Density of cigarette retailers around formal and informal educational facilities: Geospatial analysis in Indonesia

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ABSTRACT

Background: With 61.4 million current smokers in 2018, Indonesia has contributed significantly to the number of smokers globally. The latest data showed an increasing smoking prevalence among youth. **Objective**: We examined the density of cigarette retailers around formal and informal educational facilities in Indonesia. **Methods**: We employed geospatial and quantitative analyses using data on cigarette retailers (from survey during July-August 2019) and educational facilities in Depok city. Data analyses, in ArcMap 10.6 and Stata 15, compared the density within 100 meters and 100-200 meters from the facility. **Results**: We found a 40%-higher density of cigarette retailers in areas closer to educational facilities. The higher density is similar between formal (i.e., primary, junior high, and senior high schools) and informal educational facilities (i.e., early years education centers and mosques). Moreover, the density is higher near primary schools and senior high schools, compared to the average. **Conclusion**: There is a higher density of cigarette retailers around formal and informal educational facilities for youth in Indonesia. This evidence confirms the need to regulate cigarette retailers near educational facilities, to enforce the ban on sale to minors, and to ban product displays at retailers.

Keywords: Density; Cigarette retailer; Educational facility; Schools; Indonesia

Word count: 1935 (text), 190 (abstract)

INTRODUCTION

With 61.4 million current smokers in 2018, Indonesia has contributed significantly to the number of smokers globally.[1] While the smoking prevalence among adult males is the second highest in the world (67% and 2.7% among adult males and females, respectively), that among youth is high and increasing.[1] The Global Tobacco Youth Survey (GYTS) showed that 36.2% of boys and 4.3% of girls aged 13-15 years old were current smokers in 2014.[2] The latest Basic Health Survey showed that the smoking prevalence among youth aged 10-18 years old increased by 26%, from 7.2% to 9.1% during 2013-2018.[3] Moreover, 1.5% of adult smokers reported smoking from 5-9 years old, while 17.3% of them reported smoking from 10-14 years old in 2013.[4]

Unfortunately, the national tobacco control has been lagging behind almost all other nations. Indonesia is still not among the 181 signatories of the Framework Convention on Tobacco Control that provides a legal framework and support for comprehensive efforts.[5] One flagship national program has been the smoke-free policy that bans selling, advertising, promoting, and active smoking in selected facilities, including schools and places of worship. However, only 67% of districts (345 of 514) adopted the policy during 2012-2018, with huge variations with 17% compliance rates in Jayapura to 78% in Bogor city.[6,7] Other efforts such as national bans on outdoor advertisements and promotion, advertisements and product displays at point-of-sale, and zoning laws are lacking.[5]

Evidence has shown that a higher density of cigarette retailers near youth populated areas is associated with higher odds of smoking status and the number of cigarettes.[8–13] To help reduce youth initiation and smoking rates, many countries such as China, Turkey, Ghana, India, and the United States have “tobacco-free zones” that restrict tobacco sales around educational facilities.[14] While there is no such regulation in Indonesia yet, there is a national ban on selling cigarettes to minors. However, the enforcement is lacking with data showing that almost 60% of students aged 13-15 years who smoke purchasing cigarettes in stores/shops, and 64.5% reported not refused purchase of cigarettes in 2014.[2] Given the increasing smoking prevalence among youth, there is a need to assess the density of cigarette retailers in their environment, particularly educational facilities.

Literature is limited in at least two ways. First, many studies are from high-income countries such as New Zealand, Australia, and Canada [15–17], which has shown a higher density of cigarette retailers around schools. A study from a low- and middle-income country (LMIC) setting is from Lebanon, which also found a high proportion of tobacco retailers with proximity to schools.[18] Secondly, these studies have examined only near schools and evidence near other youth populated areas such as informal education facilities are lacking. Thus, our research aims to provide evidence on the density of cigarette retailers around formal (e.g., schools) and informal (e.g., community education center) educational facilities for young people in Indonesia, a lower-middle-income country.

