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**RESEARCH ARTICLE**

# SMOKING AND CORONARY HEART DISEASE IN MOROCCO: EXTENT OF THE BURDEN ON SOCIETY

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**ABSTRACT**

Smoking is an essential factor in coronary heart disease. In 2018, the total cost of coronary heart disease attributable to smoking at Cardiology B level in Rabat, Morocco was estimated at 2,446,402 MAD. Indirect costs accounted for 51% of total costs. More than 69% of direct medical costs are attributable to invasive treatment during hospitalization. The magnitude of the estimated cost highlights the urgent need for Morocco to implement comprehensive tobacco control measures to address these costs.



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# INTRODUCTION

According to WHO estimates from 2018, tobacco kills more than 7 million people every year. More than six million of them are smokers or former smokers and around 890,000 are non-smokers involuntarily exposed to smoke. In addition to mortality, smoking also causes preventable diseases such as cancers and cardiovascular diseases, poor health and disabilities (WHO, 2011). In 2015, the global prevalence of smokers was estimated at 1.1 billion, 80% of whom were in developing countries. One out of two regular smokers dies from theconsequences of tobacco and 5,000 people are victims of passive smoking each year (WHO, 2017). Inhaling tobacco smoke exposes you to more than 7,000 toxic substances and more than 70 carcinogens that damage the whole body (Cahn, W., Z., *et al* 2018). Scientific evidence has accumulated on the causal relationship between smoking and health effects: first cancers of the lung, mouth, trachea, then cardiovascular diseases (Obtel *et al* 2015; Tachfouti, 2014). In Morocco, according to the national survey on common risk factors for non-*communicable* diseases in 2018, the prevalence of smoked tobacco is 11.7% for the entire population, including 23.4% of men and 0, 3% of women (Obtel, 2015). Tobacco is also responsible for 46.4% of deaths from ischemic heart disease for the age group between 35-64 years and 15.6% for an age ÿ 65 years (Obtel *et al*., 2015; Tachfouti, 2014). In economic terms, smokingabsorbs about 6% of global health expenditure, as well as 2% of Gross Domestic Product (Bienvault *et al*, 2015). In France, for example, the health and social cost is estimated at 120 billion euros and 16,371 million dirhams to the Moroccan economy (Cahn *et al* ., 2018). This study is an advocacy with the aim of ensuring intersectoral coordination, social and community mobilization as well as the promotion of national plans for the prevention and control of non-communicable diseases to make public spaces tobacco-free. And this by the implementation of law 15-91 relating to the prohibition of smoking and of advertising and propaganda in favor of tobacco (MS, 2019). Its results allow the Ministry of Health to have an estimate of the cost of cardiovascular diseases, in particular coronary heart disease in smokers who have been treated in thecardiology department B of CHUIS Rabat for the year 2018.

# METHODOLOGY

The study is retrospective and aims to study the medical records of patients who smoke, hospitalized for a coronary pathology at the cardiology department B during the year 2018. The target population consists of 81 patients hospitalized for this pathology in 2018 in this service. The data collected was processed using SPSS software. The right to anonymity and confidentiality of the data was respected: the identities of the patients were in no way linked tothe data collected and the consultation of the files of the 81 patients was done on site to guarantee total discretion. The estimated cost includes the direct (financial) cost incurred for one year (hospitalization and drugs) and the indirect (economic) cost representing the value of lost production in the current year and future years due to illness and death. The direct and indirect costs are then added together to obtain the overall cost of illness which will be expressed in international dollars using the 2018 International Monetary Fund purchasing power parity exchange rates, in order to facilitate the comparison of the results with those of other countries in the discussion section.

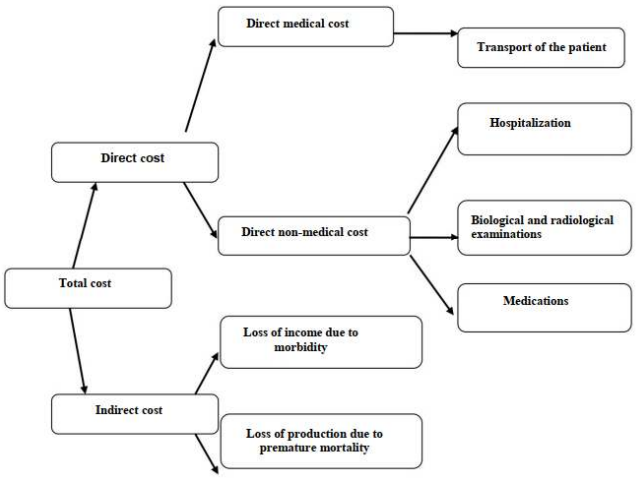


**Figure 1. Conceptual framework of the method of calculating the cost of illness**

For more precision and to have more reliable results, we opted for the SAMMEC (Smoking- Attributable Mortality, Morbidity and Economic Cost) model, an application designed by the Center for Disease Control and Prevention (CDC) to assess the overall impact of diseases caused by tobacco. The principle of this method is based on the calculation of the fraction attributable to smoking (FAT), which is the proportion of tobacco-related deaths among all deaths due to a disease. Therefore, the calculated costs are multiplied by this fraction. In Morocco, among men, the FAT is 0.464 for ischemic heart disease for the age group between 35 and 64 years and 0.156 for an age ÿ65 years (Obtel *et al* ., 2015

