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Adherence to smoke-free laws at retail points-of-sale and associated factors in 10 cities in Ethiopia

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ABSTRACT

Objectives

The objective of this study was to assess adherence to smoke-free laws at points-of-sale (PoS), i.e., retail outlets that sell various goods including tobacco products, and to identify predictors of low adherence.

Methods

This cross-sectional observational study was conducted in December 2022 across 10 Ethiopian cities covering 1,323 PoS such as regular shops, permanent kiosks, khat shops, supermarkets and minimarkets. Sampling was performed using a two-stage cluster design, with random selection of PoS. Data were collected using checklists through covert observations. Logistic regression identified predictors of low adherence.

Results

More than half of PoS (52.5%) showed good adherence, 23.2% moderate, 20.8% poor or none, and only 3.4% met full adherence. Supermarkets/minimarkets had the highest rates of good or full adherence (83.9%), whilst kiosks and khat shops had the lowest (40.7% and 35.4%, respectively) rates of good or full adherence. Low adherence was higher in kiosks [adjusted odds ratio (aOR)=7.02, 95% CI: 3.76-13.13)] and khat shops (aOR=6.26, 95% CI: 3.48-11.26). Low adherence was also observed in Semera-Logia (aOR = 21.27, 95% CI: 13.26–34.12) and Gambella (aOR = 12.07, 95% CI: 7.64–19.08). Predictors of indoor smoking included being a khat shop (aOR=3.13, 95% CI: 1.29-7.60), being located in Semera-Logia (aOR=8.47, 95% CI: 3.49-26.54), presence of outdoor smoking (aOR=3.38, 95% CI: 2.07-5.51) and lighters (aOR=5.26, 95% CI: 3.05–9.06).

Conclusion

The study highlights enforcement gaps at PoS, particularly in khat shops, kiosks, and in Semera-Logia and Gambella cities. Strengthening smoke-free law implementation requires region-specific interventions for high-risk areas and retail outlets.

WHAT IS ALREADY KNOWN ON THIS TOPIC

- Retail points-of-sale (PoS) not only serve as centers for tobacco sales and advertising but also function as public places and workplaces, where there is a risk of secondhand tobacco smoke exposure for customers and employees.
- However, studies of adherence to smoke-free laws in retail PoS are scarce.

WHAT THIS STUDY ADDS

- This study is the first to examine adherence to smoke-free laws at retail PoS in Ethiopia, offering evidence from a multi-city assessment.
- While more than three-quarters of PoS (75.7%) showed good or moderate adherence, only 3.4% fully adhered to all smoke-free law requirements.
- Adherence was highest in supermarkets and minimarkets, but markedly lower in khat shops and kiosks.
- Low adherence was especially higher in cities such as Semera-Logia and Gambella.
- Predictors of indoor smoking included being a khat shop, location in Semera-Logia, and the presence of outdoor smoking, lighters, and cigarette butts.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- Findings indicate the need to strengthen enforcement efforts to improve adherence with smoke-free laws at retail establishments through increased monitoring, awareness raising, and targeted interventions.

INTRODUCTION

Exposure to secondhand tobacco smoke (SHS) is a major public health concern, causing over 1.3 million deaths annually worldwide, with the greatest impact in low- and middle-income countries (LMICs).[1 2] Despite global efforts to reduce smoking rates,[3] around 37% of the global population remains exposed to SHS.[4 5] Exposure to SHS is also linked to an increased risk of tobacco use among adolescents.[6 7] Smoke-free policies have been effective in reducing SHS exposure and improving public health outcomes globally.[2 8] Many LMICs have comprehensive tobacco control laws.[2] However, there is a pressing need for strengthening compliance monitoring and enforcement of the laws.

In Ethiopia, recent studies have reported tobacco use rates ranging from 4.2% to 5.0% among adults aged 15 and older.[9 10] Exposure to SHS remains a significant public health concern, with 13% of adults aged 15 and over reporting exposure at home and 29% at workplaces in 2016.[10] SHS exposure is even higher in public venues, with 60% of adults exposed in bars and nightclubs and 31% in restaurants.[10] These high levels of SHS exposure across various settings highlight the need for stronger enforcement to protect public health and mitigate the harmful effects of SHS exposure.

Ethiopia enacted a comprehensive tobacco control law through Proclamation No. 1112/2019.[11] This Proclamation mandates that all public places and workplaces be 100% smoke-free, prohibits smoking within a 10-meter radius of doorways, or windows, and bans smoking-related aids such as ashtrays and lighters. It also requires 'no smoking' signage to be posted both indoors and outdoors. These measures are reinforced by the Ethiopian Food and Drug Authority (EFDA) through Directive No. 771/2021.[12] Despite these legislative frameworks, compliance remains a challenge, with high levels of non-compliance observed in various public and workplace settings.[13] In a recent study, active smoking was observed in 32% of indoor venues, and only 13% of indoor spaces were fully compliant with smoke-free requirements.[14] The tobacco industry's efforts to undermine these laws,[15 16] necessitate the need for continuous monitoring and enforcement to strengthen tobacco control in Ethiopia.

