Density of Cigarette Retailers near Facilities for Children and Adolescents in Urban and Rural Areas in Indonesia: A Geospatial Analysis

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ABSTRACT

The lack of regulation banning cigarette retailers near facilities for children and adolescents has made cigarettes easily accessible to youth in Indonesia. This study aimed to investigate the density of cigarette retailer near children and adolescent facilities in urban and rural areas in the country. We mapped all cigarette retailers and facilities for children and adolescents in SBY city (urban) and BWI district (rural) in EJ province. All types of facilities for children and adolescents and retailers visible from the streets in the study areas were mapped. We conducted geospatial analysis of the density of retailers to the facilities for children and adolescents in QGIS 2.8 and STATA 14. We found that the density of cigarette retailers was 81% higher in the areas within 100m from the facilities for children and adolescents, compared to the areas within 100-250m from facilities. We also found that the density of cigarette retailers within 100m from facilities was 2.35 times higher in the rural setting, compared to the urban setting. Controlling cigarette retailers through zoning and licensing is urgently needed in Indonesia.

Keywords: tobacco control; children and adolescents; density of cigarette retailers; prevention; urban and rural

What we already know

- Children and adolescents are surrounded by cigarette retailers in Indonesia

What this article adds

- The density of cigarette retailers was 81% higher in the areas within 100m from the facilities for children and adolescents, compared to the areas within 100-250m from facilities.
- The density of cigarette retailers within 100m from facilities was 2.35 times higher in rural, compared urban.
- In both urban and rural areas, the density of cigarette retailer is higher the shorter the distance to children and adolescents facilities.

INTRODUCTION

Indonesia remains the only country in Asia that has not ratified the Framework Convention on Tobacco Control (FCTC)[1]. The country is the second largest tobacco market in the world and hosts over 100 million youth and adult smokers[1]. The Global Youth Tobacco Survey (GYTS) 2019 reported that 40.6% of adolescents 13-15 years have tried smoking cigarettes or chewed tobacco in Indonesia[2]. Data also showed that the prevalence of smoking among adolescents aged 10–18 years increased from 7.2% to 9.1% in 2013 and 2018, respectively[3], despite the government's target of reducing adolescent smoking rate to 5.4% by 2019[4]. Moreover, a study showed that 76.6% of students who smoked buy cigarettes at shops, stalls, street vendors, or kiosks. Among those who tried to buy cigarettes, 60.6% were not prevented from buying it based on age[2].

Evidence from other countries has shown that higher density of cigarette retailers near areas populated by youths is associated with youth smoking[5], and the perception of high cigarette availability and ease of purchase, which may stimulate tobacco use among adolescents[6]. A high density of cigarette retailers near adolescent facilities, including schools, is correlated with an increase in reported attempts to purchase cigarettes[7], smoking frequency[8], and number of cigarettes smoked in the past 7 days[9]. Other studies reveal that closer distances to cigarette retailers are correlated with increased risks of smoking[10], decreased likelihood of smoking cessation[11], and higher past-30-day smoking frequencies among youths[8].

Previous studies in Indonesia showed that youth smoking was slightly lower in urban than rural area[12]. Also, another study reported that the density of outdoor tobacco advertisements in urban settings was greater than in rural settings[13], indicating that children and adolescents in urban may have higher exposure to tobacco advertisements and products. Moreover, in urban settings, a study in Depok city (West Java province) found 40% higher density cigarette retailers close to educational facilities[14]; also a study in Denpasar city (Bali province) reported that 96.8% of schools have at least one cigarette retailer within a 250 m radius[15]. In rural settings, a study in Banyuwangi district (East Java province) reported 100% of sampled schools had at least one cigarette retailer within 250 m[16].

