The lifetime health care costs of unhealthy behaviour

From a health insurer perspective

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Foreword

This thesis is my final paper of the study Master Health Economics, Policy & Law (HEPL). The paper concerns the question whether effective prevention of unhealthy behaviour leads to lower health care costs for a health insurer. I have written this thesis during my internship at the National Institute for Public health and the Environment (RIVM). During the period I have been well supported and advised by many. I would especially like to thank my supervisor Werner B.F. Brouwer, associate professor of health economics at the Department of Health Policy & Management of the Erasmus University Rotterdam and my supervisor of my internship Pieter H.M. van Baal, researcher at Centre for Prevention and Health Services Research (PZO) of the National Institute for Public Health and the Environment for their supervision and critical suggestions. Besides, I would thank my family, friends and Chie-Yong for their help and support.

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Abstract

Unhealthy behaviour, such as smoking and physical inactivity, or high calorie intake (which leads to obesity) has high priority in the prevention policy of the Dutch Ministry of Health, Welfare and Sport. Smoking and obesity are risk factors, which result in mortality, morbidity and health consumption. Thus, prevention could improve length and quality of life and could also reduce health expenditure. Therefore, health insurers should be able to profit from the effective prevention of unhealthy behaviour. However, there is evidence that preventing unhealthy behaviour does not lead to lower health care costs in the long term because, prevention of unhealthy behaviour can substantially prolong life. Healthy living persons have a longer life expectancy and develop other diseases during their life years gained, thus resulting in additional health care costs. Still, it remains uncertain whether unhealthy behaviour leads to higher health care costs for the *health insurers* only. Previous studies have estimated health care expenditure from the perspective of the entire health care sector.

This study estimated the health care costs of a healthy living cohort and an unhealthy living (obese and smoking) cohort paid for by the health insurer only. The results of this thesis are aimed at providing a better insight into whether prevention is potentially cost saving from a health insurer perspective.

To estimate the lifetime health care costs of the cohorts paid for by a health insurer, the Chronic Disease Model (CDM) and data of the Cost of Illness study (COI) in the Netherlands in 2003 were used.
The results show that, from the perspective of a health insurer, in the *short run* effective prevention of unhealthy behaviour leads to lower health care costs. Moving people from the smoking or obese cohort to the healthy living cohort results in savings during about the first 50 years. In the *long run*, however, (i.e. after 50 years) effective prevention of unhealthy behaviour leads to higher health care costs for a health insurer. Whether prevention is attractive for health insurers as a collective depends on three things: (i) the investment costs of effective prevention, which is not investigated in this thesis, (ii) the income of health insurers from the different cohorts, which is also not investigated in this thesis, but depends for the nominal premium on life expectancy and, for the risk adjusted premium subsidy also on the disease, risk profiles of the different cohorts, and (iii) the time horizon and discount rate of the insurers. For individual insurers, the strategic decision to invest in prevention also depends on the mobility of consumers on the health insurance market and the strategy of the other health insurers in this respect.

Table of content

1. Introduction

Smoking and obesity have high priority in the prevention policy of the Dutch Ministry of Health, Welfare and Sport (minVWS 2007). These two risk factors result in morbidity and mortality. Moreover, some argue that unhealthy behaviour leads to higher health care costs.[1] Unhealthy behaviour could lead to acute and chronic diseases, in turn leading to care consumption, which eventually would lead to higher health care costs (Fries *e.a.* 1993; Brouwer *e.a.* 2006).

Health insurers should be able to profit from the effective prevention of obesity and smoking (Drewes 2006). Prevention of the smoking and obesity could improve length and quality of life and therefore reduce health expenditure. In the Netherlands, for example, a Labour Party member Mr Heemskerk has claimed that health insurers need to invest more in prevention to reduce health care costs. However, studies have also shown that preventing unhealthy behaviour does not lead to lower health care costs in the long term because prevention of unhealthy behaviour can substantially prolong life. Healthy living people have a higher life expectancy and thus run greater risk of developing diseases later in life, such as dementia, psychological disorder, etc. This will result in increased health care consumption. Such health care consumption during the life years gained by healthy behaviour results in additional health care costs (Barendregt *e.a.*1997; Van Baal *e.a.* 2006; Leu and Schaub 1983; Brouwer *e.a.* 2006).

Still, it remains uncertain whether effective prevention of unhealthy behaviour also leads to higher health care costs for the *health insurers* only, since previous studies estimated the health care expenditure from the perspective of the entire health care sector. Besides, hardly any research has been conducted on this subject, also probably because financing schemes differ substantially between countries.

Therefore, it is interesting to examine whether effective prevention of obesity and smoking in the long term leads to lower health care costs for the health insurers in the Netherlands. For this study, the lifetime health care costs of a healthy living cohort paid for by the *health insurers*, are compared with those of the smoking cohort and the obese cohort. The results of this thesis are aimed at providing better insight into whether prevention is potentially cost saving from a health insurer perspective.

The research question of this thesis is:

To what extent does effective prevention of unhealthy behaviour lead to lower health care costs from a health insurer perspective?

[1] Unhealthy behaviour is behaviour which has a negative influence on health. This behaviour can be explained by genetic factors, lifestyles, environmental factors and the interaction between the various factors (RVZ 2002). Smoking, alcohol abuse, physical inactivity or high calorie intake (which leads to obesity) and unsafe sex are examples of unhealthy behaviour (Polder & Achterberg 2004). This thesis concentrates on unhealthy lifestyles: smoking and physical inactivity or high calorie intake (which leads to obesity).

The thesis is subdivided as follow. In chapter 2, the background of this study will be outlined. Chapter 3 describes the research methods and the cohort analysis. The results are presented in chapter 4. This thesis will be concluded with a discussion and some implications.

2. Background

According to the OECD the risk factors *smoking* and *obesity* are currently great health challenges. Smoking and high calorie intake or physical inactivity (which leads to obesity) are unhealthy behaviours, which result in lower life expectancy and reductions in quality of life. In the Netherlands, 40 % of the adults are overweight and 10 % are obese (minVWS 2007). Obesity is a known risk factor for several diseases, such as diabetes, hypertension, cardiovascular diseases, respiratory problems and musculoskeletal diseases (WHO 2007). Consequently, preventing overweight and obesity have a high priority in the prevention policy of the Dutch Ministry of Health, Welfare and Sport. In addition smoking is still a major public health concern in the Netherlands, with more than 20,000 people dying each year from active smoking (minVWS 2007). Smoking leads to many chronic diseases, such as certain types of cancer, asthma, coronary heart disease, chronic obstructive pulmonary disease (COPD) etc. (RIVM 2006; Doll *e.a.* 1994).

Unhealthy behaviour (smoking and high calorie intake or physical inactivity) do not only decrease life expectancy and reduce quality of life. Moreover, some argue that unhealthy behaviour leads to higher health care costs. Unhealthy behaviour could lead to acute and chronic diseases, in turn leading to care consumption, which eventually would lead to higher health care costs (Fries *e.a.*1993). Fries *e.a.* (1993) argue that reducing the need and demand for medical services by health promotion could lead to reduction in health care costs.
Health insurers should then be able to profit from the effective prevention of unhealthy behaviour (Drewes 2006). Since prevention of the risk factors of smoking and obesity could thus improve length and quality of life and could also reduce health expenditure. However, at the moment health insurers in the Netherlands invest only 0.07 percent of their total health expenditure on prevention (Slobbe *e.a.* 2006).

