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The Economic Cost of Smoking in South Africa, 2016

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Abstract

Introduction: Chronic, noncommunicable diseases are on the rise globally, with tobacco consumption being an important contributing risk factor. These increases result in significant economic costs due to increased healthcare costs, productive lives lost, and productive days lost due to illness. Estimates of these economic costs are scarce in low- and middle-income countries.
Methods: Drawing on a diverse range of data sources, direct healthcare costs, and productivity losses due to illness and premature deaths were estimated using the cost-of-illness approach. The present value of lifetime earnings was used to estimate productivity losses from premature deaths.
Results: We estimate that 25 708 deaths among persons aged 35–74 in 2016 are smoking-attributable. The economic cost of smoking was R42 billion (US$2.88 billion), of which R14.48 billion was for healthcare costs (hospitalization and outpatient department visits). The economic cost of smoking amounted to 0.97% of the South African GDP in 2016, while the healthcare cost of smoking-related diseases was 4.1% of total South African health expenditure. The costs are lower for women because of their lower smoking prevalence.
Conclusion: The economic burden of smoking calls for a further scaling-up of tobacco-control interventions in South Africa.
Implications: This article addresses the paucity of research on the detailed economic costs of smoking in low-and middle-income countries, including South Africa. Our calculations, based on an extensive range of recent data, provide the most detailed estimate to date and include quantification of the direct and indirect costs of smoking in South Africa. We found that the magnitude of the costs related to smoking in South Africa is larger than in the previous estimates and that for every Rand received in the form of cigarette tax, society loses 3.43 Rands. This article provides an economic case for evidence-based tobacco control in South Africa.

Introduction

Chronic, noncommunicable diseases are on the rise globally, and tobacco consumption is one of the important risk factors contributing to many of these diseases.[1,2] Premature deaths and morbidity from tobacco account for about 4% of the total disease burden globally, and 6.3% of disability-adjusted life-years lost.[3,4] In South Africa, smoking-associated noncommunicable diseases, such as chronic obstructive pulmonary disease (COPD), ischemic heart disease, hypertension, and other heart diseases, are among the leading causes of mortality.[5] Although smoking prevalence has declined over the last three decades,[6] South Africa still has a significant number of smokers.[7]

The South African healthcare system is markedly two-tiered, with a well-functioning but overly expensive private sector, and

an under-capacitated and under-resourced public sector. This, along with a tumultuous history of political segregation of ethnic groups, has resulted in large health inequalities across income groups, with the poor bearing the brunt.[8] Globally, there is a trend of higher smoking rates among lower socio-economic groups and South Africa is no exception.[9] As a result, smoking-related mortality and morbidity are disproportionately higher among the economically disadvantaged, which in turn results in higher costs for the public healthcare sector and perpetuates already existing health inequalities.

A quantification of the direct and indirect costs of smoking in South Africa is a useful tool for informing evidence-based policy making. It reveals the true costs attributable to smoking and provides an evidence base on which to determine extent of policy intervention required to deal with the negative externalities of smoking. These negative externalities include the health and economic costs and consequences that nonsmokers may bear because of secondhand smoke. Approximately 600 000 die annually as the result of secondhand smoke.[10] Secondly, the taxpayers of the country carry the financial burden that smoking-related illnesses place on the public health care system, regardless of their smoking status. In Brazil, the Attorney General's Office is suing cigarette manufacturers and their parent companies for costs incurred by the public healthcare sector for the treatment of 26 scientifically linked smoking-related diseases over the past 5 years.[11] This quantification of the economic burden of smoking allows for a more detailed analysis of the consequences of tobacco consumption for the economy.

The economic costs of smoking in low- and middle-income countries are relatively low compared to the costs in high-income countries (HICs), driven by the lower costs of healthcare and labor, and by lower employment levels. A global analysis of the economic burden of smoking was performed by Goodchild et al.[12] by applying a cost-of-illness approach to 2012 data. The authors find that the economic cost of smoking amounted to 1.8% of global gross domestic product (GDP). Smoking-attributable diseases accounted for 5.7% of global health expenditures. The authors also find that the economic burden was higher in Europe (with some regional variation) and proportionally lower in Africa and the Eastern Mediterranean region, driven by lower smoking prevalence and intensity.[12]

There is a paucity of rigorous, country-level estimates of the economic cost of smoking from Sub-Saharan Africa (SSA). This is partly the result of the focus on communicable diseases and maternal and infant deaths, which has shifted the attention away from noncommunicable diseases. To add to this, most Sub-Saharan African countries are in the early stages of the cigarette-smoking epidemic, implying low rates of consumption.[13] However, the epidemic model predicts that smoking rates will be increasing in most of these countries,[14] as will the economic costs attributable to smoking, making these estimates increasingly important. Another impediment to costing studies in Sub-Saharan African is access to high-quality, administrative, or publicly available data.

