Economic Burden of Smoking-Attributable Diseases in West Africa, 2012

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ABSTRACT

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Background: Smoking is a major public health threat for a variety of diseases. Developing countries are at a high risk of epidemic increases from smoking-associated illnesses since smoking prevalence in these countries has been increasing over the years, with no major policies being put forth to combat this. To date, no studies have examined the economic burden in monetary terms in West Africa. Therefore, information on the economic costs of smoking-related diseases is required to view the extent of the tobacco epidemic on society.

Methods: The economic burden of smoking-attributable diseases as defined using the ICD-10 (International Classification of Disease) codes in 2012 is estimated using the SAMMEC approach to measure the disease burden in terms of mortality and morbidity and the Cost of Illness approach to measure costs. The study includes direct costs and indirect costs where direct cost represents smoking-attributable healthcare expenditure, and indirect costs, which are estimated by identifying the productivity loss from morbidity and future income loss due to premature death. Our study included 12 West

African countries (for which all required data was available) within the age group 15–59years (because of the time lag for developing non-communicable diseases and the average life expectancy in West Africa). We calculate the Population attributable fraction for each disease using smoking prevalence by country and gender, which was used in computing values to calculate labour loss to morbidity and mortality. All necessary data was obtained from various international open sources, including the international monetary fund database, World Health Organization (WHO), and World Bank reports. The analysis was done using Excel 2013.

Results: There were about 42,033 deaths attributable to smoking in West Africa in 2012, accounting for 37% of all deaths from smoking-associated disease included in this study. Mortality rates were almost 10 times higher in men than in women. The overall cost of healthcare expenditure on smoking-attributable diseases stood at approximately PPP$784 million proportionate to 1.7% of the region's total health expenditure. The total economic costs of smoking (from healthcare expenditure and both productivity losses) estimated totaled PPP$ 3,158 million, which accounts for 0.3% of the region's annual gross domestic product (GDP) for 2012. Compared to low-and-middle-income countries, the disease burden is slightly higher in low-income countries. Furthermore, looking at the country-specific situations; Sierra Leone had a far greater economic burden

than other countries with total cost amounting to 1.1% of its country's national GDP.

Conclusions: Effective tobacco control measures such as preventive programs must be implemented in West African countries to reduce the burden of smoking-attributable diseases. The need for these urgent control policies is particularly required in Sierra Leone and Cote d'Ivoire, where the tobacco epidemic is most advanced.

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1. Introduction

1.1 Background

Health is an important component of economic growth. The return to capital investment for economic growth and development is greatly influenced by health capital because healthier workers tend to be mentally and physically more energetic. Hence, any nation experiencing a heavy burden of disease like smoking-attributable diseases (such as heart disease, or lung cancer), tends to experience multiple impediments to economic progress. Because mortality from these diseases is not immediate, morbidity and disability due to tobacco use are high and could lead to undue burdens on families caring for ill family members and on the economy.

Smoking-attributable diseases are terminal diseases and treatments require high cost. The burden of this high cost required to undergo treatment is incurred by patients, household and the government. Patients of smoking-related diseases seeking health care inquire a lot of costs such as consultation cost, hospital cost, transport cost, drugs cost and other related costs to treat diseases. The implications of these high costs directly affect the entire household of these patients; seeking health care and inquiring high costs will increase household expenditure, thereby reducing household income, leading to a subsequent decrease in the consumption of other goods. Reduction in household income may result in poverty and subsequently leads to macroeconomic problems. Also,

there is a negative impact on the government budget from smoking-related diseases[1]. At the national and subnational levels, most of the direct effects of these diseases (non-communicable diseases NCDs) will be felt within health systems. NCDs as mentioned above are expensive to treat and they require healthcare providers with greater specialization; as such, the government spends more to subsidize the healthcare cost of drugs and consultation, and also for the training of the needed specialized doctors. The Global healthcare costs associated with smoking annually are estimated at US$ 422 billion representing 5.7% of total health expenditure worldwide[2]. From some studies, the estimated cost of hospitalization for acute asthma in France was between almost $ 3,000 and approximately $ 5,000[3]. Smoking-attributable medical cost in China was estimated to be about 4.7 percent of the natural health expenditure in 1988[4].

Economic costs of illnesses are important information necessary for making health decisions. Cost estimates provide useful information for targeting programming, it helps to prioritize substance abuse issues and also identifies information gap[5]. Hence, a proper estimate of cost on the tobacco-related diseases can form a framework for important macroeconomic health policy. Many health care providers including government and non-governmental organizations plan on evaluating the costs and benefit cash flows over the short term in specific countries; however, it is a difficult task to make formulation and

implementation of a national policy on tobacco when the amount of expenditures on the diseases cannot be quantified.

1.1.1 Tobacco use and burden of smoking-related disease worldwide

Life-threatening diseases associated with tobacco result to preventable death and disabilities which now constitutes a pandemic. Diseases caused by tobacco claim the lives of many people throughout the world[5]. Tobacco use and exposure to second-hand smoke cause death to almost 6million people each year among adults and this includes more than 600,000 non-smokers who die from exposure to second-hand smoke. The World Health Organization has estimated that approximately 5.4 million people died worldwide from tobacco-related illnesses in 2006[6]. More than 5 million of these deaths are attributed directly to smoking. An estimated number of 13,000 persons dies every day from smoking-related diseases[5], and if current trend persists, the annual death from tobacco use is predicted to rise to 8.3 million by the year 2030[7], and about 1 billion by the end of this century with greater than 80 percent of these deaths projected to occur in low-and-middle-income countries (LMICs)[8]. Many of these deaths occur prematurely and this has a negative impact on the socio-economic development of any nation. In people over age 30, smoking accounts for one in every five deaths among men and one in every 20 deaths among women globally[9].

International studies have shown that the lifespan of smokers is reduced by 10years compared to non-smokers[10]. However, between 1980 and 2012, the number of cigarettes smoked worldwide increased from 4.96 trillion to 6.25 trillion[11]. While the current burden of death is distributed evenly between developing and industrialized countries[9], most of the future burden of death will occur in low and middle income countries (LMICs), where greater than 80% of the world's smokers live[6]. To reduce the burden of smoking-related diseases, global efforts to decrease tobacco use are being implemented. Smoking rates are for the most part well in decline in Western Europe, the UK, the US, Canada, New Zealand and Australia. Meanwhile, in some countries in Asia, South America and most of Africa, the prevalence of smoking is still increasing[12, 13]. The transition of tobacco hubs from the West to the African continent is of paramount importance. Between 1990 and 2009, cigarette consumption decreased by about 26 percent in Western Europe while there was almost a 60 percent increase in tobacco consumption in Africa and Middle Eastern countries[14]. Tobacco regulation has been tightened in North America and Europe in contrast to the African region where some countries are either yet to implement tobacco laws or are more susceptible to being influenced by the tobacco lobby groups that see the continent as a vast area of growth[13, 15]. As such, Africa has become a prime target for tobacco companies[15].

Tobacco use imposes a heavy economic burden on the world. The cost of smoking alone globally is estimated to be US$ 1400 billion, which is 1.8% of

global gross domestic product (GDP)[16]. Tobacco use and related diseases have devastating health and economic consequences[17]. More than half of tobacco users die of smoking related diseases. Worldwide, smoking causes 12 percent of all deaths and 3 percent of deaths in Africa. It has been estimated that approximately 450 million adults will be killed by smoking between 2000 and 2050 and at least half of these adults will die between 30 and 69 years of age, losing decades of productive life[11].

1.1.2 Tobacco use and burden of smoking-attributable diseases situation in West Africa.

In Africa, there are various types of tobacco products smoked which include cigars, pipes, cigarettes and shisha (water pipes). Tobacco products used in West Africa are either manufactures products and/or custom-made for personal use or for sale by a street vendor. Consumption patterns of tobacco differ from one region to another, and within a neighborhood, between population sub-groups as a function of gender, area of residence, education level, age, economic status and other factors. Africa appears to differ from other continents of the world in having reached only the early stages of the tobacco epidemic[18]. In a 2010 study, the global prevalence of tobacco smoking was estimated to be 22.1 percent (36.9 percent was attributed to the male and 7.3 percent for the female population globally), 12.8 percent in the African region (23.2% male, 2.5% female)[18]. Guinea ranked among the top 10countries with the highest smoking prevalence worldwide in 2002 with 52 percent, whereas,

Ghana and Senegal both had a significantly lower prevalence of lower than 5 percent[19]. In 2011, WHO estimated that adult tobacco smoking prevalence in West Africa ranged from 5 percent in Niger to 34 percent in Sierra Leone[14]. Among countries in Africa, West African countries record very high smoking prevalence in its youthful population. Statistics from the Global Youth Tobacco Survey shows that the prevalence of current tobacco users among adolescents aged 13-15 years old in West African countries Benin (11%), Cameroon (10%), Chad (18.9%), Cote d'Ivoire (19.1%), Sierra Leone (23.5%), are higher than those of countries in Eastern and Southern Africa, such as Algeria (9%), Ethiopia (7.9%), and Gabon (9.2%).

The relatively low prevalence of smoking in African countries (compared to the high smoking prevalence in other developing regions), and the more immediate need for interventions with infectious diseases, starvation and violence that more immediately threaten the health of citizens in West Africa and Africa as a whole; This may suggest that the consequences of cigarette smoking are not serious and thus, has resulted in a low priority for tobacco control in Africa. However, this could change rapidly. WHO projected in 2010 the global prevalence of tobacco use to decrease from 22.1 percent to 18.1 percent, and an increasing trend in African regions from 12.8% to 18.1% by 2015. Combined with weak government restrictions on tobacco use and sales in the most of West African countries, intensified advertising and promotions

directed to the youthful population (for example, the “Taste the Adventure Campaign” in Nigeria), a fast rate of growth from a small base is being observed[13]. Compared with western countries, the affordability of cigarettes in many West African nations has increased in the past decades due to higher income obtained[20, 21]. In Cameroon, smoking prevalence among men recorded in the year 2000 was 12.3%, which increased to 18.7% in 2005, 28.5% in 2010 and 43.8% in 2015. Also, Burkina Faso recorded 23.6% as smoking prevalence in adult men in the year 2000; However in 2015, this figure increased to 36% although with a slight decreased among women from 8.6 in 2000 to 4.5 in 2015[15]. Overall, smoking prevalence is higher in low-income countries compared to lower-middle-income countries. In 2012, the prevalence of smoking among adult male and female in Ghana and Nigeria (these are lower-middle income countries) was 12.1 and 0.5; and 15.9 and 1.2 percent respectively while low-income countries like Sierra Leone and Mali recorded 55 and 13.4 percent; and 32.6 and 3 percent respectively[21].

Very few countries in West Africa have comprehensive data on trends in tobacco use and the subsequent effects on morbidity and mortality, and most of the existing data are only estimates. Estimates suggest that smoking-attributable deaths in Africa cause 5-7 percent for men (which is low compared to smoking deaths of at least 15 percent for males in developing regions of the Americas, the Eastern Mediterranean, the Western Pacific and Southern Asia), and 1-2

percent for women[9]. In the region, 3% of all deaths among adults aged 30 years and over were attributable to tobacco use. Deaths Trachea, bronchus and lung cancers made up 55% of the total death rate while chronic obstructive pulmonary disease made of 26% of the recorded deaths. The smoking death rate for females in other developing parts of the world seldom exceeds 5 percent but still double or triple the percentage of Africa. As a result of higher smoking rates among the male population than the female population, death caused by smoking is around 4times higher among men than women in West Africa. For example, death percentage caused by tobacco in Cameroon in 2016 is 7.12%, with 5.17% among men and 1.95% for women; 4.24% of men in Burkina Faso death were caused by tobacco while in necessitating action from policymakers[14]. While the burden of smoking-attributable diseases is currently low in Africa, this will cease to be the case as tobacco consumption continues to increase across the continent and smoking prevalence among the youth population increases.

1.2 Study Purpose

Many developing countries (including West African countries) are undergoing economic transitions that will improve the quality and access to healthcare services, and increase their healthcare spending. Thus, these countries will face a substantially higher economic burden in healthcare expenditure attributable to smoking in the future if they do not adopt tobacco

control initiatives. It is therefore important that countries begin to assess the economic burden of adverse health effects caused by smoking as a benchmark, so that policy makers can monitor the health related economic impact of the escalating tobacco epidemic, and also provide a basis for plans and policies to adopt in order to allocate medical resources, intervention programs and further researches. Due to differences in healthcare systems and patterns of smoking-related diseases, the economic burden of tobacco use studies must be tailored to country-specific situations. There is a lack of country-specific research on the economic costs of tobacco use in low-and-middle-income countries and subsequently no study assessing the economic burden (in monetary units' terms) of smoking-related diseases in West Africa.

This study aims to provide estimates on the economic cost of smoking-attributable diseases in West Africa in 2012, to provide useful information to help government and policy makers to assess the economic consequences in different West African countries at the societal level for target programming with respect to countries with the high economic burden. Arising from these problems are numbers of research questions which will be answered in this study:

- ✓ What is the estimate of the direct cost of healthcare of patients suffering from tobacco-related diseases in West African countries?
- ✓ What is the cost of indirect cost from productivity loss due to morbidity and premature mortality from smoking-attributable diseases in countries

in West Africa?