Retail points-of-sale (PoS), i.e., retail outlets that sell various goods, including tobacco products, play a crucial role in tobacco control. They serve not only as venues for the sale and promotion of tobacco products, but also as environments that facilitate smoking and increase SHS exposure.[17-

[19] These establishments function as public places accessible to many people and as workplaces where employees spend significant time. Evidence shows that exposure to tobacco promotion at PoS is positively associated with increased smoking and smoking susceptibility.[18 20] Similarly, a recent study in India highlighted that combined exposure to SHS and tobacco advertisements at PoS increases the likelihood of tobacco initiation and use rates.[21] This suggests the importance of enforcing smoke-free laws at PoS to protect both customers and employees from smoking exposure and its consequences.

While research on implementation of smoke-free laws at retail PoS is limited,[17 19] the few available studies indicate that adherence to smoke-free laws at these retail outlets is generally low.[22] This lack of adherence undermines the effectiveness of smoke-free legislation, which is crucial for protecting public health by reducing exposure to SHS. This study aimed to investigate adherence to smoke-free laws at PoS, and associated factors, as part of a broader evaluation of tobacco control law compliance in 10 cities in Ethiopia.[23] The study provides critical insights to strengthen smoke-free legislation and enforcement efforts to effectively reduce public exposure to SHS.

METHODS

Study design, setting and population

This cross-sectional observational study was conducted in December 2022 in 10 purposively selected cities across Ethiopia: Addis Ababa, Adama, Assosa, Bahir Dar, Dire Dawa, Gambella, Harar, Hawassa, Jigjiga, and Semera-Logia. These cities were selected for their demographic and geographic diversity, higher population density, economic significance, and relatively high smoking prevalence.[10] Together, they are home to over seven million people. Ethiopia's total population was approximately 120 million in 2022,[24] making the selected cities a significant portion of the country's urban population.

Sample size and sampling procedures

The sample size calculation, based on the overall aims of the main study, is described elsewhere.[23] It assumed a 50% adherence to tobacco advertising and promotion laws at PoS. Using a 95% confidence level, a 4% margin of error, and a design effect of two to account for potential clustering due to cluster sampling, a minimum of 1,300 retail PoS were required for the study, including a 5% allowance for non-response.

Sampling was conducted using a two-stage cluster design across sub-cities, woredas, and kebeles in each city. The total sample size was divided among the 10 cities based on their estimated population sizes (S1 File). The sample size was further distributed to the selected woredas or kebeles using a probability proportional to size approach. In each woreda or kebele, due to challenges in obtaining accurate lists of PoS from many woredas or kebeles across selected cities, 4-6 neighborhoods with the highest concentrations of PoS were purposively chosen. Streets within these neighborhoods were mapped, selecting 4-6 streets for detailed observation on both sides to identify and list all PoS. The required number of PoS were then randomly selected from those that were listed. All operational PoS at the time of data collection were included in the study.

Data collection tools and procedures

This study used standardized checklists adopted from the "How-to-Guide for Conducting Compliance Studies" for smoke-free laws to collect data.[25] These checklists were tailored to align with the Ethiopian Tobacco Control Proclamation.[11] The checklists were translated from English to local languages, ensuring linguistic consistency through back translation (S2 File). Data collectors and supervisors underwent training on study objectives, sampling, data collection tools and procedures. Training also included sessions on the Ethiopian Tobacco Control Proclamation.[11] Pre-testing of data collection tools was conducted to identify and resolve any issues. Two data collectors collected data at each site using smartphones equipped with Open Data Kit software.

Adherence to smoke-free laws was assessed using five yes/no indicators: (1) absence of active indoor smoking, (2) absence of active outdoor smoking within a 10-meter radius of the main entrance or window, (3) presence of 'no smoking' signage at the main entrance or window, inside the premises, or both, (4) absence of indoor cigarette butts, and (5) absence of lighters inside the PoS. This study focused on enclosed or semi-enclosed retail PoS with accessible indoor spaces, as the adherence indicators such as indoor smoking, presence of cigarette butts, and indoor signage were not applicable to outdoor-only retailers.

Data collectors conducted covert observations both outside and inside of each PoS. They spent a few minutes outside each PoS, observing any active outdoor smoking within a 10-meter radius of main entrance or window, which they approximated by pacing. Observations were made inside the PoS from strategic locations such as the entrance, window, main counter, or supermarket aisles.

The data collectors noted adherence indicators, including both indoor and outdoor active smoking, and adherence to the law's requirements such as 'no smoking' signage. Data collectors entered data into their smartphones while inside the outlet when feasible or immediately outside after exiting, without the owners or staff being aware of it.

Data collectors were instructed to observe each PoS for approximately 30 minutes, ensuring they could assess all adherence indicators. While minor variations in time occurred based on the PoS size or customer activity, the observation period was kept as consistent as possible. Observations were conducted between 09:00 and 18:00 h, from December 5 to 28, 2022, to capture regular business hours and typical customer flow. We did not restrict the observations to specific times of day as our aim was to reflect usual PoS situation during routine operating hours.

Data quality control

Field supervisors reviewed at least 5% of the data collected by each pair of data collectors to ensure its quality. Supervisors also participated in data collection alongside the data collectors and resolved inconsistencies through discussions and clarification procedures. Data were uploaded daily to a central server at Addis Ababa University. The data manager provided immediate feedback, ensuring continuous review for completeness and consistency.

Operational definitions

PoS were defined as any retail establishments that sell various goods, including cigarettes and other tobacco products, regardless of whether these products were actually being sold at the time of observation. Adherence refers to the extent to which the PoS complied with smoke-free provisions outlined in the Ethiopian Tobacco Control Proclamation.[11] Active smoking means someone holding or using a lit tobacco product, such as cigarettes, cigars, or shisha, either indoor or outdoor the PoS. Further operational definitions are provided in the S3 File.

