

RESEARCH ARTICLE

Economic Burden of Smoking in Iran: A Prevalence-Based Annual Cost Approach

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Abstract

Objectives: The burden of smoking on the health system and society is significant. The current study aimed to estimate the annual direct and indirect costs of smoking in Iran for the year 2014. **Methods:** A prevalence-based disease-specific approach was used to determine costs associated with the three most common smoking-related diseases: lung cancer (LC), chronic obstructive pulmonary disease (COPD) and ischaemic heart disease (IHD). Data on healthcare utilization were obtained from an original survey, hospital records and questionnaires. The number of deaths was extracted from the global burden diseases study (GBD). The human capital approach was applied to estimate the costs of morbidity and mortality due to smoking-related diseases, classified as direct (hospitalization, outpatients and non-medical costs) and indirect (mortality and morbidity). **Results:** The total economic cost of the three most common smoking-attributable diseases in Iran was US\$1.46 billion in 2014, including US\$1.05 billion (71.7%) in indirect and US\$0.41 billion (28.3%) in direct costs. Direct costs of the three smoking-related diseases accounted for 1.6% of total healthcare expenditures and total costs were about 0.26% of Iran's gross domestic product (GDP) in 2014. **Conclusions:** Our study indicated that smoking places a substantial economic burden on Iranian society. Therefore, sustained smoking cessation interventions and tobacco control policies are required to reduce the magnitude and extent of smoking-attributable costs in Iran.

Keywords: Smoking- direct and indirect costs- prevalence approach- Iran

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Introduction

Smoking is one of the main leading preventable cause of death and associated with more than five million deaths annually throughout the world. This figure is projected to increase to more than eight million deaths by 2030, of which 80% will occur in developing countries (WHO, 2008). The negative impact of smoking on health care systems and on societies as a whole is substantial, accounting for 1.5-6.8% of national health system budgets and 0.22-0.88% of gross domestic product (GDP) of countries annually (Rezaei et al., 2016). Recognition of the harmful health and financial effects of smoking has led to increased adoption of tobacco control policies in countries around the world, regardless of their social and economic development levels (Goger et al., 2014). The prevalence of smoking in Iran is about 12.5% (23.4% males and 1.4% females), with an average of 13.7 cigarettes per day (Meysamie et al., 2010). Similar to other countries, smoking places a major economic burden on Iran's society (Rezaei et al., 2015; Rezaei et

al., 2016). Rezaei and colleagues, for example, showed that smoking is responsible for 4623 cancer deaths, 80 808 years of potential life lost and \$US 83 019 583 cost of productivity losses in Iran (Rezaei et al., 2015). Due to significant differences in the prevalence of smoking, health care systems and socioeconomic context, the costs associated with smoking-related diseases vary across countries. Therefore, it is crucial to conduct country-specific estimates of the costs associated with smoking in order to better understand the economic consequences of smoking. Understanding the economic burden of smoking in Iran can increase public awareness on the extent of the smoking problem which, in turn, can encourage the Iranian government to move forward with the ratification and implementation of the World Health Organization Framework Convention on Tobacco Control (WHO FCTC). In this study, we aimed to provide the first national-level estimate of the economic costs of smoking in Iran. Specifically, we estimated the direct and indirect costs of the three most common smoking-related diseases viz., lung cancer (LC), chronic obstructive pulmonary

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disease (COPD) and ischaemic heart disease (IHD) from the societal perspective in Iran in 2014. Considering similarities in the tobacco epidemic and social and cultural conditions among the countries in the WHO Eastern Mediterranean Region (EMRO), the findings of our study could provide a valuable evidence for understanding the health and economic benefits of tobacco control programs in this region.