However, the previous studies have at least three limitations. First, all the studies on the density of cigarette retailers near facilities for children and adolescents were from the urban setting (e.g. Depok city and Denpasar city)[14,15]. Second, the study in Denpasar city only assessed the density

of cigarette retailers near formal education facilities while the study in Depok city only assessed the density near formal and informal educational facilities. Both studies did not include other facilities for children and adolescents such as sport centers, playgrounds, and recreational facilities. Third, both studies did not analyze the density using hotspot analysis, which would allow seeing the big picture of the cigarette retailer density in the study area. Thus, our study aims to assess the density and hotspots of cigarette retailers near facilities for children and adolescents in urban and rural settings in Indonesia.

METHODS

Study Design

We conducted geospatial analysis to assess the density of cigarette retailers near facilities for children and adolescents in urban (SBY city – full name removed for peer review) and rural (BWI district) settings in Indonesia. SBY city was chosen because it is the capital of EJ province, while BWI district was chosen because it is a rural setting in the same province. Also, the main research team were based in the two settings. Within each setting, we chose two subdistricts with the highest population density and high school density. We started with choosing two adjacent subdistricts in BWI district and then we found two comparable subdistricts in SBY city. More details of the selection process have been published elsewhere[13,17].

Data Collection

The survey was conducted from July–September 2019 by five two-person teams in SBY city and four teams in BWI district. Two full day training and a field test were carried out before the survey. Enumerators walked or rode a motorbike down the streets and alleys in all study areas to record geolocations with a precision of ≤10m of all types of facilities and all retailers visible from the streets or alleys. Retailers were stores that sold consumer goods, which included kiosks, restaurants & food vendors, street vendors, mini markets, and supermarkets. We included retailers on the first floor of malls, traditional markets or shopping centers that were visible from the street but we excluded hotels because their products are not visible from the street. Cigarette retailers were

identified by observing if a cigarette pack display was visible either from the outside or inside of the retailers. Types of facilities for children included schools (primary, middle, and high schools, higher education, and non-formal education),playgrounds (playgroups, kindergartens, children care centers, Qur'anic schools, and playgrounds), sports centers, recreation centers, and religious sites in all areas of the selected subdistricts. Data were collected using KoboToolBox (https://www.kobotoolbox.org/), an Android-based data collection application. The enumerators used Google Map to identify the boundary of the study locations. A quality control team revisited 20% randomly selected geolocations sent from the mobile application to the server, checked cigarette retailers barcode placed by the enumerator during the survey to ensure that the location and information entered into the server were correct. Data collected by the quality control results were compared with those collected by enumerators by researchers, with a protocol that if there were any differences between the data, data collection would be repeated entirely by the enumerator. In order to calculate retailers density by the total area and by population number of children and adolescents, we also sought supporting data from local statistics bureaus.

Data Analysis

For the spatial analysis, we conducted buffer analysis to assess the density of cigarette retailers (i.e. number of retailers per km^2) near facilities for children and adolescents using QGIS 2.8.1 for a radius of 0–100 m and 100–250 m from facilities. Also, statistical analysis (chi-square test) was conducted using STATA 14. The buffers of 100 m and 250 m were chosen to facilitate comparisons with other studies in Indonesia and other countries[15,16,18,19]. A buffer more than 250 m will cover many areas outside of our study boundary. Also, children and adolescents can walk comfortably for a distance of 250 m. Density was calculated by dividing the number of retailers within each radius in km^2. We also conducted hotspot analysis using Getis-Ord Gi* to identify grids with significantly higher number of cigarette retailers with 5% and 1% significance level, a method that has been used in other studies[13,17,20].

Ethics Approval

Ethical approval was obtained from the Ethics Committee of the Faculty of Public Health of Universitas Airlangga approved the study. Ethics ID 172/EA/KEPK/2019.