There are a number of factors that induce this low investment in prevention. For example, when health insurers invest heavily in prevention, they could encounter the risk of adverse selection: offering prevention could attract unhealthy clients. An insurer with a relatively unhealthy client database would be at a disadvantage compared to a competitor with a relatively healthy client database (Cyril 2001).[2] This would not be a problem, if the Dutch risk equalization system were perfect.
Although the Dutch risk equalization system, internationally compared, is sophisticated and contains various parameters, the current Dutch risk-adjusted capitation payment system, which compensates the health insurers for the risk profile of their insurers, is imperfect (MinVWS 2006). According to the report of the Federation of Patients and Consumer Organisations in the Netherlands (NPCF) in 2005,

[2] It needs to be taken into account that in the Netherlands, health insurers are obliged to accept all enrolees for the same flat rate premium (MinVWS 2006). Therefore, it is impossible to adapt the premium on health status.

approximately one third of the population is still predictably unprofitable. Currently, this model contains the parameters *age, gender, region, employment or social security status* and *historical expenditure*s such as Pharmacy Based Cost Groups (PCGs)[3] and Diagnostic Costs Groups (DCGs).[4] The PCGs and DCGs are health status proxies based on prior use. Nevertheless, this system does not contain the parameters: 'healthy behaviour' and 'prevention' (van de Ven 2004), nor does it completely reduce the incentives for risk selection (Prinsze *e.a.* 2005).

Another factor that induces the low investment in prevention is that health insurers have to deal with the 'free rider problem'. The free rider problem implies that a health insurer could profit from competitors' investments in prevention (De Nationale Denktank 2006; Cyril 2001). The Dutch Health Insurance Act makes this possible by giving everyone the opportunity to opt for another health insurance provider once a year. Due to this, it is also possible that a health insurer loses clients in spite of its expenditure on prevention programmes. As it is easier to switch health insurers, the health gain (obtained by investing in prevention) could be profitable for a competing insurance provider[5].

Finally, the effects of prevention, such as health gain and cost reduction, normally do not materialize in the short term. When health insurers have a short-term horizon, this may reduce motivation to invest in prevention (Cyril 2001).

However, some claim that health insurers need to invest more in effective prevention to increase their insureds health and to reduce their health expenditures (Fries *e.a.* 1993). To back up that claim, a better view of the costs and effects related to prevention from the perspective of the health insurer is useful in that context.

Many studies have shown that in the long term promoting healthy behaviour leads to *higher* health care costs at the population level. The prevention of unhealthy behaviour leads to higher life expectancy. Lengthening life, generally, will increase health care consumption. Healthy living persons have a higher life expectancy and develop other diseases during the life years gained. Thus, it will result in additional health care costs, termed '*cost in life years gained'* (Leu & Schaub 1983; Barendregt *e.a.*1997; Van Baal *e.a.* 2006).

Nonetheless, it remains uncertain whether prevention of unhealthy behaviour leads to higher health care costs for the *health insurers* only. Previous studies have estimated the health care expenditures from the perspective of the entire health care sector. There is an indication that prevention of unhealthy behaviour probably leads to lower health care costs for the health insurers. The health care expenditures in the Netherlands are financed by various financial agents. Slobbe *e.a.* (2006) define four financing sources in the Netherlands: *the health insurer*, *the Dutch Exceptional Medical Expenses Act* (Algemene

[3] Pharmacy-based costs groups (PCGs) is an indicator of chronic conditions that is based on the use of specific drugs in the previous year (van Vliet 2006).

[4] Diagnostic cost groups (DCGs) is another indicator of chronic conditions, which is based on certain medical diagnoses established when hospitalised in the previous year (van Vliet 2006).

[5] A possible solution for this problem is the Health Transfer System, which is put forward by De Nationale Denktank in 2006. A health insurer gets a transfer sum related to the amount of investment in insured X, when insured X switches to competitor health insurer. This transfer sum will be paid by the competing health insurer (De Nationale Denktank 2006).

Wet Bijzondere ziektekosten, AWBZ), the *government* and *others sources* (Figure 1). [6] According to Drewes (2006), a great extent of the *costs in life years gained* will not be incurred by the health insurers, but by the 'Dutch Exceptional Medical Expenses Act' and municipalities (WMO). Lengthening life will lead to development of diseases in later life, such as dementia, psychological disorder, stroke, etc. These illnesses especially increase the need for long term nursing care and other elderly care (Van Baal *e.a.* 2006; Bonneux *e.a.* 1998). In the Netherlands, the Dutch Exceptional Medical Expenses Act and WMO pay the costs of nursing homes and other elderely care (minVWS 2007).

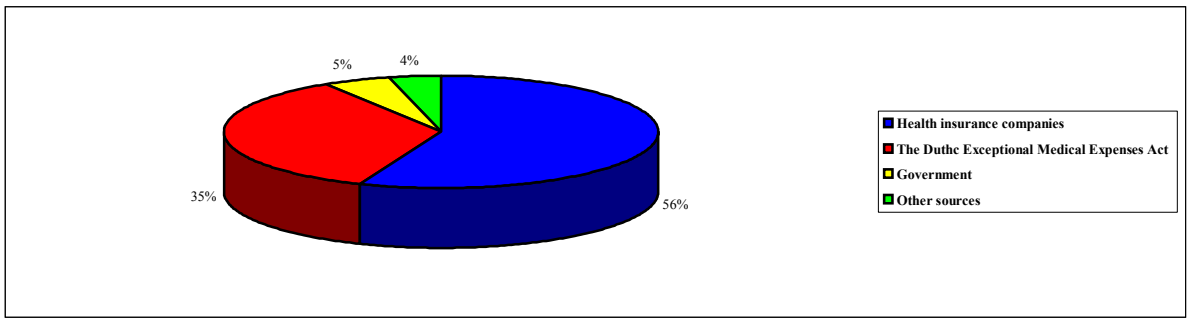


Figure 1. Total health expenditure in The Netherlands by financing agent (2003) www.kostenvanziekten.nl

Given the fact that health insurers could profit from the effective prevention of unhealthy behaviour and could play a crucial role in prevention and cure, the need for empirical evidence in this area is clear. Therefore, it is interesting to examine whether long term prevention of unhealthy behaviour is also favourable from the perspective of a health insurer only. For this study, the lifetime health care costs of a healthy living cohort paid for by the *health insurers* are compared with those of an unhealthy living cohort. The results of this thesis are aimed at providing better insight into whether prevention is potentially cost saving from a health insurer perspective.

It is important to emphasize that this thesis only considers the *health care expenditures* for health insurers and not the total balance between revenues and expenditures. For the former, the revenues of health insurers need to be considered as well. The revenues consist of two main parts: the nominal premium and the risk-adjusted premium subsidies from the Central Fund (Prinsze *e.a.* 2005). Since the latter is risk-adjusted, one would need to establish the risk profiles of a healthy and unhealthy living person to calculate total (profit) per person. This falls outside the scope of this thesis.

