

ORIGINAL ARTICLES

The association between smoking status and tobacco outlets density and proximity: A cross-sectional study with geographical data from CHILILAB, 2016

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ABSTRACT

Objective: Smoking behavior among adults still exists in Vietnam. This paper aims to describe smoking behavior among people aged 15 and above, specifically those monitored by the demographic surveillance system – CHILILAB, in order to determine the association between smoking behavior and the tobacco outlets density and proximity.

Methods: A cross-sectional study was conducted with a total of 5,076 households, with one 15-and-over member in each household selected randomly to answer the questionnaire. Coordinate data of households and tobacco outlets was collected. Smoking status was the main dependent variable. Distance from household to nearest tobacco outlet, and number of tobacco outlets in different radius were calculated using ArcGIS 10.4.1.

Results: The prevalence of current smoking status was 17.1% (36.6% among male and 1.0% among female). The average distance to nearest tobacco outlet was 170.7 meters and an average of 3.1 tobacco outlets in radius of 100 – 200 meters around participants' households. Both density and proximity of tobacco outlets showed associations with smoking prevalence. To reduce smoking prevalence among community, policymakers should consider applying a range of no-tobacco-outlet, as well as reduce the number of existed tobacco retailers.

Conclusion: The density and proximity of tobacco outlets should be considered an important factor to be controlled in analysis related to tobacco smoking.

Keywords: *smoking status; tobacco outlets; density; proximity; geographical data*

INTRODUCTION

Globally the number of adult smokers has decreased in recent years, however, the popularity of tobacco smoking behavior persists. According to the CDC, smoking is one of the leading causes of preventable death in United States, which accounts for over 480,000 deaths every year, or about one in 5 deaths (1). It has been reported that in 2016 more than 15 out of every 100 adults in the US aged 18 and above

(which accounted for about 15.5%) smoked cigarettes, which meant that around 38 million adults in the US were smokers (2). In Vietnam, data from Global Adult Tobacco Survey (GATS) in 2015 also showed the prevalence of smoking among people aged 15 and older was 22.5% (45.3% of men and 1.1% of women), which accounted for 22.5 million smokers (3).

It is gradually being recognized that local geographical characteristics are essential factors in understanding the prevalence of



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Submitted: 6 October, 2020

Revised version received: 20 October, 2020

Published: 26 March, 2021

smoking (4, 5) and the efficacy of tobacco control interventions (6, 7). Accessibility to tobacco outlets has been raised as one of these characteristics. Recent evidence has indicated a positive relationship between access to tobacco outlets and smoking behavior in youth/adolescents (8-10) as well as adults (11). Two factors that have been frequently used in many research to assess the effect of accessibility to tobacco outlets are the density (number of outlets within an area) and proximity (distances to these outlets) (6, 8, 12, 13). Previous studies have found that outlet density was associated with increased chance of smoking among youth and adolescents (8, 14, 15), while proximity was associated with decreased chance of smoking cessation among adults (16, 17). However, there are inconsistencies with these findings as some research showed no association between the number of tobacco retailers and smoking prevalence (18, 19), which implies that more evidence needs to be added in order to confirm this association.

In Vietnam, there is little evidence when examining the association between smoking behaviors and neighborhood tobacco outlets, which could contribute to explaining the high proportion of adults who see tobacco advertisement/promotion in Vietnam (3). This paper describes results from a study which was conducted in Hai Duong province, Vietnam in 2016 with 2 objectives: Firstly, we aim to describe smoking status among people aged 15 and older in 7 communes/towns in Chi Linh district, Hai Duong province, 2016. Lastly, we assess whether there are potential associations between smoking status among study participants and other personal factors and tobacco outlets characteristics.

METHODS

Study design: This was a cross-sectional study.

Study participant

Participants were aged 15 and older. Those under the demographic surveillance system management of CHILILAB (Chi Linh Health and Demographic Surveillance System) in Chi Linh District, Hai Duong Province, Vietnam in 2016 were selected to participate in this study. Information about CHILILAB and its data collection process were described in previous study (20).

