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Economic burden of smoking: a systematic review of direct and indirect costs

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Abstract

Background: Smoking imposes considerably high economic costs both on the healthcare system as well as on a country as a whole. This study was aimed at systematically reviewing the currently published literature on the direct and indirect costs associated with smoking globally.

Methods: A systematic review was performed on systematically searched articles from PubMed and Scopus databases published during the period 1990 to 2014. A combination of key terms such as "economic burden", "direct cost", "indirect cost", and smoking, tobacco or cigarette" and "productivity lost was used for the search. Original research article published in English with the age of study population greater than 35 years, at least three smoking-related diseases and reported direct or indirect cost of smoking were the inclusion criteria.

Results: Fourteen original articles were included in the review. The cost of outpatient care and premature deaths were found to be the most important cost driver of direct and indirect costs respectively. The study showed that smoking-related diseases were responsible for 1.5 – 6.8 % of the national health system expenditures and 0.22-0.88% of GDP of a country.

Conclusion: Our review indicated that the costs of smoking are substantial, and smoking have a significant impact on the economy of a country. Policies such as increasing the taxation on a cigarette are required and should be implemented to reduce the economic burden of smoking.

Keywords: Smoking, Systematic review, Direct costs, Indirect costs.

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Introduction

Cigarette smoking is the leading causes of preventable morbidity and mortality throughout the world (1). Each year, about five million adults die from conditions related to smoking. The annual death rate is expected to rise to about 8 million people by the year 2030, and more than 80% of the deaths will be in low-middle income countries (2). The negative impact of smoking on the economy of health systems as well as societies as a whole is significant (3). However, most evidence on the costs of smoking have been drawn from studies conducted in developed countries. The evidence in developing countries concerning this issue is rarely documented. Cigarette smoking was reported to be responsible for 6 to 15 % of national health care expenditure in high-income countries, 2.1–3.4% of gross domestic product (GDP) in Australia, 1.3–2.2% of GDP in Canada and 1.4–1.6% of GDP in the United States (4-5). In developing countries such as China

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and Vietnam, the annual direct healthcare cost of smoking is found to be attributable to about 4 % of the national health expenditures (1,6). In the discussions of costs of smoking, often two types of costs are brought up in the literature: direct and indirect costs. Direct costs include health care costs (hospitalization costs, medication costs, overhead costs etc.) and direct non-health care costs (transportation costs, food costs and informal costs). Indirect costs include patient's productivity lost due to premature deaths and absenteeism from work as well as lost income of family member for the patient care (2,7). Two common approaches are available for estimating the total cost attributable to smoking: the annual cost approach and lifetime cost approach. The annual cost approach (or the prevalence-based approach) estimates the total costs of smoking-related diseases in a year. The lifetime costs approach, also called the incidence-based approach, estimates the costs of smoking-related diseases in a group of current smokers compared to never smokers over their lifetimes. Collecting the required data to track costs over time is difficult. Hence, the majority of the cost of smoking studies have used the prevalence-based approach (1,7-14) and a few studies have used the incidence-based approach (3,15-16). Due to the huge cost attributable to smoking on the health system and society, quantifying the burden of smoking an important step for health policy-makers and legislators to design and implement smoking control interventions. This systematic review is aimed at generating useful information about the costs of smoking globally through seeking solutions to the following questions: what are the direct, indirect and total costs attributable to smoking?

Methods

Search Strategy and Selection Criteria

A systematic review of the literature was conducted in April 2015 to identify English- language studies, which estimated the economic burden of cigarette smoking throughout the world. PubMed and Scopus databases were searched for articles published between December 1990 and January 2014. A combination of key terms was used in the search strategy as follows: (cost*(tiab) OR economic burden*(tiab) OR productivity*(tiab) OR indirect cost*(tiab) or direct cost*(tiab)) AND (smoking*(tiab) OR tobacco*(tiab) OR cigarette*(tiab)). To obtain further studies, the manual search of the reference list of the articles was also conducted.