- ✓ What is the net cost estimate of tobacco use and which country accounts for the highest economic burden of smoking-related diseases in West Africa?

1.3 Tobacco and related diseases

Tobacco is an agricultural product processed from the leaves of plants in the genus Nicotiana. Tobacco products used can be broadly classified into smoked and smokeless forms of tobacco. Worldwide, the most common way tobacco is consumed is by smoking.

Cigarette smoke contains larger than 7000 chemicals including nicotine, reactive oxygen species, carbon monoxide, reactive nitrogen species, nitric oxides, cadmium, polycyclic hydrocarbons, and other oxidants and metals[22]. With 69 known carcinogens in cigarette smoke, plus the highly addictive drug nicotine, smoking is said to harm almost every organ in the body (HHS, 2010). Scientific evidence shows that tobacco use is a major cause of poor health and pre-mature mortality from both communicable diseases (such as upper and lower respiratory infections), and non-communicable diseases (NCDs)[10]. Furthermore, tobacco is especially dangerous for pregnant women and their fetuses in that, women who smoke during their pregnancy tend to increase the risk of stillbirth and low birth weight in their born infants. According to the Department of Health and Human Services in the United States, tobacco is

responsible for over 25 diseases in man; ten of which are malignant Neoplasms (Bladder cancer, lung cancer, leukemia etc.); five of them are cardiovascular diseases (coronary heart disease, stroke, cerebrovascular disease etc.); and the other ten which are respiratory diseases and others including hypertension heart attack, asthma etc.[10]. Smoking is also a risk factor associated with a number of health problems including: back pain, cirrhosis, complications during and after surgery, childhood cancer and leukemia, period pain and early menopause in women, facial skin wrinkling, skin diseases, hearing loss, lower fitness, sleep disorders, tooth decay and loss, poorer sense of taste and smell, complications during pregnancy, and so many others.

Cancers associated with smoking include cancers of the lung, throat, mouth, tongue, nose, nasal sinus, voice box, esophagus, pancreas, stomach, liver, kidney, bladder, ureter, bowel, ovary, cervix and bone marrow (myeloid leukemia)[23]. Smoking-related cancers accounted for about 13 percent of all cancer cases in 2010. Smoking dramatically increases one's chances of developing cancer. Compared to non-smokers, tobacco smokers are more likely to develop oral cancer, esophageal cancer, laryngeal cancer and other cancers of GI (gastrointestinal), urinary, and female reproductive systems. Men who smoke are 23 times more likely to get lung cancer and women who smoke are 13 times more likely[24]. Squamous cell carcinoma, or cancer on the lining of organs or the surface of the skin, is linked directly to tobacco and alcohol use, as such, the use of tobacco will increase the chance of getting esophageal cancer. Heart

disease (coronary HD, rheumatic, pulmonary n other forms of HD). Cardiovascular diseases and metabolic diseases include coronary heart disease, other heart diseases, cerebrovascular diseases and other vascular, diabetes mellitus. Respiratory we have pneumonia, influenza, tuberculosis, COPD. Perinary conditions (prenatal conditions, sudden infant death syndrome). Other Vascular diseases include atherosclerosis, aortic aneurysm, and other arterial diseases. COPD includes emphysema, bronchitis, and chronic airways obstruction[10]. Smokers under 65 years are around 3 times more likely to have a stroke than non-smokers of the same age[25].

Smoking is estimated by the World Health Organization to cause 71 percent of all lung cancer death, 42 percent of chronic respiratory disease, and almost 10 percent of cardiovascular disease[24]. It is also responsible for 12 percent of deaths from lower respiratory infections and 7 percent of deaths from tuberculosis[24]. Smoking is also the cause of 9 in 10 COPD related deaths. Emphysema and chronic bronchitis which are types of COPD is the number three killer in the US. Chronic bronchitis occurs in half of all heavy smokers. Around 30 percent of all cases of heart disease in those fewer than 65 years are due to smoking.

1.4 Disease burden and cost of illness

The burden of disease is a concept that was developed in the 1990s by the Harvard School of Public Health, the World Bank and the WHO to

describe death and loss of health due to diseases, injuries and risk factors. Disease burden is estimated by adding together the number of years of life a person loses as a consequence of dying early because of the disease (called Years of Life Lost , YLL), and the number of years of life a person lives with disability caused by the disease (Years of Life lived with Disability, YLD). Assessing health outcomes by both mortality and morbidity provides an encompassing view on health outcomes and the entire burden of disease measured can be called Disability Adjusted Life Years (DALY). Evaluating the burden of disease is of paramount interest to the general public, policy-makers and researches[26]. This is principal because, such assessments demonstrate the general state of health of the population and to set public health goals, to compare health status, to identify the allocation of healthcare resources, and to measure the potential costs and benefits of public health interventions.

Measuring morbidity and mortality are critical considerations for estimating the burden of disease in a population; nevertheless, they provide an incomplete view of the adverse impact of ill health on human welfare. The economic cost of illness thus plays an important role in decision making regarding the allocation of resources in the health sector. It is well recognized that health positively influences economic wellbeing, growth and wealth. The reverse influence is also well recognized. Countries would undoubtedly be economically better-off in the absence of ill-health (morbidity and mortality)

from epidemic diseases, such as tuberculosis, stroke and cardiovascular diseases etc. if left unchecked; there will be poor economic performance and poor health especially at individual and household levels.

The Cost of illness (COI), known as the burden of disease (BOD), by definition encompasses various aspects of the disease impact on the health outcomes in a country, specific regions, communities, and even individuals[27]. Costs are mostly measured in monetary terms for direct comparison among a variety of options[27]. Determining the total cost of illness is claimed to provide several useful pieces of information. Firstly, it tells the amount of money a society is spending on a particular disease and by implication the amount that would be saved if the disease were abolished. Also, it helps to identify the different cost components and the size of the contribution of each sector in society[28, 29]. Such knowledge can help to formulate and prioritize healthcare policies and interventions and eventually allocate healthcare resources in accordance with budget constraints in order to achieve policy efficiency.

The Cost of illness studies generally stratifies costs incurred by the healthcare system, society, family and individual patient into three categories, which are direct, indirect and intangible costs. Intangible costs (such as cost of pain and time) have seldom been quantified in COI studies due to measurement difficulties and related controversies as excluded[30]; hence the main focus is on the direct and indirect cost categories.

The direct cost is the value of resources (such as, hospital care, physician's services and drugs, personal healthcare) that could be allocated to other resources in the absence of diseases[31]. The direct costs consist of medical costs and non-medical costs. Medical costs are expenditures on healthcare resources which includes all costs incurred during diagnosis procedures, treatments or rehabilitation stages (such as cost of drugs, hospitalization, laboratory test, and all other Medicare expenditures). Meanwhile, non-medical costs are medical expenses spent on non-healthcare resources; this includes ambulatory costs, transportation costs to visit hospital or payments of caregivers during hospitalization. From payers perspective (for example insurance companies), the direct medical costs are most important; however, from patients perspective, it is the actual out-of-pocket expenses which are the direct non-medical costs or expenses from indirect costs that matters[32]. The direct cost estimates associated with chronic diseases are higher than those of acute diseases or communicable diseases on condition that the effective and efficacious treatments and prevention methods are adopted. Many studies have estimated the direct cost of smoking-attributable diseases especially in developed countries and some developing countries. The annual value of direct medical costs and long term care for smoking-related diseases in Hong Kong was US$532 million for active smoking and US$156million for passive smoking[33]. A study in Vietnam stated that the total direct cost of inpatient healthcare caused by smoking was at least 1161829 million

Vietnamese dollars of (US$77.5 million) in 2005; this represented about 0.22% of Vietnam Gross Domestic Product (GDP) and 4.3% of the total health care expenditure[1]. Leal et al., (2006) estimated the direct costs of cardiovascular disease and coronary heart disease in the European Union (EU). Health care costs on CVD in the EU were estimated to be EU 60 billion representing 57% of total health care[34]. The estimated direct medical cost of smoking-attributable diseases in a study in India amounted to $907 million for smoked tobacco and $285 for smokeless tobacco[35]. The direct cost of alcohol, tobacco and illicit drugs in Canada was estimated to be $18.4 billion in 1992 which represents $648 per capital and 2.7% GDP[36].

The indirect costs on the other hand, are the value of lost output because of the cessation or reduction of productivity caused by morbidity and mortality associated with a given disease borne by the individual, family, society, or the employer[16]. The indirect costs form a part of social welfare losses due to diseases, while the remaining welfare losses are represented by the losses in healthy time resulting from pain, suffering and grief caused by diseases. To explain the contents of indirect cost, morbidity costs are wages lost by people who are unable to work because of illness and disability and an imputed value for persons too sick to perform their usual tasks as well as the unpaid caregivers who forego his/her occupation to visit the hospital of the sick member or render care to the sick person at home while mortality costs are the present value of

future earnings cost by people who die prematurely[31]. Measuring indirect costs can be done by either using the Human Capital Method (HCM), the friction cost method or the willingness to pay method. Most COI researchers use the HCM approach despite having being criticized due to its strong and controversial assumptions there by leading to an overestimate of the actual cost. Under this approach, productivity losses associated with morbidity and mortality are the 'market value' of that individual's future contribution to production to the society if s/he had continued to work in full health. Using the HCM, many researchers have calculated the indirect costs which include the following: The indirect cost of diabetes mellitus in a study in Latin America was estimated to be US$ 5,496 million[37]. The indirect cost of cardiovascular disease and coronary heart disease in the EU was estimated to cost EU $29 billion, with productivity loss being estimated to cost about $24.4 billion[33]. In Germany, the indirect cost of mortality was €4.7 billion and €8.8 billion for charges due to work loss days and early retirement[38]. The indirect cost of tobacco, illicit drug, alcohol and loss of production in Canada amounted $4.14 billion while a loss to law enforcement agencies amounted to $1.36 billion[36].

The economic cost can simply mean an opportunity that is sacrificed when a choice is made[39]. Economic cost includes only real resources consumed as a result of the decision made by consumers in the market place[40]. The economic cost of illness continues to play an important role in decision

making regarding the allocation of resources in the health sector as they represent the monetary burden on society of illness and premature death[30]. Hence, economic costs are the direct and indirect costs. The annual cost of tobacco-attributable diseases in Bangladesh was estimated at 50.9 billion takas, including 5.8 billion takas for second-hand smoking[41]. A study in Uganda stated that the annual economic cost of tobacco-related diseases was approximately 126.48 million USD (includes healthcare and productivity costs)[42]. In India, the total cost of tobacco use amounted to $1.7 billion; Tuberculosis accounted for 18% of smoking-related diseases which cost $311 million[35].

2. METHODS AND MATERIALS

2.1 Definition of smoking-related diseases

The economic burden of smoking-related diseases was evaluated using a prevalence-based approach targeting current and former smokers, deaths and years lost to disability from diseases caused by smoking. The cost of illness approach, which was developed by Dorothy Rice and colleagues, was used to estimate the economic cost in this study. This approach analyzes the impact of illness from a macroeconomic perspective by aggregate impact across all economic agents to derive a societal assessment. Major diseases caused by smoking was selected with regards to international statistical classification of disease and related health problem 10th revision (ICD 10) codes and were composed of malignant neoplasm: Trachea, lungs, bronchi (C33-34), esophagus (C15), stomach (C16), pancreas (C25), lips, oral cavity, pharynx (C00-14), neck of the uterus (C53), urinary bladder (C67), acute myeloid leukemia (C92); Cardiovascular diseases including: ischemic heart disease (I20-25), and cerebrovascular disease (I60-69); Respiratory diseases such as: chronic obstructive pulmonary disease (J44-46), and bronchitis emphysema (J40-43).

2.2 Target Population / Countries

The study population was people who died from smoking associated

illnesses, or/and who suffered disabilities from these diseases. Due to the time-lag characteristics in cancers and non-communicable diseases attributable to smoking, and also because the average life expectancy in West Africa is 59.9 years, hence, the participants of interest consisted of only those aged 15 years to 59 years. This study collected necessary data from various international open sources and completed calculations for 12 countries in West Africa (namely; Benin, Burkina Faso, Cameroon, Cote d'Ivoire, Ghana, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo). The remaining countries were excluded because of insufficient and/or missing country-related data required for this study. The selected countries were later grouped according to World Bank income status and WHO region.

2.3 Definition of Costs

The gross economic burden of smoking-related illnesses included direct costs, indirect costs, and intangible costs[43]. However, an intangible cost which includes the cost of pain, suffering or bereavement is difficult to quantify and converted to monetary terms so it was excluded. Direct costs here are the expenses incurred because of the illness in a given year for hospitalization and medications. The indirect costs represent the value of lost productivity in current and future years due to disability and mortality, and are estimated in accordance with the human capital approach. This approach does not consider the impact of welfare and leisure time. Direct and indirect costs are then summed to

provide the overall economic cost to the society, often expressed as a percentage of annual gross domestic products (GDP)[44]. This approach has been used in a vast majority of studies on the economic cost of smoking, particular in developing countries. The findings are reported in international dollars using International Monetary Fund (IMF) purchasing power parity (PPP) exchange rates for 2012.