Sample size and sampling

Sample size in this study was the entire 5,585 households of CHILILAB's management, which had participated in the *2016 Socioeconomic and Health Survey in CHILILAB* (detailed sampling method was described in the design paper (21)). In each household, one person aged 15 and older was selected randomly to answer the individual questionnaire. At the time of data collection, there were only 5,076 households, others were moved away or had no person. The response rate was about 97% (4,938 households).

Measurements

Smoking status of participants in this study were drawn from the survey question: "At the current time, do you smoke?" (There were 4 categories: *daily smokers*, *intermittent smokers*, *current non-smokers*, *never smokers*). All these smoking categories were mutually exclusive. Based on these smoking statuses, we created the main binary outcome: Current smokers or not (in which one group contain participants who were *daily smokers* and *intermittent smokers* versus the opposite group with people who *never smoke* or *former smokers*).

Independent variables were gender, age group (35 and below, 36 – 60, 61 and above),

highest educational level (secondary school and below; high school; college and above), and place of residence (urban/rural). We also calculated wealth index (in quantiles).

For variables regarding tobacco outlets, we created variables to describe the density (number of tobacco outlets in radius of 20/50/100/200 meters around households) and the proximity (distance from household to the nearest tobacco outlets in meters) of them by using ArcGIS 10.4 software. Under the Proximity toolset, Point Distance function was used to calculate the average distance from each household to the nearest tobacco outlet. Buffer function was also used to draw a circle around each household with different radius (20 meters, 50 meters, 100 meters and 200 meters). Then, the number of tobacco outlets was counted in each different radius using the Spatial Join function under the Overlay toolbox in ArcGIS.

Data collection

Data collection was coordinated by Center for Population Health Sciences (CPHS) – Hanoi University of Public Health. Data collectors were collaborators who had worked in CHILILAB in each commune/town. Two phases of data collection were performed:

- In the first phase, one person in every selected households were interviewed using structured questionnaire. This questionnaire was developed using previous data collection forms of CHILILAB including questions about smoking and drinking status. Data was collected using Samsung tablets, all information was updated daily to a Cloud-storing service (Dropbox) during the data collection process.
- In the second phase, every household participated in the first phase was located using handheld GPS devices with a licensed

application (Super GEOGps) for location data. All tobacco outlets in each communes/town were also located. The longitude and latitude data were collected during this phase.

Data analysis and statistical method

We performed both descriptive and inferential statistics in this study. All independent variables were described under main outcome by calculating frequencies and percentages. Simple logistic regression was used for each independent variable with the main outcome with significant level of 0.05. Multiple logistic regression was conducted to provide a theory model with predictors from different levels (individual and tobacco outlet level).

Ethical considerations

This study was approved by the Ethics Committee of Hanoi University of Public Health under the Decision No.262/2016/YTCC-HD3. The study information about objectives, selection criteria, personal information privacy, data protection, advantages and potential harm, were all provided to participants before interviewing. Written consent forms were also collected from participants before carrying out the questionnaire. Each participant was assigned a study number and all collected data was coded.

RESULTS

General characteristics of study participants

Among 4938 study participants, the percentage of male and female were 45.6% and 54.4%, respectively. Most of participants were at the age of 36 – 60 (55.6%), people who were less than 35 and 60 or above made up 21.5% and 23.0%, respectively. About half of participants (56.3%) had the highest

educational level of secondary school and below, one forth were high school and the rest (18.0%) had educational level at college or above. People were mostly from urban areas

(68%). The prevalence of current smoking was 17.1% (36.6% among male and 1.0% among female). Other key characteristics of study participants are described in Table 1.