One of the researchers carried out screening of the titles and abstracts. Two authors further carried out full-text screening of the articles. Any disagreement among the authors was resolved through discussion. The inclusion and exclusion criteria used in the study were presented in Table 1. The articles with study participants younger than 35 years old were excluded because there is a consensus that the cumulative effects of smoking may not appear before the age of 35 years. Review articles, dissertations, working papers, comments and letters to editors as well as non-English language articles were also excluded.

If the costs were reported according to the US dollar, initially costs in the consumer price index were converted into the 2014 US Dollars. The cost data in Non-US Dollars were first converted into the 2014 current values of the consumer price index of the country and then converted into 2014

Table 1. Inclusion and exclusion criteria for the reviewed articles

Inclusion criteria	Exclusion criteria
- Published in the English language - 1990 to 2014 - Original article - Age ≥ 35 - Report on direct or indirect costs of the whole country - Availability of full-text article - At least three diseases have been evaluated	- Review articles, reports, letters, and comments; - Exclusively related to the groups of people such as Medicare, workforce or rural regions

US Dollar values using the currency exchange rate in that period. The year of article publication was considered when the year of the cost data was not reported or unclear. Also, if one study have been reported the cost of smoking for two years (2003 and 2008); the latest year (in this example; 2008) was considered.

Data extraction

The data from the included published articles concerning year of publication, year and the country where the study was conducted, age of studied participants, direct cost, indirect and total costs, number of smoking- related diseases included in the study, direct cost of smoking as percentage of the national health expenditure and total cost of smoking as percentage of GDP or GNP were extracted into a pre-constructed data extraction form. Any discrepancy in data extraction was resolved through discussion.

Systematic search of eligible studies

The primary systematic search yielded 293 and 41 articles from PubMed and Scopus, respectively. Of those, 9 articles were excluded due to duplication. After title and

