the pack. Robust SEs were applied (with post code as the clusters) and exact CI was used.

cigarette packs than those in shops. Cigarette packs in the low-price segment had 3.35 (95% CI: 2.07 to 5.43) times higher odds of tax evasion than those in the premium segment. After adjusting for pack compliance in model 3, the odds of tax evasion in Maulvibazar, Patuakhali and Comilla were estimated to be 2.50 (95% CI: 1.69 to 3.68) times higher than in Dhaka, Thakurgaon, Nawabganj, Satkhira and Mymensingh. Low price segment showed 3.48 (95% CI: 2.10 to 5.75) times higher tax evasion odds than the premium segment, while non-compliant packs had 16.31 (95% CI: 5.09 to 52.24) times higher odds than compliant packs.

**Table 2** Share of illicit cigarette packs and their structural distribution

| Pack category | Pack source | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Retail shop (N=23 207) | | | Littered (N=1156) | | | Total (N=24 263) | | |
| | n | % | 95% CI | n | % | 95% CI | n | % | 95% CI |
| Compliant and tax evaded | 1093 | 4.71 | (3.5 to 6.1) | 83 | 7.18 | (5.0 to 9.9) | 1176 | 4.85 | (3.6 to 6.3) |
| Non-compliant and tax evaded | 115 | 0.50 | (0.3 to 0.8) | 5 | 0.43 | (0.1 to 1.2) | 120 | 0.49 | (0.3 to 0.8) |
| Non-compliant and tax paid | 61 | 0.26 | (0.0 to 0.8) | 6 | 0.52 | (0.2 to 1.2) | 67 | 0.28 | (0.1 to 0.8) |
| Total share of Illicit | 1269 | 5.47 | (4.2 to 7.0) | 94 | 8.13 | (5.7 to 11.1) | 1363 | 5.62 | (4.3 to 7.1) |