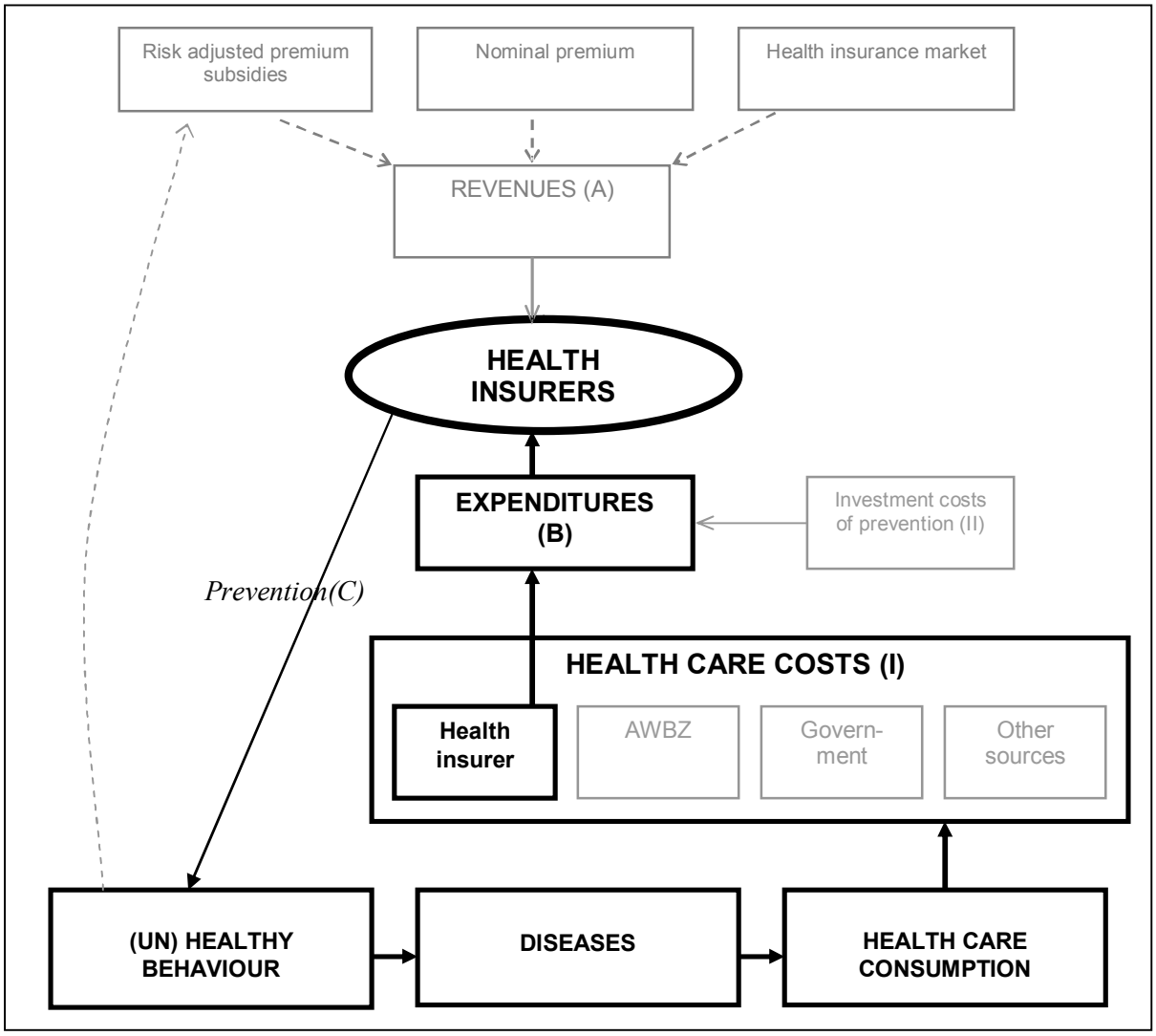
Conceptual model

A conceptual model is shown below. This conceptual model shows which factors (A+B) influence the financial incentives for health insurers to invest in prevention of unhealthy behaviour (C). The two main

[6] In 2003, health insurers paid 56 percent (32.3 billion euros) of the total health care expenditures. This figure also includes co-payments and deductibles. The AWBZ paid 35 percent (20.3 billion euros) and the rest with only 9 percent (5 billion euros) was paid by government and other sources

factors which influence these incentives are the *revenues* (A) and the *expenditures* (B) related to the prevention. The revenues of health insurers consist of the risk-adjusted premium subsidies and nominal premiums, and are influenced by other factors in a health insurance market (such as the free-rider problem, risk adverse selection and mobility of consumers on the health insurance market). The expenditures are influenced by the health care costs (I) and the investment costs of effective prevention (II). The health care costs are influenced by (un)healthy behaviour as unhealthy behaviour could lead to acute and chronic diseases. This will, in turn, lead to care consumption, which eventually would lead to higher health care costs.

As mentioned before, this study only demarcates the expenditures (B) and concentrates on the health care costs related to (un)healthy behaviour (I). Moreover, the health care costs (related to unhealthy behaviour) paid by the health insurers only are considered. Thus, health care costs paid by other financial sources are not taken into account.



3. Methods

3.1 Introduction

To estimate the lifetime health care costs of the (un) healthy living cohorts paid for by a health insurer, the Chronic Disease Model (CDM) and data of the Cost of Illness study (COI) in the Netherlands in 2003 were used. The method to calculate the lifetime health care costs is based on the method used in the studies of Van Baal *e.a.* in 2006 and Barendregt *e.a.* in 1997. However, new input data need to be created since this study examines the health care costs from the perspective of a health insurer while former studies examine the health costs from the perspective of the entire health sector. In this chapter first the CDM and the COI study are described. Subsequently, the research method and the cohort analysis will be considered.

3.2 Chronic Disease Model (CDM)

The Chronic Disease Model (CDM) is used to estimate the health care costs of diseases that can be attributed to risk factors BMI (obesity) and smoking on a population over time. An estimation can also be made of the development of health care costs when risk factors are eliminated. The CDM is a mathematical dynamic population model and is based on the life table method. This model describes the morbidity and mortality effects of risk factors for chronic diseases. Additionally, it describes the life course of cohorts in terms of changes between risk factors classes (cholesterol, systolic blood pressure, smoking, activity level and BMI) and changes between disease states over time (cardiovascular disease, acute myocardial infarction, other coronary heart disease, stroke, chronic heart failure, COPD, asthma, diabetes mellitus, dementia, osteoarthritis, dorsopathy, osteoperosis and 15 different forms of cancer). All parameters are specified by gender and age (Hoogenveen *e.a.*1998; Van Baal *e.a.* 2006).

3.3 Cost of Illness study in the Netherlands

The estimated health care costs are based on the 2003 Cost of Illness study in the Netherlands (COI). This study shows the total direct health care costs in the Netherlands of 2003. The total direct health care costs are attributed to a disease or diseases category specified by gender, age classes, sources of finance, health care provider and health care function. The sources of finance consist of health insurance companies, the AWBZ, the government and other sources. In 2003, health insurers paid 56 % (32.3 billion euros) of the total health care expenditures. This figure also includes co-payments and deductibles. The AWBZ paid 35 % (20.3 billion euros) and the rest with only 9 % (5 billion euros) was paid by government and other sources (Slobbe *e.a.* 2006).

3.4 Research method

With the help of the CDM, differences between life expectancies and health care costs paid for by a health insurer between healthy living cohort and unhealthy living (obese and smoking) cohort can be estimated. The health care costs influenced by the risk factors obesity and smoking are calculated by coupling *disease prevalence rate* and *population size* to *costs per disease per patient paid for by a health insurer*. The costs per disease per patient (paid for by a health insurer) are estimated by using COI data.

The calculation of the lifetime health care costs consists of two steps. The first step is to calculate the *related disease health care costs*. The next step is to estimate the *unrelated disease health care costs*. The sum of these two correspond with the lifetime health care costs.

In this study, the related diseases are diseases related to the risk factors smoking and obesity (BMI). Seven major categories of the related diseases can be distinguished; heart disease, stroke, lung cancer, other cancer, COPD, diabetes mellitus and musculosk system. The unrelated diseases comprise all other diseases, which are total diseases minus the total related diseases.

3.4.1 Related disease health care costs

The related disease health care costs paid for by a health insurer of a cohort are estimated with the CDM by coupling the *costs per patient per disease per year paid for by a health insurer* to the *time dependent disease prevalence rates per population specific* (Van Baal *e.a.* 2005).

The data input of the costs per patient per disease per year (*cp rd*) are adopted from the study of van Baal *e.a.* (2006).[7] These data correspond to the total sum of four financing sources (health insurances, AWBZ, the governments' expenditure and other sources):

$$cp\ rd.a,g = cp(health\ insurer)rd + cp(AWBZ)rd + cp(government)rd + cp(others\ sources)rd \quad (1)$$

cp rd,a,g *costs per year per patient for related disease rd age a gender g*

As this study only focuses on the lifetime health care costs of (un)healthy living cohorts, paid for by *a health insurer* only, the *cp rd* needs to be specified for the financing agent the 'health insurer'. To obtain these new data *(costs per patient per disease per year paid for by the health insurer)*, the adopted data *cp rd* will be multiplied by the fraction of the total expenditure per disease (age- and gender-specific), which is paid for by the financing agent 'health insurer'. With the COI study one can estimate which fraction of the total expenditure per disease is made by each financing agent. As is known, the COI data enable the attribution of the *total direct health care costs* to disease specified by gender and

[7] The calculation of health care costs per patient per disease per year is explained in appendix 1.

age classes. Besides that, the study also enables one to specify the total direct health care costs to disease specified by financing sources.