Apart from studies in Uganda[15] and Tanzania,[16] the most comprehensive analysis of the economic burden of smoking has been in South Africa. Compared to the rest of Sub-Saharan Africa, South Africa has experienced high rates of tobacco consumption. Approximately 29.3% of all South Africans smoked in 1977,[17] while the smoking rate for adults aged 16 and over was estimated to be 31% during 1989–1990.[18] A change in the political dispensation in 1994 led to substantial changes in health policy, including the implementation of stricter tobacco-control legislation. Although this contributed to a decline in smoking rates, they remain comparatively high. The 2016 Demographic and Health Survey estimates that 8% of women and 37% of men aged 15 and older smoke tobacco products, the majority of whom smoke daily.[7]

Given the high smoking rates, there have been several estimations of the costs of smoking in South Africa. These economic costing studies are often difficult to compare due to differing methodologies and analytical horizons. Furthermore, the older studies are hampered by limited data on premature death rates for multiple smoking-related diseases. In the seminal article by Yach,[19] the mortality costs of heart diseases, cancer, and bronchitis are considered. McIntyre and Taylor[20] update Yach[19] by including circulatory, respiratory diseases, and tumors caused by smoking. Later analyses included ischemic heart disease, lung cancer, respiratory heart disease, chronic obstructive airways disease, and aneurysms.[18]

McIntyre and Taylor[20] estimate the cost of smoking in 1985 to be between 362.3 and 396.9 million Rands (R). If a broader assumption of employment is assumed, where everyone (not just those employed in the formal sector) would experience a loss in productivity, the estimate increases to between R584.4 and R652 million. The higher estimate is more justifiable given the presence of a large informal sector in South Africa. Yach et al.[18] estimated the economic cost of smoking in 1988 to reach between R1.4 billion and R2.5 billion (in 1988 prices), which included healthcare costs as well as lost productivity. This amounted to 0.8% of GDP.

The most recent estimate of the economic burden of smoking in South Africa can be drawn from Goodchild et al.[12] in their article, the authors calculate the global economic costs of smoking, but country disaggregated costs are available in the supplementary material. The economic cost of smoking in South Africa amounts to 1.8% of GDP and the cost of SADs accounts for 5.8% of total health expenditures. The article's methodology does not allow it to calculate detailed country costs, as our article will do. Pearce et al.[21] find a much lower estimate of 0.49% of GDP, but these estimates are restricted to smoking-related cancer.

In this article, we extract estimates from a wide range of recent data sources to estimate the 2016 cost of smoking for South Africa. Our analysis includes a wide range of smoking-related disease categories, including tuberculosis, cerebrovascular diseases, hypertensive diseases, influenza and pneumonia, chronic lower respiratory diseases, ischemic heart disease, malignant tumors of digestive organs, and malignant tumors of respiratory and intrathoracic organs. Three cost categories relating to smoking were estimated. The costs are healthcare costs (hospitalization and outpatient department visits), cost of premature deaths, and cost due to illness. Given the data available, this is the most comprehensive analysis of the costs associated with smoking in South Africa up to this point.

Methods and Data

The economic costs of smoking included in this analysis consist of the direct healthcare costs and indirect costs owing to productivity losses and premature deaths. We estimated these costs for 2016 using the cost-of-illness approach.

Direct healthcare costs consist of hospital admissions and outpatient department visits (OPDs). Indirect costs include the value of years of productive life lost (YPLL), as well as the cost of lost output associated with absence from work as a result of SADs. We used an additive approach, estimating for each relevant disease the proportion of its management cost, which was attributable to direct smoking.

Secondary data on mortality,[5] healthcare expenditure and utilization,[22,23] labor market statistics,[24,25] and life table statistics[26] for the year 2016 were used for this analysis.