**Estimate of direct costs:** For each patient, the direct cost of the disease (CDM) includes the costs of the medical consultation (CC), the biological and radiological examinations (CE) and the drugs (CM) according to the formula:

CDM = CC+CE+CM

The diagnosis of coronary artery disease is based on the clinical examination of the patient, the performance of medical biology examinations and additional cardiac exploration examinations. These are divided into two groups: non-invasive examinations consisting of chest X-ray, resting electrocardiogram (ECG) and transthoracic echocardiography (TTE) and invasive examinations based mainly on coronary angiography which allows visualization of the coronary arteries.

The direct cost also includes a non-medical part (CDNM) such as patient transport.

CD = (CDM + CDNM) *FAT

**Estimate of indirect costs:** The indirect cost of the disease represents the costs generated following the loss of Production linked to early mortality and the costs linked to the loss of income due to the disease (Serrier, 2011; Goodchild *et al* ., 2016).
To estimate the indirect cost related to mortality, only deaths that occurred in 2018 are taken Into account.They entail costs beyond the year 2018 since the individual, if he had not died, would continue to participate in the production. Discounting techniques are then used to estimate the value in 2018 of mortality costs (Tachfouti, 2014). Most often, due to a lack of knowledge on added value, production losses are estimated by the wage, it is therefore accepted to take into account the daily wage to estimate the importance of production losses (Castiel, 2004).

**Indirect cost related to premature mortality:** Production losses linked to premature mortality were estimated using the human capital approach which is based on the expected gains remaining for the individual life, with the discount rate of 3% to convert all future gains to their current value. The indirect cost related to mortality is therefore estimated using the following method:

$V0 = \Sigma Vn\ (1+i)^{-n} * FAT$
With:

V0: Present value

Vn: Predicted Value
i:Discount rate
n= Number of years of life lost = Life expectancy at birth – age at death.

**Indirect cost related to loss of income due to morbidity:** We drew inspiration here from the approach proposed by Guiguemendé *et al* . (2003) for estimatingthe economic cost of dracunculiasis by applying the following formula:

CI = ÿ [(Ri x Pi) /100] x FAT
With :

Ri = Average annual economic income of the active equivalent in the profession determined for each patient according to his professional activity;

FAT: Attributable fraction related to tobacco which corresponds to 0.464 for ischemic heart disease for the age group between 35-64 years and 0.156 for an age ÿ 65 years.

Pi = Percentage of loss of income in the profession which corresponds to the percentage of loss of activity during the production period. It is the result of the ratio between the total number of days of disability and the duration of the period of activity producing the annual income, reduced to 100, for a given patient as indicated by the following formula:

Pi = (DI/DA) x 100
DI= Number of hospital days
DA=Duration of the period of professional activity

**Estimate of direct costs:** For each patient, the direct cost of the disease (CDM) includes the costs of the medical consultation (CC), the biological and radiological examinations (CE) and the drugs (CM) according to the formula:

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# RESULTS

**Patient identification:** The total number of patients hospitalized in cardiology department B during the year 2018 is 771 patients. Among them, 11% are male smokers with coronary artery disease. There are no women smokers hospitalized with coronary artery disease. These patients were on average 52 years old, came from the Rabat Salé Kenitra region in 83% ofcases and were without professional activity in 13% of cases. More than half benefited from the Medical Assistance Scheme for the Economically Deprived (RAMED), while 33% had no medicalcoverage.

**Direct Cost Estimate:** The estimated total direct cost of coronary heart disease attributable to smoking was 1,202,107 MAD, or 124,628 US$, which corresponded to 14,840 MAD per patient, or 1,538 US$ per patient. This cost included the cost of hospital days, medical consultations, examinations, treatments and a small part of the direct non-medical costs relating to patient transport. These results show that more than 69% of direct medical costs are attributable to invasive treatment during hospitalization, 50% of which is represented by active stent angioplasty, representing a cost of 640,212 MAD (66,373 US $). Furthermore, the various examinations carried out and hospitalization represented only 29% of the direct medical cost.

**Indirect Cost Estimate:** The indirect cost concerned four people and varied according to the mode of insurance cover and the profession exercised between 24,000 and 675,952 MAD (Table 2).

**Total Cost Estimate:** The total cost (direct and indirect included) of coronary heart disease attributable to smoking at the cardiology department B of the Rabat hospital in Morocco for the year 2018, was estimated at approximately 2,446,402 MAD (253,631US $) with a median per patient of 10,707 ($1,110).The economic indirect cost is not negligible since it represented a little more than half (51%) of the total cost.