The fraction is calculated by dividing the *health care costs per disease age and gender specific paid for by the health insurer* by the *total health care costs per disease age and gender specific*:

$$\text{f(health insurer)}rd,a,g = hc_{(health\_insurer)rd,a,g} \Big/ hc_{(total)rd,a,g} \quad (2)$$

f(health insurer)rd,a,g	*the fraction of health care costs of related disease rd paid for by a health insurer age a gender g*
hc(health_ insurer) rd,a,g	*health costs paid for by the health insurer related disease rd age a gender g*
hc(total) rd,a,g	*total health costs related disease rd age a gender*

By multiplying *f(health insurer)rd,a,g* and *cp rd,a,g*, the new data input *costs per patient per disease per year paid for by the health insurer*[8] can be obtained:

$$cp(\text{health insurer})\ rd,a,g = f(\text{health insurer})rd,a,g * cprd,a,g \quad (3)$$

To obtain the related disease health care costs of a cohort paid for by a health insurer, the CDM is used by coupling the *cp(health insurer) rd,a,g* to *time dependent disease prevalence rates per population specific*:

$$\text{cr,s,t} = pop\ s,t * \sum_{1}^{rd} P_{rd,s,t} * cp(\text{health insurer})\ rd,a,g \quad (4)$$

cr,s,t	*health care costs of related diseases paid for by the health insurer scenario s at time t*
pop s,t	*population scenario s at time t*
Prd,s,t	*prevalence rate of related disease d scenario s at time t*

3.4.2 Unrelated disease health care costs

To estimate the unrelated disease health care costs, the CDM is used by coupling the *average total unrelated disease health care costs per person paid for by a health insurer* to *the population size of a specific population*.

[8] Appendix 3

The *average total unrelated disease health care costs per person* is estimated by subtracting *the average total health care costs per person* (*age gender specific*) from *the average costs of the related disease per person per disease* (*age gender specific*).

The data of the *average total health care costs per person* and the *average costs of the related disease per person per disease* are adopted from the study of Van Baal (2006).[9] The same as the *cp rd*, these data correspond to total sum of four financing sources (health insurances, AWBZ, the governments' expenditures and other sources):

ac a,g = ac(health insurer)a,g + ac(AWBZ)a,g + ac(government)a,g + ac(other sources)a,g (5)

ac a,g *average total health care costs per person age a gender g*

cn rd,a,g = cn (health insurer)rd+ cn (AWBZ)rd + cn (government)rd + ac (other sources)rd (6)

cn rd,g,a *average costs per year per person for related disease d age a gender g*

Since this study only examines the lifetime health care costs of a (un)healthy cohort paid for by a health insurer, *cnrd,a,g* and *ac a,g* need to be specified for the financing agent, the 'health insurer'. Hence, *cnrd,a,g* will be multiplied by the fraction of *f(health insurer)rd,a,g,* function (2).

ac a,g is multiplied by another fraction than that estimated with function (2). Since the data on *ac a,g* are correspondent to the sum of all disease per person, they will be multiplied by the fraction calculated in function (7):

$$f(\text{health insurer})d,a,g = Total\_disease_{(health\_insurer)a,g} \Big/ Total\_disease_{(total)a,g} \quad (7)$$

f(health insurer)d,a,g *the fraction of health care costs of all disease paid by a health insurer age a gender g*

Total_diseases (health insure) a,g *health cost paid by a health insurer of all disease age a gender g*

Total_diseases (health insure) a,g *total costs of all disease age a gender g*

By multiplying *ac a,g* by *f(health insurer)d,a,g* the *average total health care costs paid by a health insurer per person age a gender g* [10] will be obtained. Besides, multiplying *cnrd,a,g* by *f (health*

[9] The calculation of *the average health care costs per person* and the *average costs of the related disease per person per disease* is explained in appendix 2

[10] Appendix 4

insurer)rd,a,g gives *the average costs paid by a health insurer per year per person for related disease d age a gender g*[11]*:*

$$ac(\textit{health insurer})g,a = ac\,a,g * f(\textit{health insurer})d,a,g \quad (8)$$

$$cn(\textit{health insurer})rd,g,a = cnrd,a,g * f(\textit{health insurer})rd,a,g \quad (9)$$

Subtracting *the average costs of the related disease per person per disease paid for by a health insurer* (*age gender specific*) from *the average total health care costs per person paid for by a health insurer* and multiplying it with *the population size of a specific population*, the *average total unrelated disease health care costs of population scenario s at time t paid for by the health insurer* is obtained:

$$cu(\textit{health insurer})\,s,t = pop\,s,t,a,g * \left(ac(\textit{health insurer})a,g - cn(\textit{health insurer})rd,a,g\right) \quad (10)$$

cu(health insurer)s,t — *average total unrelated disease health care costs of population scenario s at time t paid for by the health insurer*

3.5 Cohort analysis

This study estimates the health care costs of an *unhealthy living* cohort and those of a *healthy* living cohort. With CDM, the life expectancy and the health care costs for three fictitious cohorts are estimated: a *healthy living* cohort, a *smoking* cohort and an *obese* cohort. Each cohort consists of 500 men and 500 women with a starting age of 20.[12] These cohorts will be followed for a period of 100 years, thus from age 20 to 120. The course of life of these cohorts are simulated until all men and women from the cohort have died.

A *healthy living cohort* is a cohort with non-smokers and persons with a BMI <25. A *smoking cohort* is a cohort with smokers for their entire lifetime and persons with a BMI between 18.5 and 25. In this study, the intensity of smoking (number of cigarettes smoked per day) will not be taken into account. An *obese cohort* is a cohort with non-smoking obese persons (BMI >30). In addition, this cohort never loses weight.

[11] Appendix 4

[12] The reason for choosing a starting age of 20 is because this study assumes that the effect of smoking and obesity become visible after a period of time. Health care costs related to smoking and obesity are incurred mainly after a long period of smoking and physical inactivity or high calorie intake. Thus, the related health care costs are hardly visible in the first 20 years. Of course, estimating the health care costs from a starting age of 0 will give a better estimation of the lifetime health care costs.

4. Results

4.1 Introduction

In this section, the results are presented. First, the cohort characteristics will be described. The life expectancy of these cohorts will be described separately for men and women. In paragraph 4.3, the health care costs of the three cohorts will be described. The health care costs of men and women will be summed and presented as one cohort, with no distinction for gender. In paragraph 4.4, the economic consequences of elimination of the risk factors will be shown. Finally, in paragraph 4.5, the lifetime care costs per cohort will be discounted.

4.2 Life expectancy

Figure 4.1 shows the survival curves of three cohorts of men. Figure 4.2 shows the survival curves of the three cohorts of women. Based on these two figures, the healthy cohort has the highest life expectancy, followed by the obese cohort and finally the smoking cohort. This order is the same for men and women. In addition, these figures show that the differences between these three cohorts become visible after the first 20 years. This result is due to the fact that the effect of unhealthy behaviour, such as smoking and obesity, become visible after a period of time (Van Baal *e.a.* 2006).