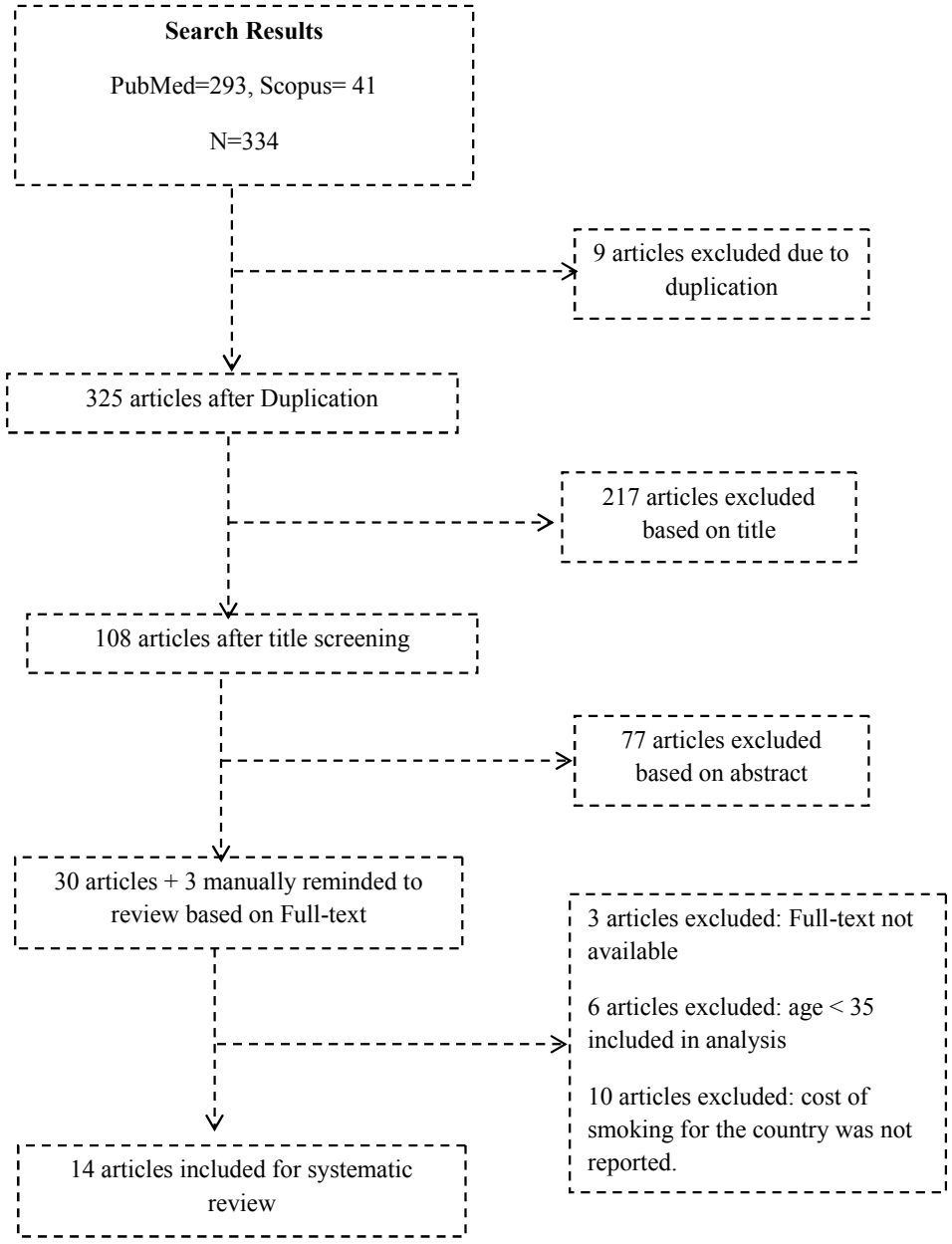

Fig. 1. The flowchart of the entire process of the systematic search of eligible articles for the review

abstract screening, 30 articles reminded to be reviewed in full text. Besides, 3 articles were added to full-text review through a search of references lists. Overall, from total 337 articles retrieved and reviewed, 14 articles met the inclusion criteria for the systematic review. The flow chart showing the entire process of the systematic search of eligible articles for the review is presented in Figure 1.

Results

Characteristics of selected studies

The characteristics of studies included in the systematic review are presented in Table 2. The review of the eligible studies indicated that there were high disparities among selected studies on number and types of smoking- related diseases. Except in one study (17), all the studies have considered lung cancer, COPD, and ischemic heart disease. Of the total studies, sensitivity analysis has been performed only in three studies (6,18-19). All the studies reported the direct costs of smoking-related diseases while ten studies reported the total cost of smoking. In four studies, the indirect (productivity) cost of smoking-related diseases was not reported (1,3,13, 20). Twelve and seven of studies have reported the direct costs and total costs of smoking as a percentage of national health expenditure and GDP or GNP respectively. Fourteen studies have used the human capital approach to estimate the productivity costs (indirect costs) of smoking. Except in one study (3), the prevalence-based approach was used to estimate the smoking-attributable costs and smoking-attributable fraction (SAF). SFA is the proportion of health care expenditure or health care utilization from a disease (lung cancer) that can be attributable to smoking.

