RESEARCH ARTICLE

Estimating the Burden of Cancers Attributable to Smoking Using Disability Adjusted Life Years in Indonesia

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Abstract

Tobacco use is a well-established risk factor for many types of cancers. Recent data on selected cancer incidence and mortality related to smoking in the Indonesian population are provided in this study. Morbidity and mortality data were derived from GLOBOCAN 2012 and the population attributable fraction (PAF) was estimated using the standard methodology developed by the World Health Organization. Using these data, we calculated disability adjusted life year (DALY) values for smoking-related cancer. The DALY was estimated by summation of the years lived with disability (YLD) and years life lost due to premature death (YLL). The cancer cases related to smoking in Indonesia numbered 45,132, accounting for 35,580 cancer deaths. The morbidity and mortality of lung cancer can be considered as the highest priority in both men and women. Furthermore the greatest YLD due to smoking in Indonesian men and women were from pancreas and lung cancers. For YLL among men, the highest years lost were from lung and liver cancers. On the other hand, among women lung oral cavity and lip were most important. Based on the DALY indicator, burden priorities for Indonesian men were lung cancer (298,980), liver cancer (60,367), and nasopharynx (46,185), while among Indonesian women they were lung cancer (34,119), cervix uteri (9,213) and pancreas cancer (5,433). In total, Indonesian burden of cancers attributed to smoking was 638,682 DALY. This study provides evidence about the burden of cancers caused by smoking as a rational basis for initiating national tobacco control policies in Indonesia.

Keywords: Burden of disease - tobacco - cancer - DALY - Indonesia

Asian Pac J Cancer Prev, **17 (3)**, 1577-1581

Introduction

Tobacco smoking is the single leading factor responsible for non-communicable diseases include the increased cancer cases and thus the cancer mortality (IARC Working group on the evaluation of carcinogenic risks to humans, 2004; World Health Organization, 2009). According to current research, smoking is the most important cause of disease burden which are known to cause malignant cancers, respiratory, and birth defects (Ezzati et al., 2005; U.S. Department of Health and Human Services, 2010). Therefore, smoking is now widely regarded as the most risky behavior engaged in by the general population.

It has been projected that total smoking deaths will rise from 5.4 million in 2005 to 6.4 million in 2015 and 8.3 million in 2030. The trends are predicted to decline by 9% between 2002 and 2030 in developed countries, but to double increase from 3.4 million to 6.8 million in low and middle income countries (Mathers and Loncar, 2006). At present, there are 121 million adult smokers in ASEAN countries (Southeast Asia Tobacco Control Alliance (SEATCA), 2014). It was found that approximately one-third of male adults in ASEAN smoke with the highest prevelence found in Indonesian (Southeast Asia Tobacco Control Alliance (SEATCA), 2014). It was recently estimated that there were over 700,000 new cases of cancer and 500,000 cancer deaths in ASEAN in the year 2008 (Kimman et al., 2012).

Kretek cigarette is very common in Indonesia and is considered culturally appropriate in the of the country (Palipudi et al., 2015) and has obvious consequences of national health and economic burden. The estimates number of deaths due to smoking-related diseases in Indonesia 2013 is approximately 74,440 deaths and that the economic loss due to premature death caused by smoking-related diseases exceeded USD 1,309 million in 2013 (Kristina et al., 2015). Furthermore, the smoking rate among Indonesian male is the highest in ASEAN countries (Southeast Asia Tobacco Control Alliance (SEATCA), August, 2013). Among all cancers, lung cancer is the leading cause of death, accounted for 80% of all cancer death, are attributable to smoking. Thus, one-third of all cancers that result in death are caused by smoking. Moreover, in 2013, the burden of premature death due to smoking was 95% in male and 5% in female in Indonesia (Kristina et al., 2015).

Recently the World Health Organization (WHO)

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developed 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). The representative health gap indicator used is disability adjusted life year (DALY). Given this background, the present study was performed to estimate the burden of cancers attributable to smoking using indicators DALY consisted of years lived with disability (YLD) and years life lost (YLL) as the first study measuring DALY of major cancers in Indonesia.

Materials and Methods

To estimate the burden of cancers related to smoking in Indonesian population, we followed four steps. First, we selected smoking-related diseases by systematic review. Second, we estimated population-related population attributable risks (PAR) using relative risks and prevalence of smoking. Third, we estimated smoking attributable incidence and mortality from the number of incidence and mortality multiply by PAR. Fourth, using above analysis result, we calculated the YLD and YLL and DALY values of cancers related to smoking in Indonesia.