Data processing and analysis

Descriptive analysis used frequencies, proportions, and means to summarize the data. Data were stratified by both city and PoS to assess variations in adherence to smoke-free laws across different regions and retail establishments. Adherence to smoke-free laws was categorized into five levels based on the number of indicators met: fully adherent (5 indicators), good (4 indicators), moderate

(3 indicators), poor (1-2 indicators), and non-adherent (no indicators met). Bivariate and multivariable logistic regression models were used to assess associations with two dependent variables: (1) low adherence, and (2) presence of active indoor smoking (yes/no). The independent variables included type of PoS, city, presence of 'no smoking' signage, presence of lighters, and outdoor smoking within a 10-meter radius of main entrance or window.

Adherence to smoke-free laws was dichotomized into two categories based on the number of adherence indicators met. PoS meeting three or more of the five adherence indicators (i.e., fully adherent, good adherence, or moderately adherent) were grouped under 'moderate-to-high adherence', while those meeting two or fewer indicators (i.e., poor adherence or none) were categorized as 'low adherence'. This threshold was chosen to differentiate PoS with at least partial compliance with key indicators from those with consistently poor or no adherence. Due to the low rate of active indoor smoking observed in some PoS categories, they were merged and used as the reference category for regression analysis. Similarly, cities with less than 10% rate of active indoor smoking, were combined and used as the reference category. This grouping was based on their relatively low smoking prevalence and small sample sizes, which allowed for improved statistical power in the analysis.

Hosmer-Lemeshow goodness-of-fit test yielded non-significant results ($p>0.05$), indicating an adequate model fit. Collinearity was checked using the Variance Inflation Factor (VIF), which indicated no multicollinearity (VIF<2). Crude and adjusted odds ratios (ORs), along with corresponding 95% confidence intervals (CIs) were presented. Statistical significance was set at $p<0.05$. Data were analyzed using SPSS version 26 (IBM SPSS Statistics for Windows, Armonk, NY, USA).

RESULTS

Characteristics of the PoS

A total of 1,323 PoS were studied, comprising 56.8% regular shops, 12.4% khat shops, 11.3% supermarkets and minimarkets, 10.2% kiosks, and 6.7% merchandise stores. These PoS were distributed across 10 cities, including Addis Ababa (17.5%), Adama (11%), Hawassa (10.4%), Bahir Dar (10.1%), Gambella (9.4%), Harar (9.3%) and four other cities (32.4%).

Smoke-free laws adherence indicators

Table 1 describes adherence indicators across PoS types and study cities. Overall, 86.8% of PoS had no active indoor smoking, while 'no smoking' signage was present in only 10.4%. Outdoor smoking near entrances or windows was frequently observed (29.7%). Addis Ababa**,** Dire Dawa, and Assosa had the highest rates of no indoor smoking.

Table 1 Smoke-free adherence indicators by PoS type and study city (n=1323)

Variable	Adherence indicators (%)					Total, n
	No indoor smoking	Presence of 'no smoking' signage	No cigarette butts	No lighters	No outdoor smoking within 10m	
Overall (%)	86.8	10.4	77.2	81.7	70.3	1323
Points-of-Sale						
Supermarket/minimarket	97.3	16.1	96.0	96.6	84.6	149
Khat shop	78.0	1.8	61.6	81.1	54.3	164
Merchandise store	83.0	12.4	84.3	79.8	80.9	89
Regular shop	88.3	8.6	77.8	82.3	73.4	752
Permanent kiosk	75.6	19.3	68.1	62.2	52.6	135
Food and drinks wholesaler	79.4	26.5	73.5	88.2	58.8	34
City						
Addis Ababa	97.8	10.8	96.1	90.9	74.9	231
Adama	83.4	8.2	61.4	71.0	51.7	145
Bahir Dar	89.9	0.0	90.3	70.1	79.1	134
Hawassa	94.2	9.5	95.6	82.5	74.5	137
Jigjiga	92.8	1.8	67.6	94.6	82.9	111
Semera-Logia	33.9	69.5	20.3	78.8	22.9	118
Dire Dawa	98.0	3.0	98.0	81.0	72.0	100
Harar	92.7	0.8	92.7	84.6	85.4	123
Assosa	98.0	0.0	95.0	99.0	92.0	100
Gambella	80.6	0.0	41.9	63.7	69.4	124

Adherence level with smoke-free laws

The majority of PoS fell into 'good' (52.5%) or 'moderate' (23.2%) adherence categories (table 2). About 82% of supermarkets/minimarkets were rated as good or moderately adherent, though only 13.4% met full adherence criteria. In contrast, permanent kiosks had the lowest adherence, with

about 32% categorized as 'poor' and only 2.2% fully adherent. Hawassa (8.8%), Addis Ababa (7.4%), and Adama (6.2%) had the highest full adherence rates, while Semera-Logia had 60.2% of PoS categorized as 'poor adherence'.