METHODS

We conducted geospatial analysis on the density of cigarette retailers around primary and high schools in Indonesia, using Depok city as an example. There are two primary data, including cigarette retailers and educational facilities. First, we surveyed all cigarette retailers during July-August 2019 in two sample subdistricts: Beji and Cipayung. The two were chosen purposively considering: (a) not adjacent; (b) variation in population (215,000 in Beji and 165,000 in Cipayung), (c) variation in area (15 and 11 square kilometers for Beji and Cipayung, respectively) and (c) variation in the distance to the mayor’s office (3 kilometers for Beji and 6 for Cipayung).[19] Data collected include locations

(latitude and longitude), selling food, cigarette, or both, and store type. We used the KoboToolBox Android application for paperless data collection.

Second, educational facility data include a comprehensive list of government and private formal and informal educational facilities in the two subdistricts. Formal facilities include primary, junior high, and senior high schools. Informal facilities include early years education centers (for children aged 0-6 years), community education centers (e.g. math and English tuitions), and mosques. Early years were included given the evidence that smokers in Indonesia are getting younger, including the infamous 2-year-old smoker.[20] Mosques are the dominant places of worship in the study area that are regularly used for children's activities including, daily prayers and after-school classes in religion. Data on schools, including addresses, were from the online database of the city education office. Data on early years and community education centers were from the online database of the Ministry of Education, while data on mosques were from that of the Ministry of Religion. We used Google Sheets and geocoding add-ons to convert each facility address into geocodes (latitude and longitude).[21,22]

The geospatial analyses were conducted in ArcMap 10.6 using the World Topographic Map as a basemap. We employed several geospatial tools: (a) geoprocessing/buffer tool to generate buffers of 100 and 200 meters around facility;[23,24] (b) spatial intersect and join tools to calculate the number of retailers around each facility buffer; and (c) kernel density tool to generate heatmap of cigarette retailers. We represented each facility as a point on the map. Once we obtained the density data for each facility from the geographic analyses, we conducted a t-test in Stata 15.1 to test the statistical significance of the differences in densities between within 100 meter and 100-200-meter buffers.

RESULTS

Table 1 shows the characteristics of cigarette retailers and educational facilities. There is a total of 2,238 cigarette retailers, half of which are in Beji and Cipayung subdistricts, respectively. Almost all sell both cigarettes and food (99.6%) and are stores, not restaurants (95.9%). Most stores are traditional (87.9%) instead of franchise stores (4.2%). There is a total of 440 educational facilities in our analysis, including early years education centers (38.2%), schools (32.7%), mosques (24.1%), and community education centers (5%). A majority of the facilities are in the Beji subdistrict (56.1%) and informal educational facilities (67.3%). Many of the schools are primary schools (54.2%) for those aged 6-12 years and have private ownership (72.9%).

Figure 1 shows the maps of Indonesia and Depok city by subdistrict. The req squares show the cigarette retailers in the Beji subdistrict that shares borders with the urban Jakarta (the country's capital) and Cipayung subdistrict that shares borders with the rural Bogor regent. Figure 2 shows the map of cigarette retailers and facility buffers in Beji (top) and Cipayung (bottom) subdistricts. Red rectangles show retailers and grey circles are 100- and 200-meter buffers around each facility. Results show that cigarette retailers are distributed all over the two subdistricts with some pockets areas that have more retailer density. To better illustrate the denser regions, Figure 3 shows the kernel density heatmap of the retailers overlaid with educational facilities in blue dots. The darker heatmap shows more density of retailers. The figure shows there are many educational facilities within the denser arear both in Beji and Cipayung subdistricts.

Moreover, Table 2 compares the density of cigarette retailers (per square kilometer) between areas within 100 meters from the facility and that within 100 to 200 meters around educational facilities. Overall, the densities were 135.9 and 97.0 retailers per square kilometer within 100 meters and 100-

200 meters, respectively, indicating a statistically significant 38.9 absolute difference or 1.40 relative difference (i.e., 40%). The overall results are similar to the results for formal and informal educational facilities. For schools, the densities were 138.2 and 98.6 within 100 meters and 100-200 meters, respectively, indicating a statistically significant 40% relative difference. These results are similar for early years education centers (45%) and mosques (39%) but are different for community education (non-significant 3%). By school ownership, the densities within 100-meter buffer were 144.7 and 135.8 for government and private schools, respectively. By the school level, the densities within 100-meter buffer were 156.3 around senior high schools, 140.2 around primary schools, and 122.6 around junior high schools.