Materials and Methods

A prevalence-based approach was used to estimate the economic costs of the three most common diseases related to smoking: LC, COPD and IHD (Sung et al., 2014). We used the smoking-attributable fraction (SAF), also known as population attributable risk, to determine the proportion of healthcare costs, work loss days and deaths attributable to smoking among adults in Iran. We restricted our analysis to adults aged 35 years and older because it is estimated that there is a latent period of 20 years and more between initial exposure to smoking and occurrence of smoking-related diseases (Sung et al., 2014). We estimated the annual direct and indirect costs of the three smoking-related disease in 2014. Direct costs included hospitalization costs (e.g., doctor visit, surgery, diagnostic tests, medications, hoteling and nursing care costs), outpatient costs and direct non-medical costs (e.g., costs of travel to the health provider, accommodation, food costs, caring for family members such as the elderly or children in the absence of the patient and other utility costs such as telephone bill). Indirect costs included mortality costs measured by the value of life lost prematurely from the smoking-related diseases and morbidity costs (patient time costs) measured by the value of time lost from activities and disability due to smoking-related illness. All the costs were converted to US dollars (US\$) using the average annual 2014 exchange rate (US\$1 = Rial 25 825).

Direct costs and data sources

Hospitalization costs

Total smoking-attributable hospitalization (inpatient) costs (TSAH) associated with LC, COPD and IHD were estimated by adopting a methodology recommended by the WHO, as follows (WHO, 2011):

$$TSAH_{ija} = ([C(H)_{ija} * Q(H)_{ija}] * SAF_{ija}) * [P_{ija} * TP_{ija}] \quad (1)$$

Where *i* indicates the type of diseases, *j* is gender, *a* is age-groups (35-64 or 65 years and above), *C(H)* is the average cost of hospitalization and *Q(H)* indexes the number of hospitalization in one year, *P* denotes the prevalence of the disease, *TP* is the total population. SAF represents the smoking-attributable fraction in percentage. As per the WHO recommendation, SAF_{ija} was estimated using the following epidemiological formula (WHO, 2011):

$$SAF_{ija} = \frac{[P_n + P_c * RR_c + P_f * RR_f] - 1}{[P_n + P_c * RR_c + P_f * RR_f]} * 100 \quad (2)$$

where P_n , P_c and P_f indicate never, current and former smoking prevalence (%), respectively. RR_c and RR_f

are the disease-specific average cost of a one-episode hospitalization for current and former smokers, compared to never smokers, respectively.

To estimate the average cost of hospitalization, *C(H)*, we performed a hospital-based medical record review study. Inpatients care in Iran is delivered in hospitals owned and operated by different health care providers. The Ministry of Health and Medical Education (MOHME) is the main provider of hospital care in Iran. Public hospitals under the MOHME account for 68% of total hospital beds. Private hospitals, social security organization (SSO) hospitals and armed force hospitals account for 12, 9 and 4% of total hospital beds. The rest of hospital beds are owned and operated by independent organizations such as National Iranian Oil Company (NIOC) and non-governmental organizations (NGOs) (Hajizadeh and Nghiem, 2013). We randomly selected 1271 patients, proportionally to the share of each provider from the total hospital beds (i.e., 415 with LC, 429 with IHD and 427 with COPD), who were discharged during the study period. Samples size for each disease was calculated based on the estimated average and standard deviation of hospitalization costs through conducting a pilot study in which medical records of 50 patients were reviewed retrospectively. Data on the smoking status of patients and number of hospitalizations for each patient, *Q(H)*, were obtained by telephone survey.

Outpatient and non-medical costs

Based on a method suggested by the WHO, we used the following formula to estimate the outpatient and non-medical costs associated with the three smoking-related diseases (WHO, 2011):

$$SAC_{ijk} = ([AC_{ijk} * Q_{ijk}] * SAF_{ijk}) * [P_{ija} * TP_{ija}] \quad (3)$$

where SAC is smoking-attributable costs, *i*, *j*, *a*, *P* and *TP* are defined as above, *k* indicates the type of services (an outpatient or non-medical visit), *AC* represents the average cost of an outpatient or non-medical care and *Q* shows the number of outpatient visits. Equation 2 was used to calculate the SAF, where RR_c and RR_f index the disease-specific average cost of outpatient visits or non-medical costs for current and former smokers, compared to never smokers, respectively. We conducted a patient survey to estimate the average cost of outpatient care (e.g., drug, exam test, laboratory, magnetic resonance imaging, carpal tunnel syndrome, physician visits) and non-medical costs for each of the three smoking-related diseases. We carried out a survey study among 600 patients (200 patients with each diagnosis) to estimate the cost of outpatient care in the previous month. Samples size for each disease was estimated based on the average and standard deviation of outpatient costs through conducting a pilot study in which 20 patients were interviewed. The estimated monthly outpatient and non-medical costs were multiplied by 12 to reflect the cost for one year. Information on smoking history, work days lost due to receiving outpatient visits, costs of outpatient visits and non-medical costs associated with each outpatient visit were obtained from the patient's questionnaire.