RESULTS

Table 1 shows the number of cigarette retailers and facilities in the study areas. We found 8,574 retailers, of which a total of 2,700 (31.5%) were cigarette retailers. The numbers of cigarette retailers were 1,551 (30.1% of total retailers) and 1,149 (33.6%) in SBY city and BWI district, respectively. Overall, the density of cigarette retailers per km^2 was 31.0, in SBY double that in BWI, but the density of retailers per 1,000 children and adolescents was similar in both areas. The most common type of retailers were kiosks (58.7% for SBY and 81.0% for BWI), followed by restaurants & food vendors that sell cigarettes (32.0% in SBY and 13.8% in BWI). The most common type of facilities was playground (31.9%) in SBY and religious sites (55.1%) in BWI district. For the school type, the most common were non formal education (37.0%) for SBYcity and primary school (53.6%) for BWI district. Chi-square tests in panel B-D in table 1 show that there were significant differences in the proportion of retailer types (p <0.001), facility types (p <0.001), and school types (p = 0.016) between urban and rural areas (Table 1).

Table 2 compares the density of cigarette retailers near facilities for children and adolescents between areas 0-100m and 100-250m from facilities. The visualization of buffer areas of 0-100m and 100-250m is provided in **Supplementary Figure 1**. In both SBY and BWI combined, for all facilities, 85.2% had at least one cigarette retailer within 0-100m and 96.0% within 100-250m. The densities were 129.6 and 71.5 retailers per km^2 within 0-100m and 100-250m, respectively, showing 58.1 absolute difference and 1.81 (or 81%) relative difference (p<0.001). For schools, the densities were 108.5 and 66.4 within 0-100m and 100-250m, respectively, showing 42.1 absolute difference and 1.63 (or 63%) relative difference (p<0.001). For other facilities (playgrounds, sport centers, and religious sites) the densities were also statistically significantly different between the radius.. When comparing between urban and rural settings, for all facilities, the densities in SBY city were 142.6 and 92 within 0-100m and 100-250m, respectively, indicating 1.55 relative difference (p-value<0.001). Meanwhile, the densities in BWI district were 116.5 and 50.9 within 0-100m and 100-250m, respectively, indicating 2.29 relative difference (p-value<0.001). For

schools, the densities in SBY city were 119.3 and 89.5 within 0-100m and 100-250m, respectively, indicating 1.33 relative difference (p=0.002), while the densities in BWI district were 97.6 and 43.2 within 0-100m and 100-250m, respectively, indicating 2.26 relative difference (p<0.001).

Moreover, **Table 2** also shows the number of facilities for children and adolescents within the hotspot of cigarette retailers. In both SBY city and BWI district combined, 297 (26.9%) of 1,106 facilities were within hotspot. The number of facilities within hotspot in BWI district were 165 (35.0%) of 472 facilities and that in SBY city were 132 (20.8%) of 634 facilities. For schools, the number of schools within hotspot in BWI district were 32 (19.4%) of 110 schools and that in SBY city were 53 (40.2%) of 189 schools. The visualization of hotspots and facilities are provided in **Figure 1**.

Figure 1 panel A, shows one large hotspot of significantly high number of cigarette retailers in each study areas. In SBY city, the hotspot with 1% significance level covered an area of 1 km^2 and reached 2.75 km^2 when using a significance level of 5%. This hotspot was located in areas where many housing, lodgings and rental rooms were available. In BWI. the hotspot with 1% significance level covered an area of 3.25 km^2 and reached 5 km^2 when using a significance level of 5%. This hotspot laid around the town center and around location where BWI government offices resided.

DISCUSSION

We found that the density of cigarette retailers was 81% higher in the areas within 100m from the facilities for children and adolescents, compared to the areas within 100-250m from facilities. We also found that the density of cigarette retailers within 100m from facilities was 2.35 times higher in the rural setting, compared to the urban setting. The study in Denpasar Bali, reported a retailer density of 32.2/km^{15}, which was higher than our observation in BWI district (22.4/km^2) but lower than in SBY (43.6/km^2). We have previously reported in 2017 that 80.6% of schools in BWI had at least one cigarette retailers within 100 m[16]. The current study that surveyed a larger area shows a higher percentage (85.5%) of schools with at least one cigarette retailers in BWI within the same distance. Our study is in line with a study in Thailand that reported tobacco retailers were more

densely located around schools[18] and a study in Depok, Indonesia that reported a 40%-higher density of cigarette retailers in areas closer to educational facilities[14].