Direct Versus Indirect Costs of Smoking-Related Diseases

The total cost of smoking- related diseases were divided into direct and indirect costs. Direct cost includes costs of inpatient care, outpatient visits, drugs and diagnostic tests as well as transportation costs. Indirect costs include productivity lost, the cost of premature retirement and morbidity costs. In seven of the studies (6,8,12,14,17-19) indirect costs greatly exceeded the direct costs and accounted for 53.3–81% of the total costs of smoking-related diseases. Three studies (11,21,22) have reported that direct cost accounted for the greatest part (51-70%) of the total cost of smoking. One study reported that direct costs account for 70% of the total cost of smoking while the indirect costs account for remaining 30% of the total cost (11). This study did not include the cost of premature mortality from smoking-related diseases. This systematic review revealed that the largest proportion of the indirect costs in six of the studies was related to the premature mortality that accounted for 58.2 % to 97.1 % of the indirect cost (6,12,18,19,21,22). The cost of premature mortality also accounted for 52.6 % to 90 % of the total cost of smoking-related diseases (6,12,18,19,21,22). The cost of premature mortality out of total cost of smoking in India (11), China (6), Korea (18) and Germany (21) was found to be approximately 84, 58, 91 and 58.3% respectively. In most of these studies, the subtotal of direct costs was not reported. The highest proportions of smoking-related outpatient health care costs reported were 57.2% and 73.2% from China (6,12) and 57.4 % from Taiwan (8). The cost of passive smoking was also substantial. However, only one study reported the total cost of passive smoking. Almost 25% of the total costs of smoking and 28 % of the smoking-related health care costs were related to the passive smoking (22). The total cost of smoking among men was higher than that in women. That is, about 88% of total costs of smoking was attributable to men while the cost in women was about 12% (11). Similarly, another study reported that the total cost of smoking among males was 2.6 times higher than the total costs among females (17). These results indicate a higher prevalence of smoking among males than among females.

Table 2. characteristics of selected articles included in the systematic review

First Authors /year	country	Years of reported cost	Total cost million $ US	Direct costs (% of TC[1])	Indirect cost (% of TC)	TC as % GDP[2]or GNP*	Direct cost as % of TNHE[3]	Diseases included
Ruff LK, 2000 [21]	Germany	1996	28722.8	14703.9 (51.2)	14018.8 (49.8)	NA	NA	COPD, Lung Cancer, Stroke, coronary artery disease, mouth and larynx cancer, atherosclerotic occlusive disease
John RM, 2008[13]	India	2004	2799.4	1968.7 (70)	829 (30)	NA	4.7	tuberculosis, respiratory diseases, cardiovascular diseases, neoplasms
Allender S, 2009 [20]	United Kingdom[4]	2005	NA	4039.1	NA	NA	5.5	Mouth and oral cancer, Trachea/bronchus/lung cancer Other cancers, COPD, Cardiovascular disease Other medical conditions[5]
Kang HY, 2002 [18]	Korea	1998	4712-6950	179.4 (26-38)	4531-6769 (72-81)	0.82-1.19	6.6–8.6	Cancers [6], Respiratory Diseases, Asthma, Pneumonia, ischemic heart disease, Stroke, emphysema, Vascular diseases, Hypertension, gastrointestinal diseases, Gastric ulcer, Duodenal ulcer, Cirrhosis
Oh IH, 2012 [17]	Korea	2008	3646.7	977 (26.8)	2669.7 (73.2)	0.33	NA	Only major cancers included: lip, oral cavity, and pharynx ; esophagus, pancreas , larynx , and trachea, lung and bronchus cancer; cancer of the cervix uteri , urinary bladder , kidney and other urinary ; stomach, liver and colorectal
Yang MC, 2005 [10]	Taiwan	2001	2350	522.6 (20.3)	1827.4 (79.7)	0.5	6.8	Cancers[7], Diabetes mellitus Rheumatic heart disease, Ischemic heart disease, Cardiac arrest and other heart disease, Cerebrovascular disease, Chronic bronchitis, asthma , Chronic airways obstruction, Peptic ulcer and GI, haemorrhage, Liver cirrhosis Kidney diseases , Accidents
Sung HY, 2005 [6]	China	2000	9495.5	3216.1 (34)	6279.4 (66)	NA	3.1	cancer(all types of malignant neoplasm(ICD-9)codes: 140–208)), cardiovascular diseases (stroke, ischemic heart disease, rheumatic heart disease) and respiratory diseases (COPD, respiratory tuberculosis, pulmonary heart disease)
Yang L, 2010 [14]	china	2008	37949.2	8156.5 (21.5)	9792.7 (78.5)	0.7	3	Cancers, cardiovascular diseases and respiratory diseases.
Bolin K, 2007 [19]	Sweden	2001	1420.5	374.6 (26.4)	1045.9 (73.6)	NA	1.5	malignant neoplasms in the upper aerodigestive tract, lungs, pancreas, urinary bladder, and kidney; COPD and other respiratory diseases; ischemic heart disease, other heart disease, stroke, and arterial disease
Leartsakulpanitch J, 2007 [15]	Thailand	2006	NA	372.8	NA	0.48	NA	lung cancer, chronic obstructive pulmonary disease (COPD), and coronary heart disease (CHD)
McGhee SM, 2005 [22]	Hong Kong	1998	864.7	576.9 (62.6)	289.1 (33.4)	NA	NA	Lung cancer, Esophageal cancer, Stomach cancer, Liver cancer , Mouth, pharynx, larynx, pancreas, bladder cancer; COPD/pulmonary heart disease, Other respiratory ; Stroke, Ischemic heart disease and Other vascular; peptic, gastric, duodenal, gastrojejunal ulcer, regional enteritis, idiopathic proctocolitis
Ross H, 2007 [1]	Vietnam	2005	NA	131.7[8]	NA	0.22	4.3	Lung cancer, chronic obstructive pulmonary disease (COPD), and ischemic heart disease.
Ginsberg GM, 2014 [16]	Israel	2014	1030	482 (46.8)	548 (53.2)	0.42*	2.6	(Cancer Respiratory, Cardiovascular, Digestive system, Endocrine metabolic, other)[8]
Chung CW, 2007 [3]	Taiwan	2001	NA	382-441	NA	NA	6.8	Neoplasms(Lip, oral cavity, pharynx; Oesophagus ; Stomach; Rectum Liver/ gallbladder; Lung; Cervix uteri); Stroke ; Acute myocardial infarction; COPD