Table 2 Adherence level to smoke-free laws by PoS type and study city (n=1323)

Variable	Adherence level (%)				
	Fully adherent	Good	Moderate	Poor	Non-adherent
Overall (%)	3.4	52.5	23.2	18.2	2.6
Points-of-Sale					
Supermarket/minimarket	13.4	70.5	11.4	4.7	0.0
Khat shop	0.0	35.4	32.3	25.0	7.3
Merchandise store	5.5	55.1	28.1	11.2	0.0
Regular shop	2.1	55.2	22.9	17.7	2.1
Permanent kiosk	2.2	38.5	22.2	31.9	5.2
Food and drinks wholesaler	2.9	47.1	29.4	20.6	0.0
City					
Addis Ababa	7.4	61.9	27.3	2.6	0.9
Adama	6.2	32.4	24.8	28.3	8.3
Bahir Dar	0.0	59.7	22.4	14.2	3.7
Hawassa	8.8	56.9	22.6	8.8	2.9
Jigjiga	0.0	53.2	36.0	10.8	0.0
Semera-Logia	3.4	13.6	19.5	60.2	3.4
Dire Dawa	2.0	61.0	25.0	12.0	0.0
Harar	0.8	71.5	17.1	8.9	1.6
Assosa	0.0	90.0	6.0	4.0	0.0
Gambella	0.0	26.6	26.8	42.7	4.8

Indoor and outdoor smoking

Table 3 shows that 10.1% of PoS had both indoor and outdoor active smoking within a 10-meter radius of the main entrance or window, while 22.8% showed evidence of either type. About two-thirds of PoS had no observed active smoking in indoor or outdoor. Permanent kiosks and khat shops had the highest rates of both indoor and outdoor smoking. Semera-Logia also had the highest proportion of PoS with both indoor and outdoor smoking types, with only 16.9% of its PoS adhering to smoke-free laws.

Table 3 Indoor and outdoor smoking by PoS type and study city (n=1323)

Variable	Percentage (%)			Total, n
	Both indoor smoking and outdoor smoking within 10m	Either indoor smoking or outdoor smoking within 10m	Neither indoor smoking nor outdoor smoking within 10m	
Overall (%)	10.1	22.8	67.2	1323
Points-of-Sale				
Supermarket/minimarket	2.0	14.1	83.9	149
Khat shop	15.9	36.0	48.2	164
Merchandise store	1.1	23.6	75.3	89
Regular shop	9.3	19.7	71.0	752
Permanent kiosk	20.0	31.9	48.1	135
Food and drinks wholesaler	17.6	26.5	55.9	34
City				
Addis Ababa	1.7	23.8	74.5	231
Adama	11.7	41.1	46.9	145
Bahir Dar	6.0	19.4	74.6	134
Hawassa	5.1	21.2	73.9	137
Jigjiga	3.6	17.1	79.3	111
Semera-Logia	60.2	22.9	16.9	118
Dire Dawa	0.0	30.0	70.0	100
Harar	4.9	12.2	82.9	123
Assosa	2.0	6.0	92.0	100
Gambella	11.3	27.4	61.3	124

Predictors of low adherence and active indoor smoking

Results of the multivariable logistic regression analyses for low adherence and active indoor smoking are shown in table 4. Compared to supermarkets, mini-markets, merchandise stores, and food and drink wholesalers, the odds of low adherence were significantly higher in regular shops, permanent kioks, and khat shops. Semera-Logia had the highest odds of low adherence (aOR=21.27, 95% CI: 13.26–34.12), followed by Gambella (aOR=12.07, 95% CI: 7.64–19.08). Active indoor smoking was significantly associated with the presence of lighters and cigarette butts, location in Semera-Logia, and outdoor smoking within a 10-meter radius of the main entrance or window. However, the presence of 'no smoking' signage was not significantly associated with indoor smoking.

Table 4 Multivariable logistic regression predictors of low adherence and indoor active smoking (n=1323)

	Adjusted OR (95% CI) for low adherence	*P-value*	Adjusted OR (95% CI) for active smoking	*P-value*
Points-of-Sale				
Supermarket, minimarket, merchandize store, and food and drinks wholesaler*	1		1	
Regular shop	**2.97 (1.81-4.88)**	**<0.001**	1.19 (0.56-2.53)	0.659
Permanent kiosk	**7.02 (3.76-13.13)**	**<0.001**	1.34 (0.50-3.60)	0.563
Khat shop	**6.26 (3.48-11.26)**	**<0.001**	**3.13 (1.29-7.60)**	**0.012**
City				
Addis Ababa, Dire Dawa, Assosa, Jigjiga, Hawassa, and Harar*	1		1	
Adama	**5.82 (3.73-9.07)**	**<0.001**	0.68 (0.32-1.46)	0.326
Bahir Dar	**2.58 (1.53-4.37)**	**<0.001**	1.48 (0.62-3.51)	0.376
Semera-Logia	**21.27 (13.26-34.12)**	**<0.001**	**8.47 (3.49-20.54)**	**<0.001**
Gambella	**12.07 (7.64-19.08)**	**<0.001**	0.90 (0.44-1.85)	0.771
Smoke-free indicators				
'No smoking' sign (yes/no)	NA	NA	1.42 (0.60-3.33)	0.422
Presence of lighter (yes/no)	NA	NA	**5.26 (3.05-9.06)**	**<0.001**
Outdoor smoking within 10m (yes/no)	NA	NA	**3.38 (2.07-5.51)**	**<0.001**
Presence of cigarette butts (yes/no)	NA	NA	**11.04 (6.30-19.34)**	**<0.001**

Values in bold indicated p-value <0.05
OR, Odds Ratio; CI, Confidence Interval; NA, Not applicable as the outcome variable is derived from a composite of these individual variables; *Combined, the rate of poor adherence and indoor smoking in each category <10%.