Table 1. Characteristics of study participants

Characteristics		Male	Female	Total N (%)
		2284 (45.6)	2728 (54.4)	4938 (100)
Age group	Less than 35	452 (19.8)	624 (22.9)	1076 (21.5)
	36-60	1298 (56.8)	1486 (54.5)	2784 (55.6)
	Above 60	534 (23.4)	618 (22.7)	1152 (23.0)
Highest educational level	Secondary school or below	1171 (51.3)	1650 (60.5)	2821 (56.3)
	High school	652 (28.6)	632 (23.2)	1284 (25.6)
	College or above	458 (20.1)	445 (16.3)	903 (18.0)
Place of residence	Rural	682 (29.9)	921 (33.8)	1603 (32.0)
	Urban	1602 (70.1)	1807 (66.2)	3409 (68.0)
Household size	1-2 persons	852 (37.3)	1122 (41.1)	1974 (39.4)
	3-4 persons	1111 (48.6)	1193 (43.7)	2304 (46.0)
	5 persons and over	321 (14.1)	413 (15.1)	734 (14.6)
Wealth index (in quantiles)	Q1 - Poorest	421 (18.4)	587 (21.5)	1008 (20.1)
	Q2	499 (21.9)	656 (24.1)	1155 (23.0)
	Q3	379 (16.6)	469 (17.2)	848 (16.9)
	Q4	440 (19.3)	515 (18.9)	955 (19.1)
	Q5 - Richest	545 (23.9)	501 (18.4)	1046 (20.9)
Smoking status	Current smokers	818 (36.6)	26 (1.0)	844 (17.1)
	Non-smokers	1418 (63.4)	2672 (99.0)	4090 (82.9)

Density and proximity of tobacco outlets around participants' households

As shown in Table 2, the average distance to nearest tobacco outlet of participants' households was 170.7 (± 191.9) meters, in urban area this distance was 136.1 (± 149.9) meters while in rural area was 246.3 (± 242.0) meters ($p < 0.05$).

The amount of tobacco outlets in 50 – 100 meters radius around urban and rural area were 1.3 and 0.5, respectively ($p < 0.05$). Same result was found for 100 – 200 meters radius, in urban area this number was 3.9 tobacco outlets and 1.3 tobacco outlets in rural area ($p < 0.05$). Table 2 also shows other information about proximity of tobacco outlets around participant households.

Table 2. Density and proximity of tobacco outlets around participant' households

Characteristics		Urban area (Mean and SD)	Rural area (Mean and SD)	Total (Mean and SD)
Average distance to the nearest tobacco outlet (meters)		136.1 (149.9)	246.3 (242.0)	171.3 (191.4)
No. of tobacco outlets in radius	20 – 50 meters	0.5 (0.02)	0.3 (0.02)	0.4 (0.01)
	50 – 100 meters	1.3 (2.1)	0.5 (1.1)	1.1 (1.9)
	100 – 200 meters	3.9 (5.3)	1.3 (2.1)	3.1 (4.7)
No. of tobacco outlets in radius	Under 50 meters	0.8 (1.5)	0.4 (1.0)	0.7 (1.3)
	Under 100 meters	2.1 (3.1)	0.9 (1.7)	1.7 (2.8)
	Under 200 meters	5.9 (7.4)	2.2 (3.1)	4.8 (6.6)

Smoking status among study participants

Table 3 demonstrates smoking status in study participants when considering their characteristics. Results showed that smoking prevalence among male was 36.6% (95% CI: 33.2% – 40.0%). The proportion of current smokers among people less than 35 years old, from 36 – 60 years old and above 60 were 8.7%, 21.8% and 13.8%, respectively. Regarding educational level, smoking prevalence was

highest among people who had high school degree (17.8%, 95% CI: 13.1 – 23.5). People who smoked came equally from both urban and rural area (about 17.0%). The average distance to the nearest tobacco outlet among current smokers was 176.5 meters (95% CI: 162.9 – 190.1) while the number of tobacco outlets in 100 – 200 meters radius around current smokers' house was about 4 outlets (95% CI: 3.5 – 4.3)

Table 3. Percentage of smoking status by selected study participants characteristics

Characteristics		Current smokers N (%)	95% CI
		846 (17.1)	14.7 – 19.9
Gender	Female	26 (0.9)	0.6 – 1.4
	Male	818 (36.6)	33.2 – 40.0
Age group	Less than 35	92 (8.7)	3.8 – 16.4
	36-60	597 (21.8)	18.5 – 25.3
	Above 60	157 (13.8)	9.0 – 20.4
Highest educational level	Secondary school or below	468 (16.9)	13.6 – 20.6
	High school	224 (17.8)	13.1 – 23.5
	College or above	154 (17.1)	11.3 – 23.8
Place of residence	Rural	268 (17.1)	12.8 – 22.2
	Urban	578 (17.1)	14.1 – 20.5