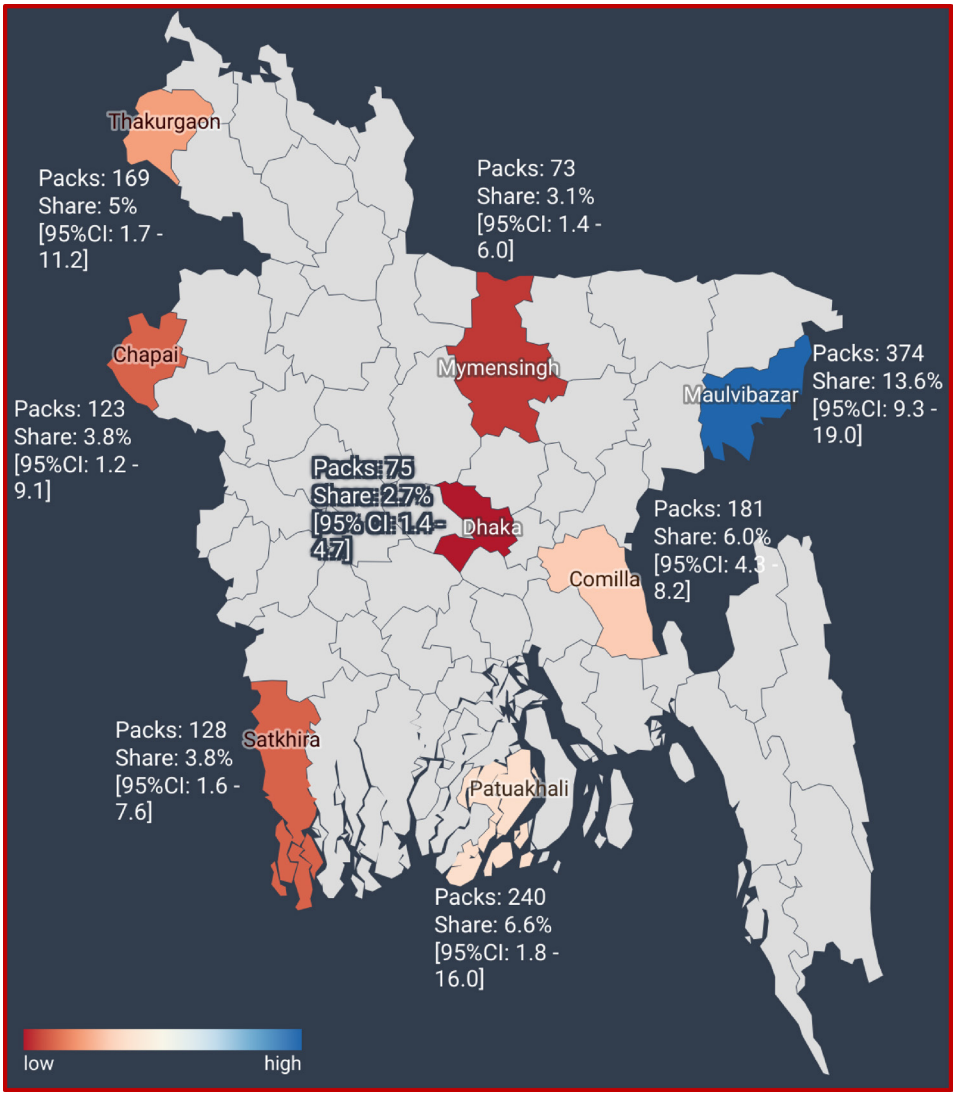


**Figure 1** Number of illicit cigarette packs and their share by administrative districts in Bangladesh. Administrative districts with a share of illicit as 5% or less were categorised as 'low', and those with above 5% were categorised as 'high'.

Models 4 and 5 used tax share in price as exposure instead of price segment. In model 4, cigarette packs with a low tax share in price had 2.40 (95% CI: 1.63 to 3.56) times higher odds of tax evasion than those with a high tax share. While controlling for pack compliance in model 5, the odds of tax evasion for cigarette packs with a low tax share in price were 2.43 (95% CI: 1.63 to 3.63) times higher than those with a high tax share. All five models had overall significance established by the significance of the Wald test. Nevertheless, the first three models satisfied the Hosmer-Lemeshow test (high p value) for goodness of fit, implying that the models were complete and specified correctly. In terms of information criterion, model 3 had the lowest BIC value. Also, it had the highest area under the ROC curve with a value of 0.70. Thus, the specification and the estimation of ORs in model 3 can be considered as the most parsimonious.

To ascertain the association between cigarette tax evasion and type of retail shops, we estimated all models restricting the pack sample with the retail shops and controlling for shop type (online supplemental table S9). The magnitude of the odds did not fluctuate widely. Compared with the departmental stores, the odds of tax-evaded cigarette packs in only tobacco shops and in shops unconventional for cigarette retailing (labelled as 'others') were around 1.50 (95% CI: 0.99 to 2.27) and 1.99 (95% CI: 1.12 to 3.54) times higher, respectively. Additionally, we estimated the models ignoring packs with removed tax stamps in the sample (online supplemental table S10). The coefficients;' magnitude and significance remained stable.

### Sensitivity and specificity of pack compliance in detecting TES

Table 4 shows the sensitivity and specificity of packaging compliance if used as a proxy for tax-evaded cigarette packs. The probability of detecting true tax-evaded cigarette packs using compliance status was 9.26% (95% CI: 8.9% to 9.6%), while the probability of detecting true tax-paid cigarette packs was 99.71% (95% CI: 99.6% to 99.8%). Online supplemental tables S11 and S12 contain the specificity and sensitivity analysis stratifying the packs by collection source.

## DISCUSSION

We analysed unique pack data from Bangladesh to provide estimates and present the structure of illicit cigarettes. Furthermore, we examined the underlying factors of cigarette tax evasion. Findings showed a low proportion of illicit cigarettes among the sample of packs collected in Bangladesh; the illicit packs in our sample were mainly due to inland tax evasion rather than due to