Indirect costs and data sources

Smoking-attributable indirect costs consist of costs associated with morbidity (patient time costs) and premature mortality due to smoking-related diseases. Similar to previous studies (Yang et al., 2011; Anh et al., 2014; Cai et al., 2014; Sung et al., 2014), we used human capital approach to estimate mortality and morbidity costs attributable to smoking.

Morbidity costs attributable to smoking

We used a methodology recommended by the WHO (WHO, 2011) to calculate indirect costs of morbidity associated with smoking as follows:

$$SAIMB_{ijk} = [SAF_{ijk} * AWLD_{ijk} * AERN_{ijk}] * (P_{ija} * TP_{ja}) \quad (4)$$

where SAIMB is the smoking-attributable indirect costs of morbidity, i, j, a, P, TP and SAF are defined as above; k indicates types of services (inpatients or outpatient care), AWLD represents the average work-loss days and AERN is average daily earnings. SAF was determined as in Equation 2 with RR_c and RR_f representing the disease-specific average work-loss days due to outpatient or inpatient care for current and former smokers, compared to never smokers, respectively. The AWLD for inpatient care were taken from medical records. The AWLD for outpatient care was estimated using a self-administrated questionnaire. We used a minimum daily wage approved by the Iranian Ministry of Cooperation, Labor and Social Welfare (IMCLSW) in 2014 as the AERN for the inpatient care. For the outpatient care, the AERN of the patient was estimated by dividing the monthly income of the patient by thirty. The patient time cost was calculated by multiplying the average number of lost days by the average daily income.

Mortality costs attributable to smoking

As per the WHO recommendation (WHO, 2011), we used the following formula to estimate smoking-attributable indirect mortality costs (SAIMT) for each disease by gender and 5-year age-groups (35-65 years):

$$SAIMT_{ija} = SAF_{ija} * \sum(Tdeath_{ija} * PVLE_{ija}) \quad (5)$$

where Tdeath is the total number of deaths, PVLE indicates the present discounted value of lifetime earnings, i, j, a, and SAF are defined as above. The PVLE per death by gender and age groups was estimated using an approach developed by Max and colleagues as follow (Max et al., 2004):

$$PVLE = \sum_{n=a}^{65} P_{a,g}(n) [Y_g(n)E_g(n) + YH_g(n)EH_g(n)] * \frac{(1+P)^{n-a}}{(1+r)^{n-a}} \quad (6)$$

where $PVLE_{ag}$ is the present discounted value of lifetime earnings for a person who died at the age a and gender g, $P_{ag}(n)$ indicates the probability of survival until the age n for a person of age a and gender g. $Y_g(n)$ represents average annual earnings of an employed person of gender g and age n. $E_g(n)$ is the proportion of the population of gender g and age n who are employed in the labor market. $YH_g(n)$ indexes the average annual

imputed value of household production for a person of gender g and age n. $EH_g(n)$ represents the proportion of the population of gender g and age n that are housekeepers. P and r denote growth rate of labor productivity (mean economic growth in the past 30 years in Iran = 3%) and appropriate discount rate (3 %), respectively.

