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The economic burden of smoking in Belgium: incremental healthcare costs and lost productivity

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Abstract

Tobacco use is among the leading behavioural risk factors for morbidity and mortality. These high rates result in a high cost to society. Therefore, the aim of the current study was to provide a contemporary overview of the direct medical and indirect costs attributable to smoking tobacco in Belgium. Data from the Belgian Health Interview Survey (BHIS) was combined with health insurance claims data. Healthcare costs were calculated on individuals' cigarette smoking patterns (daily, former, and never smokers). Lost productivity costs were calculated by multiplying the number of absence days by the national average wage cost per day. Univariate and multivariable regression analyses with negative binomial distribution and log link were performed to evaluate the average healthcare costs and indirect costs in relation to tobacco use, socio-demographic characteristics, and (behavioural) risk factors. A total of 10 829 individuals were included in the analyses, of which 47.7% were men, with 15% being smokers. Men were more likely to be smokers than women (56.8% vs. 43.2%; $P < 0.001$). Compared to never smokers, significantly higher direct medical costs were found for daily (20%; $P = 0.03$) and former smokers (27%; $P < 0.001$). No significant differences were observed for the indirect costs for the smoking population compared to never smokers. Taking into account that 15% of the Belgian population were daily smokers in 2018, the national cost for daily smokers equates to €533.861.010. Results of our study show that cigarette smoking has higher direct medical costs compared with never smokers.

Introduction

Tobacco use is prevalent worldwide and is part of many cultural and social practices [1]. In 2020, 22% of the global population used tobacco (37% men vs. 8% women) [2]. It is among the leading risk factors contributing to preventable mortality and morbidity [1]. Recent data suggests that tobacco use accounts for 14% of all deaths and 8% of all disability-adjusted life-years (DALYs) worldwide [3]. In Belgium, despite a 40% decrease in the number of daily smokers since 1997, the prevalence of tobacco use remains high [4, 5]. In 2018, 19% of the population over the age of 15 years smoked (15% daily smokers and 4% occasional smokers) [5, 6]. Previous research indicated that these high rates of tobacco use result in a high cost to the Belgian society [7]. In 2016, the societal cost of smoking was estimated at €1.5 billion [8]. The direct costs related to tobacco use and the proximate effect (i.e. hospitalization, ambulatory costs) amounted to €727 million, and the indirect costs related to productivity losses amounted to €476 million [9]. Despite this considerable impact, however, there is no systematic monitoring of the societal burden attributed to tobacco use in Belgium to date.

Therefore, the current study aims to provide a contemporary overview of the direct and indirect costs attributable to smoking tobacco in Belgium. This manuscript is part of the SUBOD (improved monitoring of the disease burden attributable to substance use) and facilitates an improved and routine monitoring of the burden and the cost of substance use [10].

Methods

Data sources

To calculate direct and indirect costs related to tobacco use, data from the HISLINK database was used, which links the Belgian Health Interview Survey (BHIS) to health insurance data from the InterMutualistic Agency (IMA) (i.e. HISLINK database).

The BHIS is a nationally representative cross-sectional survey aimed to provide an overview of the health status, including self-reported data on socio-demographics, health status, lifestyle, risk factors, health, and social care of a representative sample of the general population in Belgium ($N = 10\,829$). The survey began in 1997 with a wave approximately every 5 years with the most recent published wave in 2018. Detailed information on the BHIS has been reported elsewhere [11]. The IMA database includes information on reimbursed health care and medication for the population covered by the compulsory health insurance (about 99% of the total population in Belgium). The IMA database comprises reimbursed total health care costs for every payment modality (directly paid by the health insurance, patients out-of-pocket, and supplements). These expenditures include (1) ambulatory care (over-the-counter pharmaceuticals excluded), (2) hospital care, and (3) reimbursed medicines purchased through pharmacies [12]. Information on reimbursed healthcare costs was available from 2018 to 2020 for all HIS participants. Healthcare costs include hospital care,

ambulatory care (including pharmaceuticals), and reimbursed medicines purchased through public pharmacies. The linkage of the data from the two databases occurred through the national registry numbers.