Selection of smoking-related cancers

The selection of smoking-related cancers included in this study was based on a systematic review. According to the levels of evidence, we decided to include 14 smoking-related cancer diseases. The prevalence of smoking was obtained from WHO country report in 2002 since lag time of the effects of smoking is believed to be 15-20 years after initial exposure.

Estimation of population attributable risk (PAR) of cancers due to smoking

To calculate PAR values due to smoking, three parameters were considered: 1) the relative risks of smoking for the different smoking-related cancers, and 2) prevalence of smoking for male and female. The relative risks for most cancers were obtained from meta-analysis by Gandini et al. (2008). For the colorectal cancer and ovary cancer, RR were obtained from (Zheng et al., 2014) and respectively (Park et al., 2014).

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, GLOBOCAN data in the current year (2012) (International Agency for Research on Cancer, 2012) was derived. 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, 2015). 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 smoking related cancer incidence, duration, and disability weight.

To estimate years life lost (YLL), we developed estimated of population and deaths due to smoking from GLOBOCAN 2012 data. Population attributable risk was used to estimate the number of smoking deaths attributable to smoking. We use WHO standard expected years of life in 2012 (World Health Organization, 2010) to calculate the years of prematurely death. To estimate age-specific YLL we applied the YLL formula as number of smoking 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).

Results

As shown in Table 1, tobacco smoking is attributable to about 85% of lung cancer in Indonesian men while accounted to approximately 19% in Indonesian female. Comparing the cancers, for male, SAF were the highest in lung cancer while the second and third ranks were identified in larynk cancer and pharynk cancer, 80% and 79% respectively. Similar pattern was found in female, SAF were the highest in lung cancer (19%) while the second and third highest were found in larynk and pharynk cancer, 15% and 14% respectively.

Cancer morbidity and mortality related to tobacco smoking are displayed by cancer types in Table 2. It can be explained that smoking attributable morbidity and mortality were accounted for 28.36% and 31.05% of cancer morbidity and mortality respectively. The highest proportion of male cancer cases was lung cancer, colorectum cancer, and liver cancer, accounted for 25,332, 15,985, and 13,365 respectively. While the highest number of female cancer cases was cervix uteri (20,928), followed by colorectum cancer (11,787) and ovary cancer (10,238). The number of cancer deaths among male, the

Table 1. Relative Risks and Population Attributable Risks (PAR) Values Due to Smoking for Selected Cancers

Cancers	Relative risks		Population attributable risks due to smoking (%)	
	Male	Female	Male	Female
Lip, oral cavity	3.43	3.43	62.6	6.79
Nasopharynx	1.95	1.95	39.5	2.77
Pharynx	6.76	6.76	79.9	14.7
Esophagus	2.5	2.5	50.9	4.30
Stomach	1.74	1.74	33.8	2.17
Colorectal	1.13	1.13	8.23	0.38
Liver	1.56	1.56	27.9	1.65
Pancreas	1.7	1.7	32.6	2.05
Larynx	6.98	6.98	80.5	15.2
Lung	8.96	8.96	84.6	19.3
Cervix uteri	0	1.83	0	3.11
Ovary	0	2.07	0	1.53
Kidney	1.52	1.52	26.4	1.53
Bladder	2.77	2.77	55.0	5.04

three highest were lung cancer (22,525), liver cancer (12,654), and colorectum cancer (10,559). On the other hand, among female, the three highest cancer deaths were cervix uteri (9,498), colorectum cancer (7,839), and lung

Table 2. Smoking Attributable Morbidity and Mortality in Selected Cancers in Indonesian Population