DISCUSSION

This study is the first to assess adherence to smoke-free laws across various types of PoS, providing a comprehensive view within retail establishments in Ethiopia. More than half of PoS (52.5%) showed good adherence to smoke-free laws, 23.2% moderate, 20.8% poor or none, and only 3.4% met the full adherence criteria. About 10% of PoS were observed with both indoor and outdoor smoking, 22.8% with either indoor or outdoor smoking, and 67.2% with neither indoor nor outdoor smoking. Supermarkets and minimarkets showed the highest level of adherence, while khat shops and permanent kiosks reflected the lowest. Among cities, Addis Ababa and Hawassa demonstrated the highest adherence, whereas Semera-Logia and Gambella showed the lowest.

This study highlights the challenges of enforcing smoke-free laws in retail establishments in Ethiopia, particularly at khat shops and kiosks, where cultural norms and concurrent substance use

contribute to lower adherence.[26] Moreover, khat shops often operate informally without formal business licenses, as khat is not regulated like other retail commodities in Ethiopia. EFDA and regional health bureaus are mandated to enforce the smoke-free provisions of the tobacco control law, including at PoS. According to the law, violations such as allowing smoking in prohibited areas, are subject to administrative penalties, including monetary fines, temporary closure, or license suspension.[11 12] However, weak enforcement mechanisms, and minimal deterrent penalties may reduce the perceived risk of non-adherence among retailers. This suggests that stronger enforcement could improve adherence in these high-risk retail establishments.

Supermarkets, being more formal and organized, often sell goods in full packages, reducing the likelihood of casual smoking behaviors within the premises. Moreover, targeted awareness creation efforts by regulatory bodies, which focused on educating supermarket and minimarket staff in major cities in Ethiopia about smoke-free laws, may have further contributed to higher adherence in these settings. Similar trends were observed in Guatemala[27] and India,[28] where small businesses and transit sites often show poor adherence. Studies indicate that adherence is generally lower in informal and smaller retail environments, with factors such as lack of enforcement, inadequate signage, and cultural acceptance of smoking contributing to non-adherence.[17 19]

Geographic variations in adherence to smoke-free laws highlight significant regulatory gaps across cities, with Semera-Logia and Gambella showing the lowest adherence rates. Cultural acceptance of smoking likely contributes to weak enforcement of smoke-free laws in these settings. Their role as key entry points for illicit tobacco may also undermine adherence.[10] Additionally, the availability of illicit cigarettes in border regions near Djibouti, Somalia, and South Sudan may further explain the lower adherence levels observed in these areas.[29] This trend is consistent with findings from rural and under-served urban settings where enforcement and public awareness of smoke-free laws are generally weaker.[30] Consequently, regionally tailored interventions may be essential to improve adherence to smoke-free regulations.

Our findings indicate a higher rate of active indoor smoking in PoS (13.2%), contributing to lower adherence, compared to a previous study that reported a rate of 7.7% in public places.[13] Our study was conducted in major cities across 10 regions, including high-prevalence areas and venues like khat shops, where concurrent tobacco use is common. The difference may also be partly explained by the inclusion of settings like educational institutions and government offices in the previous

study,[13] where smoking is generally less common. Stronger enforcement of smoke-free laws in workplaces, particularly by the EFDA in Addis Ababa and other regional cities, may have contributed to lower smoking rates in those settings. In contrast, PoS environments, especially informal or less regulated ones, may not receive the same level of oversight, leading to higher rates of active smoking, a trend also observed in other studies.[31]

A study in India reported a very low level of active smoking rates (2%), with higher indoor smoking rates observed in transit stations.[32] Similarly, research in Nepal indicated active smoking rate of up to 38.5% in transit areas and 26% in hospitality venues.33 In Bangladesh, 12% of indoor public places had smokers, with an association between the absence of 'no smoking' signage or the presence of cigarette butts with the presence of active smoking.[31] These variations across countries suggest that enforcement, venue type, and the presence of visible signage significantly influence smoking behavior in public spaces. However, the existing literature predominantly focuses on adherence to smoke-free laws in public places, with few studies examining the PoS.[31-33]

The overall low percentage of 'no smoking' signage observed in our study likely reflects gaps in the implementation and enforcement of smoke-free laws, which may contribute to lower adherence. Furthermore, the presence of lighters and cigarette butts in many PoS underscores the need for stronger enforcement and public awareness initiatives. During our data collection, we observed ongoing initiatives and campaigns promoting the use of 'no smoking' signage at PoS in Semera-Logia. However, despite these visible efforts as reflected in 69.5% of PoS displaying the signs, our findings suggest that the absence of enforcement mechanisms limited their effectiveness in improving adherence to smoke-free laws. This highlights that signage alone is not sufficient to ensure adherence to smoke-free laws without active regulatory enforcement.

In our study, the presence of 'no smoking' signage did not significantly influence indoor smoking, despite being a widely used smoke-free law indicator. Previous research presents mixed results regarding signage efficacy. For instance, studies from Greece and Turkey found that signage was not a strong determinant of indoor smoking behavior.[34 35] However, studies from India and Nepal reported lower odds of active smoking in public places with visible signage.[32 33] Systematic reviews suggest that successful smoke-free policy enforcement often combines visible signage

with awareness raising activities, and policy promotion.[36] Enhancing the visibility, clarity, and enforcement of signage may improve adherence to smoke-free policies in Ethiopia.