Variables and definitions

Direct medical costs

Healthcare costs were calculated based on individual smoking patterns. Smoking was defined as self-reported cigarette smoking and was divided into four categories: never smoker, former smoker, occasional smoker, and daily smoker. Based on the following questions, 'Have you ever tried a whole cigarette', 'Have you ever smoked ≥100 items in your lifetime', 'What is your current smoking status (i.e. every day, occasionally, no)', participants were categorized as daily smokers, occasional smokers, former smokers (i.e. persons who have smoked at least 100 cigarettes in their lifetime but do not currently smoke), and non-smokers (or smoked fewer than 100 cigarettes in their lifetime). Socio-demographic characteristics included age (continuous), gender, educational level, region, and reimbursement status. The educational level was divided into four categories: no diploma or primary education, lower secondary education, higher secondary education, and higher education. Reimbursement status was divided into two categories: no preferential reimbursement and preferential reimbursement. In Belgium, regulations regarding reimbursement policy apply automatically in some cases (i.e. living wage), and in some cases, it is necessary to apply to health insurance funds [13]. Moreover, the geographical region was separated into Flemish Region, Walloon Region, and Brussels Capital Region. The analysis also included the use of alcohol as behavioural risk factor with respect to smoking status. The use of alcohol was defined as self-reported use of alcohol in the past 12 months taken also from the BHIS.

Indirect costs

Indirect costs (i.e. cost of absenteeism) were calculated by multiplying the number of absence days by the national average wage cost per day [14]. Using data from 2018, the average Belgian labour cost per day was estimated at €293.36 [14]. The total days absent from work were subtracted from the maximum number of working days per year (i.e. 253 days in 2018). Days absent from work were reported in the BHIS as follows: 'Have you been absent from work during the past 12 months due to health problems? In doing so, take into account any conditions, injuries, or other health problems you may have had which resulted in an absence from work'. The latter was followed by the question, 'How many days in total have you been absent from work for the past 12 months due to health problems? If you are unable to indicate this number of days correctly, please give an estimate.'

Statistical analysis

Descriptive statistics, respectively *t*-test and chi-square test, were used, stratified by smoking behaviour, to describe individuals' characteristics and medical costs. Univariate and multivariable regression analyses with negative binomial distribution and log link were performed to evaluate the average healthcare costs and indirect costs in relation to smoking status, socio-demographic characteristics, and (behavioural) risk factors. The univariate model shows the unadjusted incremental healthcare costs related to smoking status. A total of three regression models were performed, each adjusting for relevant demographic characteristics. The final regression model includes socio-demographic characteristics and lifestyle factors such as age, gender, educational level, region, reimbursement status, and alcohol use to evaluate the adjusted incremental healthcare costs. A previous manuscript of our research group was based as inspiration for the methods [15].

To quantify healthcare costs and indirect costs attributable to smoking, incremental costs at individual level were calculated using the G-computation method (i.e. direct standardization, the method of recycled predictions). This approach facilitated the determination of individual-level incremental costs, taking into account subjects' smoking behaviour, and assessing the additional cost incurred due to smoking compared to a scenario where they did not smoke. To calculate the incremental costs linked to smoking, regression model coefficients were utilized to predict healthcare expenditures, assuming all participants were never smokers, while maintaining all other characteristics constant. Subsequently, individual incremental costs of smoking were computed as the difference between predicted costs for individuals assuming they were (former) smokers versus never smokers.

In order to jointly reflect prediction and survey uncertainty, a bootstrapping procedure was performed to compute means and confidence intervals (CIs) by smoking categories. The association between healthcare costs and smoking was expressed as rate ratios and their 95% CIs. The threshold indicating statistical significance was set at $P < 0.05$. All statistical analyses were performed in RStudio software (2023.03.0) [16].

To calculate healthcare costs at population level, the incremental direct costs were multiplied by the number of individuals in Belgium who smoked daily in 2018 [17]. According to data from 2018, 15% of the Belgian population smokes [4]. Total indirect costs were calculated by multiplying the individual incremental costs by the number of individuals that smoke in the total population with a paid job according to the BHIS2018.

Results

Demographic characteristics

Data from 10 829 individuals was available, of which 47.7% were men. A total of 4171 (57%) individuals reported that they never smoked, while 1131 (15%) individuals reported they were daily smokers. On average, never smokers were slightly older than smokers (49 years vs. 48 years, respectively; $P < 0.001$). Men were more likely to be daily smokers (56.8% vs. 43.2%); $P < 0.001$), occasional smokers (57% vs. 43%; $P < 0.001$), or former smokers (59% vs. 42%; $P < 0.001$) than women. Moreover, daily smokers and former smokers were more likely to have a lower educational attainment compared to never smokers. In addition, the highest smoking rates were found for the Walloon Region (41%; $P < 0.001$), while the Brussels Capital Region reported the lowest smoking rates (23%; $P < 0.001$). A detailed overview of the demographic characteristics is presented in Table 1.