**Table 1: Identification of smoking patients with coronary artery disease**

| Total number of hospitalized patients | Effective |
|---|---|
| Number of male patients with heart disease | 394 |
| Number of male smokers with heart disease | 165 |
| Number of men smokers with coronary heart disease | 81 |
| Number of female smokers with coronary artery disease | 0 |
| Total patients | 771 |

Source: Calculation of authors

| Age | Profession Mode of | Blanket | Average annual economic ncome | Factor discount | FAT | CI related to mortality premature |
|---|---|---|---|---|---|---|
| 42 | Marchand | Paying | 42.000 | 0.37 | 0.464 | 422.538 |
| 39 | Employee | CNSS | 46.344 | 0.33 | | 266.524 |
| 60 | Official | CNOPS | 146.100 | 0.62 | | 675.952 |
| 52 | No ocupation | RAMED | 4.4500 | 0.49 | | 24.378 |
| Total | | | | | | 1.2.9.390 |

Source: Autors' calculation

**Table 3: Cost of smoking-related cardiovascular diseases (MAD)**

| | CDM | Transport | CD | C.Morb | C.Death | CI | CT |
|---|---|---|---|---|---|---|---|
| Average | 14.787 | 53 | | | | | |
| Median | 7.897 | | | | | | |
| Standard | 727a | | | | | | |
| deviation | 14.552 | | | | | | |
| Minimum | 727 | | | | | | |
| Max | 69.918 | | | | | | |
| Sum | 1.197.794 | | | | | | |
| 25 percentiles | 3.264 | | | | | | |
| 50 percentiles | 7.897 | | | | | | |
| Percentiles 75 | 25.742 | | | | | | |

Notes: CDM: Direct Medical Cost; DC: Direct cost; C.Morb: Morbidity cost; C.Mort: Mortality cost; CI: Indirectcost; TC: Total Cost

# DISCUSSION

Our study has some limitations that deserve to be mentioned first. We limited our calculations to active smoking, thus excluding the cost of passive smoking. However, it has been noted that 41% of the Moroccan population is exposed to passive smoking, thus constituting with active smoking, the main cause of cardiovascular diseases. Our study was conducted on an annual basis, which is insufficient in view of a chronic disease that sometimes requires multiple hospitalizations. At the same time, costs related to outpatient care and hospitalizations in private clinics, resulting in higher expenditure compared to the public sector, were not taken into account. Finally, the use of the human capital method to estimate production losses is likely to constitute certain limitations inherent in the method. It calculates the economic loss only for "economically active" people and assuming that they are not replaced,which is very unlikely. In a 2012 study of the overall cost of ischemic heart disease worldwide, the direct costs werearound $65 billion, which was 60% of the total cost compared to $43 billion (40%) for the indirect costs (Emamgholipour *et al* ., 2018). Health care related to cardiovascular diseases in general and coronary heart disease in particular represented by far the largest share of health care expenditure. Their coverage is linked to significant expenditure within the consumption of medical goods and services. This explains the 1538 US$ relating to the cost of care per patient for coronary heart disease attributable to smoking. This expenditure represented eight times the total health expenditure per capita in Morocco, which was US$188, according to the latest national health accountsof 2015. In the majority of studies evaluating the burden of cardiovascular disease, direct hospital medical costs were the largest category, accounting for 50–66% of total direct costs (Liu *et al .,* 2002; Leal *et al* . ., 2006). These results agree with the results found in our study, although the latter does not deal with ambulatory costs since the collection of data was done retrospectively, from the files of hospitalized patients. The loss of production attributable to tobacco was a significant loss. A study conducted in Thailand on the economic burden of smoking-related diseases found that indirect costs account for 83% of total estimated costs. This difference with our results is probably due to differences in the approaches used to estimate the total cost.

The approach developed in Thailand was based on estimating the cost at the national level, while our study only concerned a hospital service (Bundhamcharoen *et al .,* 2016). The estimated total indirect cost of coronary heart disease was US$129,002, the majority of which is attributable to premature mortality. This result is consistent with the results of other studies on the economic cost of cardiovascular diseases where the cost attributable to mortality represented 67% of the indirect cost in Iran, 70% in the EU or 90.63% in Latvia (Leal *et al . ,* 2006). Studies conducted in the UK, Canada, Finland and Mexico are also quite similar to our study. The results showed that the highest share was attributable to indirect costs (Leal *et al .,* 2006). Our study also shows that the highest indirect costs occur in the under-65 age group. This result is consistent with that of a study conducted in the United Kingdom (Scholz *et al* .,2019) and is explained by a greater loss of future output due to a greater number of years of active life lost due to premature mortality.

**Conclusion**

Our study presents important additional elements to prepare an advocacy with political decision- makers in order to set up a tobacco control strategy based on a prevention policy, more adapted to the epidemiological situation of Morocco and able to save an enormous burden. in the country. By estimating the annual expenditure to provide health care services to patients suffering from preventable tobacco-related diseases, decision-makers will better appreciate the importance of the expenditure while these costs could be avoided and the corresponding sums used for other non- preventable diseases (cancers).

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