Our study also found that the presence of smoking-aids, such as lighters, was a significant predictor of indoor smoking, supporting the idea that these aids and environmental cues facilitate smoking behaviors and reduce the ability to resist smoking.[37 38] A previous study has shown that tobacco-related items like ashtrays and lighters can reinforce smoking habits, making quitting more challenging.[34] Similarly, cigarette butts, often used as proxies for smoking activity, were observed in 22.8% of PoS, with the highest prevalence in khat shops and permanent kiosks. This finding aligns with prior studies that used cigarette butts as an indicator of non-adherence to smoke-free laws.[13 37]

Compared to indoor smoking, outdoor smoking was more prevalent, with 29.7% of PoS having active smoking within a 10-meter radius of main entrance or window. Studies indicate that outdoor smoking near main entrances or windows can lead to higher levels of indoor SHS exposure, especially during periods of active smoking.[39] SHS levels remain hazardous up to nine meters from the source, with smoke particles entering indoor environments via air intakes.[39-41] Although outdoor smoke-free zones are already legally mandated, strengthening enforcement and compliance monitoring in these areas could further reduce exposure to SHS and support adherence to indoor smoke-free laws.

Strengths and limitations

This study included a diverse range of PoS types and geographic locations, enhancing its generalizability to urban settings. Rigorous data collection methods strengthen the credibility of the findings, while the inclusion of composite adherence indicators adds depth to the understanding of enforcement challenges and successes. Moreover, the findings provide valuable baseline data for future studies assessing adherence to smoke-free laws at PoS. The use of observational data collection may lead either to underestimation or overestimation of adherence levels, potentially affecting the accuracy of the assessment. Observations were limited to a 30-minute period at each PoS, which may not capture smoking behavior at different times of the day and could lead to under or overestimation of non-adherence. Additionally, the way we categorized certain variables such as grouping cities with low smoking prevalence to improve statistical power and dichotomizing adherence levels, may have influenced the study findings. .

Conclusion and recommendations

The findings reveal significant variations in adherence across PoS types and locations. While supermarkets and minimarkets demonstrated higher adherence, khat shops, permanent kiosks, and cities like Semera-Logia and Gambella exhibited notably low adherence. To address this, there is a need for actions to increase adherence in settings where this is low. This could include targeted smoke-free interventions such as awareness raising, staff training, community engagement and mobilization, and strengthening compliance monitoring and enforcement mechanisms.

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Contributors

SAK, TGA, NDM, WD, and SH conceptualized the study. WD curated the data and conducted the formal analysis. SAK, TGA, and NDM acquired the funding. WD and SH conducted the investigation. WD, SH, TGA, and NDM developed the methodology. WD and SH managed the project and supervised the work. WD wrote the original draft. WD, SH, NDM, and TGA reviewed and edited the manuscript. All authors reviewed and approved the manuscript. WD is responsible for the overall content as the guarantor.

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Data availability statement

Data is provided within the manuscript or supplementary information files. In addition, the full datasets used and analyzed in the current study are available from the corresponding author upon reasonable request.

Ethics approval

Ethics approval for the study was obtained from the Institutional Review Board of the Ethiopian Public Health Association (EPHA) (EPHA/OG/201/22; November 18, 2022). Observation checklists did not include names, addresses, or any other identifying information, ensuring anonymity, privacy, and data confidentiality. As this study was based on covert observation, there was no need of consent to participate.

Consent for publication

Not applicable

Competing interests

The authors declare no competing interests.

