RESEARCH ARTICLE

National Burden of Cancers Attributable to Secondhand Smoking in Indonesia

Ni Putu Ayu Linda Permitasari[1], Satibi Satibi[2], Susi Ari Kristina[2]*

Abstract

Background: The high prevalence of smokers in Indonesia is also increase the number of people as secondhand smokers. Secondhand smoke causes many health problems, including cancer. Thus, Indonesia will bear large number cancer burden of disease, but research on cancer related to secondhand smoking in Indonesia still does not exist. Therefore, this study aimed to determine the number of secondhand smoke attributable fractions (SAFs) of six cancers (lung, bladder, colorectal, stomach, pancreas and larynx) and burden of cancer caused by secondhand smoking in Indonesia using Disability Adjusted Life Years (DALYs) indicator. **Material and Methods:** This research was using descriptive epidemiological prevalence-based research design, with cancers prevalence data gained from Indonesian health assurance system database in 2016. The SAFs is calculated by combining both data of secondhand smoking prevalence and relative risk and the DALY indicator is calculated as the sum of years of life lost due to premature mortality (YLL) and the equivalent healthy years lost due to disability (YLD). **Results:** Based on SAFs proportion, the highest SAFs among men were in pancreas cancer (80.20%), stomach cancer (79.54%) and laryngeal cancer (69.61%), whereas in women, pancreas cancer (78.95%), stomach cancer (78.26%) and bladder cancer (63.30%). Meanwhile, burden priorities for Indonesian men and woman were lung cancer (110,491), colorectal (68,131), and bladder cancer (39,140). **Conclusions:** In total, DALYs 6 cancer diseases due to secondhand smoke analyzed in this study were 283,360 DALYs. Thus, the results of the research can be used as a basis for further policies making on national cigarette prevention and control in Indonesia.

Keywords: Burden of disease- secondhand smoke- cancer- DALYs- Indonesia

Introduction

The high number of smokers in Indonesia resulted in higher risk of people exposed to or inhaling cigarette smoke as secondhand smokers. Cigarette smoke is a heterogeneous aerosol generated by burning tobacco. According to the study, there are 4,000 harmful chemical compounds contained in cigarette smoke, including nicotine, tar, cyanide, benzene, cadmium, methanol, ammonia, and arsenic (World Health Organization, 2015a).

The amount of harmful substances in the body of secondhand smokers is greater than active smokers, because the toxins inhaled through the breath are not filtered; make them more susceptible to health problems compared to active smokers. On the other hand, although the prevalence rate of smoking among women is relatively low, women and children still have health risks as secondhand smokers due to men smoking at home or elsewhere. In addition, the 2001 Indonesia National Socio-Economic Survey in Reimondos et al., (2012) estimates that nearly 50% of the total population is affected by secondhand smoking caused by family members who

smoke indoors.

These conditions become necessary because many studies have reported that exposure to secondhand smoke can cause a number of health problems. Exposure to secondhand smoke is still a global health problem, because it can cause various diseases such as coronary heart disease, stroke, and respiratory disorders in adults, and infant death syndrome in infants and children (Chen et al., 2015). Several studies have also reported a link between cancer and secondhand smoking. From the International Agency for Research on Cancers' (IARC) monograph data, which is a summary of various meta-analyzes of cancer due to secondhand smoking, shows the result that there is an association between secondhand smokers with some types of cancer indicated by relative risk value of more than one (World Health Organization, 2015a).

Based on the facts, Indonesia will bear burden of cancer due to secondhand smoking because Indonesia is one of the countries that ranks top in terms of cigarette consumption. In the world, more than 0.6 million premature deaths and 10.9 million disability adjusted life years (DALYs) occur due to non-smokers who becoming

*[1]Undergraduate Program, [2]Department of Pharmaceutics, Faculty of Pharmacy, University Gadjah Mada, Yogyakarta, Indonesia. *For Correspondence: susiari_k@ugm.ac.id*

passive smokers (Chen et al., 2015). According to global burden of disease (GBD) calculation, secondhand smoking contributed 9,316,121 DALYs globally in 2013 (World Health Organization, 2017). However, there is currently no research on measuring the burden of cancer due to secondhand smoking in Indonesia.