Direct medical costs

Table 2 provides an overview of the average yearly healthcare costs per individual (reference period 2018–2020). The mean total healthcare cost was estimated at €2320 (4940) per capita (mean (SD)). The ambulatory costs (78%) were responsible for the largest share of the total costs, followed by hospital costs (19%). Stratified per smoking category, our results indicated that the highest costs were found for former smokers and daily smokers (€3239 and €2279 per capita per year, respectively).

Supplementary Table S1 describes the unadjusted healthcare costs in relation to individuals' smoking behaviour. The unadjusted incremental cost did not significantly differ in never smokers vs. daily smokers ($P = 0.42$) and never smokers vs. occasional smokers ($P = 0.47$). However, the average yearly healthcare costs were significantly higher for former smokers compared with never smokers (46%; $P < 0.001$), with a mean incremental cost of €972.20.

Table 3 presents the average incremental cost per individual evaluating the impact of socio-demographic characteristics on annual healthcare expenditures. In contrast with the unadjusted costs, a significant higher cost was found for both daily smokers and former

Table 1. Socio-demographic characteristics

	Total sample	Non-smoking	Daily smokers	Occasional smoker	Former smoker	*P*-value
Total (*N*)	*N* = 10 829	*N* = 4171	*N* = 1131	*N* = 301	*N* = 1722	
Age, mean (SD)	43.2 (23.8)	49.4 (19.8)	47.5 (15.4)	43.8 (16.3)	57.7 (15.8)	<0.001
Gender, % (*n*)						<0.001
Men	47.7% (5165)	39.4% (1644)	56.8% (642)	56.8% (171)	58.5% (1007)	
Women	52.3% (5664)	60.6% (2527)	43.2% (489)	43.2% (130)	41.5% (715)	
Household education, % (*n*)						<0.001
No diploma or primary education	7.1% (772)	6.31% (263)	5.92% (67)	3.99% (12)	5.92% (102)	
Lower secondary	12.7% (1375)	11.0% (458)	18.0% (204)	6.64% (20)	13.9% (239)	
Higher secondary	29.9% (3243)	28.3% (1179)	40.1% (454)	24.9% (75)	30.1% (518)	
Higher education	48.6% (5264)	53.0% (2209)	33.7% (381)	61.8% (186)	48.6% (837)	
Alcohol use						<0.001
No alcohol past 12 months	16.6% (1802)	29.5% (1229)	21.8% (246)	7.97% (24)	15.2% (262)	
Alcohol use past 12 months	51.3% (5558)	69.5% (2900)	77.1% (872)	91.7% (276)	83.9% (1444)	
Major coverage—2018						0.54
No preferential reimbursement	79.2% (8579)	82.4% (3438)	75.3% (852)	86.4% (260)	86.8% (1494)	
Preferential reimbursement	20.6% (2232)	17.5% (728)	24.4% (276)	13.6% (41)	13.0% (224)	
Region						<0.001
Flemish Region	38.9% (4208)	42.2% (1761)	35.9% (406)	40.9% (123)	47.8% (823)	
Brussels Capital Region	26.2% (2835)	22.4% (933)	23.2% (262)	32.6% (98)	19.6% (337)	
Walloon Region	35.0% (3786)	35.4% (1477)	40.9% (463)	26.6% (80)	32.6% (562)	

Table 2. Mean annual healthcare costs (in euros)

	Total sample	Non-smoking	Daily smokers	Occasional smokers	Former smokers	*P*-value
Total (*N*)	*N* = 10 829	*N* = 4171	*N* = 1131	*N* = 301	*N* = 1722	
Ambulatory costs	1800	1769	1798	1672	2439	<0.001
Hospital costs	442	426	535	351	685	<0.001
Not specified costs	180	185	87.6	32.0	208	0.26
Unknown costs	81.0	84.1	73.9	52.2	115	0.004
Total healthcare costs (mean)	2320	2279	2407	2075	3239	<0.001

smokers (i.e. 20% and 27%, $P < 0.05$). When looking at the most complete model (i.e. Model 3), a higher cost was found for daily (21%; $P = 0.02$) and former smokers (26%; $P < 0.001$) compared with never smokers. The adjusted mean attributable cost for daily smokers and former smokers was estimated at €311.38 and €500.61, respectively. Taking into account that 15% of the Belgian population were daily smokers in 2018, the national cost for daily smokers equates to €533.861.010.