Retailers are the front-runner of tobacco marketing and distribution chain[15]. Our study depicts the distribution of cigarette retailers in Indonesia, where cigarette sales are almost completely unregulated[21]. Tobacco retailers in Indonesia are still allowed to display cigarette packs and to place advertisements and promotion. In addition, tobacco companies create retailer programs to help promote tobacco sales[21]. Thus, the high density of cigarette retailers and cigarette retailer hotspots approximated the hotspots of facilities in the two study locations were not surprising. Despite the ban on expansion of franchised minimarket in BWI, small kiosks that sell cigarettes were rampant. Although the profit made from a pack of cigarette was not high[22], small shop owners believe that tobacco is important for their business due to the perception that tobacco attracts customers into the shop who may then buy other products[22]. Therefore, the ban did not provide any protection to children adolescents whatsoever from the harm of cigarette sales. SBY has a greater mean density of tobacco retailers than BWI in all radii. This may be due to SBY being the second largest city in Indonesia and the capital of the EJ province, where economic activities thrive more than in BWI. Also in SBY the hotspots were located in areas where many lodgings and rental rooms were available. Evidence from this study show that adolescents are likely targeted by the tobacco industry, as indicated by high density of cigarette retailers[14-16] and high density of outdoor tobacco advertisements[13,23] around children and adolescents facilities especially in rural area. The high density of tobacco retailers can give adolescents the perception of wide availability of cigarettes[24] and the easy access to obtain cigarettes which may stimulate tobacco use among adolescents. High density of outdoor tobacco advertisements around schools is associated with up to 2.16 times increase in the odds of smoking among adolescents [23].

The main strength of our study is the comparison of the density of cigarette retailers near facilities for children and adolescents between urban and rural setting. This is the first evidence in Indonesia. Also, we mapped all types of cigarette retailers and all types of facilities for children and adolescents, and thus presents a more detailed picture of the presence of cigarette retailers surrounding them. However, our study has at least two limitations. First, our study areas only covered four subdistricts in urban (two subdistricts) and rural (two subdistricts) settings, which

may not be generalizable to all parts of Indonesia. Further studies should assess the density of cigarette retailers in larger area and outside of Java and Bali (most developed areas in the country). Also, further studies should be conducted in districts that lack tobacco control efforts to get a better picture of the tobacco control situation in Indonesia. Second, our sampling strategy when selecting subdistricts with highest population density and high school density. While a public health perspective may mean these are good areas to focus on in terms of policies impacting the greatest number of people, methodologically this seems to bias our findings towards a higher likelihood of there being a retailer in proximity to a facility with children and adolescents. Further study may be able to choose study locations randomly.

For policy, our findings have at least two implications. First, our results are potential to provide evidence for policy makers to establish zoning laws to prevent cigarette retailers from being in the vicinity of children and adolescents facilities[15,16,18,19]. Such policy is needed not only in urban areas where trade generally thrives more, but also in rural areas as cigarette retailer density around children and adolescents may be greater. Zoning law has been implemented to change food environments and to ban fast food outlets in some countries[25,26]. As an example, a proposal to ban cigarette sales within 100 m from schools is currently with the Sri Lankan parliament as an amendment to the National Authority on Tobacco and Alcohol Act 2006[14]. A study in India recommended tobacco sales ban near educational institutions to be expanded beyond 100 m to reduce retailer density[19]. A study in Bali also suggests a tobacco sales ban within 500 m from facilities, as it may deliver the greatest impact on reducing smoking prevalence among adolescents[15]. Second, our findings support the need for retailers licensing considering as it allows the government to track tobacco sales[27] and enforce the prohibition of sales to minors[15,16]. License can be revoked when retailers violate the prohibition of sales to minors[28]. As shown in Philadelphia USA cigarette sale zonation and licensing can be effective policy approaches to reduce the availability of tobacco, tobacco marketing, and decrease the number of tobacco outlets near schools[29].