Given this background, the present study was performed to estimate the burden of cancers attributable to secondhand smoking using indicators DALY consisted of years lived with disability (YLD) and years life lost (YLL) as a global burden of disease methodology and recommended that health indicators summary be used to estimate health and economic burden of tobacco (World Health Organization, 2011). By assessing the estimated burden of cancer due to secondhand smoking in Indonesia, the data obtained can be used as a basis for further research and contribute in policy making in the context of prevention and control of tobacco and cigarettes through health promotion to raise public awareness about the negative impact of cigarette smoke, both in terms of the quality of life and the economic burden of the country.

Materials and Methods

This research was using descriptive epidemiological prevalence-based research design to estimate the burden of cancers due to secondhand smoking in Indonesian population. There were four steps to gain the data, first we selected secondhand smoke-related cancers by systematic review. Second, we estimated population-related secondhand smoke attributable fraction (SAF) using relative risks and prevalence of secondhand smokers in Indonesia. Third, we estimated smoking attributable incidence and mortality from the number of incidence and mortality multiply by SAF. Fourth, using that analysis result, we calculated the YLD and YLL and DALY values of cancers related to secondhand smoking in Indonesia.

Selection of secondhand smoke-related cancers

The selection of secondhand smoke-related cancers included in this study was based on a systematic review. According to the levels of evidence, we decided to include 6 secondhand smoke related cancer diseases. The prevalence of smoking was obtained from Global Adult Tobbaco Survey: Indonesian Report 2011 (World Health Organization, 2012).

Estimation of secondhand smoke attributable fraction (SAF) of cancers

The concept of the secondhand smoke attributable fraction (SAF) is the proportion of disease in a population which can be attributed to secondhand smoke. To calculate SAF values due to cancers, two parameters were considered: 1) the relative risks of secondhand smokers for the different related cancers, and 2) prevalence of secondhand smokers for male and female. The relative risks for most cancers were obtained from monograph of meta-analysis by International Agency for Research on Cancers (World Health Organization, 2015a). The formula of SAF is

shown below,

$$SAFs = \frac{p\,(RRi-1)}{1+p\,(RRi-1)}$$

(SAF Formula (Zahra et al., 2016)

where "p" is the prevalence of secondhand smokers in the national population, "RR" is the relative risk of illness due to secondhand smoking, sub-scipt-i is a category of disease (Zahra et al., 2016).

Computation of DALY for cancer

To estimate years lived with disability (YLD), epidemiological parameters were estimated as follows. First, to estimate the number of incidence and mortality of cancers by age, gained from Indonesian health assurance system database 2016 which projected into Globocan data in the current year (2012) (International Agency for Research on Cancer, 2012). Second, to estimate disability weight of each cancer, we use a recent study conducted in Korea (Choi et al., 2013) which is assumed had similar characteristics among Asia Pacific population. Third, we measure duration of selected cancers by using computer model called DISMOD II software developed by WHO (World Health Organization, 2015b).

Under the DISMOD II model, it is assumed that any individual or group that is susceptible to a specific cancer at a certain point in time will trigger the incidence of the cancer as they become infected. It is also assumed that the remission of all cancers is not occured. The fourth, we calculate YLD from the number of secondhand smoke related cancer incidence, duration, and disability weight. To estimate years life lost (YLL), we used WHO standard expected years of life in 2015 to calculate the years of prematurely death. To estimate age-specific YLL we applied the YLL formula as number of secondhand smoke attributable deaths multiply by number of years remaining to lives. To determine DALY values, we summed YLD with YLL results. The formula of DALY was derived from WHO economic of tobacco toolkit 2011 (World Health Organization, 2011).

$$DALYs = YLL + YLD$$

Results

As shown in Table 1, secondhand smoke is attributable to about 80.20% of pancreas cancers in Indonesian men while accounted to approximately 78.95% in Indonesian female. Comparing the cancers, for male, SAF were the highest in pancreas cancer while the second and third ranks were identified in stomach cancer and larynx cancer, 79.54% and 60.61% respectively. Different pattern was found in female, SAF were the highest in pancreas cancer (78.95%) while the second and third highest were found in stomach and bladder cancer, 78.26% and 63.30% respectively.