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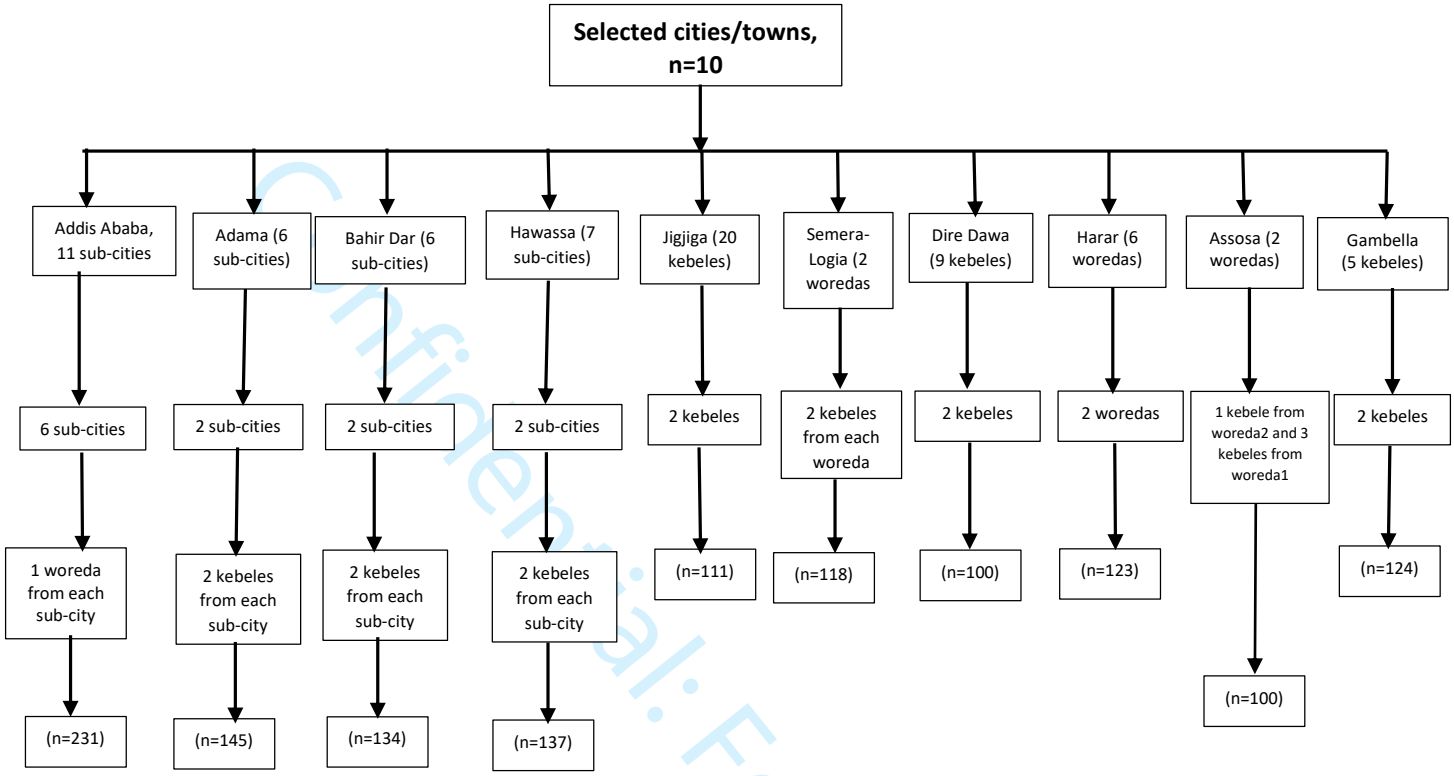

S1. Multistage schematic sampling technique, Ethiopia, December 2022

S2. Observation Checklists for Points of Sale

Observation Form for Smoke-free Adherence

Section I: Point of Sale Identifier

Variable Name	QUESTIONS	Response/response categories	Skip
POSID	Unique ID for the point of sale (POS)		
POS101	Administrative Region	1. Addis Ababa 2. Oromia 3. Amhara 4. Sidama 5. Somali 6. Afar 7. Dire Dawa 8. Harari 9. Benishangul Gumuze 10. Gambela	
POS102	City/Town	1. Addis Ababa 2. Adama 3. Bahir Dar 4. Hawassa 5. Jigiga 6. Semera -Logia 7. Dire Dawa 8. Harar 9. Assosa 10. Gambela	
POS103	Zone/sub-city		
POS104	Woreda		
POS105	Kebele		
POS106	Date of the visit (DD/MM/YY)	⌊_⌋⌊_⌋ ⌊_⌋⌊_⌋ ⌊_⌋⌊_⌋ **dd mm year**	
POS107	Type of the point of sale	1. Supermarket 2. Khat shop 3. Merchandise Store 4. Mini market 5. Regular shop 6. Permanent kiosk 7. Street vendor 8. Food and drink wholesalers 96. Other, please specify_____	

SECTION II: Indoor and Outdoor Observation

Variable Name	QUESTIONS	Response (For each item, please select "0" if you don't observe it today. Please enter "1" if you observe/ available today.	
	Warning Signage		
POS208	Presence of any person smoking tobacco (within 10meter radius of the shop)	0.No	1. Yes
POS319	Presence of clear and prominent posts regarding the prohibition of tobacco smoking and use along with its corresponding **"no-smoking sign".**	0.No	1.Yes
	Presence of tobacco consumption		
POS 321	Do you observe anyone smoking in the indoor space of the retail point?	0. No	1. Yes
POS 322	Do you observe a cigarette butt in the indoor space?		
POS 323	Do you observe a lighter?	0.No	1. Yes
POS 325	Any additional information about the indoor observation.		

S3. Operational definitions

Food and drink wholesaler: means any person who sells food products and beverages to retailers or governmental and non-governmental organizations or cooperatives by wholesale after having bought such goods from producers or importers.

Indoor: means any place within a retail establishment that has a fully enclosed and secure structure with an entrance. This definition doesn't include street or mobile vendors.

Khat shop: An establishment where khat leaves (*Catha edulis*) are sold. These shops are typically permanent structures, often located in buildings or housing complexes, and cater to customers purchasing khat for personal consumption. Khat shops often have counters and shelves for displaying and selling khat, as well as complementary products such as cigarettes, alcoholic and non-alcoholic beverages, snacks, and other goods. The use of khat within these shops may occur, and tobacco use (e.g., cigarettes) may also take place in some shops depending on the size and the practices of the owner, but it is not universal. Sale of khat at these shops is not illegal in Ethiopia.

Merchandise store: a store that is big and sells a variety of things such as food products and beverages, and household supplies including clothes.

Minimarket: refers to a store that sells food and sometimes other goods but is not as big as a supermarket.

Outdoor: means any place outside of any retail establishment that is not 'indoors', including any verandah, exterior wall or a window facing outward in any such establishment. This definition also includes street or mobile venders.

Permanent kiosk: refers to a small, permanent, stand-alone venue/location used for marketing purposes.