2.4 Estimating the economic burden of smoking-related diseases

2.4.1 Estimating the physical burden of disease

In order to estimate the economic cost of smoking-related disease in this study, the physical burden of disease which includes estimates of number of deaths attributable to smoking and smoking years lost to disability were needed to complete variables needed to estimate the present labour years lost to premature death and morbidity, and subsequently the productivity loss due to mortality and mobility respectively. The Adult Smoking-Attributable Mortality, Morbidity and Economic Costs (SAMMEC) method, an online application developed by the Centers for Disease Control and Prevention (CDC), was used to calculate the smoking-attributable mortality and morbidity (in terms of smoking years lost to disability) from cancers, cardiovascular and respiratory diseases[45].

Smoking-attributable mortality (SAM) was calculated for each cause of

mortality (k) by gender (j) and country (i) as calculated in Morocco[46] using the following formula:

$$\mathbf{SAM_{ijk} = OM_{ijk} * PAF_{ijk}};$$

Where:

- OM is the observed (absolute) mortality
- The population attributable fraction (PAF). The absolute number of death (observed mortality data) was provided by the WHO, Global report on mortality attributable to tobacco. Using the epidemiological approach, PAF was calculated as follows[16]:

$$\mathbf{PAF_{ijk}} = \frac{P*(RR-1)}{P*(RR-1)+1}$$

Where,

- P = Prevalence of smokers. Smoking prevalence of adult smokers 15 years and above was used and this data was obtained from sources including WHO, Global Health Observatory Data Repository, and The Tobacco Atlas (appendix 1).
- RR = Relative risk of dying for smoking-related pathologies of smokers. RR here is the summation of RR current smokers and RR for former smokers. Since West Arica does not have an estimate of cause-specific mortality or morbidity relative risk, we used the cause-specific mortality

RRs based on phase II of the American Cancer Society Cancer Prevention Study (CPS II) (See table 1).

With respect to morbidity, earlier WHO estimations in 2004 included the number of disability-adjusted life years (DALY) lost to smoking – where DALY defined morbidity as the number of years lost to disability (YLD). This study estimates the smoking years lost to disability ($SYLD_{ijk}$) in 2012 using the formula[45]:

$$\mathbf{SYLD_{ijk} = YLD_{ijk} * PAF_{ijk};}$$

Where,

- YLD is the absolute years lost to disability in 2012 by gender (j), disease (k) and country (i)
- PAF of morbidity for malignant neoplasms is the same values for PAF of mortality, while PAF of morbidity for cardiovascular and respiratory diseases are half the PAF of mortality of these diseases.

Table 1 Relative risk of death for smokers and ex-smokers comparing to nonsmokers

Disease type	Male		Female	
	Current smoker	**Former smoker**	**Current smoker**	**Former smoker**
Trachea, Lungs, Bronchi	23.26	8.70	12.69	4.53
Esophagus	6.76	4.46	7.75	2.79
Stomach	1.96	1.47	1.36	1.32
Pancreas	2.31	1.15	2.25	1.55
Lips, Oral cavity, Pharynx	10.89	3.40	5.08	2.29
Cervix uteri	0.00	0.00	1.59	1.14
Urinary bladder	3.27	2.09	2.22	1.89
Acute myeloid leukemia	1.86	1.33	1.13	1.38
Ischemic heart disease	2.80	1.64	3.08	1.32
Cerebrovascular disease	3.27	1.04	4.00	1.30
Chronic obstructive pulmonary disease	10.58	6.80	13.08	6.78
Bronchitis emphysema	17.10	15.64	12.04	11.77

Source: Centers for Disease Control and Prevention, Project "Smoking-Attributable Mortality, Morbidity, and Economic Costs (SAMMEC)", https//apps.nccd.cdc.gov/sammec/show_risk_data.asp.

2.4.2 Estimating Direct Costs

The direct cost of smoking under the Cost of illness studies most often categorizes cost into healthcare or non-healthcare expenditures (expenditures incurred outside the health system for example loss properties from fires caused by cigarettes). However, for the purpose of this study, non-healthcare costs are excluded due to lack of data form individual countries; direct costs of smoking here are also called smoking-attributable healthcare expenditures (SAHE). This

healthcare expenditures result from the treatment of smoking-related diseases, covering hospitalization, investigations and medications. To obtain direct costs, country-specific total health expenditure data obtained from WHO Global Health Expenditure Database were used; meanwhile death records of smoking-related illnesses were extracted from Global burden of disease database.

Since the designated illnesses may be caused by risk factors other than tobacco use, we need to attribute the healthcare expenditures to tobacco use. For this measure we have to calculate the smoking-attributable fraction for health expenditure (SAFHE). However, due of the absence of studies with direct values for SAFHE in west African countries, this study follows the method of obtaining SAFHE as in the global cost of smoking-attributable diseases study - in which the value for SAFHE in countries with no related health cost studies of smoking-attributable diseases was calculated by computing values of the regression coefficient from the estimated equation as follows: $\mathbf{SAFHE_i = 0.024643SAD_i}$ **[47]**. Smoking-attributable death (SAD) rate by country (i) used was calculated by dividing the number of death caused by smoking on total country population and multiplied by 100,000.

In estimating direct cost known as smoking-attributable healthcare expenditures (SAHE) by country (i), smoking-attributable fraction for health expenditure (SAFHE) is multiplied with the total health expenditure (THE) for

country-specific data[47] as can be seen in the formula below:

$$\mathbf{SAHE_i = SAFHE_i \times THE_i}$$

2.4.3 Estimating Indirect Costs

Meanwhile, indirect costs consisted of the loss of earnings due to premature death and productivity loss due to morbidity. This economic loss from mortality was quantified using the human capital method (HCM) which has been used by many other studies and calculates the present value of labour productivity loss due to premature death and morbidity[16, 48].

With respect to loss productivity due to premature death, the estimates of smoking-attributable mortality were then converted into labour years lost using the International Labour Organization employment-to-population ratio for each country. Firstly we calculate the number of labour years lost due to mortality (LYLM) which includes all future labour years lost until retirement at age, which was assumed to be the average age of life expectancy for individual countries. LYLM was calculated as the sum of smoking-attributable death (SAD) rate by gender (j) and country (i) for age group 15-59 years multiplied by the average years until reaching retirement (YRS_{ij}) and then by the corresponding employment-to-population ratio[47]:

$$\mathbf{LYLM_i = \sum_j \sum i\ (SAD_{ij} * YRS_{ij} * EMP_{ij})}$$

For the final step in calculating the indirect cost associated with mortality, we

calculated the present value of productivity loss over all future years that an individual would have worked if they had not died prematurely from a smoking-attributable disease. The present value of loss productivity due to mortality (PVLM) includes the current and future labour years lost and was calculated thus[47];

$$\mathbf{PVLM_i = \sum (LYLM_i * PROD_i) * (1 + V_i) / (1+ r)}$$

- PROD is the amount of gross domestic product (GDP) generated per adult worker in PPP international dollar terms for 2012 by country (i). GDP per worker for each country was obtained by dividing the country national GDP by total employment in the age group 15+.
- V is the growth rate of labour productivity; the IMF′s forecast of growth in GDP/capita was used as a proxy for productivity growth (V).
- r is the discount rates. As per standard practice in health economics, a discount rate of 3% was applied to all countries[2]

The formulae used to estimate the cost of productivity loss due to morbidity were as similar as those of other studies[47], estimates of smoking-attributable disability were converted to labour years lost to disability ($LYLD_i$) using the employment-to-population ratio statistics from the International Labour Organization database. LYLD was calculated by multiplying smoking years lost to disability ($SYLD_{ijk}$) for all diseases by gender

(j), disease (k) and country (i) by the corresponding employment-to-population rate by country (i) and by gender (j).

$$\mathbf{LYLD_i = \sum_j \sum i\ (SYLD_{ijk} * EMP_{ij})}$$

The cost of lost productivity due to disability ($CLPD_i$) in each country was calculated thus:

$$\mathbf{CLPD_i = LYLD_i * PROD_i}$$

It is important to note that the loss in productivity from disability is calculated annually, while the loss from mortality is calculated as the present value of production losses over all future years the deceased would have worked if they had not died maturely.

2.4.4 Sensitivity analysis by discount rates

Sensitivity analysis was performed for the productivity loss following premature death with 0% and 5% annual discount rates. All the analysis included was conducted using Excel 2013.

Table 2. Cost and variable type, description and sources of data

Cost	Variable	Description			Data Sources
Direct Cost	Smoking-attributable health expenditure	Total health expenditure			WHO Global Health Expenditure Database
		Smoking-attributable health expenditure fraction	Smoking-attributed death rate	Observed deaths	WHO, Global report on mortality attributable to tobacco
				Country Population	World Bank population estimates
			Regressed coefficient		Global Economic Cost of Smoking-Attributable disease study
		Smoking-attributable fraction	Relative Risk*		Centers for Disease Control and Prevention, Project "Smoking-Attributable Mortality, Morbidity, and Economic Costs
			Smoking Prevalence		WHO, Global Health Observatory Data Repository
Indirect Costs	Productivity loss due to morbidity (absence from work)	Number of years lost to disability			Global Burden of Disease database
		Employment-to-population ratio			International Labour Organization ILOSTAT Database
		National gross domestic product			World Bank, International Comparison Program Database
		Employment rates			International Labour Organization ILOSTAT Database and World Bank population estimates
	Future income loss due to premature death	Number of deaths			WHO, Global Report on Mortality Attributable to Tobacco
		Employment-to-population ratio			International Labour Organization ILOSTAT Database
		Life expectancy			World Bank, World Development Indicators
		Gross domestic product per capital growth rate			IMF, World Economic Outlook Database
		Discount rates			WHO, WHO guide to cost effectiveness analysis. Geneva: WHO, 2003
		Country Population			World Bank population estimates

*Note: Relative risk of mortality from disease types by gender was obtained from Centers for Disease Control and Prevention, Project "Smoking-Attributable Mortality, Morbidity, and Economic Costs" (CPS II Study), due to the absence of RR of mortality from disease types from West African countries and/or Africa.

3. RESULTS

3.1 Burden of Disease

Using country-specific prevalence rates by gender (appendix 1) and the RRs (table 1) from CPS II estimates, PAFs were calculated by disease and by gender. The PAFs were substantially smaller for women than men. Cancer showed the highest disease-specific PAFs for men, while for women, respiratory diseases showed the highest PAFs (appendix 2 and 3).

In 2012, there were approximately 42,033 smoking-attributable deaths in West Africa. The death rate was significantly different among men and women; the number of death was about 11 times higher among men than the women in the West Africa population recording 38,737 and 3,296 deaths for males and females respectively as can be seen on table 3 and 4. In terms of individual countries and among men, Nigeria recorded the highest number of deaths with 19,085 estimated deaths. Meanwhile, smoking-attributable mortality among men was the lowest in Liberia. With respect to the female population, the lowest deaths were observed in Togo and Niger (63 deaths per country) where tobacco use in the female population is lowest, while, Sierra Leone had the highest deaths trend caused by smoking among women (estimated deaths being approximately 697 deaths) where the tobacco epidemic among women is fast approaching.

Table 3 Smoking-attributable mortality applying PAF for males aged 15 – 59years by disease and country in West Africa, 2012.

Disease type	Benin	Burkina Faso	Cameroon	Cote d'Ivoire	Ghana	Liberia	Mali	Niger	Nigeria	Senegal	Sierra Leone	Togo	Total
Malignant neoplasm													
Trachea, Lungs, Bronchi	84	91	91	356	162	0	0	83	747	0	94	0	1,708
Esophagus	0	0	0	73	0	0	0	62	124	0	0	0	259
Stomach	0	0	0	78	23	0	88	28	168	35	57	0	477
Pancreas	0	0	0	39	0	0	0	0	84	0	0	0	123
Lips, Oral cavity, pharynx	69	81	246	156	124	77	0	93	1,674	75	88	61	2,744
Cervix uteri	-	-	-	-	-	-	-	-	-	-	-	-	-
Urinary bladder	0	59	0	53	53	0	0	41	164	0	0	0	370
Acute myeloid leukemia	26	42	86	144	126	36	42	207	1,725	33	55	21	2,543
Subtotal	**179**	**273**	**423**	**899**	**488**	**113**	**130**	**514**	**4,686**	**143**	**294**	**82**	**8,221**
Cardiovascular Diseases													
Ischemic heart disease	216	477	810	1,128	480	141	371	525	4,305	387	520	145	9,663
Cerebrovascular disease	210	520	795	1,104	464	138	416	544	4,454	378	520	140	9,528
Subtotal	**426**	**997**	**1,605**	**2,232**	**944**	**279**	**787**	**1,069**	**8,759**	**765**	**1,040**	**285**	**19,191**
Respiratory Disease													
COPD	144	252	425	729	396	81	252	360	3,240	234	270	132	6,515
Bronchitis emphysema	84	182	276	445	316	89	182	320	2400	176	182	158	4,810
Subtotal	**228**	**434**	**701**	**1,174**	**712**	**170**	**434**	**680**	**5,640**	**410**	**452**	**290**	**11,325**
Total death	**833**	**1,704**	**2,729**	**4,305**	**2,144**	**562**	**1,351**	**2,263**	**19,085**	**1,318**	**1,786**	**657**	**38,737**

COPD: Chronic Obstructive pulmonary disease

Table 4 Smoking-attributable mortality applying PAF for females aged 15 – 59 years by disease and country in West Africa, 2012