CONCLUSIONS

We found that the density of cigarette retailers was 81% higher in the areas within 100m from the facilities for children and adolescents, compared to the areas within 100-250m from facilities. We also found that the density of cigarette retailers within 100m from facilities was 2.35 times higher in the rural setting, compared to the urban setting. Controlling cigarette retailers through zoning and licensing is urgently needed in Indonesia.

AUTHOR'S CONTRIBUTION:

DSMKD designed the study, conducted data collector training, designed data architecture, conducted data cleaning and analysis, and prepared the manuscript. SIP and EA helped design the study, conducted training, coordinated field data collection, conducted data cleaning, and revised the manuscript. DK designed the study, conducted data analysis training, and revised data analysis and manuscript. SNM helped design the study and revised the manuscript. SKS designed the study, conducted data collector training, designed data architecture, conducted data cleaning and analysis, and revised the manuscript.

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Table 1. Number of Cigarette Retailers and Facilities for Children and Adolescents in SBY City and BWI District

		SBY city		BWI District		Overall		p value
		No of facility	%	No of facility	%	No of facility	%	
A.	**Total number and density**	**[1]**		**[2]**		**[3]**		**[4]**
	Total number of retailers	5,158		3,416		8,574		
	Total number of cigarette retailers	1,551	30.1	1,149	33.6	2,700	31.5	
	Total population	203,188		139,734		342,922		
	Population age 0 – 19 years	58,490		41,823		100,313		
	Area (km^2)	35.6		51.2		87		
	Cigarette retailers per km^2	43.6		22.4		31.0		
	Cigarette retailers per 1,000 children and adolescents	26.5		27.5		26.9		
B.	**Cigarette retailers by type**	1,551		1,149		2,700		<0.001*
	Street retailers	47	3.0	22	1.9	69	2.6	
	Kiosks	910	58.7	931	81.0	1,841	68.2	
	Mini markets & supermarkets	93	6.0	37	3.3	130	4.8	
	Restaurants & food vendors	497	32.0	159	13.8	656	24.3	
	Others	4	0.3	0	0.0	4	0.1	
C.	**Children and adolescents facilities**	634		472		1,106		<0.001*
	Playgrounds	202	31.9	72	15.3	274	24.8	
	Recreation centers	2	0.3	8	1.7	10	0.9	
	Religious sites	199	31.4	260	55.1	459	41.5	
	Schools	189	29.8	110	23.3	299	27.0	
	Sports centers	42	6.6	22	4.7	64	5.8	
D.	**Schools by type**	189		110		299	27.0	0.016*
	Primary schools	46	24.3	59	53.6	105	9.5	
	Middle schools	24	12.7	16	14.5	40	3.6	
	High schools	26	13.8	20	18.2	46	4.2	
	Higher education	23	12.2	8	7.3	31	2.8	
	Non-formal education	70	37.0	7	6.4	77	7.0	

Note: * Statistically significant, p value for panel B, C and D was estimated using chi-square test comparing columns 1 and 2

Table 2. Density of cigarette retailers near facilities for children and adolescent in SBY city and BWI District