**Table 3** Estimation of adjusted ORs (AOR) for tax evasion of cigarette packs using multiple logistic regression models

| | Model 1 | | | | Model 2 | | | | Model 3 | | | | Model 4 | | | | Model 5 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variables (dependent: tax evasion status)** | **AOR** | **P>\|Z\|** | **95% CI** | | **AOR** | **P>\|Z\|** | **95% CI** | | **AOR** | **P>\|Z\|** | **95% CI** | | **AOR** | **P>\|Z\|** | **95% CI** | | **AOR** | **P>\|Z\|** | **95% CI** | |
| District (Ref: Dhaka, Thakurgaon, Nawabganj, Satkhira, Mymensingh) | | | | | | | | | | | | | | | | | | | | |
| Maulvibazar, Patuakhali and Comilla | 2.64*** | 0.00 | 1.71 | 4.08 | 2.46*** | 0.00 | 1.67 | 3.63 | 2.50*** | 0.00 | 1.69 | 3.68 | 2.51*** | 0.00 | 1.70 | 3.69 | 2.54*** | 0.00 | 1.73 | 3.75 |
| Location (Ref: rural) | | | | | | | | | | | | | | | | | | | | |
| Urban | 1.13 | 0.81 | 0.42 | 3.05 | 1.10 | 0.85 | 0.41 | 2.92 | 1.06 | 0.91 | 0.40 | 2.82 | 1.10 | 0.84 | 0.41 | 2.96 | 1.06 | 0.91 | 0.39 | 2.86 |
| Border (Ref: non-border area) | | | | | | | | | | | | | | | | | | | | |
| Border area | 1.82 | 0.23 | 0.68 | 4.88 | 1.64 | 0.31 | 0.63 | 4.28 | 1.63 | 0.32 | 0.63 | 4.26 | 1.69 | 0.29 | 0.64 | 4.44 | 1.68 | 0.29 | 0.64 | 4.42 |
| Pack size (Ref: less than 20 sticks pack) | | | | | | | | | | | | | | | | | | | | |
| 20 sticks pack | – | – | – | – | 1.16 | 0.39 | 0.82 | 1.65 | 1.23 | 0.24 | 0.87 | 1.74 | 1.12 | 0.54 | 0.79 | 1.57 | 1.17 | 0.37 | 0.83 | 1.65 |
| Price segment (Ref: premium) | | | | | | | | | | | | | | | | | | | | |
| High | – | – | – | – | 2.21** | 0.03 | 1.08 | 4.53 | 2.37** | 0.02 | 1.14 | 4.92 | – | – | – | – | – | – | – | – |
| Medium | – | – | – | – | 2.12*** | 0.00 | 1.30 | 3.46 | 2.24*** | 0.00 | 1.34 | 3.74 | – | – | – | – | – | – | – | – |
| Low | – | – | – | – | 3.35*** | 0.00 | 2.07 | 5.43 | 3.48*** | 0.00 | 2.10 | 5.75 | – | – | – | – | – | – | – | – |
| Pack source (Ref: shop) | | | | | | | | | | | | | | | | | | | | |
| Littered | – | – | – | – | 1.52** | 0.01 | 1.09 | 2.13 | 1.52** | 0.01 | 1.09 | 2.13 | 1.54** | 0.01 | 1.10 | 2.14 | 1.53** | 0.01 | 1.10 | 2.14 |
| Pack status (Ref: compliant) | | | | | | | | | | | | | | | | | | | | |
| Non-compliant | – | – | – | – | – | – | – | – | 16.31*** | 0.00 | 5.09 | 52.24 | – | – | – | – | 15.08*** | 0.00 | 4.69 | 48.52 |
| Tax Incidence (Share) (Ref: High Tax (81%)) | | | | | | | | | | | | | | | | | | | | |
| Low tax (71%) | – | – | – | – | – | – | – | – | – | – | – | – | 2.40*** | 0.00 | 1.63 | 3.56 | 2.43*** | 0.00 | 1.63 | 3.63 |
| Intercept | | | | | | | | | | | | | | | | | | | | |
| Constant | 0.03*** | 0.00 | 0.01 | 0.07 | 0.01*** | 0.00 | 0.00 | 0.02 | 0.01*** | 0.00 | 0.00 | 0.02 | 0.01*** | 0.00 | 0.01 | 0.03 | 0.01*** | 0.00 | 0.00 | 0.03 |
| Number of observations | 24363 | | | | 24283 | | | | 24283 | | | | 24283 | | | | 24283 | | | |
| Wald $\chi^2$ (p value) | 29.02*** (0.000) | | | | 77.95*** (0.000) | | | | 94.27*** (0.000) | | | | 65.40*** (0.000) | | | | 83.87*** (0.000) | | | |
| Number of covariate patterns | 6 | | | | 93 | | | | 108 | | | | 48 | | | | 62 | | | |
| Hosmer - Lemeshow $\chi^2$ (P value) | 0.09 (0.769) | | | | 0.53 (0.468) | | | | 0.88 (0.348) | | | | 4.21** (0.040) | | | | 5.22** (0.022) | | | |
| Area under ROC curve | 0.64 | | | | 0.68 | | | | 0.70 | | | | 0.67 | | | | 0.69 | | | |
| BIC | 9843.86 | | | | 9235.94 | | | | 9120.266 | | | | 9251.121 | | | | 9140.4 | | | |