Cancers	Cancer morbidity			Morbidity due to smoking			Cancer mortality			Mortality due to smoking		
	M	F	Total	M	F	Total	M	F	Total	M	F	Total
Lip, Oral Cavity	3.002	2.327	5.329	1.88	158	2.039	1.263	987	2.25	791	67	858
Nasopharynx	9.355	3.729	13.084	3.704	103	3.807	5.283	2.108	7.391	2.092	58	2.150
Other Pharynx	1.479	555	2.034	1.182	82	1.263	1.427	426	1.853	1.14	63	1.203
Oesophagus	1.513	678	2.191	770	29	799	1.394	629	2.023	709	27	736
Stomach	3.811	2.2	6.011	1.288	48	1.336	3.43	1.976	5.406	1.159	43	1.202
Colorectum	15.985	11.787	27.772	1.316	46	1.362	10.559	7.839	18.398	869	30	900
Liver	13.365	4.756	18.121	3.725	79	3.804	12.654	4.521	17.175	3.527	75	3.601
Pancreas	3.011	2.818	5.829	981	58	1.039	2.576	2.719	5.295	839	56	895
Larynx	2.255	402	2.657	1.815	61	1.876	1.053	187	1.24	848	28	876
Lung	25.322	9.374	34.696	21.422	1.807	23.229	22.525	8.379	30.904	19.056	1.615	20.671
Cervix Uteri	0	20.928	20.928	0	651	651	0	9.498	9.498	0	295	295
Ovary	0	10.238	10.238	0	157	157	0	7.075	7.075	0	109	109
Kidney	2.093	1.132	3.225	553	17	570	1.593	866	2.459	421	13	434
Bladder	5.705	1.273	6.978	3.137	64	3.201	2.94	659	3.599	1.616	33	1.650
Total	86.896	72.197	159.093	41.772	3.360	45.132	66.697	47.869	114.566	33.067	2.514	35.580

*M = Male; F = Female

Table 3. Years Lived with Disability (YLD) and Years Life Lost (YLD) in Selected Cancers Related to Smoking in Indonesian Population

Cancers	Years lived with disability (YLD) (person-years)			Years life lost (YLL) (person-years)		
	Male	Female	Total	Male	Female	Total
Lip, Oral Cavity	1.658	807	2.465	14.846	1.577	16.423
Nasopharynx	3.094	2.562	5.656	43.092	1.518	4.461
Other Pharynx	2.465	2.536	5.001	20.079	1.488	21.568
Oesophagus	3.374	3.414	6.788	12.124	450	12.574
Stomach	2.378	1.936	4.314	17.228	745	17.973
Colorectum	238	2.426	4.806	14.089	538	14.627
Liver	2.496	2.77	5.267	57.871	1.326	59.197
Pancreas	4.464	4.542	9.005	14.035	891	14.926
Larynx	610	682	1.291	12.672	527	13.199
Lung	4.317	3.969	8.285	294.664	30.15	324.814
Cervix Uteri	0	2.625	2.625	0	6.587	6.587
Ovary	0	129	129	0	2.458	2.458
Kidney	995	1.117	2.112	9.923	331	10.253
Bladder	651	654	1.305	19.915	507	20.423
Total	28.882	30.168	59.05	530.538	49.094	579.632

Cancers	Disability adjusted life years (DALY) (person-years)		
	Male	Female	Total
Lip, Oral Cavity	16.504	2.384	18.888
Nasopharynx	46.185	4.081	50.266
Other Pharynx	22.544	4.024	26.569
Oesophagus	15.498	3.864	19.362
Stomach	19.606	2.681	22.287
Colorectum	16.469	2.964	19.433
Liver	60.367	4.096	64.464
Pancreas	18.499	5.433	23.931
Larynx	13.281	1.209	14.49
Lung	298.98	34.119	333.099
Cervix Uteri	0	9.213	9.213
Ovary	0	2.587	2.587
Kidney	10.917	1.448	12.365
Bladder	20.566	1.161	21.727
Total	559.419	79.263	638.682

cancer (8,379).

According to the estimates in Table 2, tobacco smoking accounted for 45,132 of cancer cases in Indonesian in 2012 (41,772 in male and 3,360 in female). In male, the total number of smoking attributable cancer cases were the highest in lung cancer (21,442), followed by liver cancer (3,725), and nasopharynk cancer (3,704). On the other hand, the highest number of smoking attributable cancer cases in female was found in lung cancer (1,807), followed by cervix uteri (651), and lip, oral cavity (158). When looking at the mortality of cancer, it was found that tobacco smoking is accounted for 19,056 of lung cancer male deaths 3,527 liver cancer deaths, and nasopharynk cancer deaths 2,092. On the other hand, it was responsible for 1,615; 295, and 109 deaths of Lung cancer, uterine cancer, and ovary cancer among Indonesian female, respectively.

Based on calculation considered the duration of cancer and disability weight, the YLD in Indonesian population, cancer burden priorities due to smoking in Indonesian men were pancreas cancer (4,464), lung cancer (4,317), and oesophagus cancer (3,374). For Indonesian female, the highest burden of cancers in term of YLD were pancreas cancer (4,542), followed by lung cancer (3.969), and oesophagus cancer (3,414) (Table 3).