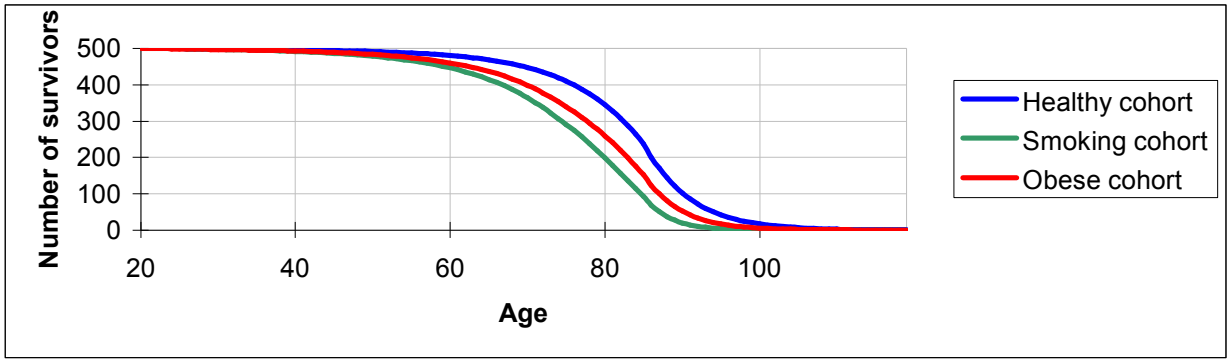


Figure 4.1 Survival curves of three cohorts (men)

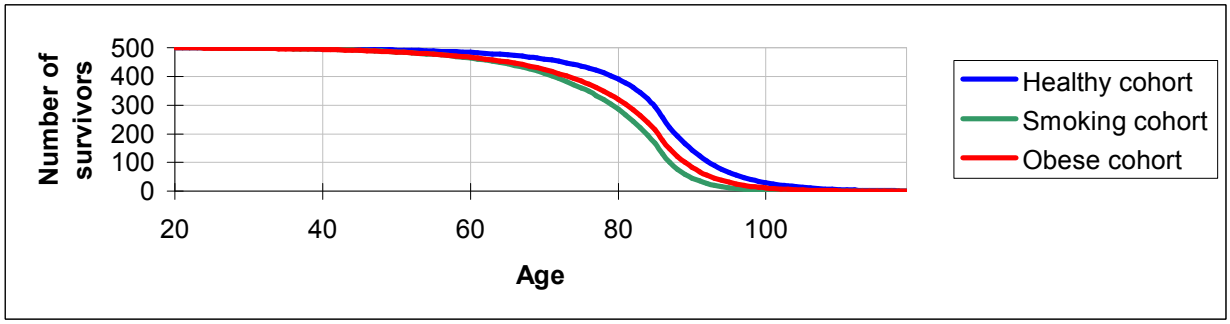


Figure 4.2 Survival curves of three cohorts (women)

Table 4.1 shows the life expectancy of three cohorts. In all cohorts women have the highest life expectancy. There is a considerable difference between healthy living persons and smokers; the differences are almost 8 years for men and 6 years for women. This result implies that the healthier a person is, the more likely he/she will reach old age.

Table 4.1 Life expectancy (remaining at age 20)

	Men	Women	Total
Healthy person	63,1	65,7	64,4
Smoker	55,4	59,4	57,4
Obese person	58,5	61,3	59,9

4.3 Health care costs

This section shows the results on the lifetime health care costs of three cohorts without making a distinction between men and women. The health care costs of men and women are summed up in one graph.

Figure 4.3 shows the additional health care costs per year of a smoker and those of an obese person compared to a healthy living person. This figure shows the additional health care costs per person per year paid by *a health insurer* only. Over the whole lifetime, the yearly health care costs of a smoker and an obese person are higher than those of a healthy living person. The health care costs per year rise sharply with age. An obese person has higher additional health care costs than a smoker in the first 40 years.[13]After the age of 60 years, a smoker has higher additional health costs than an obese person, especially between the age of 75 and 85.

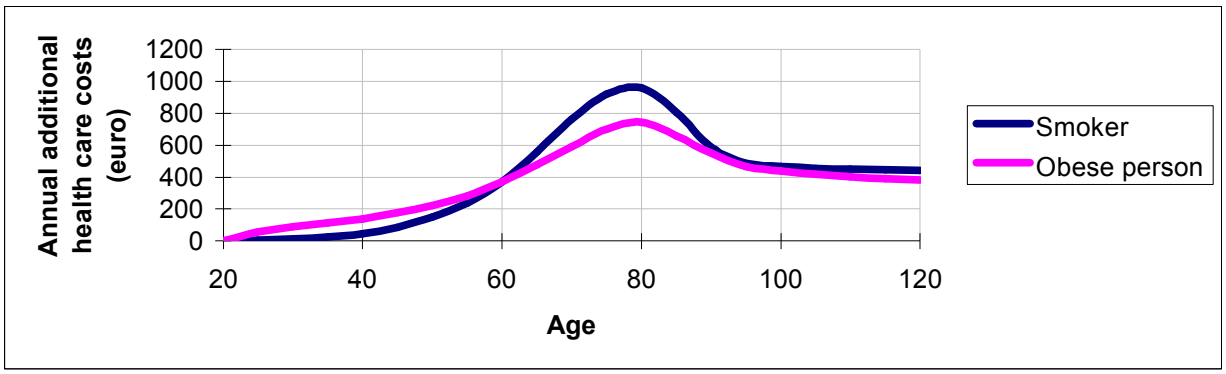


*Figure 4.3 Annual additional health care costs per year vis à vis healthy person (costs paid for by a health insurer)*1000 euro*

However, Figure 4.3 ignores the differences in the life expectancy between a healthy and an unhealthy living person (smoker, obese person). As shown in Table 4.1, it can be concluded that healthy living persons have a substantially higher life expectancy than unhealthy living persons. Thus, compared to

[13] After the age of 20. In the further analysis of this study, this age will be regarded as the starting point.

unhealthy living persons, a greater number of healthy living persons remain alive at old age (Barendregt *e.a.* 1997; Van Baal *e.a.* 2006).

Figure 4.4 shows the lifetime health care costs of three cohorts as far as it concerns costs paid for by the health insurer. As healthy living persons live longer, the costs incurred by a healthy living cohort are higher. The health care costs are not only influenced by the average health care costs, but also by the *amount* of survival in a cohort (Barendregt *e.a.* 1997; Van Baal *e.a.* 2006).

The three cohorts show little difference in costs during the first 50 years, the healthy living cohort shows slightly lower health care costs than the other two cohorts. After that, the differences in health care costs become more apparent, where the healthy living cohort shows higher health care costs than the two other cohorts. The costs rise sharply with age. At a certain age, these costs decline due to mortality. From Figure 4.4 it can be concluded that from approximately the age of 75 years on, the healthy living cohort is more expensive than the other two cohorts, from the point of view of a health insurer. As healthy living persons have a higher life expectancy, more healthy living persons live longer. Thus at the end of the life time, more healthy living persons survive at old age than smokers and obese persons, thus leading to higher costs, also from the perspective of the health insurers.

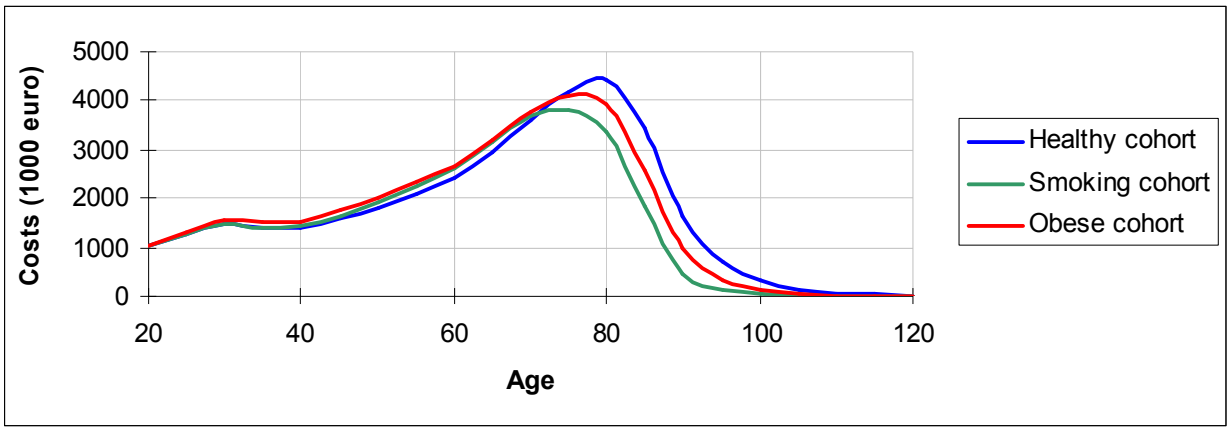


*Figure 4.4 Total health care cost of three cohorts paid for by health insurer (*1000 euro)*

Table 4.2 shows the expected health care costs of a 20-year-old person from each of the three cohorts by disease category. The costs are divided into *total related* health care costs, *unrelated* health care costs and the *total* health care costs. This table also shows in which proportion the costs are paid for by a health insurer, by the AWBZ and by all financial agents. The health care costs paid for by the government and the others are omitted since these costs are negligible.