The total number of deaths in 5-years in different age groups due to lung cancer for Iran was extracted from the Institute for Health Metrics and Evaluation (IHME) and the Global Burden of Disease Study (GBD). Data on the age- and gender-specific wages for the study period was obtained from the IMCLSW. Further, data on the age and gender-specific employment and housekeeping rates for the study period were drawn from the Iranian Statistical Center and Central Bank of Iran. Since there is no available data on the wages for housekeeping activity in Iran, the minimum daily wage approved by the IMCLSW was used for the females engaged in housekeeping activities. The probability of survival until the age n for a person of age a and gender g was obtained from the WHO data set. We restricted our analysis to individuals aged 65 (retirement age in Iran) and younger when we measured the costs of lost productivity attributable to smoking due to morbidity and premature mortality.

Results

Table 1 reports Prevalence (%) of smoking and smoking attributable fraction for hospitalization costs and

Table 1. Prevalence (%) of Smoking and Smoking Attributable Fraction for Hospitalization Costs and Outpatient Costs (Outpatient Care and Non-Medical Costs) by Disease, Gender and Age-Groups in Iran in 2014

Disease	Male		Female	
	35-64	65+	35-64	65+
Lung cancer (LC)				
Current smoking (%)	57	42	21	20
Former smoking (%)	13	15	16	11
Never smoking (%)	30	43	63	69
SAF for hospitalization costs (%)	44.3	42.6	11.5	11.4
SAF (%) outpatient care costs	17.26	21.68	5.68	3.86
(%) direct non-medical costs	27.07	14.18	9.07	8.27
Chronic obstructive pulmonary disease (COPD)				
Current smoking (%)	45	38	12	10
Former smoking (%)	14	13	9	9
Never smoking (%)	40	49	79	81
SAF for hospitalization costs (%)	29.2	13.6	9.09	10.7
SAF (%) outpatient care costs	16.32	5.46	2.91	6.51
(%) direct non-medical costs	21.05	24.41	13.06	4.77
Ischaemic heart disease (IHD)				
Current smoking (%)	38	27	13	10
Former smoking (%)	9	16	7	8
Never smoking (%)	54	57	81	82
SAF for hospitalization costs (%)	13.83	13.82	5.62	6.56
SAF (%) outpatient care costs	12.5	16.4	4	3.2
(%) direct non-medical costs	18.5	10.9	4.78	4.78

Table 2. Estimated Number of Outpatient Visits, Total Outpatient Care and Non-Medical Costs (US\$) Attributable to Smoking By Type of Diseases, Gender and Age-Groups in Iran in 2014

Disease	Male		Female	
	35-64	65+	35-64	65+
Lung cancer (LC)				
Estimated number of outpatient visits	1,377	1,884	773	741
Costs of outpatient care	1,144,523	1,534,087	630,649	691,411
Non-medical care costs	949,770	1,331,210	546,192	538,691
Costs of outpatient care attributable to smoking	197,549	332,558	35,845	26,676
Costs of non-medical care attributable to smoking	188,774	445,913	49,557	44,527
Total costs of outpatient care associated with LC			4,000,674	
Total non-medical costs associated with LC			3,365,862	
Total costs of outpatient care attributable to smoking associated with LC			592,631	
Total costs of non-medical care attributable to smoking associated with LC			539,992	
Chronic obstructive pulmonary disease (COPD)				
Estimated number of outpatient visits	56,683	32,126	101,178	25,860
Costs of outpatient care	37,791,179	18,465,994	54,737,820	14,801,917
Non-medical care costs	35,974,134	23,093,688	60,590,587	17,450,963
Costs of outpatient care attributable to smoking	6,167,520	1,008,244	1,592,871	963,605
Cost of non-medical care attributable to smoking	7,554,567	563,4862	7,876,774	832,414
Total costs of outpatient care associated with COPD			125,796,910	
Total non-medical costs associated with COPD			137,109,375	
Total costs of outpatient care attributable to smoking associated with COPD			9,732,240	
Total costs of non-medical care attributable to smoking associated with COPD			2,189,8614	
Ischaemic heart disease (IHD)				
Estimated number of outpatient visits	467,637	88,348	760,523	145,786
Costs of outpatient care	471,223,946	102,785,231	765,039,710	159,087,775
Non-medical care costs	438,211,802	83,808,306	666,186,265	119,606,912
Costs of outpatient care attributable to smoking	58,902,993	3,060,159	16,891,493	5,090,807
Costs of non-medical care attributable to smoking	81,226,362	9,124,968	31,873,010	5,711,899
Total costs of outpatient care associated with IHD			1,498,136,666	
Total non-medical costs associated with IHD			1,307,813,286	
Total costs of outpatient care attributable to smoking associated with IHD			176,135,237	
Total costs of non-medical care attributable to smoking associated with IHD			127,936,240	