Clustered robust SEs with PSU as the cluster were used to estimate the ORs. Wald $\chi^2$ statistic tests the overall significance of the models and Hosmer-Lemeshow $\chi^2$ tests the goodness of fit for the models. Numbers for the area under the ROC curve measure the diagnostic ability of the models.
***, **, * indicates significance at 1%, 5% and 10% level.
BIC, Bayesian information criterion; PSU, primary sampling unit; ROC, receiver operating characteristic.

**Table 4** Specificity and sensitivity of packaging compliance in detecting cigarette tax evasion

| TES of pack (using tax stamp legitimacy–true tax payment status) | | |
|---|---|---|
| | **Tax evaded** | **Tax paid** |
| Pack compliance status (using packaging features -screening tool) | | |
| Non-compliant | A: Non-compliant and tax evaded–true positive (n=120) | B: Non-compliant and tax paid–false positive (n=67) |
| Complaint | C: Compliant and tax evaded–false negative (n=1176) | D: Complaint and tax paid–true negative (n=23 000) |
| Sensitivity and specificity (95% CI) | Sensitivity=A/(A+C)=9.26% (8.9% to 9.6%) | Specificity=D/(B+D)=99.71% (99.6% to 99.8%) |

TES, tax evasion status.

packaging noncompliance. Cigarette packs with non-compliant packaging are illicit for violating government tobacco regulations.[18 22 28 36] The proportion varied across the sampled districts and price segments. Although it varied across the sampled urban–rural and border–non-border locations, the differences were not statistically significant. We observed a statistically significant association between the likelihood of cigarette tax evasion and districts, price segment and shop type.

For other settings, it was argued that data on cigarette tax evasion is not widely accessible or transparent.[16] Similarly, Bangladesh's National Board of Revenue does not record such statistics.[26] Using ITC data and self-reported packaging information, Guindon *et al* estimated the share of tax-evaded cigarette packs for Bangladesh to be low but increasing (0.4% (wave I-2009) and 3.7% (wave II-2010)).[25] We estimated that 5.62% (95% CI: 4.3% to 7.1%) of cigarette packs in the sampled districts were illicit, including both tax-evaded and non-compliant packs. This figure is primarily driven by tax-evaded cigarettes, which accounted for an estimated 5.32% (95% CI: 5.04% to 5.60%) of the sampled packs. Compared with other South Asian countries, Bangladesh has a higher share of illicit cigarettes than India (2.7%) and Nepal (0.3%) but lower than Pakistan (17.8%) and Sri Lanka (10.8%).[22–24 37] The share is also lower compared with some other Asian (Malaysia, Vietnam, Turkey, Iran, Indonesia and Mongolia),[38–43] African (South Africa, Ghana, Nigeria, Kenya and Gambia),[18 44–47] and Latin and South American (Argentina, Brazil, Uruguay, Chile, Mexico and Colombia) countries.[15 20 48–51]

We found that only 0.77% (95% CI: 0.4% to 1.4%) of cigarette packs in selected districts of Bangladesh were non-compliant, and merely 0.33% (95% CI: 0.2% to 0.6%) originated from other countries. Thus, most illicit cigarettes in Bangladesh were manufactured domestically, primarily resulting from tax evasion rather than packaging noncompliance. Illicit trade and packaging non-compliance are often associated with high-priced cigarettes.[17 52] However, in the sampled districts in Bangladesh, the proportion of illicit cigarette packs in the low-price segment was three times higher than in the premium segment, with tax evasion odds being three and a half times greater. Since low-price segment cigarettes dominate the market in Bangladesh, evasion in this segment offers higher returns, as observed in India and Argentina.[15] The likelihood of illicit economy packs in Argentina was over 200 times greater than the premium packs.[15]