Cancer morbidity and mortality due to secondhand smoking are displayed by cancer types in Table 2. According to that table, total number of cancer cases in Indonesia in 2016 is 39,597 cases (24,599 in male and 14,998 in female). The number of cancer deaths among male, the three highest were lung cancer (7,879),

Table 1. Relative Risks and SAFs Due to Secondhand Smoking for Selected Cancers in Indonesia

Cancers	Relative risks		SAFs (%)	
	Male	Fe male	Male	Female
Lung	2.28	1.31	50.90	18.86
Colorectal	1.90	1.80	42.16	37.50
Stomach	5.80	5.80	79.54	78.26
Bladder	1.75	3.30	37.79	63.30
Pancreas	6.00	6.00	80.20	78.95
Larynx	2.90	2.90	60.61	58.76

Table 2. Secondhand Smoking Attributable Morbidity and Mortality for Selected Cancers in Indonesia

Cancers	Cancer morbidity		Morbidity due to secondhand smoking		Cancer mortality		Mortality due to secondhand smoking	
	M	F	M	F	M	F	M	F
Lung	7,879	4,220	4,011	796	9,054	4,785	4,608	902
Colorectal	5,204	4,636	2,194	1,739	7,898	6,955	3,330	2,608
Stomach	441	648	351	507	490	722	390	565
Bladder	3,101	895	1,172	567	3,319	956	1,254	605
Pancreas	1,013	899	812	710	1,043	905	836	714
Larynx	1,305	314	791	185	2,795	675	1,694	397
Total	18,943	11,612	9,331	4,503	24,599	14,998	12,113	5,792

M, Male; F, Female

colorectal cancer (5,204) and bladder (3,101). Meanwhile, the number of cancer deaths due to secondhand smoking in male, the three highest were lung cancer (4,608), colorectal (3,330) and larynx (1,694). In female, the highest number of cancer is colorectal cancer (6,955), followed by lung cancer (4,785) and bladder cancer (956). Meanwhile, colorectal cancer (2,608), lung (902) and pancreas (714), are the three highest number of cancer deaths due to secondhand smoking in female, respectively.

When looking at the morbidity of cancer, it was found that secondhand smoking is accounted for 4,011 of lung cancer, 2,194 of colorectal cancer and 1,172 of bladder cancer morbidity in male. On the other hand, it was responsible for 1,739; 796, and 710 of colorectal, lung and pancreas cancer morbidity among Indonesian female, respectively.

Based on calculation considered the duration of cancer and disability weight in Table 3, the YLD in Indonesian population, cancer burden priorities due to smoking in Indonesian men were lung cancer (36,390), colorectal (16,258), and bladder cancer (10,944). For Indonesian women, the highest burden of cancers in term of YLD were 10,722 ; 9,917; and 8,663 person years for colorectal, lung and pancreas cancers.

The years lost due to premature deaths of cancers related to smoking are also displayed in Table 3. Among men, the highest years lost was lung cancer (51,534), colorectal (21,673) and bladder cancer (14,496). Among women, three highest YLL attributed by lung cancer (64,184), colorectal cancer (41,151), and pancreas cancer (22,832).

Based on DALY indicator as the result of YLL plus YLD shown in Table 3, burden priorities for Indonesian men were lung cancer (87,924), colorectal cancer (37,931) and bladder cancer (25,440). While among women, the priorities were colorectal cancer (30,200), lung cancer (22,567), and pancreas cancer (19,366). In total, during 2016, Indonesian burden of cancers attributed to secondhand smoking was 283,360 DALYs.

Furthermore, Figure 1 presents the percentage

Table 3. YLL, YLD, and DALYs of Selected Cancers Due to Secondhand Smoking in Indonesia

| Cancers	Years lived with disability (YLD) (person years)			Years of life lost (YLL) (person years)			Disability adjusted life years (DALYs) (person years)		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Lung	36,390	9,917	46,307	51,534	12,650	64,184	87,924	22,567	110,491
Colorectal	16,258	10,722	26,980	21,673	19,478	41,151	37,931	30,200	68,131
Stomach	1,688	3,133	4,821	4,379	7,495	11,874	6,067	10,628	16,695
Bladder	10,944	5,364	16,308	14,496	8,336	22,832	25,440	13,700	39,140
Pancreas	7,978	8,663	16,641	11,523	10,703	22,226	19,501	19,366	38,867
Larynx	2,714	657	3,371	5,146	1,518	6,664	7,860	2,175	10,035
Total	75,973	38,455	114,428	108,751	60,180	168,932	184,724	98,635	283,360