DISCUSSION AND CONCLUSION

Our study showed an average of 40% higher density of cigarette retailers within 100-meter around educational facilities, compared to areas of 100-200 meters in Indonesia. To our knowledge, this is the first evidence in a lower-middle-income country setting. This result of the higher density of cigarette retailer is similar to studies from high-income countries such as New Zealand, Australia, and Canada,[15–17] as well as a study from Lebanon.[18] Moreover, the higher densities are similar near formal (i.e., primary, junior high, and senior high schools) and informal educational facilities (i.e., early years education centers, community education centers, and places of worships). To our knowledge, this is the first evidence in the literature to assess comprehensively near both formal and informal educational establishments. In many LMICs, including Indonesia, where formal schooling is mandatory, informal educations such as math and English tuitions are among the most popular for children. Also, places of worship such as mosques are also among the most youth populated areas with activities ranging from daily and Friday prayers to afternoon/evening religious education.

Our findings also show the density of cigarette retailers is higher near primary schools (usually 6-12 years old) and senior high schools (16-18 years old), compared to the averages of all facilities and all schools. First, this is an essential finding because primary schools are usually a lot more (e.g., 54% of all schools in our data) in numbers compared to junior high schools and senior high schools. All this highlights the potential exposure to point-of-sale cigarette advertising, including tobacco product displays to many very young children. A study in Scotland analyzed data from 96 retailers and almost 1,500 students in 2013 (before the implementation of the point-of-sale legislation). It found that tobacco products were displayed close to products of interest to children (e.g., confectionery). It also showed that 80% of students recalled seeing tobacco displays.[25] Second, this is also an important finding because of experimental smoking, especially among high school students. A study in the United States analyzed data from 135 high schools in California. It found that the density of retailers was associated with experimental smoking (but not established smoking) only among high school students. It also showed that high school students were more likely to obtain cigarettes from a retailer.[9]

There are at least two policy implications. First, our evidence confirms the need to regulate cigarette retailers near educational facilities. India's Cigarettes and Other Tobacco Products Act (COTPA) 2003, for instance, bans tobacco sales within 100 yards (about 90 meters) of educational institutions.[23] A proposal to ban cigarette sales within 100 meters from schools is currently with the parliament as an amendment to the National Authority on Tobacco and Alcohol (NATA) Act 2006.[26] Second, our findings support the need to enforce the ban on cigarette sales to minors fully and to nationally ban product displays at point-of-sales to prevent exposure to children, particularly around schools. The COTPA regulation in India bans tobacco advertisements within 100 yards (about

90 meters) of educational institutions.[23] The Tobacco and Primary Medical Services Act 2010 in Scotland prohibits point-of-sale tobacco displays by supermarkets since 2013 and smaller retailers since 2015.[25]

Our study has two limitations. First, our study areas only covered two subdistricts in one urban setting in Indonesia. Also, Depok city is among the front runner in tobacco control in Indonesia, including higher compliance of the national smoke-free policy and city-level bans on tobacco product displays in franchise and traditional retailers since late 2018. Further study should assess the density of cigarette retailers in other settings (e.g., rural, outside Java, and lacking tobacco control efforts). Secondly, there is only a total of eleven wards within the two sampled subdistricts, which has limited our analysis to examine socioeconomic disparity within the study areas further. Also, the observational design of our study shows associations, so the results must be interpreted with this in mind. Despite these limitations, our findings have important policy implications for Indonesia and beyond.