[1] Total cost; [2] Gross Domestic Production; [3] Total National Healthcare Expenditure; [4] England, Wales, Northern Ireland and Scotland; [5]Includes peptic ulcer disease and all respiratory conditions except COPD; [6] include Pharynx, Larynx, Lung, Oesophagus, Stomach, Colon, Rectum, Pancreas, Prostate, Leukemia, Kidney, Bladder, Liver; [7] cancers include (lip, oral cavity, Pharynx; oesophagus; stomach; rectum; liver, gallbladder, bile ducts; trachea, lung, bronchus; cervix, uteri). [8]Cancer (Bladder, Cervical, Endometrial, Esophageal, Laryngeal, Lecumeia, Lung, Lip, buccal, Pharynx, pancreatic, Renal, Stomach, Unspecified, other cancers); Respiratory (Tuberculosis, Bronchitis, COPD, Asthma Adults, other Respiratory); Cardiovascular (Rheumatic heart disease, Aortic aneurism, Coronary artery disease, Coronary heart disease, Cardiac dysrhythmias, MI, Peripheral vascular disease, other heart disease); Digestive system (Crohn's disease, peptic ulcers, Ulcerative colitis); Endocrine- Metabolic (Diabetes), Other (Parkinson's disease).

Direct Costs of Smoking-Related Diseases and National Health Care Expenditure

Smoking causes a significant burden on the spending of health systems globally. Ten of the reviewed studies (1,3,6,8,11,12, 14,18-20) reported the proportion of national health care expenditure on the direct costs of smoking-related diseases. The total direct costs of smoking-related diseases accounted for 1.5% to 6.8% of the national health care expenditure. Studies in Taiwan (8) and India (11) have reported the direct cost of smoking-related diseases that accounted for 6.8 and 4.7% of the national

healthcare expenditure respectively.