Indirect costs—cost of absenteeism

No significant differences ($P > 0.05$) were observed for the cost of absenteeism for the smoking population compared with never smokers (Supplementary Table S2). However, the adjusted analyses indicated a borderline significant result (i.e. Model 3) in disfavour of former smokers compared with never smokers (39%, $P = 0.07$). This equates with an adjusted incremental cost of absenteeism of €1198.58 per capita. A detailed overview of the adjusted incremental cost of absenteeism is provided in Table 4.

Discussion

The present study shows the economic impact, including direct and indirect costs of smoking in Belgium. The yearly healthcare costs were estimated at a mean incremental cost of €972.20, in disfavour of daily smokers, which equates to a national cost of €533.861.010. There are substantial differences in healthcare costs between subjects who smoke or were former smokers, and those who report they never smoked. Overall, our study confirms previous evidence showing that healthcare costs attributable to smoking are higher for daily and former smokers (20% and 27%, respectively). The higher costs of former smokers can possibly be explained by the long-term consequences of smoking [18]. In contrast with previous literature [19, 20], no significant differences were found for indirect costs (i.e. cost of absenteeism) in smokers compared with never smokers. A possible explanation could be that health problems related to smoking mostly occur at later age, possibly after people have already retired [21], hence on average smoking has a lower impact on absence from work. However, since the questionnaire was self-reported, recall bias and social desirability bias should be taken into account. The actual number of workdays lost, and therefore the actual productivity losses, may potentially be higher than reported during the interview. With regard to direct smoking-related healthcare costs, our study confirmed the findings of previous evidence, indicating a higher healthcare cost in smokers [22–25]. According to a recent report from the WHO, smoking-related healthcare costs and productivity losses are estimated at more than US$1.4 trillion globally [22]. As reported in our study, smoking-related costs are high. The high smoking-related costs are also seen by previous evidence, indicating that smoking-related costs range from 1.2% to 8.9% of the total healthcare costs in the European Region [22]. These findings were confirmed by the systematic review of Barrio *et al.*, indicating that the total smoking-related costs are estimated at €10.55–€391 per capita [24].

The findings of our study provide valuable information on the societal impact of smoking and are important from a health policy perspective, to reduce the prevalence of smoking in Belgium. Employing a global perspective, our research presents a holistic understanding of the contemporary challenges surrounding the economic impact of smoking within the Belgian population. Nevertheless, while this broad methodology allows for a comprehensive overview, it may inadvertently obscure the precise delineation of individual cost categories and their respective influences.

Table 3. Adjusted incremental healthcare costs related to smoking behaviour

	RR[a]	Standard error	*P*-value	95% CI	Attributable cost
Model 1					
Never smoked (reference)	1	-	-	-	-
Daily smoker	1.24	0.08	0.006	1.06–1.44	444.43
Occasional smoker	1.17	0.13	0.26	0.90–1.52	275.73
Former smoker	1.21	0.06	0.004	1.06–1.38	529.91
Model 2					
Never smoked (reference)	1	-	-	-	-
Daily smoker	1.18	0.08	0.03	1.01–1.38	364.18
Occasional smoker	1.19	0.13	0.18	0.92–1.52	305.54
Former smoker	1.20	0.06	0.002	1.07–1.37	517.82
Model 3					
Never smoked (reference)	1	-	-	-	-
Daily smoker	1.20	0.08	0.03	1.02–1.41	393.50
Occasional smoker	1.27	0.13	0.07	0.98–1.63	412.85
Former smoker	1.27	0.06	<0.001	1.13–1.43	647.73

a: Rate ratio; expected value of the coefficient with never smoked as reference.
Model 1: adjusted for age and gender.
Model 2: adjusted for age, gender, educational level, and preferential reimbursement.
Model 3: adjusted for age, gender, educational level, region, preferential reimbursement, and alcohol use.