Disease type	Benin	Burkina Faso	Cameroon	Cote d'Ivoire	Ghana	Liberia	Mali	Niger	Nigeria	Senegal	Sierra Leone	Togo	Total
Malignant neoplasm													
Trachea, Lungs, Bronchi	0	0	0	22	0	0	0	0	0	0	0	0	22
Esophagus	-	33	-	0	0	0	22	-	-	-	-	0	55
Stomach	0	8	2	3	3	0	15	0	2	1	0	0	34
Pancreas	0	0	0	0	0	0	0	0	0	0	0	0	0
Lips, Oral cavity, pharynx	0	0	5	9	0	0	0	13	7	5	0	0	39
Cervix uteri	4	24	12	21	4	5	15	2	12	6	38	2	145
Urinary bladder	0	0	0	0	2	0	0	0	0	0	0	0	2
Acute myeloid leukemia	2	7	2	9	7	0	4	6	24	2	17	0	80
Sub total	**6**	**72**	**21**	**64**	**16**	**5**	**56**	**21**	**45**	**14**	**55**	**2**	**377**
Cardiovascular Diseases													
Ischemic heart disease	16	90	24	50	20	8	45	5	56	24	124	6	468
Cerebrovascular disease	40	216	64	154	32	30	121	13	80	48	296	15	1,109
Sub total	**56**	**306**	**88**	**204**	**52**	**38**	**166**	**18**	**136**	**72**	**420**	**21**	**1,577**
Respiratory Disease													
COPD	17	98	45	96	18	34	72	12	57	39	72	12	572
Bronchitis emphysema	20	108	51	140	30	38	82	12	66	45	150	28	770
Sub total	**37**	**206**	**96**	**236**	**48**	**72**	**154**	**24**	**123**	**84**	**222**	**40**	**1,342**
Total death	**99**	**584**	**205**	**504**	**134**	**115**	**376**	**63**	**304**	**170**	**697**	**63**	**3,296**

COPD: Chronic Obstructive pulmonary disease

In general, smoking is responsible for 37 percent of all deaths from smoking-associated diseases included in this study as can be seen in table 5. About 1,145,000 years were lost to disability in 2012 as a result of these diseases (appendix 10 and 11). All working years lost due to premature death from smoking-related diseases was approximately 95,000years, while the productive years lost due to morbidity was estimated to be 73,744 years. For all countries, smoking was responsible for the lowest deaths in Ghana (22 percent) and highest in Sierra Leone (58%).

Table 5. Smoking-attributable burden of disease and loss of labour force for age group 15-59

Countries	Burden of disease			Labour force loss	
	Years lost to disability (years)	**Adult deaths (deaths)**	**All Deaths (percent)**	**Labour lost: Disability (years)**	**Labour lost: Mortality (years)**
Benin	26,600	932	28	1,911	4,387
Burkina Faso	64,950	2288	40	5,447	6,196
Cameroon	49,700	2,934	35	3,848	8,059
Cote d'Ivoire	114,360	4809	37	8,088	12,906
Ghana	60,214	2,278	22	4,457	5,715
Liberia	17,860	677	40	1,086	1,816
Mali	50,370	1,727	34	3,582	5,740
Niger	56,172	2,326	26	4,838	6,929
Nigeria	582,250	19,389	44	32,434	59,022
Senegal	39,544	1,425	23	2,464	2,823
Sierra Leone	65,590	2,483	58	4,262	6,268
Togo	17,400	720	25	1,327	2,361
Overall	**1,145,010**	**42,033**	**37**	**73,744**	**95061**

3.2 Direct Costs

In West Africa, the total spending for the healthcare of smoking-related illnesses in 2012 was approximately 783,949,867 PPP$, which was accountable for 1.7 percent of the region's total health expenditure. We also categorized these costs by the World Bank income group and the WHO region. The absolute amount for smoking associated healthcare expenditure was highest in lower-middle-income countries compared to low-income countries; however the proportion of cost on this sub-region's total health expenditure was 1.5 percent in contrast to 1.9 percent of the total health expenditure in low-income countries. As clearly indicated in table 7, the cost proportion on total health expenditure was highest in Sierra Leone – where the tobacco epidemic is generally most advanced. Meanwhile, contrary to Sierra Leone, the lowest proportion of cost estimated to be 1.1 of the country's total expenditure on health was observed in Ghana. For countries classified under lower-middle-income countries, the country with the highest proportion of estimated cost on total health expenditure was Cote d'Ivoire.

Table 6. Direct costs of smoking-related diseases in West Africa, 2012.

Countries	**SAHE (PPP$)**	**THE (percent)**
Benin	10,548,340	1.2
Burkina Faso	23,282,667	1.8
Cameroon	48,274,851	1.7
Cote d'Ivoire	100,499,567	2.7
Ghana	49,736,815	1.1
Liberia	6,682,172	2.1
Mali	25,307,587	1.3
Niger	19,119,798	2
Nigeria	428,702,994	1.4
Senegal	16,856,497	1.3
Sierra Leone	49,124,442	4.5
Togo	5,814,130	1.3
Overall	783,949,867	1.7
Low-income-countries[a]	156,735,640	1.9
Lower middle-income countries[b]	627,214,227	1.5

(SAHE, smoking-attributable health expenditure; THE, total health expenditure; PPP$, power purchasing parity international dollar)

a- Countries include Benin, Burkina Faso, Liberia, Mali, Niger, Senegal, Sierra Leone, Togo

b- Cameroon, Cote d'Ivoire, Ghana, and Nigeria

3.3 Indirect costs

An estimate of approximately 870 million PPP international dollars was lost during hospitalization and the inability to work in West Africa because of smoking-associated diseases in 2012. More than 80 percent of the total loss of productivity was attributed to low-and-middle-income countries at around 761 million PPP$, whereas the potential earnings lost throughout smoking-related diseases diagnosis/treatment in low-income-countries were much lower, at only 108 million PPP$. Since the employed population in low-and-middle-income countries are quite higher those of low-income-countries (appendix 5), it was not surprising to see such a remarkable difference in the cost of lost productivity.

More also, the future earnings lost due to premature death in West Africa's smoking-related deceased population in 2012 were estimated at a high of about 1.5 billion international dollars PPP. It was also noticeable that the loss of income resulting from premature deaths according to the World Bank income group and WHO region was higher in lower-middle-income countries as nearly 8 times as that of low-income countries. For production costs of death for individual countries, Nigeria, Cameroon and Ghana were recorded as the top three countries bearing significant future income loss as can be seen in table 7. In contrast to these three countries, Liberia and Togo had the lowest future income loss.

Table 7. Cost of productivity loss due to morbidity, future income loss due to premature death and total indirect cost from smoking-attributable diseases by country in West Africa

Countries	**Productivity loss due to morbidity (PPP$)**	**Future income loss due to premature death (PPP$)**	**Total Indirect Costs (PPP$)**
Benin	9,130,758	20,741,790	29,872,548
Burkina Faso	23,590,957	26,915,672	50,506,529
Cameroon	30,272,216	62,783,347	93,055,563
Cote d'Ivoire	73,180,224	122,442,399	195,622,623
Ghana	37,002,014	49,148,234	86,150,248
Liberia	2,771,472	4,729,682	7,501,154
Mali	19,844,280	32,020,953	51,865,233
Niger	11,059,668	16,548,760	27,608,428
Nigeria	621,078,666	1,113,968,748	1,735,047,414
Senegal	19,041,792	21,466,005	40,507,797
Sierra Leone	18,701,656	27,036,097	45,737,753
Togo	4,047,350	7,135,596	11,182,946
Overall	869,721,053	1,504,937,283	2,374,658,336
Low income countries[a]	108,187,933	156,594,555	264,782,488
Lower middle income countries[b]	761,533,120	1,348,342,728	2,109,875,848

(PPP$ - Power Purchasing Parity International dollar)

a- Benin, Burkina Faso, Liberia, Mali, Niger, Senegal, Sierra Leone, and Togo

b- Cameroon, Cote d'Ivoire, Ghana, and Nigeria

3.4 Overall costs

The total cost of malignant neoplasms, cardiovascular diseases and respiratory diseases attributed to smoking in West Africa were estimated to have reached an amount of nearly 3,160 million PPP international dollars in 2012, proportionate to approximately 0.3 percent of the entire region's gross domestic product. This includes a slight sub-regional variation, with the costs in low-income countries amounting to 0.3 percent of GDP compared with 0.2 percent in lower-middle-income countries. Furthermore, there was a clearly noticeable significant difference in the impact of smoking among individual countries. The economic burden of smoking was highest in Sierra Leone where the cost of smoking-related diseases was equivalent to about 1 percent of the country's annual gross domestic product, in contrast to Ghana which recorded 0.1 percent of its GDP. Similar to Ghana, the cost of smoking-attributable diseases was lowest in Senegal and Togo.

Table 8 Overall costs of smoking-attributable diseases by country.

Countries	**Total cost (PPP$)**	**GDP (percent)**
Benin	40,420,888	0.2
Burkina Faso	73,789,196	0.3
Cameroon	141,330,414	0.2
Cote d'Ivoire	296,122,190	0.5
Ghana	135,887,063	0.1
Liberia	14,183,326	0.4
Mali	77,172,820	0.3
Niger	46,728,226	0.3
Nigeria	2,163,750,408	0.2
Senegal	57,364,294	0.2
Sierra Leone	94,862,195	1.1
Togo	16,997,076	0.2
Overall	3,158,608,203	0.3
Low-income-countries[a]	421,518,128	0.3
Low and middle-income countries[b]	2,737,090,075	0.2

(PPP$ - power purchasing parity international dollar; GDP – gross domestic product)

a- Benin, Burkina Faso, Liberia, Mali, Niger, Senegal, Sierra Leone, and Togo

b- Cameroon, Cote d'Ivoire, Ghana, and Nigeria

3.5 Sensitivity analysis by discount rates

The changes in future income loss were estimated by applying two different discount rates, 0% and 5%. There was an increase of nearly PPP$ 59.4 million in the total costs of smoking-attributable diseases regarding the discount rate of 0%, with an estimate of almost 3,220 million PPP$ spent. Meanwhile, at the discount rate of 5%, the cost experienced a slight decline in total costs of approximately PPP$ 14.5 million, at around 3,144 million PPP$ for the year 2012 in West Africa.

Table 9. Sensitivity analysis of Economic cost by discount rates

Countries	**Zero (0)% discount rate Total cost (PPP$)**	**5% discount rate Total cost (PPP$)**
Benin	41,042,637	40,025,325
Burkina Faso	74,596,734	73,276,586
Cameroon	143,215,223	140,135,787
Cote d'Ivoire	299,795,158	293,789,664
Ghana	137,363,636	134,952,931
Liberia	14,325,359	14,093,372
Mali	78,134,412	76,563,815
Niger	47,224,561	46,412,890
Nigeria	2,197,173,165	2,142,535,474
Senegal	58,006,769	56,953,985
Sierra Leone	98,781,832	97,307,749
Togo	28,394,538	28,024,532
Overall	3,218,054,024	3,144,072,110
Low income countries[a]	440,506,842	432,658,254
Lower middle income countries[b]	2,777,547,182	2,711,413,856

a- Benin, Burkina Faso, Liberia, Mali, Niger, Senegal, Sierra Leona, Togo

b- Cameroon, Cote d'Ivoire, Ghana, and Nigeria

3.6 Figure explanations

After adjusting mortality by individual country population in 2012, Sierra Leone accounted for the highest smoking-attributable death rate for both male and female population with a mortality rate of approximately 27 per 100,000 deaths and 10 per 100,000 deaths respectively. The death rate among men in Mali and Ghana stands lowest at about 8.4 and 8.3 per 100,000deaths respectively. For all countries, the lowest smoking-related mortality rate among women was observed in Nigeria with a death rate of 0.2 per 100,000deaths. Overall, the average death rate for West Africa in 2012 for both genders was 12.6 and 2.2 per 100,000 deaths for men and women respectively.

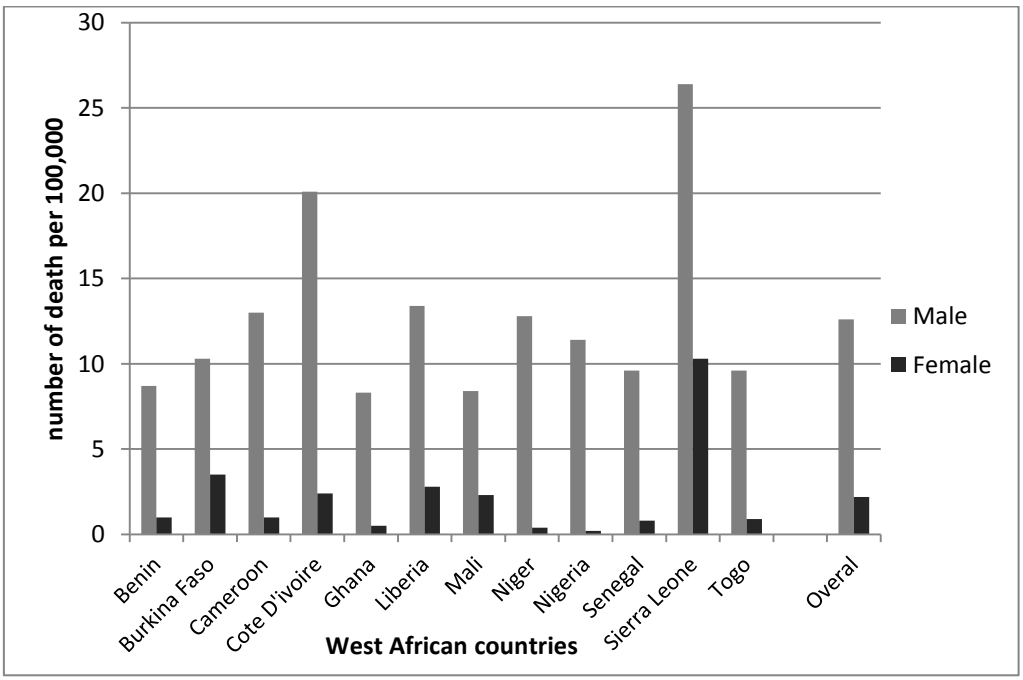

Figure 1. Smoking-attributable mortality rate by gender in West Africa

It is noticeable from figure 2 that cardiovascular diseases are the most common death causing illnesses from smoking in West Africa. Overall, around 50 percent of deaths from all disease types are caused by cardiovascular diseases. Deaths caused by malignant neoplasm are lowest in Senegal and highest in Nigeria. Respiratory diseases caused the highest deaths in Togo.