outpatient costs (outpatient care and non-medical costs) by disease, gender and age-groups in Iran in 2014. Based on patient's survey, the prevalence of current smoking among patients was 33.9%. The prevalence of former and never smoking were 12% and 54.1%, respectively. Prevalence of smoking was higher among males compared to females (42.8 vs. 15.3 % for current smoking). The smoking-attributable fraction associated with outpatient care and non-medical costs for LC was 12.1 and 14.7%, respectively, whereas the corresponding figures for COPD were 7.8 and 15.8 % and for IHD were 9 and 9.7 %.

The estimated number of patients who were admitted to hospitals in the entire country due to LC, COPD and IHD in 2014 were 4775,16,236 and 398,807, respectively. Total costs of hospitalization for the three diseases was estimated to be US\$762 558 114, of which US\$688,464 976 was related to IHD, US\$64,559,299 to COPD and US\$9 533 839 to LC. Total smoking-attributable costs of hospitalization for three diseases was estimated to be US\$75,703,330, of which US\$62,094,385 was related

to IHD, US\$10 396 701 to COPD and US\$3,212,244 to LC. Generally, smoking was responsible for 9.9% of total cost of hospitalization for these diseases. Table 2 presents the total number of outpatient visits, total costs of outpatient care and non-medical costs-attributable to smoking in 2014 for the entire country by type of diseases, gender and age-groups. Total costs of outpatient care and non-medical care for the three smoking-related diseases were estimated to be US\$1 627 934 250 and US\$1 448 288 523, correspondingly. Based on the results reported in Table 4, 11.5% (US\$186 460 109) of total costs of outpatient care and 10.4 % (US\$150 374 846) of total costs of non-medical care were associated with smoking.

The estimated total costs of morbidity due to hospitalization and outpatient care for the three diseases were estimated to be US\$58 032 650 and US\$636 455 578, respectively. In LC, total costs of morbidity due to hospitalization and outpatient due to smoking was estimated to be US\$98 892 and US\$176 999, respectively. Whereas the corresponding figures for COPD were US\$2

Table 3. Total Deaths, Years of Potential Life Lost and Costs of Mortality (US\$) Due to Smoking by Type of Diseases and Gender in Iran, in 2014

Disease	Male		Female	
	35-64	65+	35-64	65+
Lung cancer (LC)				
Number of total death*	1303	1851	525	713
Smoking-attributable total death	877	1126	77	127
Total years of potential life lost	1,755,745	1,332,743	753,664	544,935
Smoking-attributable total years of potential life lost	1,179,860	810,307	109,884	96,780
Total cost of mortality	76,219,427	-	26,126,072	-
Smoking-attributable costs of mortality	51,219,454	-	3,809,181	-
SAF for death, YPPL and costs of mortality	67.3	60.8	14.6	17.8
Chronic obstructive pulmonary disease (COPD)				
Number of total death	1285	3830	555	2616
Smoking-attributable total death	605	1647	75	377
Total years of potential life lost	4,428,010	2,435,190	2,615,717	1,712,408
Smoking-attributable total years of potential life lost	817,359	1,047,132	105,710	246,587
Total cost of mortality	154,687,644	-	81,692,457	-
Smoking-attributable costs of mortality	72,857,882	-	11,028,585	-
SAF for death, YPPL and costs of mortality	47.1	43	13.5	14.4
Ischaemic heart disease (IHD)				
Number of total death	14,704	32,704	6136	24,456
Smoking-attributable total death	6190	4742	669	1167
Total years of potential life lost	19,970,576	20,988,542	8,656,190	162,90,412
Smoking-attributable total years of potential life lost	8,407,612	943,525	3,043,339	777,053
Total cost of mortality	1,863,483,338	-	897,232,720	-
Smoking-attributable costs of mortality	784,526,486	-	97,798,366	-
SAF for death, YPPL and costs of mortality	42.1	14.5	10.9	4.8

Note, Since we do not have available information on the number of deaths associated with the three diseases included in our study for the year 2014, we used number of deaths in 2013 in our calculations.