Disease-Specific Deaths Disaggregated by Age, Gender, and Ethnicity

Mortality data disaggregated by ethnicity and disease were extracted from Statistics South Africa's 2016 report on mortality and causes of deaths.[5] The mortality report relies on the civil registration system and is based on the national statistical agency's compilation of death certificates. We used the definition of ethnicity groups used by the national statistical agency, namely black African, Colored, Indian/Asian, white and Other.[27] Colored as a self-identified ethnic category refers collectively to various diverse groups with their own distinct ancestry, linking indigenous South African, Asian, African, and European.[28] Indian/Asian and Others were grouped together as they both contained few observations. Age and gender distributions of mortality were applied to mortality data in order to calculate age- and gender-disaggregated deaths. In addition, deaths from hypertension, ischemic heart disease, and COPD were restricted to older adults[5] due to their greater prevalence among this group compared to the rest of the population.

Diseases and Smoking-Attributable Fraction

Using previous literature,[29–32] we were able to include eight ICD10-code disease categories. These included tuberculosis, cerebrovascular diseases, hypertensive diseases (I10–I15), influenza and pneumonia (J09–J18), chronic lower respiratory diseases (J40–J47), ischemic heart disease (I20–I25), malignant neoplasms of digestive organs (C15–C26), and malignant neoplasms of respiratory and intrathoracic organs (C30–C39). Other smoking-related diseases not explicitly classified by race were assumed to be included under "other natural causes" of death in the mortality report. These include diseases of the arteries, arterioles and capillaries, and other neoplasms (lip, oral cavity, and pharynx [C00–C14]), and of lymphoid, hematopoietic, and related tissue (C81–C96).

We estimated the smoking-attributable fraction (SAF) for each smoking-related disease by ethnicity and gender using the published South African relative risk of mortality from various smoking-related diseases.[29] Following Groenewald et al.[30] and Chen et al.[33] the SAF for each SAD was determined as

$$SAF_{\text{Disease } i} = \frac{p(RR_{\text{Disease } i} - 1)}{p(RR_{\text{Disease } i} - 1) + 1} \quad (1)$$

where p is the prevalence of smoking within the population and RR the Relative Risk of dying from smoking-related disease i among ever-smokers compared to never-smokers who die from the same disease. Smoking status 5 years prior to death is captured on the death certificate. The 2012 smoking prevalence rates disaggregated by ethnicity and gender are used for p.[34] In 2012, nearly 21% of adult South Africans reported having ever smoked.[34] There are clear ethnic and gender differences in smoking rates among South Africans (Table 1). For males, smoking prevalence was highest among Colored men (51%) and lowest among white men (25%). Smoking rates among females were highest among Colored women (39.7%) and lowest among African women (4.8%). As the effects of smoking on health only manifest gradually over time,[35,36] we used the prevalence of smoking in 1998[30] as a base measure, on the assumption that smoking-related deaths in 2016 were the result of long-term smoking.

Table 1. Smoking Prevalence by Gender and Ethnicity in South Africa, 1998 and 2012

Group	Male		Female	
Year	1998[a]	2012[b]	1998[a]	2012[b]
Colored	57.2	51	40.0	39.7
White	40.4	25.5	27.7	23.7
African	42.4	31.4	5.0	4.8
Asian/others	54.8	41.4	9.0	9.4

Source: [a]Groenewald et al.[30]; [b]Shisana et al.[34].

Smoking-Attributable Deaths

To obtain the smoking-attributable deaths (SADs) for each disease, the number of deaths from that disease for persons in each age, ethnic, and gender category was multiplied by the SAF.[5]

Costs

Three cost categories relating to smoking were estimated, namely healthcare costs (ie, hospitalization and OPD visits), the cost of premature deaths (YPLL), and the cost of lost productivity due to illness. The costs are estimated using the prevalence-based, annual cost approach where costs are incurred through the presence of smoking-related diseases in 2016 but caused by cumulative use of tobacco in the past.[32,33] A societal perspective was adopted in the analysis; therefore, the value of resources used by hospitals in treating the diseases was included regardless of who pays for them.

Smoking-Attributable Healthcare Utilization and Cost

Healthcare cost attributed to smoking refers to all the costs of hospitalization and OPD visits associated with SADs. This is calculated by multiplying smoking-attributable healthcare utilization by the appropriate healthcare unit costs. All analyses were disaggregated by age and gender.