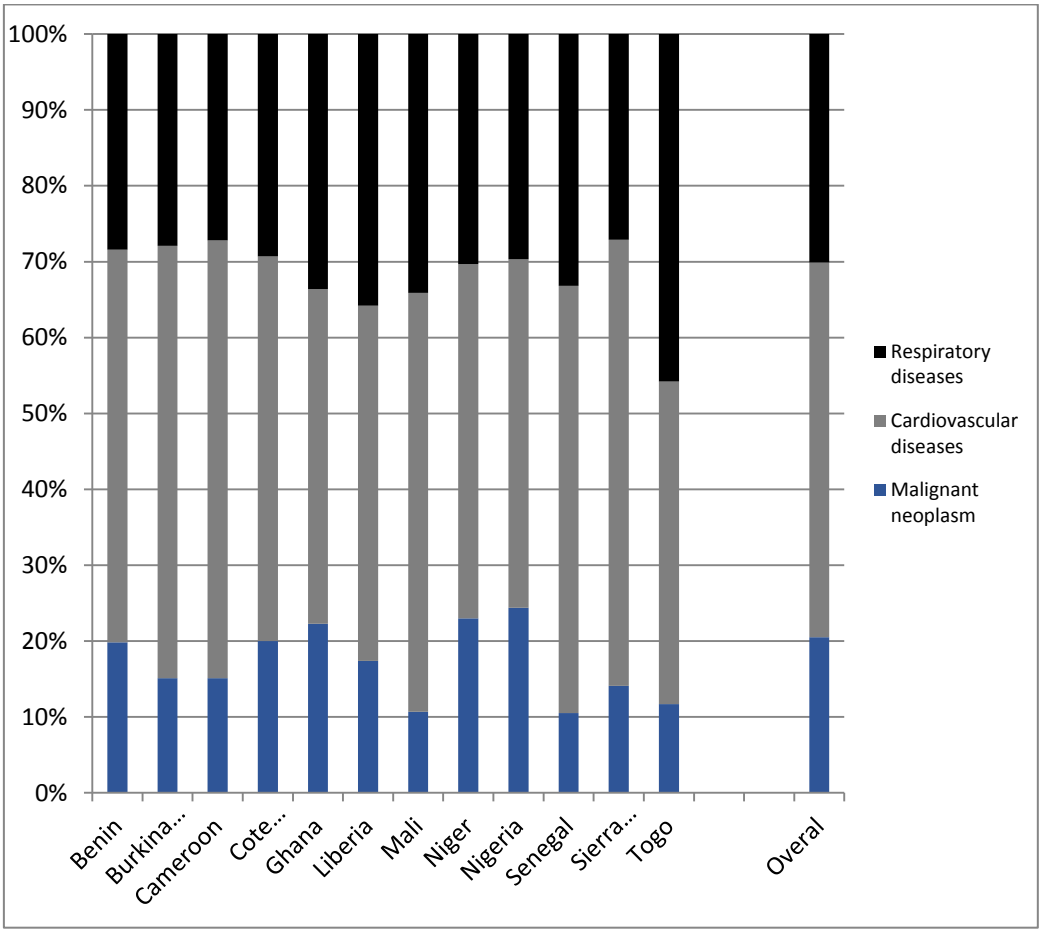

Figure 2. Proportion of deaths caused by smoking-related diseases in West Africa, 2012

In West Africa, the average mortality rate of smoking-related illnesses included in this study was approximately 42.6 per 100,000deaths, and smoking alone accounted for 14.8 per 100,000 deaths (figure 3).

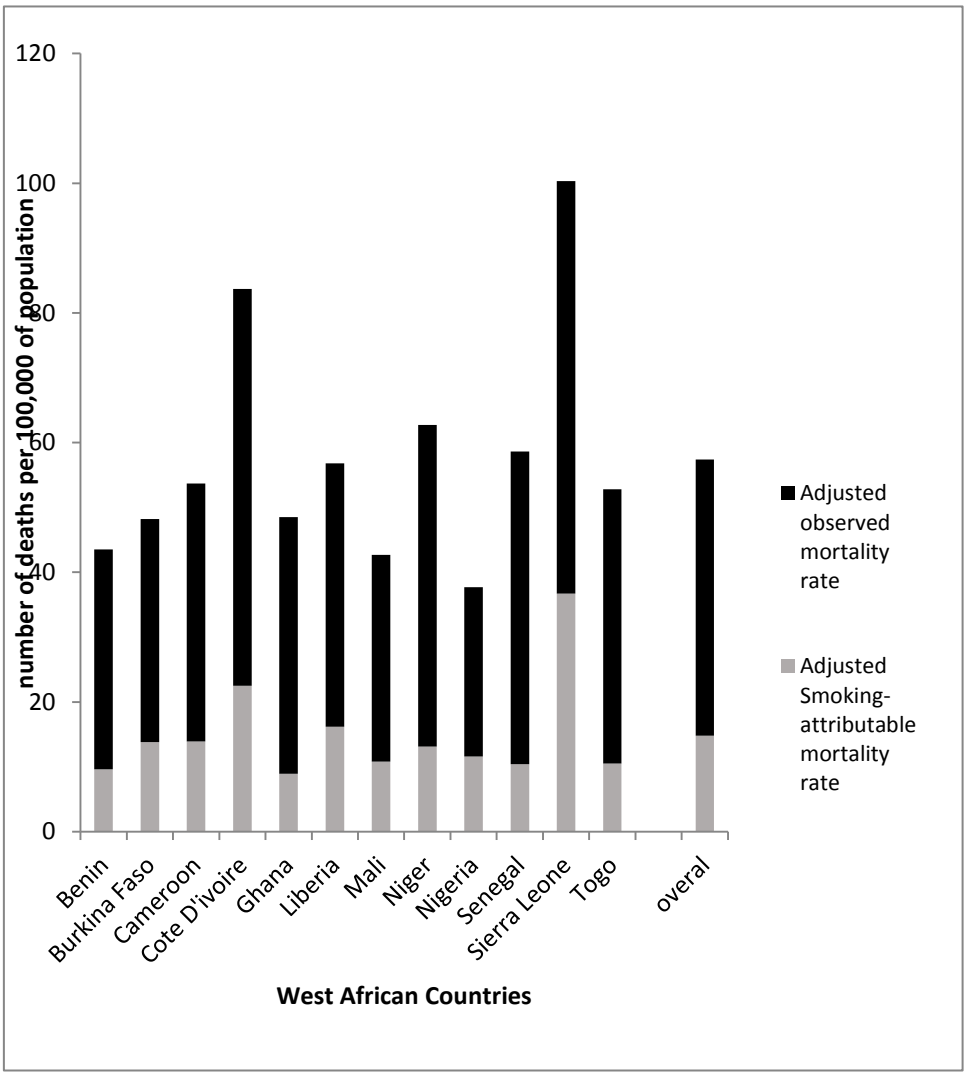

Figure 3. Total observed* mortality rate and total smoking-attributable mortality rate for age group 15-59years in West African Countries, 2012

* Observed mortality implies death from smoking associated diseases types included in this study: cancers, cardiovascular and respiratory diseases.

For total costs of smoking-related disease distribution in West Africa in 2012, as it is clearly evident in figure 5, it can be noted that the largest burden of economic costs of smoking-associated diseases was due to the potential future income loss resulting from deaths happening before the life expectancy (49.4%). Healthcare expenditures and lost incomes due to absence from work and e made up for 30.1 % and 20.5% respectively.

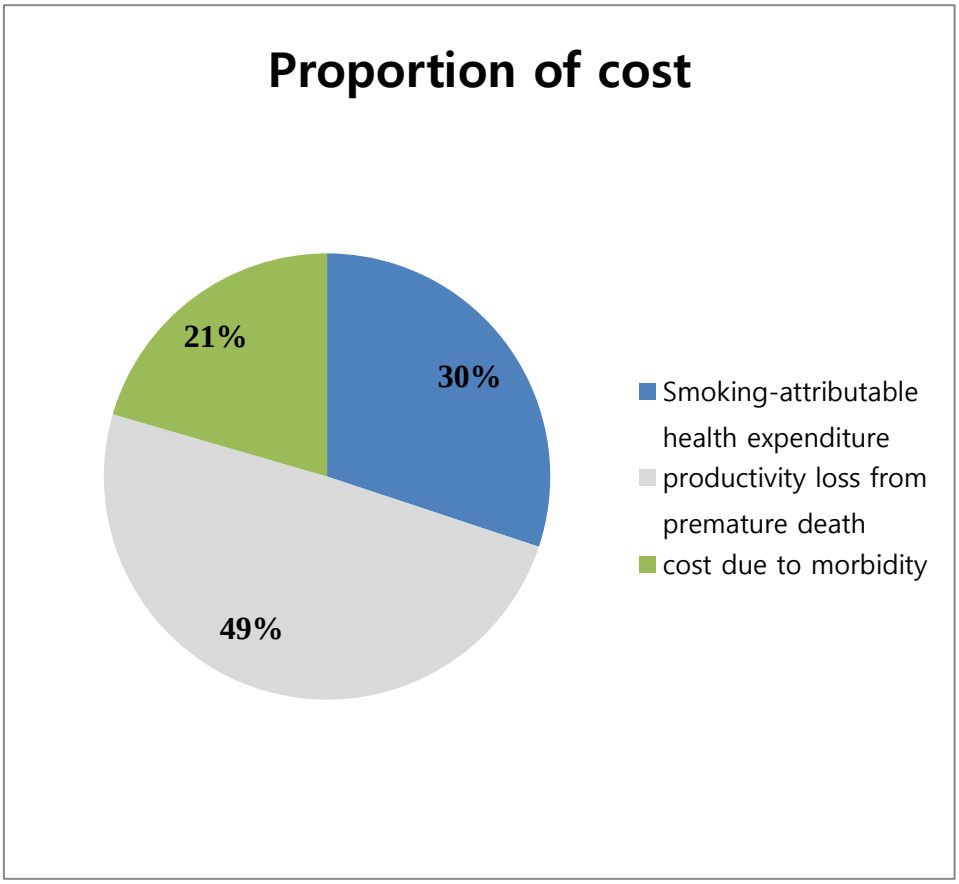

Figure 4. Proportion of cost component (%)

Furthermore, it is also important to make critical comparisons in cost of diseases related to smoking by country. As it can be noticed in figure 4, indirect costs always take the greater proportion of total costs. The most noticeable difference between direct and indirect costs was seen in Nigeria where productivity loss due to morbidity and premature deaths accounted for 80 percent of all costs. Indirect costs were higher than direct costs in all countries excluding Sierra Leone where direct costs estimated was slightly above indirect costs (52% versus 48%).

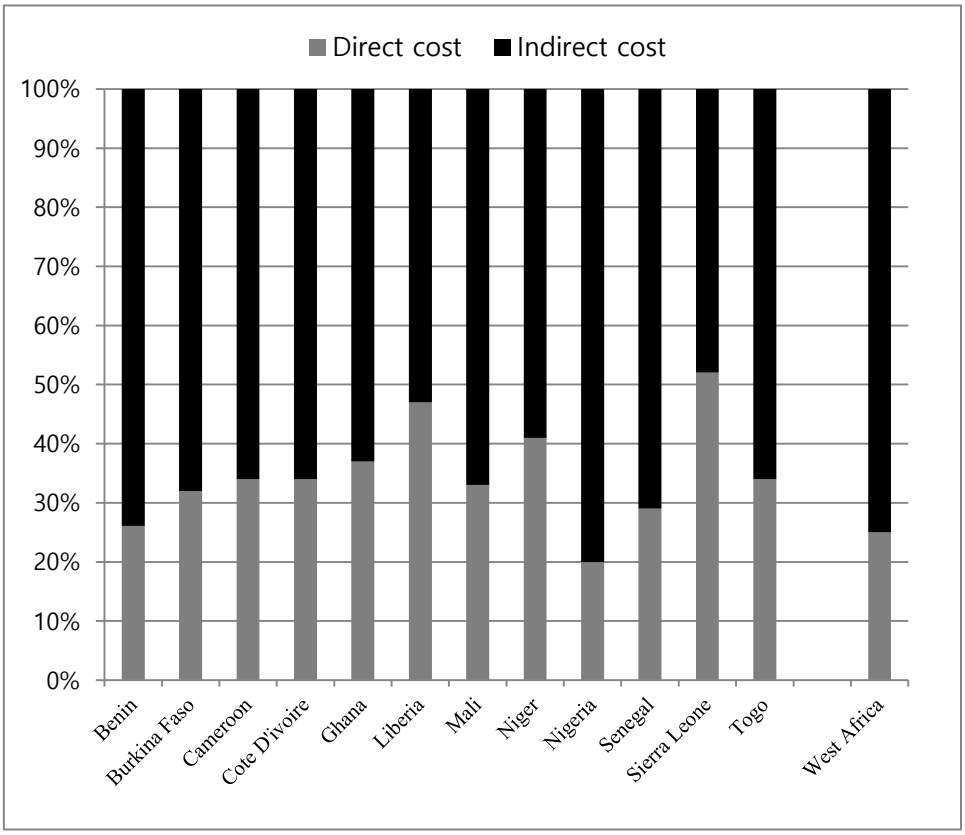

Figure 5. Proportion of direct and indirect cost by country

In addition, a relative comparison of total cost of smoking-attributable diseases on the region's gross domestic product (GDP) between West Africa and other countries together with the world's average[47] clearly indicates that, compared to the world's average and other regions, the burden of smoking-related diseases is lowest in West Africa although comparable to that of Eastern Mediterranean. Also, the burden of disease associated to smoking makes up for 1% GDP in Africa, and approximately 0.3% GDP in West Africa.