455,900 and US\$3 962,978 and for IHD were US\$1 502 676 and US\$16 536 956, respectively. The study showed that smoking was responsible for 7% (US\$4 050 467) of total costs of morbidity due to hospitalization and 3.25% (US\$20 676 933) of total costs of morbidity due to receiving outpatient care for the three disease included in the study.

The overall number of deaths from LC, COPD and IHD was estimated to be 90 678 over the study period in Iran and smoking was responsible for approximately 19.5% of these deaths (17, 679 deaths). Moreover, years of potential life lost (YPLL) for three diseases was estimated to be 81,484,132 years and 21.6% of these years (17,585

148 years) was attributable to smoking. Based on 3% discount rate, the overall costs of mortality attributable to smoking was estimated to be US\$ 1,021,239,953 (approximately 32.9% of the overall costs of mortality), including US\$908 603 822 for males (89%) and US\$112 636,132 (11%) for females (see Table 3).

Table 4 displays total direct and indirect costs attributed to smoking for Iran in 2014. The total economic cost of smoking for the three smoking-related diseases was US\$1 458 505 657, including US\$1 045 967 357 (71.7 %) in indirect costs (mortality and morbidity costs) and US\$412 538 296.2 (28.3 %) in direct costs (hospitalization, outpatient and non-medical costs).

Table 4. Total Economic Burden of Smoking (US\$) by Each Component of Costs and Disease in Iran, in 2014

Disease	Hospitalization Costs	Outpatient Costs	Non-medical Costs	Morbidity Costs	Mortality Costs	Total Costs
Lung Cancer	3,212,248	592,627	539,992	268,891	55,028,635	59,642,401
Chronic Obstructive Pulmonary Disease	10,396,705	9,732,240	21,898,618	6,418,881	83,886,467	132,332,906
Ischaemic Heart Disease	62,094,389	176,135,237	127,936,240	18,039,632	882,324,852	1,266,530,350
Total	75,703,342	186,460,104	150,374,850	24,727,404	1,021,239,954	1,458,505,657
Percentage of total costs	5.2	12.8	10.3	1.7	70	100

Discussion

This study is the first attempt to estimate the economic burden of smoking in Iran. The results of our study confirmed that smoking imposes significant health and economic costs on society in Iran. The direct costs of smoking-attributable costs for the three main diseases associated with smoking in Iran (i.e., LC, COPD and IHD) amounted to US\$ 412,538,296 and accounted for 1.6% of Iran's total expenditures on health in 2014. Additionally, smoking led to 17 679 premature deaths corresponding to 17,585,148 YPLLs. It is also responsible for US\$ 1,021,239,955 in indirect costs of lost productivity due to premature deaths and US\$ 24,727,404 in indirect costs of loss-work days due to smoking-related diseases. These costs summed to US\$1,458,505, 657, accounting for 0.26 % of Iran's GDP in 2014.

It should be noted that comparing economic costs of smoking-related diseases in different countries is extremely difficult. This is because income and employment rates among males and females can affect the estimated indirect costs associated with smoking-related diseases in different countries. Differences in health systems, including costs and service delivery, can also explain some of the variations in the estimated costs of smoking-related diseases across countries. However, despite these limitations, our results indicated that the proportion of GDP losses related to the smoking in Iran is comparable to those estimated for Vietnam (0.22%) (Anh et al., 2014), and is less than those reported for Taiwan (0.4 %) (Sung et al., 2014), South Korea (ranging from 0.59 % to 0.78 %) (Kang et al., 2003) and China (0.7 %) (Yang et al. 2011). The lower economic burden of smoking in Iran compared to other Asian countries can partially be explained by lower smoking prevalence in Iran (Meysamie et al., 2010). Moreover, the actual direct costs associated with smoking is higher than what we have reported in our study because our measurement is based on the hospital records that do not contain information on any payments for long-term care and nursing home care. Furthermore, unlike to the previous studies (McGhee et al., 2006; Cai et al., 2014; Sung et al., 2014), we estimated smoking-attributable costs for only three smoking-related diseases among active smokers in Iran, which led to lower economic costs of smoking in Iran compared to other countries.