From the perspective of a health insurer, the expected *total* health care costs of a healthy living person are the highest. Compared to a healthy living person, a health insurer spends 21,000 euros less on a smoker and 6000 less on an obese person.

Regarding the expected *total related* health care costs, a health insurer spends the least for a healthy living person. Nevertheless, a health insurer spends the highest *unrelated* health care costs on a healthy living person.

The results from the perspective of a health insurer also apply for the 'sum of all financial agents'. The results of the 'sum of all financial agents' are the same as those in the studies of van Baal *e.a.* (2006) and Barendregt *e.a.* (1997). These two studies estimate the health care costs of a (un) healthy living person based on the total health care costs, thus, the costs paid by all financial agents. When only focusing on the perspective of a health insurer (compared to the sum of all financial agents), the differences between the cohorts appear smaller.

Table 4.2 Health care costs of a 20 years old person of three cohorts (1000 euro)*

	Healthy living cohort			**Smoking cohort**			**Obese cohort**		
	Health insurer	AWBZ	Total*	**Health insurer**	AWBZ	Total*	**Health insurer**	AWBZ	Total*
Heart disease	**10**	2	12	**13**	1	14	**12**	2	14
Stroke	**4**	11	15	**5**	8	13	**4**	9	12
COPD	**1**	0	1	**4**	1	4	**1**	0	1
Diabetes	**2**	1	3	**2**	0	2	**9**	1	10
Musculosk system	**10**	3	13	**7**	1	9	**13**	3	16
Lung cancer	**0**	0	0	**3**	0	3	**0**	0	0
Other cancer	**5**	0	5	**5**	0	5	**5**	0	6
Total related health care costs	**31**	18	50	**38**	13	51	**43**	15	59
Total unrelated health care costs	**140**	164	317	**112**	90	214	**122**	116	251
Total health care costs	**171**	182	366	**150**	103	265	**165**	131	310

* Sum of all financial agents: health insurer, AWBZ, government and other sources

4.4 The economic consequences of elimination of the risk factors

Figure 4.6 presents the economic effects of successful elimination of the risk factors *smoking* and *obesity* in a cohort from the perspective of a health insurer. Derived from this graph, it can be stated that, from the perspective of a health insurer successful prevention of the risk factors leads to slightly lower health care costs during approximately the first 50 years. However, after approximately 50 years, prevention leads to much higher health care costs. Due to a healthy lifestyle, a greater number of persons remain alive in a cohort.

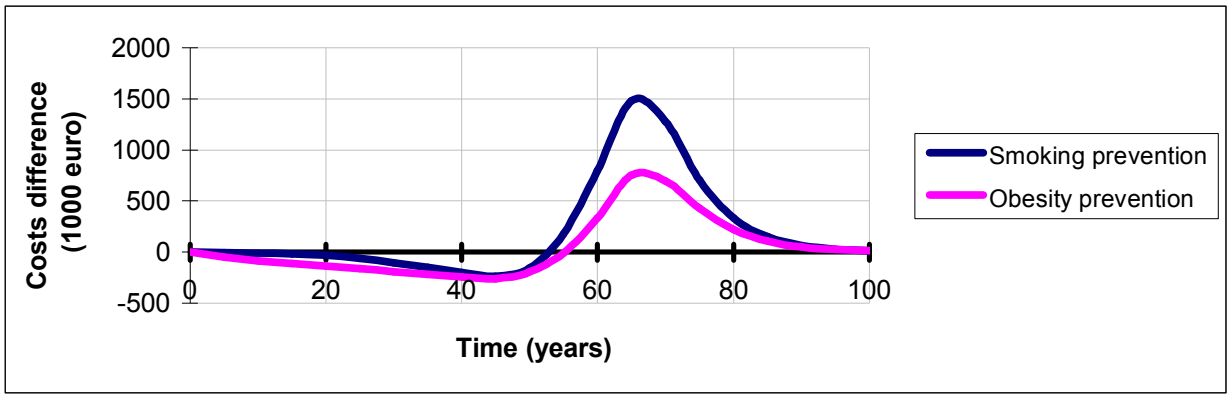


Figure 4.6 Economic effects of successful elimination of the risk factors smoking and obesity in a cohort of 1000 persons (health insurer)

4.5 Time horizon and discounting

Figure 4.6 indicates that from the perspective of a health insurer, effective prevention of smoking and obesity in 20 year olds (i.e. the relevant population in this cohort), results in cost savings for the first 50 years after which cost increases occur. The first question then becomes what the relevant time frame for decision making within health insurance companies is or should be. One may assume that not many companies will work with a time horizon of longer than 50 years, not even socially oriented companies, such as (some) health insurance companies. If that is indeed the case, the short term savings of prevention will be the only relevant consequence of prevention for the health insurer.[14]

Assuming that health insurers do take the complete time frame of the analysis into account, it is unlikely that they will consider all costs and savings equally. In other words, health insurers are likely to weight costs and savings for the timing at which they occur, placing more weight on the near future and less weight on the further future. This phenomenon is common and normally labelled time preference or discounting.

In economic analysis, it is common to discount for future costs and gains. This is due to 'time preferences', i.e. one is 'impatient', 'short sighted', or 'unsecured' for the future. On that account, money received now is preferred over money received in the future. By discounting, the future costs are given lower weights; so medical expenditure made in the future are weighted lower (Drummond 2005). Therefore, by discounting, the present value of lifetime health costs made by a healthy living person become lower compared to an unhealthy living person as the first lives longer and their medical care expenditures are deferred to the future (Hodgson 1992).

However the question is which discount rate would be appropriate from the perspective of *a health insurer*. There is even much debate about appropriate discount rates from the point of view of society

[14] Note that we are still focusing here only on the cost-side, abstracting from the income side of health insurers, as well as from the costs of effective prevention.

(Brouwer & Rutten 2005). Internationally, different percentages are used as basis for discounting. Some guidelines maintain even different discount rates for effects on the one hand and costs on the other. The guidelines in the UK indicate a discount rate of 6 % for costs, while the rate for effects is only 1.5 %. In the Netherlands, the discount rate is the same for both effects and costs (Hjelmgren *e.a.* 2001), which is currently 4 % (CVZ 1999). [15]

It is uncertain which discount rate would be appropriate from a health insurer perspective. Furthermore, it is questionable whether health insurers should maintain the same discount rate for effects as for costs. It is likely that health insurers will be relatively myopic, i.e. placing more weight on short- and medium-term savings than on long-term expenditure related to prevention. If so, health insurers may have high discount rates or even (relatively) short time horizons. Then, at least for the health insurers as a collective, the short term cost savings due to effective prevention may receive most weight in decision making.

Table 4.3 shows the effects of discounting the costs of the three cohorts from the perspective of a health insurer. The three cohorts are discounted by five discount rates, namely 0, 1.5, 4, 5 and 6 %. Derived from this table it can be concluded that discounting has a huge impact on the present value of lifetime health care costs.

Without discounting (0%), the lifetime health care costs of a healthy person are the highest, while a discount rate of 1.5 % results in the highest lifetime health care costs for an obese person. When applying a discount rate of at least 5.6 % to the life tables of the three cohorts, then the healthy cohort shows the lowest health care present value costs.