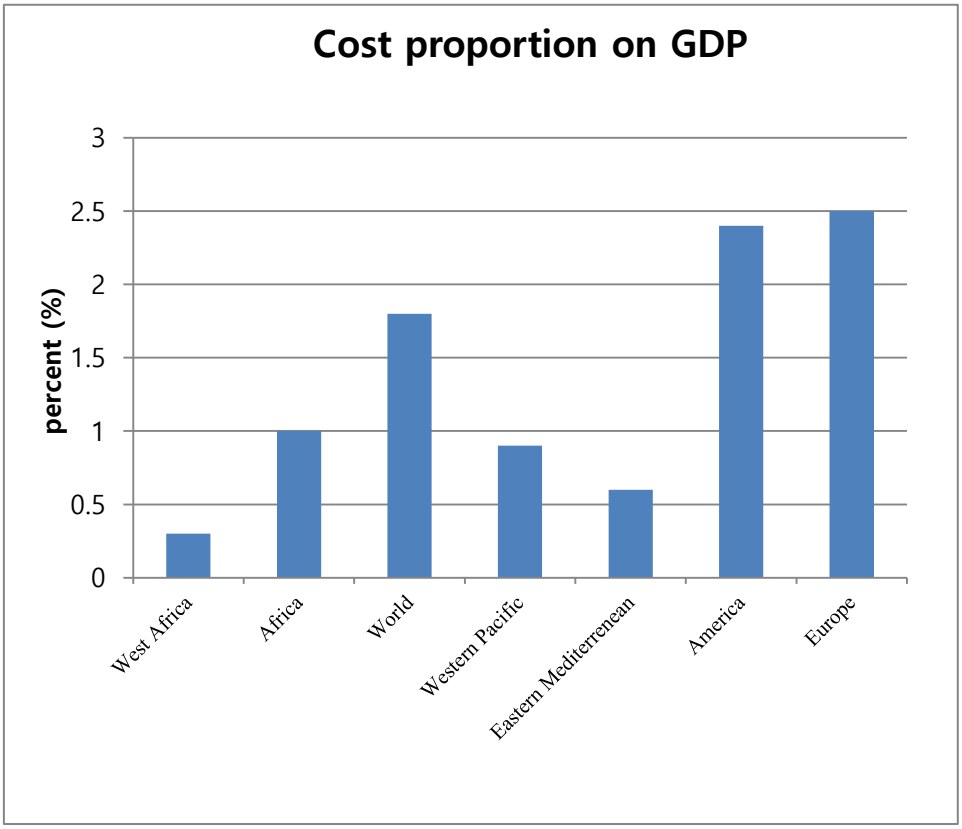

Figure 6. Relative comparison of costs related to tobacco use between West Africa, and other westernized and world's average.

4. DISCUSSION

4.1 Overall results

This is the first study to present estimates and analyzes of the economic burden of smoking-related diseases in West Africa in which cost estimates of twelve West African countries were obtained. The direct cost of treating smoking-induced diseases constitutes between 1.1% to 2.7% of all 11 countries national health expenditure and 4.5% of Sierra Leone's national health expenditure as earlier mentioned. These shares are comparable to the percentages of total health care cost devoted to treating smoking-attributable illnesses in other LMICs, such as, 1.4% in Mexico[34], 2.4% in Vietnam [20], 3% in China[49], 2.7% in Uzbekistan[50], as well as high income countries (HICs), such as, 2.2% in Australia[51], 1.4% in the Republic of Korea[52], and 2.4% in UK[53]. In making comparison with other studies, we should make the clear distinction that our study was limited to estimating the medical health costs of smoking only while most of the studies cited here estimated healthcare costs of medical and non – medical costs.

Our calculations indicate that the total economic burden of diseases attributed to smoking in West Africa in 2012 stood at approximately purchasing power parity(PPP) $3,158million which is equivalent for 0.3% of

the region's annual gross domestic product (GDP). This indicates that the relative economic burden of smoking-attributable diseases in West African countries can be as high or even larger than those in other LMICs, such as, 0.1% in Mexico, 0.6% in Uzbekistan[50], 0.6% in China[49], 0.9% in Vietnam[54], as well as HICs, such as, 0.2% in UK[53], 0.3% in the Republic of Korea[52], and 0.9% in Australia[51]. The opportunity cost of these resources is very high as these resources could have been diverted to competing and more productive uses benefiting public health as well as the economy.

With respect to cost distribution, indirect costs (PPP$2,374 million) were significantly much higher than the direct costs (PPP$ 785 million) as nearly 3.03 times larger equivalent to 69.8% of the total costs in West Africa. By country, indirect costs of smoking represent between 63 – 80 percent of total costs. This is comparable to the ratio of direct and indirect costs in Taiwan (77%), but slightly lower compared to Vietnam (49.5%)[54]. The ratio of direct and indirect costs is highly sensitive to healthcare prices and labour costs.

Cigarette smoking was responsible for 37% of smoking related disease deaths in the studied population (recording a number of 42,033 deaths with about 1,145 thousand of smoking years lost to disability), with the highest death rates recorded in Sierra Leone (58%). Differences in

smoking-attributable mortality (SAM) largely reflect the stage of the smoking epidemic in each country[55]. The SAM in Mexico in 2004 is much higher than the one observed for specific countries in this study[56]; this is because the prevalence of smoking in Mexico is higher than those of West African countries, such difference in SAM is likely to reflect, at least in part, to the higher amount of cigarettes smoked daily in Mexico[57]. The current smoking-attributable mortality (SAM) reported in this study shows clearly how hazardous and costly in lives smoking is to society. Mortality rates in men were about 9 times higher than women. This is mainly because the population-attributable fraction (PAF) in men is higher compared to women as can be seen in appendix 2 and 3. The high PAF in men compared to women is explainable by the fact that the overall female prevalence of smoking is 1/8 that of males and relative risk are different for several diseases.

Although the absolute cost of healthcare on smoking-related diseases was higher in lower- middle-income countries (PPP$ 627,214,227) than that of low-income-countries (almost 157 million PPP$), the burden of this cost was higher in LICs than in LMICs because direct cost was proportionate to 1.9% of the sub-region's total health expenditure (THE) to 1.5% THE in LMICs. This difference in burden is due to the fact that the gross income attributed to the health sector is much higher in LMICs. Furthermore, overall,

cardiovascular diseases caused the highest number of deaths (20,765 deaths), followed by respiratory diseases (12,665 deaths), and the least being cancers (8,603 deaths).

4.2 Further evaluation of disease burden caused by smoking

The economic costs of tobacco use among countries in West Africa are important. Sierra Leone was responsible for the largest economic burden of smoking-attributable diseases in 2012; with its direct costs proportionate to 4.5 percent of the country's total health expenditure and total costs (both direct and indirect costs) amounting to approximately 1% of the country's national GDP. Meanwhile, Ghana on the other hand faced the least economic burden as the smoking healthcare costs and total economic costs accounting for only 1.1% of THE and 0.1% of its GDP respectively.

This huge discrepancy in the economic costs of disease linked to smoking recorded between West African countries is strongly articulated to the fact that smoking prevalence among men and women between countries are significantly different. According to data from global adult tobacco survey, there has been increasing tobacco prevalence over the years in Sierra Leone and in 2012, 55% of adult men and 13% of women smoked tobacco; in contrast, Ghana has experienced a decreasing trend in tobacco use and recorded smoking prevalence of 12% and 0.5% respectively in 2012. Possible

explanations for this gap in smoking prevalence lies with facts that Ghana has focused on reducing the health impact of smoking since 1993 when the first Ghana Committee on Tobacco Control (GCTC) was established. In 2005, she also became a part to the WHO Framework Convention on Tobacco control. Even before 2005, there was a fluctuation in the prices of cigarettes in Ghana; cigarette brands were sold between US$0.67 and US$1.12 in 1978, and in 1987, prices went up equivalent to US$0.83 to US$1.67 per pack. Due to constant monitoring and high taxes imposed by the Ghanaian government, the prices of cigarettes in 2008 reached approximately US$0.85 to US$3.50[58]. Although the tax on tobacco products in Ghana is low in relation to many developed countries, it is highest in comparison with other West African countries[35]. Also, in 1982, the Ghanaian government imposed a directive banning all cigarette advertisements on state television, radio and printed media[43]. Currently, there is a national steering committee mandated by the Ministry of Health to oversee tobacco control activities, including media campaigns, health promotion and lobbying for smoke-free legislation in Ghana[52, 56]. However, the resources provided for tobacco control activities are very low; there is also no control on cigarette sales and although a bill to prohibit smoking in public places was submitted to cabinet in 2005, very little progress has been made since then. Hence, Ghana is still classified as an endemic area of smoking-related diseases.

Meanwhile unlike Ghana, countries like Sierra Leone, Cote d'Ivoire and other West African countries have done little over the years to control tobacco use in their countries. For instance, a directive on excises duties on tobacco was introduced since 2000 in West Africa stating that excise duty rates should be in the range of 15% to 100%. In Ghana, the excise rate is 150%, above the maximum standard rate fixed by the community directive; meanwhile Sierra Leone surprisingly, excise duties are no longer imposed on tobacco products since 2006. In the case of Nigeria, excise duties are imposed only on imported tobacco products leaving out the domestic produced tobacco products. Most West African country rates are below 30%[59]. This failure in imposing tax on tobacco products increases the affordability of cigarettes leading to increased smoking prevalence, consequently high burden of smoking-related diseases. Furthermore, according to WHO 2013 report, countries in West Africa which have achieved full implementation of selected demand-reducing measures prescribed in the Framework Convention on Tobacco control are Burkina Faso – where all public places are completely smoke free; Ghana, Niger and Togo – ban on all forms of direct and indirect tobacco advertisements[60].

In this study, the absolute number of deaths from smoking-attributable diseases is highest in Nigeria (19,389 deaths), thereby resulting in the largest figures in terms of all costs and labour years loss. This

high deaths and figures are from the fact that Nigeria is the most populated country with a population equivalently almost half of all West Africa's population (about 150million people) higher than other West African countries nearly 6 to 10 times (appendix 4). This justification is clearly backed up by the results of mortality rates, after being adjusted by country-population, smoking-attributable mortality rates were the third lowest at 13.1 per 100,000 deaths; and also a lower burden of disease compared to other countries in terms of cost proportion to the nation's GDP. The low mortality rate as compared to other countries is because the smoking prevalence in Nigeria is lower than in other countries. This is due to the fact that just like Ghana and Burkina Faso, there exist some tobacco control measures in Nigeria; which doesn't apply in Cameroon, Cote d'Ivoire and other countries. The prohibition of tobacco sales to minors and by minors, and no free distribution of tobacco products are applicable in Nigeria, and also, there is a ban on cross-border advertising, promotion and sponsorship[15]. Diagnosis and treatment of tobacco dependence included in the healthcare system and pharmaceutical products are available in Nigeria, Ghana, Burkina Faso and Benin[15]. These reasons can justify the low mortality rates in these countries.

Ischemic heart disease (IHD) constituted the major part of the disease burden in both genders for all countries. There is strong evidence of the

relation between smoking and ischemic heart disease. The relative risk (RR) of IHD caused by smoking was highest among all diseases, which resulted in a higher PAF value and consequently a higher disease burden. In general, cardiovascular disease (CVDs) remained stable as the highest cause of death (20,765 deaths) among all disease types in both males and females in all countries with a slight difference in Togo. The possible explanation for this high death rate is that, cardiovascular diseases have been recorded as the most frequently diagnosed disease type in Africa. High blood pressure which is the most common and most important risk factor for CVDs, its prevalence is estimated to be about 20 million in the African Region. Poverty, lack of education, and unplanned urbanization can increase exposure to cardiovascular risk factors[8], and all these factors are characteristics of West African countries. Despite these uncontrollable factors, most CVDs can be prevented by addressing behavioral risk factors such as tobacco use, unhealthy diet and obesity, physical inactivity and harmful use of alcohol. People with cardiovascular disease or who are at high cardiovascular risk (due to the presence of one or more risk factors such as hypertension, diabetes) need early detection and management using counseling and medicines, as appropriate.