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Table 1. Characteristics of sample

	n	%
(a) Cigarette retailers	2,238	
Selling cigarette only	8	0.4%
Selling food and cigarette	2,230	99.6%
Beji subdistrict	1,128	50.4%
Cipayung subdistrict	1,110	49.6%
Store (not serving food)	2,146	95.9%
Restaurant	92	4.1%
(b) Store (not restaurant)	2,146	
Traditional store (permanent establishment)	1,887	87.9%
Roadside store (non-permanent)	163	7.6%
Franchise store/minimarket (e.g. Indomaret)	90	4.2%
Specialty store (e.g. eggs, chicken)	6	0.3%
(c) Children's educational facility	440	
Early years education center	168	38.2%
School	144	32.7%
Community education center	22	5.0%
Mosque	106	24.1%
Beji subdistrict	247	56.1%
Cipayung subdistrict	193	43.9%
Formal education (i.e. school)	144	32.7%
Informal education	296	67.3%
(d) School	144	
Primary school (6-12 years old)	78	54.2%
Junior high school (13-15)	40	27.8%
Senior high school (16-18)	26	18.1%
Government	39	27.1%
Private	105	72.9%

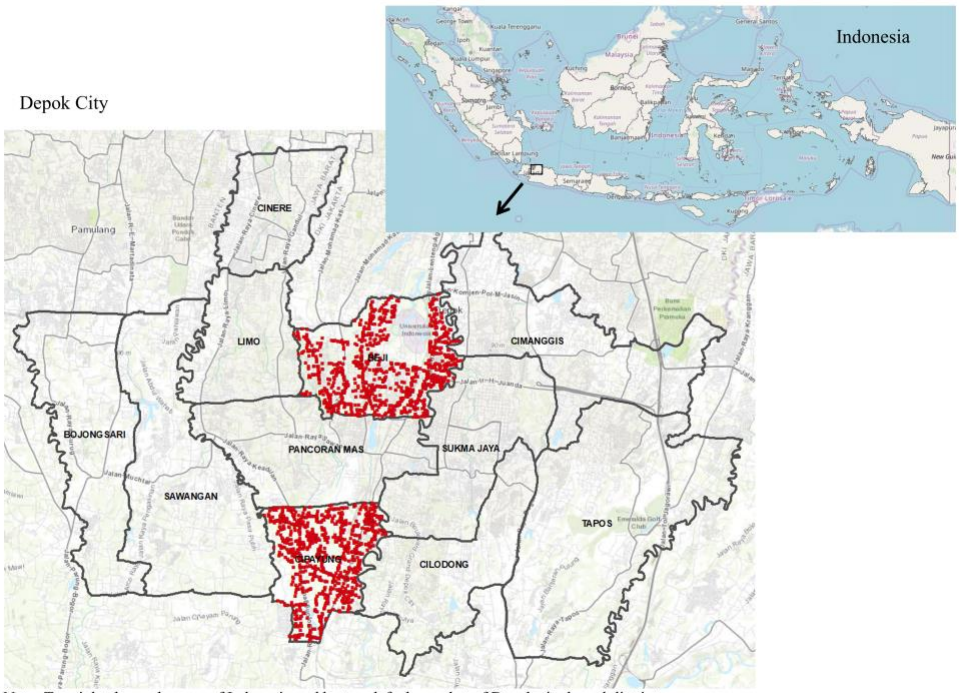
Note: Permanent establishment may be concrete or wood building, while non-permanent one maybe a tent. Franchise stores include large brands like Indomaret or smaller ones like Ceriamart. Restaurants include fast food, specialty (e.g., coffee, bread), traditional rice-based restaurants (e.g., *warung* Padang, *warung* Tegal). Early years is for aged 0-6 years. Community education centers, including maths tuition and English tuition. Mosques are for after-school classes in religion.