We found significant differences in the share of illicit cigarette packs among the administrative districts in Bangladesh. Maulvibazar, a northeastern district, had the highest share of illicit cigarettes (13.63%; 95% CI: 9.3% to 19.0%), consistent with earlier findings of tobacco tax evasion in northern districts.[26] Patuakhali and Comilla also had a higher share of illicit tobacco than the national average. It may stem from inconsistent enforcement of tobacco control laws and relatively high tobacco prevalence. Maulvibazar and Patuakhali, in the Sylhet and Barishal divisions, have the second and third-highest tobacco prevalence in Bangladesh, respectively (47.7% and 40.4%).[1] Comilla, in the Chittagong division, also has a higher prevalence than others (28.2%).[1] The share of illicit cigarettes and odds of tax evasion were similar in both border and non-border areas of Bangladesh, perhaps because cross-border smuggling offers low financial incentives. A 20-stick cigarette pack from the most sold brand costs US$1.12 in Bangladesh, compared with US$2.54 in neighbouring India (the nearest neighbouring country with the largest land border), making smuggling less profitable.[53]

We found that cigarette tax evasion is about twice as common in unconventional retailers (eg, bakeries, fruit retailers, cosmetics and stationery shops, newspaper shops, saloons and variety stores) as in ordinary or departmental stores. These retailers rely on informal distribution and may operate with less oversight, making it easier to avoid monitoring and evade taxes. Furthermore, research in other settings showed that informal retailing contributes to the distribution of illicit cigarettes, creating easy access to informal distribution and facilitating underage sales.[18 54 55]

Although small in magnitude, the sale of illicit cigarettes in shops highlights weak institutional capacity to regulate legal channels. We found that pack compliance accurately detects over 99% of tax-paid cigarette packs but only 9% of tax-evaded ones, suggesting a need for a robust tax track and trace system. Despite being an early signatory of the FCTC, Bangladesh has not signed and ratified the illicit tobacco trade protocol, which mandates a proper tracking system for supply chain monitoring.[56] Although introduced in 2002, Bangladesh's cigarette tax stamps remained non-digital and require enhanced security features for zero reproducibility.

Independent and consistent data on the share of illicit cigarettes in Bangladesh are lacking. Applying a rigorous method, we provided an independent and replicable estimate of the magnitude of illicit cigarette packs in Bangladesh. Often, illicit tobacco studies fail to distinguish between legal tax avoidance and illegal tax evasion.[23–25] Nevertheless, since our findings are based on tax stamp legitimacy, such limitation probability is low. A similar approach was followed in Argentina recently to explain illicit cigarette trade.[15] Additionally, the sampling captured urban–rural and border–non-border geographical aspects, yielding robust estimates with internal validity, further endorsed by littered pack estimates.

Despite the various strengths, the study findings have a few limitations. Although our sample included border and non-border districts, the generalisability of our findings is still limited to the sampled districts within the data collection time period. The estimates based on the packs collected from the retailers might have underestimated illicit cigarette sales for example, if the retailers only handed over the tax-paid and compliant packs. On the other hand, the estimates based on the littered packs were unlikely to have this limitation. However, we acknowledge that the sample size of the littered packs was significantly smaller than the packs collected from the retailers. Mobile vendors selling cigarettes remained out of the scope in the sample. We could not assess foreign packs' true tax payment status as they had no tax stamps. However, the effect of this limitation on the findings would be minimal as the share of foreign packs was

only 0.33% in the sample. Since we have a single data point, the scope of determining potential seasonality related to cigarette tax evasion was limited.

## CONCLUSIONS

We have found a low share of illicit or tax-evaded cigarette packs in Bangladesh. Also, cigarette packs mostly follow recommended features and are compliant. Despite the low share, continuous policy initiatives and their enforcement should be there to limit the share and keep it at a minimum. The low-price segment of the cigarette market should be prioritised while under surveillance as it has a higher share of tax-evaded cigarette packs than other segments. Given the association between shop type and cigarette tax evasion, unique licensing should be obligatory for retailing cigarettes. Strengthening institutional capacity and monitoring within legal enforcement is essential for improved surveillance coverage.

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