We found a gender difference in the number of deaths, YPLL and total costs attributable to smoking in Iran. The results revealed that 68% of 17,679 smoking-attributable deaths and 87% of 17,585,148 YPLL caused by smoking were among males. Similarly, 87.2% of total smoking-attributable costs were among males. These results are in consistence with the findings from studies conducted in Germany in 2003 (Neubauer et al., 2006), South Korea in 2003 (Kang et al., 2003) and Taiwan in 2010 (Sung et al., 2014). A study by Neubauer et al., (2006) indicated that smoking was responsible for 13.4% of total deaths in Germany, which 69.3% of these deaths were among males. Another study by Sung et al., (2014) in Taiwan also demonstrated a substantial difference between

males and females with respect to smoking-related deaths in Taiwan, 13,744 male deaths compared to 615 female deaths. Yung et al., (2011) showed that the total costs of smoking in China were US\$ 28.9 billion in 2008 and 92% of total smoking-attributable costs was among males. The main reasons for the observed gender differences in smoking-attributable costs can be explained by higher prevalence of smoking, employment rate, and wage rates among males compared to their female counterparts.

The results of our study suggested that total costs of smoking for the three common smoking-related diseases were US\$1,458,505,657. The mortality costs associated with the three diseases is estimated to account for 70% of total costs of smoking and 97.6% of total indirect costs of smoking. Furthermore, the direct costs accounting for 28.3% of total costs of smoking. The costs of premature deaths were reported to be responsible for 76.1%, 91%, 46%, 64% and 50% of the total costs of smoking in China (Yang et al., 2011), Vietnam (Anh et al., 2014), South Korea (Kang et al., 2003), USA (Max et al., 2004), Germany (Neubauer et al., 2006) and Taiwan (Sung et al., 2014), correspondingly. Our findings are comparable to a study by Yang et al., (2011) which demonstrated that the total costs of smoking for Germany to be \$ 28.9 billion; US\$ 6.2 billion (21.5%) in direct costs and US\$ 22.0 billion (76.1%) in indirect mortality costs and US\$ 0.7 billion (2.4%) in indirect morbidity costs.

The actual total direct and indirect costs of smoking in Iran are higher than what we have reported in our study. This is because we only focused on the economic costs of the three main smoking-related diseases in our study and it has been shown that smoking is closely associated with many other diseases such as different type of cancers (e.g., stomach, uterine, cervix, pancreas and kidney and acute myeloid leukemia), pneumonia, abdominal aortic aneurysm, reproductive and erectile as we did not measure the costs associated with all smoking-related diseases, our study underestimated the actual costs of smoking in Iran. In addition, since we did not measure the costs of secondhand smoke exposure on society in Iran, the actual costs of smoking are projected to be higher than what we have reported in this study. In fact, the results of some recent studies (McGhee et al., 2006; Cai et al., 2014; Sung et al., 2014) demonstrated that the costs associated with secondhand smoke exposure contributed significantly to the overall costs of smoking. For example, the costs associated with secondhand smoke represented 23% and 8% of the total costs of smoking in Hong Kong (McGhee et al., 2006) and Taiwan (Sung et al., 2014), respectively. Furthermore, since we used the average income per capita in Iran to estimate the indirect cost of smoking (i.e., GDP per capita for mortality and daily wage rate for morbidity), we underestimated the overall costs of smoking in Iran because a greater proportion of smokers are males who have higher income compared to females. Caveat considered, our study indicated that smoking places a substantial economic burden on Iran's health system and on society as a whole. Therefore, sustained smoking cessation interventions and tobacco control policies are required to reduce the magnitude and extent of smoking-attributable costs in Iran.

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