Regular shop: a small retail store in a building or part of a building where certain goods including food products and drink items are sold or purchased.

Street vendor: a person who offers goods or services for sale to the public without having a permanently built structure but with a temporary static structure with an open front on the street.

Supermarket*:* a large type of retail store that generally sells a range of household items, including food and beverages, sanitary materials, and cosmetics, and is properly placed and arranged in specific departments.

Tobacco product: any product entirely or partly made of the tobacco leaf as a raw material which is manufactured to be used for smoking, chewing, sucking, or snuffing.

September 02, 2025

Point-by-Point Responses to Reviewers' Comments

Manuscript Title: Adherence to smoke-free laws at retail points-of-sale and associated factors in 10 cities in Ethiopia

Manuscript ID: tc-2025-059540

Reviewer(s)' Comments to Author

Reviewer: 3
Comments to the Author
Review of Adherence to smoke-free laws at retail points-of-sale and associated factors in 10 cities in Ethiopia

Thank you for asking me to review this paper. The paper is well-written and presents important novel information on compliance with smoke-free legislation in PoS in Ethiopia.

My comments are as follows:
'What this study adds' section
1. The final point 'Predictors of poor adherence included the presence of lighters and cigarette butts, type of PoS, and geographic location ' is a bit confusing as absence of indoor cigarette butts and absence of lighters are items 4 and 5 on the indicators of adherence (line 165 pg6). They can't be part of the measure of adherence and a predictor. I think this sentence is mixing the predictors of adherence and the predictors of indoor smoking and these need to be separate.

Author responses:
We thank the reviewer for carefully noting this mistake. The sentence has now been corrected to accurately reflect our findings. The revised text reads as follows:
"Predictors of indoor smoking included being a khat shop, location in Semera-Logia, and the presence of outdoor smoking, lighters, and cigarette butts."

We appreciate the reviewer's attention to detail, which has helped us improve the clarity and accuracy of the manuscript.

Introduction
2. A very minor point but line 113 'Exposure to the PoS tobacco promotion is positively associated with increased smoking and smoking susceptibility,' and associated references , while very true is not directly relevant to this study and analysis.

Author responses:
We appreciate this insightful comment. Our intention was to highlight the broader impact of PoS environments, where exposure not only involves secondhand smoke but also tobacco promotion, both of which can influence smoking initiation and use. To clarify this link and ensure relevance

to our study objectives, we have revised the paragraph as follows to explicitly connect PoS exposure with the importance of smoke-free law enforcement.

"Evidence shows that exposure to tobacco promotion at PoS is positively associated with increased smoking and smoking susceptibility.[18 20] Similarly, a recent study in India highlighted that combined exposure to SHS and tobacco advertisements at PoS increases the likelihood of tobacco initiation and use rates.[21] This suggests the importance of enforcing smoke-free laws at PoS to protect both customers and employees from smoking exposure and its consequences."

Methods

3. The methods for sampling the PoS and the sample size calculation both refer to two stage cluster sampling and also the sample size calculation refers to the inclusion of a design effect. Was the design effect of the two-stage sampling included in the analysis?

Author responses:

We thank the reviewer for this observation. The design effect of two was incorporated during the sample size calculation stage to account for potential clustering due to the two-stage sampling approach, as already stated in the Sample Size and Sampling Procedures part of Methods section.

Results

4. It is right to note in limitations that the categorisation of cities and PoS types for analysis based on observed adherence may have affected findings. No further action necessary.

Author responses:

We thank the reviewer for this observation. We note that this point has already been acknowledged in the limitations section of the manuscript.

Discussion

5. The sentence 'The overall low percentage of 'no smoking' signage in our study may indicate limited smoke-free regulations, potentially lowering adherence' is unclear. I thought that the signage was already law through Proclamation No. 1112/2019. Should this refer to implementation or enforcement rather than regulation?

Author responses:

Thank you for the comment. We agree that the issue pertains to implementation and enforcement rather than regulation. We have revised the sentence to read: "*The overall low percentage of 'no smoking' signage observed in our study likely reflects gaps in the implementation and enforcement of smoke-free laws, which may contribute to lower adherence.*"

6. The same for 'Extending smoke-free zones to cover outdoor areas adjacent to PoS could strengthen indoor smoke-free law enforcement and reduce risks from SHS exposure'. This is already law, is this support for implementation or more enforcement that is suggested to be required?

Author responses:
Thank you for the comment. We agree that the law already covers these areas. The intention of the sentence is to highlight the need for stronger enforcement and compliance monitoring in these outdoor zones, rather than proposing a legal change. We have revised it to read: "*Although outdoor smoke-free zones are already legally mandated, strengthening enforcement and compliance monitoring in these areas could further reduce exposure to SHS and support adherence to indoor smoke-free laws.*"

Other
7. The high prevalence in khat shops is interesting. For readers unfamiliar with khat shops it would be really useful to note whether the use of khat predominantly occurs within the shops i.e. are these social spaces where khat is used and tobacco is part of that? Also it is still not fully clear whether use of khat is legal. The manuscript states these PoS are unlicenced but is use and or sale illegal?

Author responses:
We thank the reviewer for this comment. We have revised the operational definition of khat shops in the Supplement to clarify that, while these establishments primarily sell khat legally, use of khat may occur on-site. In addition, tobacco products such as cigarettes may also be used within these khat shops, depending on the size of the shop and the practices of the owner.