Healthcare use due to smoking is calculated as healthcare used (as reported in the national district health barometer)[22,37] and multiplied by the SAF. Publicly available healthcare use data is only available for public healthcare facilities. In South Africa, 27% of all healthcare use is private sector use.[38] To compensate for the lack of private sector data, public sector use data is multiplied by 1.37 (or 100 / [100 – 27]) in order to get an estimate of total healthcare use. Smoking-attributable healthcare use was calculated by multiplying the SAF with the number of hospitalization and OPD visits.

Healthcare costs are drawn from published literature[22,23,37,39] and adjusted to distinguish between inpatient and OPD visit costs. To estimate the cost of hospitalization as a result of smoking, the expenditure per patient day equivalent for 2016 was multiplied by the total smoking-attributed inpatient days (the product of the average length of stay and separations/admissions) based on public and private sector use rates.[22,23] We assume that the cost of an outpatient visit is 1/3 of the patient day equivalent expenditure for both sectors.[20,22,37] This was then multiplied by the total smoking-related outpatient visits, based on smoking-attributable deaths. Healthcare costs were calculated for the 35 to 74 age group.

Cost of Premature Deaths

To obtain the cost of premature deaths due to smoking, different procedures were followed. First, the number of potential life-years lost (YPLL) at ages 35–39, 40–44, and so on up to 60–64 was

calculated using variables from the life table (probability of survival and life expectancy at different ages).[26] Secondly, we calculated the average lifetime earnings lost for each smoking-related death. This is calculated by multiplying the YPLL by the average South African gross monthly salary in May 2016,[24] and is in line with previous studies.[15,40] The calculation takes into account the differing labor force participation and unemployment rates for men and women.[25] The real interest rate in 2016 (ie, 3.45%) is used to discount all future output/earnings to present earnings, while an exchange rate of R14.71 per US$1 is used to obtain a dollar equivalent.[41]

$$\sum_{i=1}^{n} FE = \frac{[Y(e) * E(e)][(1+p)^n]}{(1+r)^n} \quad (2)$$

In equation 2, the sum of the present value of all future earnings (FE) or output for persons who died in 2016 is the product of average annual earnings for those employed (Y), the proportion of the population that is employed (E), the growth rate in output (p = 1%), the years of life lost at the time of death (n), and the discount rate (r = 3.45%). Output/earnings were assumed to grow by 1% annually, while older adults were assumed to earn 1% more than young adults because of differences in experience. Another assumption is that people will be productive during their lifetimes in accordance with the present earning trends and experience.[15,40] The total lost output for each person was calculated and multiplied by the number of smoking-attributable deaths in each age category. Men and women were assumed to receive an equal average monthly pay of R17 834, based on the quarterly employment statistics in May 2016.[24]

Given that the effects of smoking take longer to manifest, we expected smoking to cause few deaths before age 35. Multiple comorbidities can result in death information being unreliable in old age.[29] The South Africa-specific relative risk is available for ages 35 to 74.[29] For these reasons and for comparability with previous studies,[29,33,42] we restricted our analysis to those aged between 35 and 74.

Cost of Lost Output Due to Illness

We assumed that only a portion of those hospitalized or admitted with smoking-attributable conditions were employed full-time. Based on the number of smoking-attributed hospitalizations (admissions) and the average length of stay, the total number of smoking-attributable workdays lost was estimated using the labor force participation and unemployment rates. This gave us the number of smoking-attributed hospitalizations and we then calculated the number of employed persons based on the labor force participation and unemployment rates. Next, the average length of stay was multiplied by the number of employed persons to obtain workdays lost. The daily wage rate, obtained by dividing the average monthly salary by 30, was multiplied by the workdays lost to ascertain the cost of productivity losses due to illness. We make no separate assumptions about the number of workdays for a full-time employed person and the rate of employment of a person with chronic illnesses/disabilities.

Study Limitations

This study is not without its limitations. Although we calculated the smoking-attributable deaths by ethnicity, we are unable to calculate economic costs disaggregated by this sub-category, as healthcare utilization information is not disaggregated by ethnicity. Another limitation is that our study does not consider secondhand smoking, which also poses health risks to nonsmokers and would increase our cost estimates. In addition, because of the unavailability of data on the RR of morbidity, we use the RR of mortality as a proxy in estimating healthcare utilization. The assumption that the RR of mortality equals that of morbidity is overly simplistic.