Wealth index (in quantiles)	Q1 - Poorest	169 (17.0)	11.8 – 23.7
	Q2	194 (17.3)	12.5 – 23.6
	Q3	138 (16.5)	10.4 – 23.5
	Q4	131 (13.9)	8.4 – 20.8
	Q5 - Richest	214 (20.6)	15.4 – 26.6
Distance to the nearest tobacco outlet (m) (Mean and SD)		176.5 (201.3)	162.9 – 190.1
No. of tobacco outlets in radius (Mean and SD)	20 – 50 meters	0.5 (1.7)	0.4 – 0.6
	50 – 100 meters	1.3 (2.5)	1.2 – 1.5
	100 – 200 meters	3.9 (5.9)	3.5 – 4.3

The association between smoking status and their personal characteristics, density and proximity of tobacco outlets

A theoretical multivariate logistic regression model for a binary response variable (current smokers/non-smokers) was applied to examine the effects of personal characteristics, density and proximity of tobacco outlets on smoking status. Results showed that gender, age, educational level, density and proximity of tobacco outlets were in a statistically significant association with smoking status. In details, people aged from 36 – 60 and 60+ had the odds of smoking 3.2 (95% CI: 2.5 – 4.2) and 1.5 (95% CI: 1.1 – 2.1) higher than people aged less than 35,

respectively. Participants with lower educational level showed higher odds of smoking, for example people who finished secondary school or below had the odds of smoking 20% (95% CI: 10% - 30%) and 30% (10% - 50%) higher than those who finished high school and college or above, respectively. Results also showed for each 100 meters reduced from household to the nearest tobacco outlet, the odds of smoking reduced 7% (95% CI: 2% - 12%). Number of tobacco outlets in the radius of 20 – 50 meters and 50 – 100 meters around households had no association with the odds of smoking. While in the radius of 100 – 200 meters, for each tobacco outlets reduced, the odds of smoking reduced 6% (95% CI: 4% - 8%).

Table 4. Multivariate logistics regression model for association between smoking status and participants characteristics

Smoking status (Current smokers vs. Non-smokers)		OR	95% CI Lower	95% CI Upper
Gender	Female	1		
	Male	66.6	44.6	99.3
Age group	Less than 35	1		
	36-60	3.2	2.5	4.2
	Above 60	1.5	1.1	2.1

Highest educational level	Secondary school or below	1		
	High school	0.8	0.7	0.9
	College or above	0.7	0.5	0.9
Place of residence	Rural	1		
	Urban	0.8	0.6	1.0
Wealth index (in quantiles)	Q1 - Poorest	1		
	Q2	0.9	0.7	1.2
	Q3	0.8	0.6	1.1
	Q4	0.6	0.4	0.8
	Q5 - Richest	0.8	0.6	1.1
Distance to the nearest tobacco outlet (m) (Mean and SD)		1.0007	1.0002	1.0012
No. of tobacco outlets in radius (Mean and SD)	20 – 50 meters	0.9	0.8	1.1
	50 – 100 meters	1.05	0.99	1.10
	100 – 200 meters	1.06	1.04	1.08
Constant		0.004	0.003	0.007

DISCUSSION

To our knowledge, this is the first study in Vietnam using a combination of geographic data and surveillance data to examine whether density and proximity of tobacco outlets was associated with smoking prevalence among a community monitored by a demographic surveillance system (CHILILAB). The study participants were well representative in quantity and quality aspects when they have been under monitoring by a qualified system from which many results have used its primary data for smoking behavior analysis (22-24). The reliability of data can also be an advantage of this research when comparing with others using only secondary data (8, 25).

The use of geographical data is a recommended method for smoking behavior investigation (26). In this study we used a local data

collection team, who are collaborators and health staffs from commune health centers, they also joined in previous rounds of studies conducted by CHILILAB. By doing that, we ensure that our data collection team know the participants and their household's location well. It is essential in this study when in rural areas as most households don't have a specific address. We also used tablets to collect coordinate data, which was synchronized immediately whenever data collectors obtained a household's coordinate.

Our results showed that smoking prevalence was 17.1%. This result is lower than findings from the 2015 Vietnam Global Adults Tobacco survey (GATS) (3) but similar to previous work by CHILILAB (22). This can be explained by the differences of smoking definition between CHILILAB and GATS: when in GATS survey, smoking tobacco

included cigarette, water pipe and cigar (3), while in our study, only people who smoked cigarettes were considered, this is the reason why our smoking prevalence was not as high as GATS.