	0–100 m					100–250 m				Comparison				
	n	n with at least 1 retailer	% with at least 1 retailer	Mean no. of retailers	Mean density	n with at least 1 retailer	% with at least 1 retailer	Mean no. of retailers	Mean density	Difference	Ratio	p value	n facility within retailer hotspot	% facility within retailer hotspot
SBY (Urban)	[1]				[2]				[3]	[4]=[2-3]	[5]=[2/3]	[6]	[7]	[8]
A. Overall	634	502	79.2	4.4	142.6	606	95.6	15.6	92.0	50.6	1.55	<0.001*	132	
B. Schools	189	140	74.1	3.7	119.3	177	93.7	15.1	89.5	29.8	1.33	0.002*	53	40.2
Primary Schools	46	39	84.8	4.6	148.0	45	97.8	15.5	91.5	56.5	1.62	0.004*	9	6.8
Middle Schools	24	18	75.0	4.1	133.1	24	100.0	21.0	124.0	9.1	1.07	0.782	10	7.6
High Schools	26	20	76.9	4.2	135.2	23	88.5	16.2	96.0	39.2	1.41	0.235	11	8.3
Higher Education	23	18	78.3	3.7	120.6	22	95.7	17.8	105.5	15.1	1.14	0.635	8	6.1
Non-formal Education	70	45	64.3	2.8	89.4	63	90.0	11.6	68.8	20.6	1.30	0.106	15	11.4
C. Playgrounds	202	161	79.7	4.5	144.5	195	96.5	15.5	91.4	53.1	1.58	<0.001*	34	25.8
D. Sports centers	42	22	52.4	1.8	58.4	38	90.5	9.6	57.1	1.3	1.02	0.900	7	5.3
E. Recreation centers	2	2	100.0	3.5	112.9	2	100.0	5.0	29.6	83.3	3.81	0.465	0	0.0
F. Religious Sites	199	177	88.9	5.6	180.7	194	97.5	17.4	103.0	77.7	1.75	<0.001*	38	28.8
BWI (Rural)														
A. Overall	472	430	91.1	3.6	116.5	455	96.4	8.6	50.9	65.6	2.29	<0.001*	165	
B. Schools	110	94	85.5	3	97.6	107	97.3	7.3	43.2	54.4	2.26	<0.001*	32	19.4
Primary Schools	59	56	94.9	3.6	114.8	57	96.6	7.6	45.2	69.6	2.54	<0.001*	21	12.7
Middle Schools	16	12	75.0	3.5	112.9	16	100.0	7.8	45.9	67	2.46	0.037*	3	1.8
High Schools	20	13	65.0	1	32.3	20	100.0	5.3	31.4	0.9	1.03	0.895	3	1.8
Higher Education	8	7	87.5	3	96.8	8	100.0	5.5	32.5	64.3	2.98	0.023*	2	1.2
Non-formal Education	7	6	85.7	3.3	106	6	85.7	11.3	66.8	39.2	1.59	0.773	3	1.8
C. Playgrounds	72	66	91.7	3.9	128.1	72	100.0	9.3	55.3	72.8	2.32	<0.001*	26	15.8
D. Sports centers	22	22	100.0	4	129	21	95.5	7.7	45.7	83.3	2.82	0.002*	3	1.8
E. Recreation centers	8	7	87.5	4.6	149.2	8	100.0	13.9	82.1	67.1	1.82	0.073	6	3.6
F. Religious Sites	260	241	92.7	3.7	119.2	247	95.0	8.9	52.5	66.7	2.27	<0.001*	98	59.4
Total (Urban+Rural)														
A. Overall	1106	932	85.2	4.0	129.6	1061	96	12.1	71.5	58.1	1.81	<0.001*	297	
B. Schools	299	234	79.8	3.4	108.5	284	95.5	11.2	66.4	42.1	1.63	<0.001*	85	28.6
Primary Schools	105	95	89.9	4.1	131.4	102	97.2	11.55	68.4	63.05	1.92	<0.001*	30	10.1
Middle Schools	40	30	75.0	3.8	123.0	40	100	14.4	85.0	38.05	1.45	0.166	13	4.4
High Schools	46	33	71.0	2.6	83.8	43	94.25	10.75	63.7	20.05	1.31	0.229	14	4.7
Higher Education	31	25	82.9	3.4	108.7	30	97.85	11.65	69	39.7	1.58	0.258	10	3.4
Non-formal Education	77	51	75.0	3.1	97.7	69	87.85	11.45	67.8	29.9	1.44	0.057	18	6.1
C. Playgrounds	274	227	85.7	4.2	136.3	267	98.25	12.4	73.35	62.95	1.86	<0.001*	60	20.2
D. Sports centers	64	44	76.2	2.9	93.7	59	93	8.65	51.4	42.3	1.82	0.013*	10	3.4