Table 4. Adjusted lost productivity costs related to smoking behaviour

	RR[a]	Standard error	*P*-value	95% CI	Attributable cost[b]
Model 1					
Never smoked (reference)	1	-	-	-	-
Daily smoker	1.41	0.18	0.06	0.99–2.01	1218.83
Occasional smoker	1.12	0.23	0.61	0.72–1.75	321.52
Former smoker	1.27	0.17	0.17	0.90–1.79	930.94
Model 2					
Never smoked (reference)	1	-	-	-	-
Daily smoker	1.33	0.17	0.11	0.94–1.87	1030.89
Occasional smoker	1.04	0.23	0.87	0.67–1.62	86.26
Former smoker	1.26	0.17	0.18	0.90–1.77	910.59
Model 3					
Never smoked (reference)	1	-	-	-	-
Daily smoker	1.35	0.18	0.10	0.95–1.92	1090.66
Occasional smoker	1.14	0.23	0.57	0.73–1.77	355.16
Former smoker	1.37	0.18	0.07	0.97–1.93	1196.39

a: Rate ratio; expected value of the coefficient with never smoked as reference.
b: Based on days of work missed due to illness.
Model 1: adjusted for age and gender.
Model 2: adjusted for age, gender, educational level, and preferential reimbursement.
Model 3: adjusted for age, gender, educational level, preferential reimbursement, region, and alcohol use.

Hence, further research should adopt a more focused 'cost of illness' approach to furnish a nuanced analysis of both direct and indirect costs associated with smoking [26]. The integration of both broad and granular approaches is imperative for the formulation of effective smoking control strategies.

Evidence-based interventions such as tobacco taxation, smoke-free policies, inter-federal strategy for a smoke-free generation, and public awareness campaigns have been shown to be effective to reduce the tobacco consumption [27–30]. Also, further actions should be taken to reduce other forms of smoking such as e-cigarettes [31]. Moreover, the investment in smoking cessation and interventions to reduce smoking, have proven to be cost-effective and result in long-term savings by preventing smoking-related diseases, improving the overall health, and consequently reducing healthcare costs. A Canadian study evaluated the effect of policy implementations to reduce the use of tobacco in Canada [32]. They evaluated the cost and benefits of the strategies (e.g. lower healthcare costs, productivity losses, etc.) and calculated a return on investment for the government perspective and societal perspective of $19.8 and $21.9 per dollar invested, respectively [32]. These results were confirmed by the study of Leão *et al.*, evaluating tobacco control policies in seven European countries [23]. The results of this study also show that policy decisions to reduce smoking are highly cost-effective in all countries [23]. The latter results address the need for a multi-sectoral approach, involving governments, healthcare providers, and the society. Therefore, several policy recommendations recommend smoking cessation to prevent smoking [4, 33]. In 2022, 43% of the Belgian smokers had the intention to stop smoking, and 27.6% actually took action to quit smoking [33]. This highlights the importance of awareness campaigns and education to encourage smoking cessation [33].

Strengths and limitations

A major strength of this study is the use of a representative sample of the population in Belgium to estimate the costs related to smoking. Therefore, we believe that this study provides reliable information about the cost of smoking in Belgium. Although our study

provides a contemporary overview of smoking in Belgium and the related costs, some limitations should be taken into account. Data in this study is based on self-reported questionnaires and interviews. Self-reported smoking does not necessarily reflect true smoking status. Therefore, non-responders or non-participants may have an even worse lifestyle, which could lead to an underestimation of the actual healthcare costs. This may also be reflected in the large number of missing values on smoking-related questions. However, missingness in our database is mainly due to auto-questionnaire non-response and should not affect the generalizability of the found association between costs and smoking behaviour. Also, no information is available about the frequency of smoking tobacco in the group of former smokers, thus precluding any data on smoking frequency. In addition, no data on second-hand smoke was included in the analysis. Therefore, further research should have a specific focus on costs related to second-hand smoking. Another shortcoming of the current strategy is that costs associated with smoking-attributable premature mortality were not included, which may also lead to an underestimation of the actual costs.

Conclusions

Based on the results of this study, smoking has a substantial impact on direct medical costs in the Belgian society. However, no significant differences were found for productivity losses. Nevertheless, this study demonstrated the urgent need for active monitoring of smoking and the implementation of adequate interventions to reduce smoking in Belgium, which will lead to a decrease in smoking-related healthcare costs.

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Supplementary data

Supplementary data are available at *EURPUB* online.

Conflict of interest: There are no conflict of interests.

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Key points

- Smoking has a substantial impact on medical costs.
- No significant differences were found for productivity losses.
- There is an urgent need for active monitoring of smoking.
- The implementation of adequate interventions to reduce smoking in Belgium is crucial.

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