Finally, the data required to calculate non-medical out-of-pocket expenditures associated with the treatment of SADs is unavailable for South Africa. One such cost would be the cost of care for the ill. Family members often take time off from work to assist with caregiving. Costs associated with this would be salary and productivity losses or transportation and accommodation costs so that family could be close to those that may be hospitalized. Excluding these costs from our analysis will result in an underestimation of the costs of smoking.

Results

Deaths and Years of Life Lost

Overall, we estimated that 25 708 deaths among persons aged 35–74 in 2016 were due to smoking. This represents 10.1% of all deaths among persons in this age group (Table 2). The proportion of deaths attributable to smoking was higher among men (14.2%) than among women (5.4%). SADs constituted 21.6% of Colored deaths, 14.2% of white deaths, 9% of African deaths, and 6.9% of deaths among other ethnic groups (Asians and others). Overall, the resulting years of potential life years lost (YPLL) for these deaths were 365 339 for men and 155 259 for women. Overall, men accounted for 74% of the total smoking-attributed deaths.

Table 2. Deaths by Race and Gender (35–74 Years)

Race/group	Male		Female		Both sexes	
	SA deaths		SA deaths		SA deaths	
	Deaths	Percent	Deaths	Percent	Deaths	Percent
Colored	2211	23.1	1700	19.8	3911	21.55
White	1619	13.3	1665	15.3	3284	14.24
African	13 371	14.2	2713	3.21	16 084	9.00
Asian/Others	1937	10.4	492	2.94	2429	6.87
Total	19 138	14.2	6571	5.44	25 708	10.1

SA = smoking-attributable.

Table 3 summarizes the number of deaths by gender and disease in 2016. Smokers died predominantly from COPD (1778), Tuberculosis (1541), lung cancer (887), and ischemic heart disease (882).

Among men, there were 1 052 019 admissions and 22 million OPD visits in both public and private facilities, of which approximately 13% (138 739 admissions and 2.9 million OPD visits) were attributed to smoking. Among women, there were 1.18 million admissions and 24.7 million OPD visits in both public and private facilities, of which approximately 6% (70 537 admissions and 1.48 million OPD visits) were attributed to smoking.

Workdays Lost Due to Illness

A total of 621 058 workdays were lost due to illness from smoking. Workdays lost were higher among males (461 914) than females (159 144) and skewed towards the younger population within the 35 to 64 age brackets.

Cost of Smoking

The costs associated with smoking are presented in Tables 4 and 5. In 2016, the economic cost to South Africa of smoking, for persons aged 35–74 years, was R42.32 billion (US$2.88 billion). This is equal to 0.97% of the South African GDP in 2016 (Table 4). R14.48 billion of the total economic costs were from healthcare costs, which amount to 4.1% of total South African health spending (Table 4).

The cost of premature deaths, or the cost of future outputs, amounted to R27.5 billion. The value of productivity losses due to illness from smoking was R369 million, of which 74% occurred among men. Higher RR and smoking prevalence resulted in higher smoking-attributed costs among men (R31.8 billion) compared to women (R10.5 billion). The cost per person was estimated to be R1.1 million (US$75 223). Table 5 summarizes the cost attributed to each disease. Overall, COPD, Tuberculosis, lung cancer, and ischemic heart disease imposed significant costs (Table 5). Disaggregation by ethnicity was impossible due to data limitations.

Sensitivity Analyses

Sensitivity analyses were performed by varying the parameters of uncertainty.