Table 2. Density of cigarette retailer around children's formal and informal educational facilities in Depok, Indonesia

		Density (SD) per km2				Comparison		
	Sample	Area 100 m		100-200 m		Difference	Ratio	p-value
	[1]	[2]		[3]		[4]=[2-3]	[5]=[2/3]	[6]
All educational facility	440	135.9	(109.5)	97.0	(58.9)	38.9	1.40	<0.001
Formal	144	138.2	(101.2)	98.6	(56.1)	39.7	1.40	<0.001
Informal	296	134.8	(113.5)	96.3	(60.3)	38.5	1.40	<0.001
Early years education	168	142.9	(119.9)	98.7	(63.9)	44.1	1.45	<0.001
Beji subdistrict	82	123.9	(123.6)	90.0	(56.1)	33.9	1.38	0.005
Cipayung subdistrict	86	160.9	(114.1)	107.0	(69.9)	53.9	1.50	<0.001
Schools	144	138.2	(101.2)	98.6	(56.1)	39.7	1.40	<0.001
Government	39	144.7	(104.1)	97.1	(71.9)	47.6	1.49	<0.001
Private	105	135.8	(100.5)	99.1	(49.4)	36.7	1.37	<0.001
Primary	78	140.2	(99.6)	96.6	(60.6)	43.6	1.45	<0.001
Junior high	40	122.6	(74.2)	95.2	(46.4)	27.4	1.29	0.034
Senior high	26	156.3	(136.8)	109.6	(56.5)	46.8	1.43	0.066
Beji subdistrict	79	133.9	(101.6)	86.7	(53.7)	47.2	1.54	<0.001
Cipayung subdistrict	65	143.4	(101.2)	113.0	(56.1)	30.4	1.27	0.009
Community education	22	89.4	(88.4)	86.8	(69.2)	2.7	1.03	0.892
Beji subdistrict	19	81.5	(68.3)	78.7	(70.6)	2.8	1.04	0.884
Cipayung subdistrict	3	139.8	(189.0)	138.0	(29.2)	1.7	1.01	0.987
Mosque	106	131.5	(106.0)	94.3	(52.3)	37.1	1.39	<0.001
Beji subdistrict	67	126.1	(95.4)	82.9	(48.9)	43.2	1.52	<0.001
Cipayung subdistrict	39	140.6	(122.8)	114.0	(52.6)	26.7	1.23	0.162

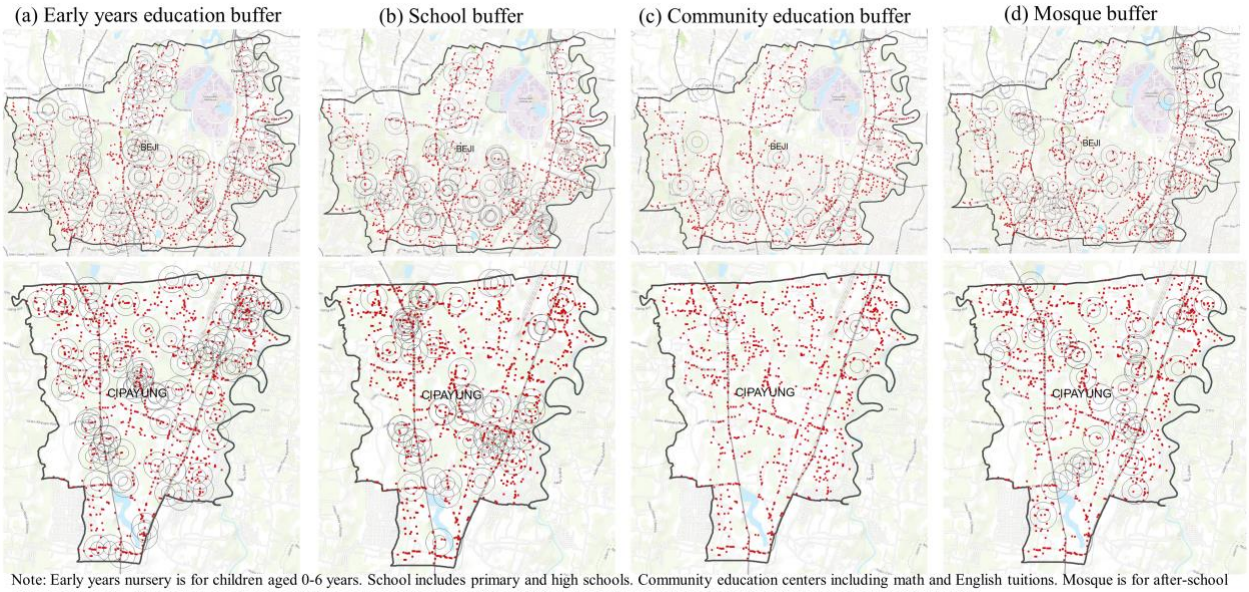
Note: m = meter; km2 = square kilometer; SD=standard deviation; Early years nursery=aged 0-6 years. Community education centers, including maths tuition and English tuition. Density is the number of schools per square kilometer. Density calculations were conducted in ArcMap 6.10. P-values show the statistical significance of the difference using the t-test in Stata 15.1.