*M, Male; F, Female
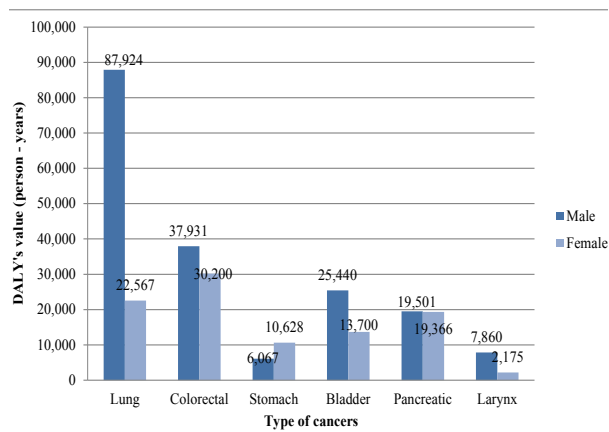
Figure 1. DALYs of Cancer Diseases Related to Secondhand Smoking in Indonesia in both Men and Women 2016.

ratio of DALYs of cancer due to secondhand smoking in both men and women. The results show that DALYs between the sexes vary with each other depending on the type of cancer. DALYs higher values in males appear in almost all types of cancer (lung cancer, colorectal, bladder, pancreas and larynx), only in stomach cancer the DALYs value higher in women.

Discussion

A common approach that is widely applied in the burden of disease study is the effect of the loss of productive years due to illness and death caused by certain risk factor. Translation of the burden of diseases with the parameters of the loss of productive years expressed as disability adjusted life years (DALYs) is able to provide strong evidence, so policy makers can understand that ultimately the state will still be harmed because of decreased public productivity and increased health costs to be borne by the government as a result of that risk factors (Centers for Disease Control and Prevention, 2012).

DALYs estimates the difference between the health status of the population and the ideal level of health, by counting the number of years life lost (YLL) due to premature death in a population and the years lived with disability (YLD) used in cancer related to secondhand smokers. In Table 3, shows DALYs values from each cancer of secondhand smoking in Indonesia are found in male, female and total population. Of the data, the total lifetime loss or DALYs was highest due to lung cancer 110,491 DALYs, followed by colorectal cancer of 68,131 DALYs, 39,140 DALYs of bladder cancer, 38,867 DALYs of pancreas cancer, stomach cancer 16,695 DALYs, and laryngeal cancer 10,035 DALYs.

Research on DALYs of cancer disease due to secondhand smoking is still very limited. The most research on this topic, specifically discuss the burden of lung cancer. One study was conducted in Korea by Zahra et al., (2016) who calculated DALY for several diseases, one of which was lung cancer from passive smokers, obtained in men as many as 5,803 DALYs and 5,537 DALYs. As part of the country in Asia Pacific, the DALYs calculations in Korea are still much lower than the DALYs

of lung cancer from secondhand smokers in Indonesia which reached 87,924 in males and 22,567 in females. Therefore, cigarette control policy in Korea can be an example to be considered in Indonesia to reduce the number of smokers and secondhand smokers, such as the advocacy of smoking bans in public and workplaces.

On the other hand, although the exposure to cigarette smoke is very high from public places, the duration of the exposure is not proportional to the time at home or workplace where people often spend most of their time. Therefore, appropriate policies to reduce both home and workplace smokers are also indispensable. Not only the ban or punishment, appreciation may also need to be given to the agency or workplace that is firmly in the smoking ban. To effectively reduce the incidence of secondhand smokers at home, it is necessary to counsel, educate, and advise on the dangers of cigarette smoke and make plans to eliminate the habits, especially in men (Zahra et al., 2016). Furthermore, biologically the association of cigarette smoke with various cancers looks directly proportional due to local deposition of components of the smoke and its metabolites (in synonasal and gastrointestinal cancers) and their systemic distribution (in breast, bladder, pancreas, abdominal, brain, liver, ovarian, leukemia, and lymphoma cancers) (World Health Organization, 2015a).