*Table 4.3 Total health care costs of a person from each of the three cohorts from the perspective of a health insurance with no discounting and with three discounting rates (*1000)*

	0%	**1.5%**	**4%**	**5%**	**6%**
Healthy cohort	**170.9**	92.2	41.2	32.1	25.9
Smoking cohort	149.6	85.3	40.5	31.9	26.0
Obese cohort	165.4	**92.4**	**42.9**	**33.7**	**27.4**

[15] Since this rate is dated from 1995, there are critics concerning the necessity of the reconsideration of the discount rate.

Discussion

Conclusion

The aim of this study is to examine the question of whether effective prevention of unhealthy behaviour (smoking and obesity) leads to lower health care costs for health insurers. In this study, the lifetime health care costs of a healthy living cohort paid for by the *health insurers* are compared with those of an unhealthy living (smoking and obese) cohort.

This study shows that, from the perspective of a health insurer, in the *short run* effective prevention of unhealthy behaviour leads to lower health care costs for a health insurer. Moving people from the smoking or obese cohort to the healthy cohort results in savings during approximately the first 50 years. In the *long run*, however (i.e. after 50 years), effective prevention of unhealthy behaviour leads to higher health care costs for a health insurer. Healthy living persons namely have a higher life expectancy, which results in additional health care costs, termed *cost in life years gained*. Moreover, as healthy living people have a higher life expectancy, more healthy living people live longer. Thus at the end of the life time, more healthy living persons survive at old age than smokers and obese persons, thus leading to higher costs.

The results of this study correspond with the results of earlier studies, which examined the lifetime health care costs of (un)healthy living persons from the perspective of the entire health care sector. (Van Baal *e.a.* 2006; Barendregt *e.a.* 1997). The relative differences between the studied healthy, smoking and obese cohorts become smaller, when focusing only on the health care costs paid for by the health insurers.

It should be considered that the value of the health care costs also depends on discount rates. Without discounting (0%) the lifetime health care costs of a person in the healthy living cohort are the highest among the three cohorts (healthy, smoking and obese). When using a small discount rate of 1.5 % the lifetime health care costs of an obese person are the highest. It seems plausible that health insurers, as private companies and therefore often for profit companies, will not have a very low discount rate.

Implications

Based only on the health care expenditures side without discounting, the results show that long term effective prevention of unhealthy behaviour does not lead to lower health care costs for the health insurers, but this changes for a low discount rate for obesity prevention and a moderate discount for smoking prevention. This study shows that effective prevention of obesity leads to lower net present value of health care costs for the health insurers by applying a discount rate of 1.5%. Applying a higher discount rate of, for example, 6%, results in a lower net present value of health care costs for the health

insurers for both prevention of obesity and of smoking. Currently, it is uncertain which discount rate is appropriate from a health insurer perspective. Due to recent health market reforms and increasing competition among health insurers, it can be assumed that health insurers will be relatively myopic, thus maintaining a high discount rate. Still, the results of this study cannot answer the question whether prevention of unhealthy behaviour is financially attractive or unattractive for the health insurers, since this study only demarcates the health care expenditures. In practice, a prevention policy of a health insurer should depend on revenues such as the nominal premium as well as on strategic behaviour of competing health insurers.

To answer the question of whether prevention is financially and strategically attractive, at least three more aspects are important: (i) the life time revenues of the different cohorts, (ii) the investment costs of effective prevention and (iii) the possibility of strategic behaviour of health insurers. Although this falls outside the scope of this thesis, it is clear that a good calculation of the revenues would require an estimation of revenues for insurers, not only in terms of the nominal premium (which mainly depends on life expectancy), but also on the basis of the current risk-equalisation scheme for the three different cohorts. The latter calculation requires an indication of the risk profiles (over the life course) for the different cohorts. These revenues need to be confronted with the life time costs of the different cohorts. Just to give a very rough illustration:

In case of successful prevention of the risk factors *smoking* and *obesity*, this study shows the additional, undiscounted health care costs for a smoker are 21,000 euros and for an obese person 6000 euros. Based on the CDM analysis, the life expectancy of a 20-year old smoker is approximately 7 years lower than that of a non-smoker. The life expectancy of a 20 years old obese person, is approximately 5 years lower than that of a non-obese person. Thus, a health insurer receives 7 years extra premium when he successfully prevents smoking and receives 5 years extra premium when he successfully prevents obesity. If we assume that a health insurer receives approximately 2200 euros premium[16] for each person per year, this adds up to an additional 15,400 euros premium-revenue for successfully preventing smoking and 11,000 euros for obesity. So in total a health insurer, who prevents smoking, will lose 5600 euros (15,400 minus 21,000 euros), without discounting. However, a healthy insurer, who prevents obesity, will gain 5000 euros (11,000 minus 6000 euros) (undiscounted). Thus, under these assumptions and abstracting from discounting and the investment costs of effective prevention, preventing the risk factor obesity could be profitable. Nevertheless, no hard conclusion can be drawn as this calculation is roughly based on some assumptions regarding the additional revenue costs.

[16] In the Netherlands, an insured pays a nominal premium, on average approximately 1050 euros per year, to a health care insurer. In addition, depending on the level of income, the Health Insurance Act obliges citizens to also pay a contribution of 4.4 -6.5 percent of their income. The income from this contribution is put into a Health Care Insurance Fund. This fund compensates the health insurers for any financial disadvantage they incur through imposition of the obligation to accept anybody who is under legal obligation to take out insurance. It is difficult to give an exact indication of how much a health insurer receives from a Health Care Insurance Fund for an insured at different stages of his life, since this amount depends on many characteristics of a person (minVWS 2007). We have (too) simply assumed an average capitation payment of 1100 euros per person per year. This is based on the following calculation: a modal income of a Dutch citizen is 20,300 euros (CBS 2007). Thus, the average of 4.4 and 6.5 percent of 20,300 euros is 1100 euros. The total rough estimated premium is the sum of the nominal premium and the fund contribution – without any further adjustment for the parameters in the risk adjustment model.

Recommendations

Health insurers who would like to reduce their health care expenditure in the short term, are recommended to invest in effective prevention of smoking and obesity. The results of this study show that in the short run (for the first 50 years) effective prevention of smoking and obesity results in cost savings, abstracting from the income side of health insurers, as well as from the investment costs of effective prevention.[17]

Even in the long term, it is recommended to invest in effective prevention from a health insurer perspective. Besides the fact that prevention of obesity and smoking improves the length and quality of life, it reduces health care expenditures from a particular discount rate. This study shows that effective prevention of obesity leads to lower net present value of health care costs for the health insurers by applying a discount rate of 1.5%. Applying a higher discount rate of, for example, 6%, results in a lower net present value of health care costs for the health insurers for both prevention of obesity and of smoking. In addition, the above rough calculation, in which both expenditures (excluding investment costs of prevention and discounting) and revenues are included, shows that effective prevention of obesity can be profitable for health insurers. Of course, more empirical evidence on the additional revenues related to prevention is needed.

Also, health insurers could profit more from effective prevention of smoking and obesity when they also insure other health related risks, such as industrial disability insurance, WIA insurance and sickness absence insurance. Since smoking and obesity result in morbidity, effective prevention of these risk factors could reduce the claim on other health related insurances.

At last, prevention of unhealthy behaviour could also be used as a marketing instrument to increase their market share. When health insurers offer prevention, they could attract more clients.

Limitations

Limitations of this study need to be mentioned. First, using the data of the COI study gives an overestimation of the health care expenditure by the health insurer. The data of the health care costs paid by the health insurance companies also include *co-payments* and *deductibles*. Thus, these figures include costs which are not only paid by the health insurers.

Secondly, the results of this study only apply to health insurers who operate in the Netherlands or in a similar health insurance system. Health insurance systems differ strongly among countries. Besides, the health care expenditures of a cohort are based on the data of COI in the Netherlands. These expenditures could differ between countries. Additionally, the estimated lifetime table of the three cohorts are based on the CDM, which can only be used to simulate the changes in the Dutch public health state.

Another limitation is that health care costs paid by the health insurer are assumed to be constant during the whole experiment of hundred years. The estimated lifetime health care costs of a healthy

[17] Without discounting

living person and those of an unhealthy living person are based on the data of COI in 2003. Of course in reality, due to the inflation, the prices will change yearly. Hence, the lifetime health care cost of the three cohorts could be underestimated.