The years lost due to premature deaths of cancers related to smoking are displayed in Table 3. Among men, the highest years lost was lung cancer (294,664), followed by liver cancer (57,871) and nasopharynk cancer (43,092). On the other hand, the YLL among women attributed by lung cancer (30,150), lip, oral cavity (1,577), and nasopharynk cancer (1,518) (Table 3).

Based on DALY indicator, burden priorities for Indonesian men were Lung cancer (298,980), liver cancer (60,367), and nasopharynk (46,185). While among Indonesian women were Lung cancer (34,119), cervix uteri (9,213) and pancreas cancer (5,433). In total, during 2012, Indonesian burden of cancers attributed to smoking was 638,682 DALY (Table 3).

Discussion

The present study estimated the burden of cancers related to smoking using DALY indicator in Indonesia. The indicator, which is composite measure of the summation of years lived with disability (YLD) and years life lost due to premature death (YLL) provide comprehensive picture in evidences of tobacco impacts on society as a whole. This evidence positively influence health policy making especially in developing countries which is the smoking rates is elevated (Murray CJL et al., 2002).

Since the introduction of these indicators by Murray et al in 1997 (Murray CJL and Lopez AD, 1997), some potential applications of these parameters are increasing. These measures able to compare the population health for different health system and to facilitate the effects of health risk behaviors include smoking and alcohol consumption on overall population health. Finally, they provide information on priorities for public health program planning in country level.

The present study shows that disease burden by tobacco smoking is about 28.36% for morbidity and 31.05% for mortality caused by smoking. The highest mortality and morbidity due to smoking was lung cancer. Based on cohort study conducted in Thailand, current smokers were more likely to die than never smokers and the excess mortality was greatest for lung cancer (Kamsa-ard et al., 2013). It has been acknowledged that survival time of the patients with lung cancer is very short (Abazari et al., 2015), while early diagnosis may improve the life expectancy effective treatment is not available in most countries. The findings were coherent with the burden of diseases related to tobacco in Indonesia, using national data, showed that estimated 74,440 people in Indonesia died prematurely as a result of cancers attributable to smoking, accounted for 30.6% of the total deaths (Kristina et al., 2015). A recent study conducted in UK, cancers has been responsible for about 109.164 (19% of all deaths, 27% deaths in men and 11% of deaths in women (Allender et al., 2009). These patterns highlight that as prevalence of smoking in developing countries is emerging since past 10 years, the morbidity and mortality due to smoking is increasing in current years and projected to elevate dramatically in next 10-20 years as mentioned by Mathers et al. 2006 (Mathers and Loncar, 2006).

The results of the present study show that the rankings of major cancers burden due to smoking assessed by DALY values. The burden ranking of cancers for Indonesian men were highest in lung cancer, liver cancer, and nasopharynk cancer. While among Indonesian women were lung cancer, cervix uteri, and pancreas cancer. In total, during 2012, Indonesian burden of cancers attributed to smoking was 638,682 DALY. These results indicate that lung cancer burden due to smoking is higher than other cancers burden attributable to smoking in Indonesia. This findings was consistent with Korean study, showed that DALY for lung cancer was 96.6 per 100,000 people, as the first priority burden in Korea (Lee et al., 2006). In US, burden of lung cancer measured by DALY was 550 thousand, accounted for 3.6% DALY of total 20 top selected diseases and attributed to 5.7% of total deaths (McKenna et al., 2005). Since the same methods are used to estimate Indonesia specific, and international DALYs, these disparities can also be placed in a global context. Health service and policy researchers have encouraged the use of summary health measures to assess the performance of health systems, prioritize public health research agendas, and evaluate the appropriateness of health expenditures (Murray et al., 2002).

Although, we included all cancers with sufficient evidence of carcinogenicity related to tobacco smoking in our analysis the following limitations should be acknowledged. First, RRs used in our analysis were not limited to ASEAN population. Further study examining the risk of cancer related to tobacco smoking should be conducted among ASEAN population for more valid estimated in the future. Secondly, it should be noted that the same RRs were used for both incidence and mortality with the assumption that tobacco smoking does not affect survival. Separate RR estimates for cancer mortality and cancer incidence should be used in the future study. Lastly, our estimates might have been underreported because

burden of second-hand smoking was not included due to lack of prevalence data. In addition, it should also be noted that secondhand smoke which are more than 80% of Indonesian people affected was not included in our analysis.

Acknowledgements

This study funding was supported by the research grant of Faculty of Pharmacy, Gadjah Mada University.

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