Exposure to secondhand smoke has been identified as a risk factor for various cancers associated with the respiratory system, especially lung cancer, since the last three decades. In Asomaning et al., (2008) research, it was reported that people exposed to secondhand smoke have a higher risk of lung cancer than active smokers, especially in subjects exposed to cigarette smoke before the age of 25 years. Cigarette smoke particles that accumulate in the lungs through the respiratory system can lead to sister chromosome exchange, DNA oxidative damage, and increase the number of P53 mutations in lung cancer.

In colorectal cancer, carcinogen particles of cigarette smoke reach the colon through direct respiration, to the circulatory system of the lung through epithelial cells, digested to reach the intestine. Some studies also suggest that cigarette smoke can induce cell division in colorectal adenocarcinomas, tumor growth factors, and reduce apoptosis in the colon (Peppone et al., 2010). Meanwhile, the biological mechanisms of the relationship between passive smoking and cancer in the organs of the digestive system remain unclear. In many types of cancer, especially those not directly related to the respiratory system, there are risk factors other than cigarette smoke associated with cancers such as diet, body mass index (BMI), and alcohol consumption (Peppone et al., 2009).

However, some limitations of the study need to be highlighted. The use of incidence and mortality data from National Health Insurance might not cover all Indonesian population. In addition, the combining data from different time, where data from National Health Insurance in year 2016 and data from Globocan in year 2012 resulting underestimated incidence and mortality. In many studies of the association of secondhand smoke with cancer, those variables are not included in the research model and thus have the potential to cause bias

towards the results of the study, included this study which is became one of our limitations. Lastly, RRs used in our analysis were not limited to ASEAN population. Further study examining the risk of cancer related to secondhand smoking should be conducted among ASEAN population for more valid estimation. The secondhand smoke contributed a huge proportion of public health problem. DALYs of cancers contributed major part of disease burden. Effective intervention policies with more targets on vulnerable groups should be implemented to control secondhand smoke related burden.

Acknowledgements

References

Asomaning K, Miller D P, Liu G, et al (2008). Second hand smoke, age of exposure and lung cancer risk. *J Lung Cancer*, **61**, 13-20.

Centers for Disease Control and Prevention (2012). State tobacco revenues compared with tobacco control appropriations. *MMWR Weekly*, **61**, 370-4.

Chen J, Wang MP, Wang X, et al (2015). Secondhand smoke exposure (SHS) and health-related quality of life (HRQoL) in Chinese never smokers in Hong Kong. *BMJ Open*, **5**, 1-7.

Choi KS, Park JH, Lee KS (2013). Disability weights for cancers in Korea. *J Korean Med Sci*, **28**, 808-13.

Peppone LJ, Hyland A, Moysich KB, et al (2009). Examining the association between cigarette smoking and colorectal cancer using historical case-control data. *J Cancer Epidemiol*, **33**, 182–8.

Peppone LJ, Reid ME, Moysich KB, et al (2010). The effect of secondhand smoke exposure on the association between active cigarette smoking and colorectal cancer. *J Cancer Causes Control*, **21**, 1247-55.

Reimondos A, Utomo ID, McDonald P, et al (2012). The 2010 greater Jakarta transition to adulthood survey policy background No. 2 Merokok dan Penduduk Dewasa Muda di Indonesia. Australia : Australian demographic and social research institute The Australian National University.

WHO (2011). National burden of disease studies : A practical guide. Edition 2.0. Global program on evidence for health policy. Geneva: World Health Organization.

WHO (2015a). International Agency for Research on Cancer Monographs on the evaluation of carcinogenic risks to humans - second-hand tobacco smoke. Paris : WHO Publications.

WHO (2015b). Health statistics and information systems, DISMOD II software tool [Online]. Geneva: World Health Organization.

WHO (2017). Metrics: Disability-adjusted life year (DALYs). [Online]. Geneva: World Health Organization.

Zahra A, Cheong HK, Lee EW, et al (2016). Burden of disease attributable to secondhand smoking in Korea. *Asia Pac J Public Health*, **1**, 737-50