Figure 1. Maps of Indonesia and Depok city by subdistrict



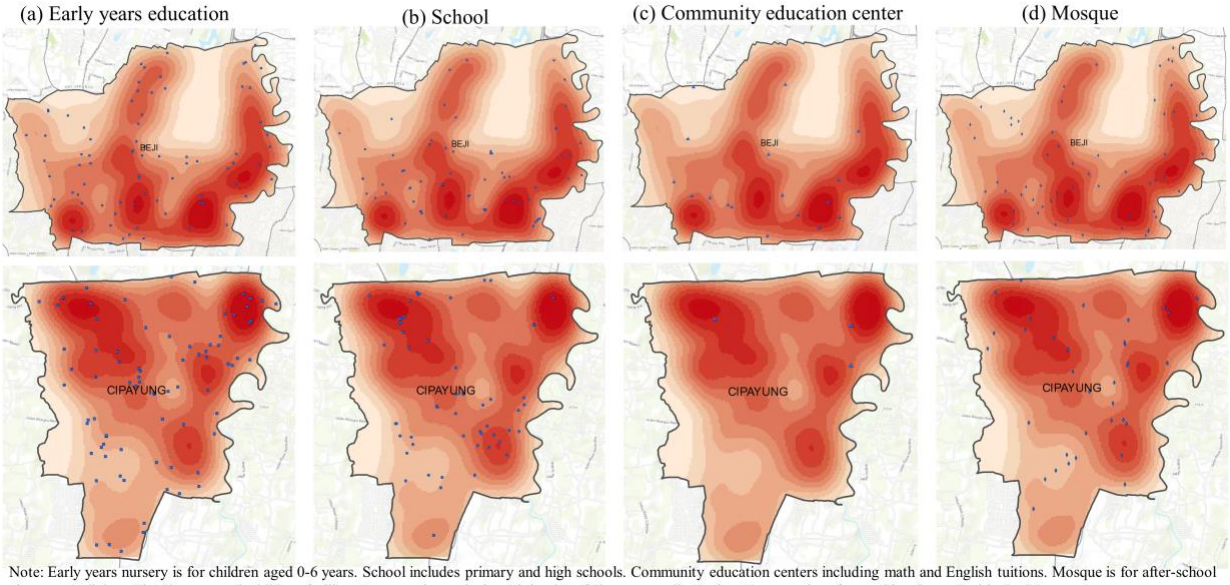
Note: Top right shows the map of Indonesia and bottom left shows that of Depok city by subdistricts.
The red squares show the cigarette retailers in Beji and Cipayung subdistricts.

Figure 2. Map of cigarette retailers and facility buffers in Beji (top) and Cipayung (bottom) subdistricts



Note: Early years nursery is for children aged 0-6 years. School includes primary and high schools. Community education centers including math and English tuitions. Mosque is for after-school classes on religion. Red dots show cigarette retailers and grey lines show 100 and 200-meter buffers around each facility. Buffers were created in ArcMap.

Figure 3. Kernel density heatmap of cigarette retailers by facility in Beji (top) and Cipayung (bottom) subdistrict



Note: Early years nursery is for children aged 0-6 years. School includes primary and high schools. Community education centers including math and English tuitions. Mosque is for after-school classes on religion. Blue dots are each children facility. Heatmap shows the kernel density of cigarette retailers using 10 categories of natural breaks method in ArcMap.