- We allowed real output to grow by 1.5% per annum while using a discount rate of 3%. This productivity growth rate is the

Table 3. Smoking Attributed Deaths by Gender and Disease, 2016

Disease (ICD Version 2010)	Male	Female	Both sexes
Tuberculosis (A15–A19)	1136	404	1541
Other forms of heart disease (I30–I52)	570	229	799
Cerebrovascular diseases (I60–I69)	464	212	676
Hypertensive diseases (I10–I15)	448	186	634
Influenza and pneumonia (J09–J18)	514	104	619
Chronic lower respiratory diseases (J40–J47)	1112	666	1778
Ischaemic heart diseases (I20–I25)	442	440	882
Malignant neoplasms of digestive organs (C15–C26)	459	355	814
Malignant neoplasms of respiratory and intrathoracic organs (C30–C39)	478	409	887
All other smoking-related diseases[a]	13 513	3564	17 077
All causes	19 138	6571	25 708

[a]These diseases are those in Groenewald et al.[30] and Sitas et al.[31]

Table 4. Summary of Costs Due to Smoking, 2016

	Healthcare cost			Productivity loss due to illness	Cost of premature deaths	Total cost	Total cost, USD	Total cost, % of GDP	Total healthcare cost, as percent of THE
	OPD	Inpatient	Healthcare cost, total (OPD + inpatient)						
Male	5081	4516	9597	274	21 903	31 774	2160	0.73	2.72
Female	2583	2296	4879	95	5568	10 542	717	0.24	1.38
Total	7664	6812	14 476	369	27 471	42 316	2877	0.97	4.10

All amounts are in South African R (million) unless otherwise stated. US$1 = R14.71. Figures rounded. THE = Total Health Expenditure.

Table 5. Cost Attributed to Each Diseases (Millions)

Disease (ICD version 2010)	SA deaths	Percent of total	Total healthcare	Productivity losses	Premature death	Total cost	Total cost, USD
Tuberculosis (A15–A19)	1541	0.060	868	22	1646	2536	172
Other forms of heart disease (I30–I52)	799	0.031	450	11	854	1315	89
Cerebrovascular diseases (I60–I69)	676	0.026	381	10	723	1113	76
Hypertensive diseases (I10–I15)	634	0.025	357	9	678	1044	71
Influenza and pneumonia (J09–J18)	619	0.024	348	9	661	1018	69
Chronic lower respiratory diseases (J40–J47)	1778	0.069	1001	26	1900	2927	199
Ischaemic heart diseases (I20–I25)	882	0.034	497	13	943	1452	99
Malignant neoplasms of digestive organs (C15–C26)	814	0.032	459	12	870	1340	91
Malignant neoplasms of respiratory and intrathoracic organs (C30–C39)	887	0.034	499	13	948	1460	99
Other smoking-related diseases	17 077	0.664	9616	245	18 248	28 110	1911
All causes/total	25 708	1.000	14 476	369	27 471	42 316	2877

SA = smoking-attributable.
The share of each disease in total SA deaths is used to attribute cost to the disease. Amounts are in million Rands unless otherwise stated. US$1 = 14.71.

average growth rate of South Africa's GDP in the past 5 years. The total cost increases to R49 billion or 1.14% of GDP.

- We assumed that the rate at which smoking contributes to mortality would be the same rate at which it contributes to total healthcare expenditure. For this reason, we applied the SAF of 10.1% to the total health expenditure in 2016 with the same discount rate of 3% and 1.5% productivity growth rate. This brings the total health expenditure due to smoking to R35.5 billion and the cost of premature deaths to R34.6 billion. The total economic cost amounted to R70.48 billion (US$4.79 billion) or 1.6% of GDP. This is closer to the earlier estimate for South Africa.[12]
- We also used the individual's remaining years to retirement to calculate the cost of premature deaths. Applying the same 3% discount rate, 1.5% productivity growth rate, and SAF for healthcare cost (10.1%) brings the total cost of smoking to R56.7 billion (1.31% of GDP). In a scenario where the healthcare cost of R14.48 billion (Table 4) is applied, the total cost of smoking is 0.82% of GDP.
- Using the smoking prevalence in 1998,[30] the number of deaths attributable smoking increases from 25 708 (10.1%) to 30 465 (11.93%). Likewise, the economic cost of smoking increases to R50 billion (1.2% of GDP) under the 1% productivity growth and 3.45% discount rates. Applying a 3% discount rate, 1.5% productivity growth, and the SAF (11.93%) increases the total economic cost to R83.8 billion (1.93% of GDP). The per capita cost of smoking is ~R1.4 million (US$94 683).
- Similarly to Goodchild, Nargis, and d'Espaignet[12] we used GDP per worker, obtained by dividing the 2016 GDP by the total number of employed persons in the 35–64 age group, as the output per head. Discount and productivity growth rates are, respectively, 3% and 1.5%. Again, we apply a SAF of 10.1% (based on 2012 smoking prevalence) to obtain healthcare cost. The economic cost is now R101.8 billion (2.3% of GDP) of which cost of productivity losses from smoking-related illness were R780 million. By using smoking prevalence in 1998, the economic cost increases to 3% of GDP.