Smoking prevalence among male and female in our study was 36.6% (95% CI: 33.2% – 40.0%) and 0.9% (95% CI: 0.6% – 1.4%), respectively. These results are in accordance with previous results from Huong et. al in CHILILAB (34.7% among male with 95% CI: 32.9% - 36.6% and 0.9% among female with 95% CI: 0.6% – 1.3%) (22). Our results showed no differences in smoking prevalence between urban and rural areas, but these rates are still consistent with findings from Vietnam GATS in 2015 (27). Unlike the capital Hanoi, Hai Duong is not an economically well-developed and growing province, therefore the gap between urban and rural areas may be blurred. Additionally, access to tobacco point-of-sale in both rural and urban areas was shown to be the most common type of adults' exposure to tobacco advertising and promotion by GATS data (28). These reasons might contribute to our explanation that there was no difference in smoking status in these two areas.

After full adjustment for other individual characteristics (age, educational level), and household characteristics (rural/urban status, wealth index), we found tobacco outlets characteristics (density and proximity) seems to have an association with smoking behavior: the closer a person is living to tobacco outlets as well as the bigger the number of tobacco outlets are around them, the more likely they become smokers. Therefore, these findings suggest that smoking is more popular among environments where there is a greater availability of tobacco outlets. Our results are broadly consistent with other works from

Scotland, North America to Australia (16, 25, 29) which have found that residents are more likely to become smokers in areas with higher availability of tobacco retailers. Although our findings may be different from other studies (8, 30) which showed an inverse relation between current smoking status and retailer density. This inconsistency can be explained plausibly. The most popular type of tobacco use in our study are cigarettes, since participants from those studies often use other types of tobacco (31), therefore the density of tobacco outlets in their studies may not be important for participants to get their tobacco. However, a revealing pattern in our study reflects the true context in Vietnam: low prices and taxes on tobacco (32), along with high exposure to tobacco advertising and promotion among adults (28, 33) make tobacco outlets become more popular and easier to access. People in Vietnam usually live into residential groups (village, ward, etc...), among them many households have a small business which sells tobacco, alcohol, small consumer items (soap, shampoo, etc...). This explains the reason why the average distance to nearest tobacco outlets in our study is just about 170 meters (approximately 0.1 miles). Indeed, many of our participants' households were also tobacco outlets. Moreover, selling tobacco to children, is relatively common in Vietnam (any adults can ask a child to buy them a pack of cigarettes), which also increases accessibility to tobacco outlets.

Limitations

Aside from contributions, this study needs to note some limitations. Firstly, this study was limited by its cross-sectional design which is typical among most studies on tobacco outlets density and proximity. Data on tobacco outlets may be inadequate due to many reasons: refusal, unofficial (unregistered) tobacco

outlets, mobile tobacco retailers etc..., which can make our association underestimated. Our results did not control for some other tobacco outlet characteristics such as: the size of outlet, operation hours, type of selling tobacco, which could be some important factors when accessing tobacco outlets. Finally, we did not collect the coordinate data and data on tobacco bans among schools in study sites, which can be a useful indicator when considering impact of different levels on smoking behavior. Future analysis should take into account controlling for different types of tobacco outlets, their characteristics as well as collect data from different levels (individual/household/tobacco outlet/school level), therefore more advanced analysis such as multilevel analysis can be done to see the impact of each level to smoking behavior among individuals.

CONCLUSION

In this study we found a significant association between smoking behavior and density and proximity of tobacco outlets at individual level. Our evidence contributes to the fact that we need to reduce smoking prevalence within the community by applying a range of non-tobacco-outlet, as well as reduce the number of existing tobacco retailers. Finally, besides other predictors in both individual and household level on smoking status, the density and proximity of tobacco outlets should be considered an important factor to be controlled for when investigating the impact of tobacco control policy intervention on each community.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Acknowledgement

The author team would like to thank Center for Population Health Sciences (CPHS) and the data collection team in CHILILAB for making these data available. We also acknowledge the technical support and coordination of the Hanoi University of Public Health.

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