E. Recreation centers	10	9	93.8	4.1	131.1	10	100	9.45	55.85	75.2	2.35	0.031*	6	2.0
F. Religious Sites	459	418	90.8	4.7	150.0	441	96.25	13.15	77.75	72.2	1.93	<0.001*	136	45.8

Note : *statistically significant, p value was estimated using t-test comparing the density within 100m and 100-250m,Mean density = mean number of cigarette retailers per square kilometer for all and each type of facilities

Figure 1a. Hotspots of cigarette retailers in SBY and BWI, Indonesia
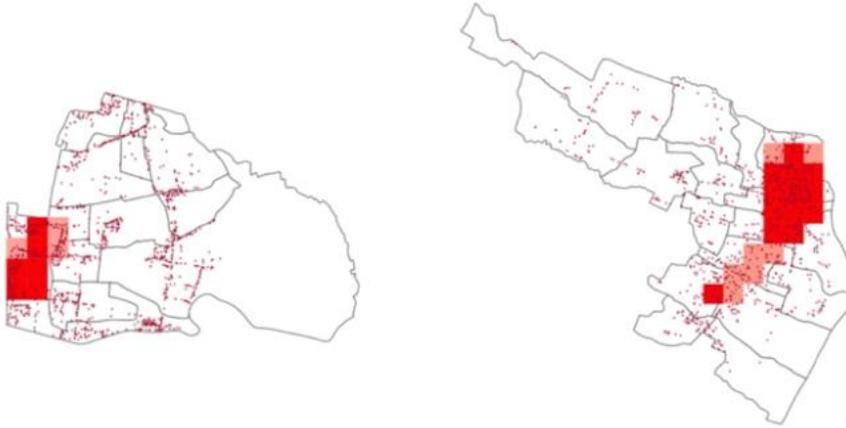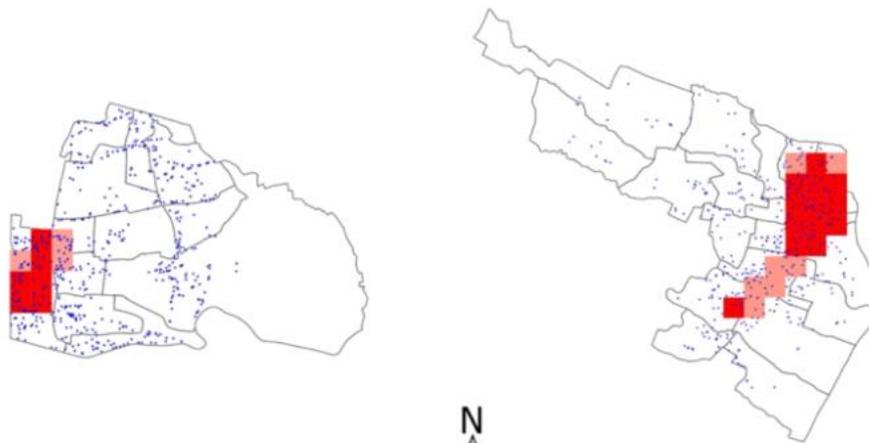

Figure 1b. Hotspots of number of cigarette retailers and children and adolescents facilities in SBY and BWI, Indonesia

N

Scale : 1:54000

Note: Red dots represent cigarette retailers. Blue dots represent facilities for children and adolescents. Darker red squares/grids represent hotspot with 1% significance level (99%). Lighter red squares/grids represent hotspot with 5% significance level (95%).