The overall economic cost is between 0.82% and 3% of GDP, depending on the assumptions made, while healthcare costs due to smoking amount to between 4.1% and ~12% of total health spending in South Africa.

Discussion

Tobacco is a major contributor to mortality and morbidity in South Africa. In 2016, 25 708 adults died from smoking-related diseases. This represents 10.1% of all adult deaths in the 35- to 74-year age-group in the same year, which corresponds to previous South African estimates.[30,31] The total economic cost of smoking for 2016 was R42.32 billion (US$2.88 billion), or 0.97% of South Africa's 2016 GDP. This estimate reflects the average cost of smoking for adults in the 35–74 age group. By varying the model inputs, such as smoking prevalence, annual output per head (productivity), and the discount and productivity growth rates, we find that the cost ranges from 0.82% to 3% of GDP. The total cost of smoking as a share of GDP is similar to the findings in other low- and middle-income country studies.[15,33]

Previous estimates for South Africa have ranged between R250 million and R1.39 billion during the 1980s (or R6.5 and R10.6 billion in 2016 prices).[18–20] This constitutes between 0.39% and 0.64%

of GDP. These values are arguably not comparable as they consider different age distributions and diseases. More recent estimates of the cost of smoking are US$1.89 billion (0.49% of GDP), when only considering cancer,[21] and PPP$12 billion (US$7.2 billion, 1.8% of GDP)[12] for all causes in 2012. Thus, our upper-bound estimate is substantially larger than any previous estimates of the costs of smoking in South Africa.

The results show that smoking imposes a huge cost on society despite the contribution it makes to tax revenue. In 2016, the total value of the cigarette market in South Africa was R28.3 billion (based on the value of legal sales).[43] This includes taxes levied by the South African Revenue Service (SARS), payments to tobacco leaf farmers, wholesale and retail margins, manufacturer's cost, and profits. Applying cost estimates from Table 4 (ie, R42.32 billion), for every R generated by the cigarette market, there is a cost of R1.5 imposed on society.

In 2016, SARS collected R12.34 billion in cigarette excise taxes.[43] Therefore, for every R that SARS receives in form of cigarette excise tax, society loses R3.43.

Our findings show that of all the SADs, COPD, tuberculosis, cancers, and ischemic heart disease impose the biggest mortality costs. Smoking is responsible for over R14 billion in health expenditure, or 4.1% of overall health expenditure in South Africa (Table 4). In other low- and middle-income countries, such as Uganda and Vietnam, 2.3% and 4.3% of total healthcare expenditure, respectively, are due to smoking.[15,44] Our estimates also compare closely with the smoking-attributed healthcare expenditure in Australia, Hong Kong, China, and India,[12,33,42,45] and are slightly higher than the shares reported in certain high-income countries such as Canada, Israel, Sweden, and Switzerland.[12,46] Given that the public health system in South Africa serves approximately 70% of all patients, government bears a significant portion of these costs, owing to the subsidized care in the public sector.

Despite the decline in smoking prevalence in South Africa, smoking still has substantial consequences for the economy. One potential reason for this is that the health consequences of smoking take longer to manifest. The significant change in the SAF and the associated deaths and cost, after applying smoking prevalence for at least a decade prior to death, shows that reducing smoking prevalence is key to reducing future smoking-related deaths and costs. Another potential contributor to a larger impact of smoking over time is rising healthcare costs in South Africa.

The findings call for proactive measures to combat smoking. The most cost-effective measure to decrease smoking rates is to increase tobacco excise taxes. Higher taxes result in higher prices, thereby reducing the affordability, and consequently consumption, of tobacco.[3] A percentage of excise revenue from tobacco may be earmarked for smoking cessation and other public health interventions to help current smokers quit. Such taxes may also help smokers obtain healthcare for any smoking-induced disease they may be suffering from.

Supplementary Material

A Contributorship Form detailing each author's specific involvement with this content, as well as any supplementary data, are available online at https://academic.oup.com/ntr.

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Declaration of Interests

None declared.

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