In Senegal and Mali, the lowest death percentage caused by cancer was recorded, 10.5% and 10.7% respectively. The attributable rate is

predicted to be smaller as a consequence of a decline in cancer incidence and prevalence are as compared to the other countries; According to Globocan 2018, new cancer cases in Senegal was 10,549, meanwhile Cameroon recorded 15,769 new cases.

Over the years and in recent times, anti-smoking policies have been implemented in Africa including some countries in West Africa. Analysis of the effectiveness of these control measures showed that overall cigarette price decreased from PPP$ 2.08 in 2008 to PPP$ 2.04 in 2010[61]. Table 10 shows the different tobacco control measures which have been implemented in West African countries. It is evident that countries like Ghana, Benin, and Nigeria with tobacco control policies being implemented are most likely to have a lower burden from smoking-attributable diseases, than countries like Sierra Leone, Cote d'Ivoire, and Liberia where tobacco control measures have been rarely implemented.

Table 10. The extent of tobacco control measures implemented in West African Countries.

Tobacco control measure	Extent of Policy Implementation	Countries
Protection from exposure to tobacco smoke	Yes – although to an extent	All countries
	Data not Available	Sierra Leone
Offering help to quit tobacco use	Diagnosis and treatment of tobacco dependence included in the health care system	Ghana, Benin, Burkina Faso, Nigeria
	Not included in healthcare systems, physicians only give brief counseling	Cameroon, Cote d'Ivoire, Togo
	Data not available	Niger, Senegal, Sierra Leone, Liberia
Warn against the dangers of tobacco	Health warnings on tobacco packages	Other countries
	No health warnings on tobacco packages	Sierra Leone, Cote d'Ivoire
Enforce bans on advertisement, promotion and sponsorship	Ban on cross-border advertisement and ban of a display at points of sales	Ghana, Nigeria, Niger, Mali, Burkina Faso, Senegal,
	Ban on a cross-border advertisement, promotion and sponsorship	Cameroon, Togo, Benin
	No ban	Sierra Leone, Liberia, Cote d'Ivoire
Raise taxes	Tax and price policy on tobacco products	Ghana, Nigeria, Mali, Burkina Faso, Benin, Togo
	No price and tax policy	Cameroon, Sierra Leone, Cote d'Ivoire, Senegal, Niger
Sales to and by minors	Prohibit the sale of tobacco products to minors	Senegal
	Prohibit tobacco sales to minors and prohibit sales of cigarette per stick or in small packs	Benin, Burkina Faso, Ghana, Nigeria, Mali, Togo
	No prohibition of sales to minors	Cameroon, Liberia, Sierra Leone, Cote d'Ivoire
Protection of the environment and health of persons in relation to tobacco manufacturing	YES	Benin, Ghana, Nigeria
	NO	Other countries

Source: Country reports on the implementation of the WHO FCTC

Nevertheless, despite the tobacco control measures implemented in table 10, more is still to be done. Although the smoking prevalence in West African countries is not quite high as compared to other LMICs, analysis of tobacco control policies revealed that most countries have not yet achieved full FCTC implementation[61].

4.3 Limitations and Strengths

Our study had some shortcomings. To begin, in estimating smoking-attributable mortality, we used the relative risks estimated from CPS II. Although this represents one of the largest and best conducted studies to provide RRs of mortality according to smoking status, the validity of applying the RRs of a US population to the West African one is open to discussion. Smoking histories, including in particular intensities and duration, and tobacco product usage of the CPS II participants might in fact differ from the West African one, thus influencing the RRs of various tobacco-related diseases[10]. Secondly, to get an estimate for cost of premature death, we assumed that the deceased patients would have lived up to the age of average life expectancy, worked and earned a salary following the age profile of

economic burden of smoking-related diseases was estimated only for the population who smoked cigarettes while excluding the negative effects of

second-hand smoking and pollution which is also an issue calling for concern in West Africa, for this reason we could say that compared to similar studies in other regions, we most likely underestimated the total cost of smoking. Additionally, in conducting this study, very few data were collected from original studies on disease-specific morbidity and medical costs by country; this was due to the lack of previous studies to provide data on these variables required from the study, hence, the call for further studies is necessary.

However, despite the above limitations, our study has some strengths. To begin, this is the first study to our knowledge to estimate the economic costs of smoking-attributable diseases in West Africa. In addition, costs were analyzed from a societal perspective demonstrating the extensive effect of smoking on the overall society. In contrast to some other studies on the burden of smoking-related diseases which estimated either the mortality or costs (in monetary units) of the disease, the economic burden in this study included both the physical burden of disease estimates and costs in monetary units. More also, our results show the importance and the priority to be accorded to measures to reduce the rate of smoking in the West African population. Reducing smoking prevalence would have an important impact on SAM. A study in Taiwan has demonstrated that if the annual smoking rate were to be reduced by 10% between 2001 and 2020, the corresponding projected SAM would decrease by 30%.

5. CONCLUSIONS

In spite of the limitations of the data, this study has several important implications for public health research and policy in West Africa. Our study shows that smoking-attributable mortalities are quite high in the majority of countries in West Africa for which data are available. There is also some evidence to suggest that smoking mortality rates may be higher in some countries with high smoking prevalence, especially among men. In addition, we can say that the level of implementation of tobacco control policies in counties is a possible explanation of whether the burden of diseases associated with smoking is higher or lower in some countries.

Data on smoking-attributable mortality, and also the economic costs of tobacco-related deaths in West Africa are needed to demonstrate that smoking should, and can, be addressed as a major population health priority in West Africa. The continued influx of international aid for infectious diseases, such as malaria and HIV/AIDS, has caused distortions within health systems and health policy priorities, and continues to draw resources away from tackling non-communicable diseases, and the single biggest risk factor, smoking.

In conclusion, having determined the economic burden of diseases attributable to smoking in West Africa in 2012, we found that diseases caused by smoking accounted imposes a heavy economic burden throughout West

Africa, particularly in Senegal and Cote d'Ivoire where the tobacco epidemic is most advanced. Our results act as a practical useful tool for policy making in terms of policy enforcement on tobacco control and raising awareness. In addition, this study can be used as a baseline for further research conducted to examine the economic burden in individual countries using country's national statistics if available.

APPENDICES

Appendix 1. Smoking Prevalence by gender among adults aged 15+, 2012.

Countries	**Male (percent)**	**Female (percent)**
Benin	16.4	1.1
Burkina Faso	33.1	5.1
Cameroon	33.7	0.9
Cote d'Ivoire	26.2	1.7
Ghana	12.1	0.5
Liberia	25.4	2.7
Mali	32.6	3.0
Niger	15.9	0.2
Nigeria	15.9	1.2
Senegal	22.1	0.8
Sierra Leone	55.0	13.4
Togo	14.3	1.0

Sources: World Health Organization, Global Health Observatory Data Repository (http://apps.who.int/ghodata/), The Tobacco Atlas (https://tobaccoatlas.org>country>togo), Global Youth Tobacco Survey, Cote d'Ivoire (apps.who.int>tobacco>economics>civ)

Appendix 2 Population-attributable Fraction of smoking-related diseases for male population by country in West Africa, 2012

Disease type	**Benin**	**Burkina Faso**	**Cameroon**	**Cote d'Ivoire**	**Ghana**	**Liberia**	**Mali**	**Niger**	**Nigeria**	**Senegal**	**Sierra Leone**	**Togo**
Malignant neoplasm												
Trachea, lungs, bronchi	0.84	0.91	0.91	0.89	0.81	0.89	0.91	0.83	0.83	0.87	0.94	0.79
Esophagus	0.63	0.77	0.77	0.73	0.55	0.72	0.77	0.62	0.62	0.69	0.85	0.55
Stomach	0.28	0.45	0.45	0.39	0.23	0.38	0.44	0.28	0.28	0.35	0.57	0.23
Pancreas	0.29	0.45	0.45	0.39	0.23	0.38	0.45	0.28	0.28	0.35	0.58	0.22
Lips, oral cavity, Pharynx	0.69	0.81	0.82	0.78	0.62	0.77	0.81	0.93	0.93	0.75	0.88	0.61
Cervix uteri	-	-	-	-	-	-	-	-	-	-	-	-
Urinary bladder	0.42	0.59	0.59	0.53	0.53	0.53	0.59	0.41	0.41	0.49	0.71	0.34
Acute myeloid Leukemia	0.26	0.42	0.43	0.36	0.21	0.36	0.42	0.69	0.69	0.33	0.55	0.21
Cardiovascular Diseases												
Ischemic heart disease	0.36	0.53	54	0.47	0.30	0.47	0.53	0.35	0.35	0.43	0.65	0.29
Cerebrovascular disease	0.35	0.52	0.53	0.46	0.29	0.46	0.52	0.34	0.34	0.42	0.65	0.28
Respiratory Disease												
COPD	0.72	0.84	0.85	0.81	0.66	0.81	0.84	0.72	0.72	0.78	0.90	0.66
Bronchitis Emphysema	0.84	0.91	0.92	0.89	0.79	0.89	0.91	0.80	0.80	0.88	0.91	0.79

COPD: Chronic Obstructive pulmonary disease

Appendix 3. Population-attributable fraction of smoking-related diseases for female population by country in West Africa, 2012

Disease type	**Benin**	**Burkina Faso**	**Cameroon**	**Cote d'Ivoire**	**Ghana**	**Liberia**	**Mali**	**Niger**	**Nigeria**	**Senegal**	**Sierra Leone**	**Togo**
Malignant neoplasm												
Trachea, lungs, bronchi	0.15	0.45	0.13	0.22	0.08	0.31	0.33	0.03	0.16	0.12	0.68	0.10
Esophagus	0.09	0.33	0.08	0.14	0.05	0.21	0.22	0.02	0.10	0.07	0.56	0.06
Stomach	0.02	0.08	0.02	0.03	0.003	0.04	0.05	0.003	0.02	0.01	0.18	0.01
Pancreas	0.03	0.12	0.02	0.05	0.01	0.07	0.08	0.005	0.03	0.02	0.27	0.02
Lips, oral cavity, Pharynx	0.07	0.25	0.05	0.09	0.03	0.15	0.16	0.13	0.07	0.05	0.46	0.04
Cervix uteri	0.02	0.08	0.02	0.03	0.008	0.05	0.05	0.003	0.02	0.01	0.19	0.01
Urinary bladder	0.03	0.14	0.03	0.05	0.02	0.08	0.09	0.01	0.04	0.02	0.29	0.02
Acute myeloid Leukemia	0.02	0.07	0.01	0.03	0.007	0.04	0.04	0.003	0.12	0.01	0.17	0.01
Cardiovascular Disease												
Ischemic heart disease	0.04	0.15	0.03	0.05	0.02	0.08	0.09	0.01	0.07	0.03	0.13	0.02
Cerebrovascular disease	0.05	0.18	0.04	0.07	0.02	0.10	0.11	0.01	0.05	0.03	0.37	0.03
Respiratory Disease												
COPD	0.17	0.49	0.15	0.24	0.09	0.34	0.36	0.04	0.19	0.13	0.72	0.12
Bronchitis Emphysema	0.20	0.54	0.17	0.28	0.10	0.38	0.41	0.04	0.22	0.15	0.75	0.14

COPD: Chronic Obstructive pulmonary disease

Appendix 4. Economic characteristics of West African countries for 2012

Country	**GDP (PPP current International dollars)**	**GDP per capital growth**	**THE (percentage of GDP)**
Benin	18,388,390,000	1.92	4.86
Burkina Faso	25,676,770,000	3.31	5.33
Cameroon	64,867,500,000	1.76	4.34
Cote d'Ivoire	59,165,500,000	8.0	6.14
Ghana	95,195,500,000	6.7	4.79
Liberia	3,287,228,000	5.12	10.9
Mali	29,423,310,000	-3.72	6.47
Niger	15,576,830,000	7.61	6.11
Nigeria	909,730,000,000	1.52	3.30
Senegal	30,524,140,000	1.34	4.31
Sierra Leone	9,665,618,000	12.55	11.24
Togo	8,797,506,000	2.07	5.11

(GDP – Gross Domestic Product; PPP – Power Purchasing Parity; THE – Total Health Expenditure)

Sources: World Bank, International Comparison Program database (https://www,indexmundi.com/fact/country/gdp); World Bank national accounts data, and OECD National Accounts data files (https://www.indexmundi.com/facts/country/gdp-per-capital-growth); World Health Organization Global Health Expenditure database (http://apps.who.int/nha/database)

Appendix 5. Population and Employment Structure in West African Countries for 2012

Country	**Country Population**	**Country life-expectancy**	**Employed Population**	**Employment to population-ratio**	
				Male	**Female**
Benin	9,729,160	59.8	3,848,711	72.3	68.5
Burkina Faso	16,571,220	58.33	5,929,243	87.1	74.5
Cameroon	21,082,380	56.2	8,246,000	78.5	67.4
Cote d'Ivoire	21,418,600	51.49	6,539,152	74.5	46.1
Ghana	25,733,050	61.52	11,465,996	74.2	70.8
Liberia	4,181,563	60.59	1,287,959	62.0	55.0
Mali	16,006,670	56	5,310,782	72.3	45.3
Niger	17,731,630	58	6,814,517	87.1	39.5
Nigeria	167,297,300	51.6	47,508,218	59.4	43.8
Senegal	13,703,510	65.3	3,949,932	64.1	38.5
Sierra Leone	6,766,103	49.75	2,202,585	65.4	63.8
Togo	6,859,482	58.64	2,884,490	76.3	75.7

Sources: World Bank, World Development Indicators; International Labour Organization ILOSTAT Database and World Bank population estimates.