Total Cost of Smoking-Related Diseases and Gross Domestic Production (GDP)

The impact of smoking and its consequences on the economy of a country is considerable. The economic burden of smoking on the national economy is usually expressed as a percentage of GDP. This systematic review has found that the burden of smoking accounted for 0.22 to 0.82 % of GDP (1,8,12-14,17,18). In another study, the total cost of smoking without including the cost of smoking-related premature mortality was 16% more than the total tax revenues collected from all tobacco products and many times higher than the total budget on tobacco control activities by the government (11).

Discussion

In this study, 14 original articles were systematically reviewed for the economic burden of smoking-related diseases. Despite the different methods used (prevalence or incidence-based approaches) to estimate the costs of smoking, the economic burden of smoking was found to be substantial. Smoking had a significant negative impact on national of health expenditures and society as a whole. This study was aimed at producing evidence for health policy-makers about the direct, indirect and total cost of smoking on health systems as well as countries.

The findings showed that the direct cost attributable to smoking accounted for 6.8 (3) to 1.5% (19) of the national health care expenditure. Besides, the total cost of smoking was between 0.22% (1) and 0.82 % (18) of the GDP. According to Chung et al. (3) the cost of smoking among adults in Taiwan ranged from 6 to 14% of the personal expenditure on health care. The total cost of smoking included both direct and indirect costs. Direct costs consisted of the hospitalization costs, medication costs, food and transportation costs etc. Indirect costs consisted of the cost of productivity loss and premature death. This systematic review showed that indirect costs accounted for a large proportion of the total cost and were identified to be higher than direct costs in seven studies (6, 8, 12, 14, 17-19). This can be explained by the high costs of premature deaths. In addition, our finding indicated that the cost of smoking-related premature mortality accounted for 52.6 % (6) to 90 % (18) of the total cost. Because the prevalence of smoking among males was higher than among the females, the largest proportion of the cost of smoking was attributed to the males. About 94.5 % of the total lifetime medical costs in Taiwan for the year 2001 was attributed to males (3).

The systematically reviewed studies were heterogeneous in many aspects including the number and types of diseases, inclusion or exclusion of passive smoking, inclusion or exclusion of premature mortality cost and with the use of different perspectives. All these factors influence results of the total cost of smoking. Thus, drawing a comparison among the studies was difficult. Except one study (17), all of the studies included chronic obstructive pulmonary diseases (COPD), lung cancer and cardiovascular disease. Hence, estimating the economic burden of smoking required consideration of these diseases in each study. Smoking has a negative impact on the health status of other people (passive or second smokers) and places costs on them. This review study has found that only one study reported on the cost of passive smoking that accounted for 23 % of the total cost of smoking (22). Thus, future studies should consider the impact of passive smoking.

Except one study which used incidence-based approach (3), all the reviewed studies used to calculate the SAF were prevalence-based approach. The relative risk of mortality has been used to estimate the SAF for the direct medical cost which would lead to under- or over- estimation of the total cost of smoking. The WHO also recommends medical cost ratio, utilization ratio, and disease incidence ratio to calculate the SFA of

the direct medical cost of smoking (2). Accordingly, if an appropriate data is available, the medical cost ratio is preferred; followed by utilization ratio, disease incidence ratio, and mortality ratio respectively. There is a consensus among health policy makers that raising taxes on a cigarette can reduce smoking (23-25). It is, however, suggested that policies such as increasing tobacco taxes are required to decline the economic burden of smoking in each country.

Conclusion

The study indicated that smoking not only causes morbidity and mortality but also it places a considerable economic burden on both health system and society as a whole. Our review indicated that the total cost of smoking accounted for 1.5 to 6 % of national health systems' expenditure and 0.22 to 0.88 % of GDP of countries. Also, outpatient care and cost of premature mortality have been found to be the most important cost drivers of direct and indirect costs, respectively.

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