Appendix 6 Observed mortality in Male by disease type for West African Countries in 2012

Disease type	**Benin**	**Burkina Faso**	**Cameroon**	**Cote d'Ivoire**	**Ghana**	**Liberia**	**Mali**	**Niger**	**Nigeria**	**Senegal**	**Sierra Leone**	**Togo**	**Total**
Malignant neoplasm													
Trachea, lungs, bronchi	100	100	100	400	200	0	0	100	900	0	100	0	20000
Esophagus	0	0	0	100	0	0	0	100	200	0	0	0	400
Stomach	0	0	0	200	100	0	200	100	600	100	100	0	14000
Pancreas	0	0	0	100	0	0	0	0	300	0	0	0	400
Lips, oral cavity, Pharynx	100	100	300	200	200	100	0	100	1,800	100	100	100	3200
Cervix uteri	-	-	-	-	-	-	-	-	-	-	-	-	-
Urinary bladder	0	100	0	100	100	0	0	100	400	0	0	0	800
Acute myeloid leukemia	100	100	200	400	600	100	100	300	400	100	100	100	2600
Sub total	**300**	**400**	**600**	**1500**	**1200**	**200**	**300**	**700**	**4,600**	**300**	**400**	**200**	**10700**
Cardiovascular disease													
Ischemic heart disease	600	900	1,500	2400	1,600	300	700	1500	12,300	900	800	500	
Cerebrovascular disease	600	1000	1,500	2400	1,600	300	800	1,600	13,100	900	800	500	
Sub total	**1200**	**1900**	**3000**	**4800**	**3,200**	**600**	**1500**	**1,800**	**25,400**	**1800**	**1600**	**1000**	**47,800**
Respiratory Disease													
COPD	200	300	500	900	600	100	300	500	4,500	300	300	200	
Bronchitis emphysema	100	300	300	500	400	100	200	500	3,000	200	200	200	
Sub total	**300**	**600**	**800**	**1400**	**1000**	**200**	**500**	**900**	**7,500**	**500**	**500**	**400**	**14600**
Total death	**1800**	**2900**	**4400**	**7700**	**5400**	**1000**	**2300**	**3400**	**37500**	**2600**	**2500**	**1600**	**73100**

Appendix 7. Observed mortality in Female by disease type for West African Countries in 2012

Disease type	**Benin**	**Burkina Faso**	**Cameroon**	**Cote d'Ivoire**	**Ghana**	**Liberia**	**Mali**	**Niger**	**Nigeria**	**Senegal**	**Sierra Leone**	**Togo**	**Total**
Malignant neoplasms													
Trachea, lungs, bronchi	0	0	100	100	0	0	0	0	0	0	0	0	
Esophagus	0	100	0	0	0	0	100	0	0	0	-	0	
Stomach	0	100	0	100	100	0	300	100	100	100	0	0	
Pancreas	0	0	0	0	0	0	0	0	0	0	0	0	
Lips, oral cavity, Pharynx	0	0	300	100	0	0	0	100	100	100	0	0	
Cervix uteri	200	300	-	700	500	100	300	600	600	600	200	200	
Urinary bladder	0	0	0	0	100	0	0	0	0	0	0	0	
Acute myeloid Leukemia	100	100	200	300	1000	0	100	200	200	200	100	0	
Sub total	**300**	**600**	**600**	**1300**	**1700**	**100**	**800**	**1000**	**1000**	**1000**	**300**	**200**	**8,900**
Cardiovascular diseases													
Ischemic heart disease	400	600	1,500	1000	1,000	100	500	800	800	800	400	300	
Cerebrovascular disease	800	1200	1,500	2200	1,600	300	1100	1,600	1600	1600	800	500	
Sub total	**1200**	**1800**	**3000**	**3200**	**3,600**	**400**	**1600**	**2,400**	**2,400**	**2400**	**1200**	**800**	**24000**
Respiratory Disease													
COPD	100	200	500	400	200	100	200	300	300	300	100	100	
Bronchitis Emphysema	100	200	300	500	300	100	200	300	300	300	200	200	
Sub total	**200**	**400**	**800**	**900**	**500**	**200**	**400**	**600**	**600**	**600**	**300**	**300**	**5800**
Total death	**1700**	**2,800**	**4,400**	**5,400**	**5,800**	**700**	**2400**	**4000**	**4,000**	**4,000**	**1800**	**1300**	**38700**

Appendix 8 Disability-adjusted Loss of Years (000's) in Male by disease type for West African Countries 2012

Disease type	**Benin**	**Burkina Faso**	**Cameroon**	**Cote d'Ivoire**	**Ghana**	**Liberia**	**Mali**	**Niger**	**Nigeria**	**Senegal**	**Sierra Leone**	**Togo**
Malignant neoplasms												
Trachea, lungs, bronchi	1	1	2	6	3	0	0	2	16	1	1	1
Esophagus	0	0	1	2	1	0	1	1	5	0	0	0
Stomach	1	1	0	4	3	0	3	1	11	1	1	1
Pancreas	0	0	0	2	1	0	0	1	4	1	1	0
Lips, oral cavity, Pharynx	1	2	5	3	4	1	1	2	35	1	1	1
Cervix uteri	-	-	-	-	-	-	-	-	-	-	-	-
Urinary bladder	0	2	0	1	1	0	1	1	7	1	1	0
Acute myeloid Leukemia	4	2	5	10	15	2	3	8	56	3	3	2
Cardiovascular diseases												
Ischemic heart disease	12	19	29	46	32	6	16	30	249	18	18	9
Cerebrovascular disease	15	24	33	53	37	8	20	35	295	20	20	10
Respiratory Disease												
COPD	6	9	14	20	14	3	8	15	120	8	8	4
Bronchitis Emphysema	8	14	18	24	22	5	11	14	175	12	12	7

Appendix 9 Disability-adjusted Loss of Years (in thousands) in Female by disease type for West African Countries in 2012

Disease type	Benin	Burkina Faso	Cameroon	Cote d'Ivoire	Ghana	Liberia	Mali	Niger	Nigeria	Senegal	Sierra Leone	Togo
Malignant neoplasms												
Trachea, lungs, bronchi	0	1	0	1	0	0	0	0	2	0	0	0
Esophagus	0	2	0	0	1	0	1	1	4	0	0	0
Stomach	1	1	2	2	2	0	6	1	10	1	1	1
Pancreas	0	1	0	1	1	0	0	1	5	1	0	0
Lips, oral cavity, Pharynx	0	1	2	1	1	0	0	1	7	1	0	0
Cervix uteri	5	9	12	14	12	3	7	7	86	5	5	3
Urinary bladder	0	1	0	0	1	0	1	1	3	1	0	0
Acute myeloid Leukemia	2	2	4	8	6	1	3	3	49	1	3	2
Cardiovascular diseases												
Ischemic heart disease	8	11	16	22	19	3	11	14	148	10	8	5
Cerebrovascular disease	19	31	37	55	36	7	26	33	349	22	18	13
Respiratory diseases												
COPD	3	5	7	9	5	1	5	6	61	4	3	2
Bronchitis Emphysema	6	9	12	25	14	4	8	9	114	8	6	7

COPD: Chronic Obstructive Pulmonary Disease

Source: Global Burden of Disease Database (www.who.int/healthinfo/global_burden_disease/metrics_daly/en/).

Appendix 10 Smoking years lost to disability (000s) by applying PAF in Male population, by disease and country in 2012

Disease type	Benin	Burkina Faso	Cameroon	Cote d'Ivoire	Ghana	Liberia	Mali	Niger	Nigeria	Senegal	Sierra Leone	Togo	Total
Malignant neoplasms													
Trachea, lungs, bronchi	0.84	0.91	1.82	5.34	2.43	0	0	1.66	13.28	0.87	0.94	0.79	
Esophagus	0	0	0.77	1.46	0.55	0	0.77	0.62	3.1	0	0	0	
Stomach	0.28	0.45	0	1.56	0.69	0	1.32	0.28	3.08	0.35	0.57	0.23	
Pancreas	0	0	0	0.78	0.23	0	0	0.28	1.12	0.35	0.58	0	
Lips, oral cavity, Pharynx	0.69	1.62	4.1	2.34	2.48	0.77	0.81	1.86	32.55	0.75	0.88	0.61	
Cervix uteri	-	-	-	-	-	-	-	-	-	-	-	-	
Urinary bladder	0	1.18	0	0.53	0.53	0	0.59	0.41	2.87	0.49	0.71	0	
Acute myeloid Leukemia	1.04	0.84	2.15	3.6	3.15	0.72	1.26	5.52	38.64	0.99	1.65	0.42	
Sub total	**2.85**	**5**	**8.84**	**15.61**	**10.06**	**1.49**	**4.75**	**10.63**	**94.64**	**3.8**	**5.33**	**2.05**	**165.05**
Cardiovascular diseases													
Ischemic heart disease	2.16	5.04	7.83	10.81	4.8	1.41	4.24	5.25	43.58	3.87	5.58	1.31	
Cerebrovascular disease	2.63	6.24	8.75	12.19	5.37	1.84	5.2	5.95	50.15	4.2	6.5	1.4	
Sub total	**4.79**	**11.28**	**16.58**	**23**	**10.17**	**3.25**	**9.44**	**11.2**	**93.73**	**8.07**	**12.08**	**2.71**	**206.3**
Respiratory Disease													
COPD	4.32	7.56	11.9	16.2	9.24	2.43	6.72	10.8	86.4	6.24	7.2	2.64	
Bronchitis Emphysema	3.36	6.35	8.28	10.68	8.69	2.23	5	5.6	70	5.28	5.46	2.77	
Sub total	**7.98**	**13.91**	**20.18**	**26.88**	**17.93**	**4.66**	**11.72**	**16.4**	**156.4**	**11.52**	**12.66**	**5.41**	**305.65**
Total death	**15.62**	**30.19**	**45.6**	**65.49**	**38.16**	**9.4**	**25.91**	**38.23**	**344.77**	**23.39**	**30.07**	**10.17**	**677**

Appendix 11 Smoking years lost to disability (000's) by applying PAF in Female population, by disease and country in 2012

Disease type	**Benin**	**Burkina Faso**	**Cameroon**	**Cote d'Ivoire**	**Ghana**	**Liberia**	**Mali**	**Niger**	**Nigeria**	**Senegal**	**Sierra Leone**	**Togo**	**Total**
Malignant neoplasms													
Trachea, lungs, bronchi	0	0.45	0	0.22	0	0	0	0	0.32	0	0	0	
Esophagus	0	0.66	0	0	0.05	0	0.22	0.02	0.4	0	0	0	
Stomach	0.02	0.08	0.04	0.06	0.006	0	0.3	0.003	0.2	0.01	0.18	0.01	
Pancreas	0	0.12	0	0.05	0.01	0	0	0.005	0.15	0.02	0	0	
Lips, oral cavity, Pharynx	0	0.25	0.1	0.09	0.03	0	0	0.13	0.49	0.05	0	0	
Cervix uteri	0.1	0.72	0.24	0.42	0.096	0.15	0.35	0.021	1.72	0.05	0.95	0.03	
Urinary bladder	0	0.14	0	0	0.02	0	0.09	0.006	0.12	0.02	0	0	
Acute myeloid Leukemia	0.04	0.14	0.04	0.24	0.042	0.04	0.12	0.009	5.88	0.01	0.51	0.02	
Sub total	**0.16**	**2.56**	**0.42**	**1.08**	**0.254**	**0.19**	**1.08**	**0.194**	**9.28**	**0.16**	**1.64**	**0.06**	**17.1**
Cardiovascular diseases													
Ischemic heart disease	0.16	0.83	0.24	0.55	0.19	0.12	0.50	0.042	5.18	0.15	1.24	0.05	
Cerebrovascular disease	0.48	2.79	0.74	1.93	0.72	0.35	1.43	0.132	8.73	0.33	3.33	0.19	
Sub total	**0.64**	**3.62**	**0.98**	**2.48**	**0.91**	**0.47**	**1.93**	**0.174**	**13.91**	**0.48**	**4.57**	**0.24**	**30.4**
Respiratory Disease													
COPD	0.51	2.45	1.05	2.16	0.45	0.34	1.8	0.24	11.59	0.52	2.16	0.24	
Bronchitis Emphysema	0.6	2.43	1.02	4.5	1.4	0.76	1.64	0.18	12.54	0.6	2.25	0.49	
Sub total	**1.11**	**4.88**	**2.07**	**4.66**	**1.85**	**1.1**	**3.44**	**0.42**	**24.13**	**1.12**	**4.41**	**0.73**	**49.9**
Total death	**1.75**	**11.02**	**3.47**	**8.22**	**3.014**	**1.76**	**6.45**	**0.788**	**47.32**	**1.76**	**10.62**	**1.03**	**97.4**

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