Also, this study uses the CDM, which simplifies reality. The real insurance market, in which the health insurers operate, involves different clients with different lifestyles. This model assumes that all persons in the different cohorts are homogenous, i.e. all healthy living persons in a cohort have never smoked, the intensity of smoking of all smokers is the same or persons in an obese cohort never lose weight.

Moreover, the cohorts have been modeled with a starting age of 20 years. Of course, the current Dutch population does not only consist of persons aged 20. Therefore, the results do not fully represent the actual Dutch population and situation. Further research, could be based on more realistic cohorts in terms of demographic characteristics.

The CDM importantly assumes diseases to be independent. Only primary diagnoses are taken into account, while co-morbidity is ignored. In real life, diseases often occur simultaneously and death is often the end of a complex process.

At last, this study only demarcates the health care expenditure and does not take revenues and the investment costs of effective prevention into account. Whether effective prevention of unhealthy behaviour is financially attractive or not to the health insurers, also depends on both sides. Nevertheless, the evidence of this study does show the influence of effective prevention of unhealthy behaviour on health care expenditures of a health insurer.

Future research

A suggestion for future research is to also consider the revenues of the health insurers in the model. A rough calculation of the health expenditures[18] and revenues of the health insurers shows that prevention of obesity may be financially attractive.

Given the changes in the insurance system in the Netherlands, it can be important to update current calculations for the post 2006 situation.

Another suggestion is to examine the appropriate discount rate from the perspective of the health insurers. This study shows that the discount rate has a major impact on the expected value of the lifetime health care costs.

[18] Abstracting from the investment costs of effective prevention

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Appendix 1

The costs per patient per disease per year (*cprd)* are estimated by coupling the data of the COI study with the CDM. The COI study enables the specification of the total costs to disease, disease category, gender and age classes. To assign the COI data on total costs per disease to individual patient, Van Baal *e.a.* (2005) assume that the total costs allocated to disease in that study can also be attributed to individual person. To estimate the age and sex specific *cprd* , the total costs per disease per year are divided by the number of patient years lived as estimated with the CDM (Van Baal *e.a.* 2005).

However, CDM diseases do not always match with the COI categories. Namely, in some cases the COI category includes more than one CDM disease. This implicates that for particular diseases different types are distinguished in the CDM, but not in the COI study. It is then assumed that the average costs per type are equal. This assumption is also made by Van Baal *e.a.* (2005).

Appendix 2

The cost per individual unrelated disease per person per year is not estimated. As same as the study of Van Baal *e.a.* (2005), it is assumed the prevalence rates of indirect related disease are constant, thus the average total unrelated disease health care costs per person is estimated.

The costs of all unrelated disease per person (age gender specific) is estimated by to subtract the average health care costs per person (age gender specific) from the average costs of the related disease per person per disease (age gender specific).

The cost per individual unrelated disease per person per year is not estimated. In the study of Van Baal *e.a.*, it is assumed that the prevalence rate of unrelated disease constant, so the average health care costs of all unrelated diseases can be estimated. The average health care costs per person are estimated by the sum of total health care costs for disease d divided by the population size in the Netherlands:

$$ac = \sum_{d} tc_{d,2003} \Big/ pop_{2003}$$

ac	*average total health care costs per person*
tcd,2003	*total health care costs for disease d in 2003*
pop 2003	*population size the Netherlands 2003*

To estimate the health care costs of all unrelated disease per person the average costs of the related disease per person per disease are computed:

$$cn\ rd = tc\ rd,\ 2003 \,/\, pop\ 2003$$

cnrd,	*average costs per year per person for related disease d*

Appendix 3

Diseases	Gender	Age															
		20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-85	86-90	91-95	95+
AMI_	Men	1100	1100	1100	1089	1091	1093	1090	1093	1088	1089	1084	1053	1022	822	670	1100
	Women	1100	1100	1100	1100	1100	1086	1091	1086	1091	1084	1070	1043	948	773	613	212
other_CHD	Men	2500	2500	2500	2476	2479	2484	2477	2485	2472	2474	2463	2393	2323	1867	1522	2500
	Women	2500	2500	2500	2500	2500	2468	2480	2468	2479	2464	2433	2370	2155	1757	1394	482
CHF	Men	3910	4630	2572	4630	4630	3936	4630	4584	4474	4442	4313	4092	3851	3241	2749	2572
	Women	1720	2270	2970	3850	5210	4291	5210	4714	5123	4917	4770	4352	3524	2874	2274	1042
CVA	Men	3940	3940	3782	3546	2991	3694	2933	2781	2545	2621	2678	2922	3232	3316	2590	2693
	Women	3940	3940	2955	3399	3370	2863	2885	2586	2312	2341	2476	3118	3540	4304	3805	3628
Asthma	Men	341	335	340	343	341	339	340	342	336	338	330	304	294	215	169	64
	Women	350	350	346	341	341	343	345	339	339	330	312	285	263	218	151	162
COPD	Men	224	230	263	303	361	426	506	606	692	820	923	981	1092	904	802	340
	Women	180	270	366	478	604	745	908	1056	1240	1395	1516	1572	1628	1517	1167	1380
Diabetes	Men	2793	2317	1922	1568	1260	1080	911	820	755	750	805	866	966	937	1304	2150
	Women	2736	2290	1872	1567	1279	1070	902	792	750	716	753	775	754	841	795	593
Dementia	Men	0	0	0	0	0	814	0	225	366	385	952	923	707	681	254	0
	Women	0	3020	0	0	0	0	1061	192	705	355	313	527	354	371	312	225
atrhrosis of the hip	Men	190	260	340	430	530	615	742	874	989	1134	1244	1352	1346	1229	709	0
	Women	190	208	340	385	436	590	713	806	975	1107	1223	1251	1154	692	365	292
arthrosis of the knee	Men	270	380	500	640	800	942	1168	1380	1587	1828	2032	2236	2240	2066	1200	0
	Women	270	304	500	573	659	903	1121	1274	1563	1785	1998	2069	1921	1164	617	497
arthrosis other	Men	320	420	560	740	970	1231	1663	2204	2860	3764	4814	6146	7221	7823	5389	0
	Women	320	336	560	662	799	1180	1596	2034	2817	3675	4733	5687	6193	4409	2770	2657
Dorsopathies	Men	264	313	368	429	491	573	650	743	839	930	1064	1089	1193	964	630	1780
	Women	480	547	604	653	702	741	769	783	858	1122	1689	2343	3070	3761	4039	5182
Osteoporosis	Men	80	80	80	80	100	230	370	464	582	770	865	906	967	1064	1440	1570
	Women	0	40	40	40	70	330	640	914	1229	1479	1710	1857	2007	1860	1841	350
cancer of lung	Men	7800	7800	7800	7800	7800	7600	7605	7316	7477	7545	7391	7071	6897	5200	2925	7800
	Women	0	0	14900	14900	14900	13754	14674	14105	14532	13997	13618	11475	9262	11175	14900	0

cancer of rectum	Men	3500	3500	3500	3500	3500	3500	3500	3500	3475	3481	3500	3500	3500	3442	3500	3500
	Women	0	3500	3500	3500	3500	3500	3500	3463	3500	3500	3500	3500	3482	3500	3500	3500
cancer of colon	Men	3700	3700	3700	3700	3700	3700	3700	3700	3674	3680	3700	3700	3700	3638	3700	3700
	Women	0	3700	3700	3700	3700	3700	3700	3661	3700	3700	3700	3700	3681	3700	3700	3700
cancer of stomach	Men	0	0	6500	6500	6500	6500	6139	6500	6500	6500	6500	6367	6500	6500	6500	0
	Women	0	0	6500	6500	6500	6500	6500	6500	6500	6500	6268	6500	6500	6500	6500	6500
cancer of oesophagus	Men	0	0	26300	19725	26300	26300	26300	26300	26300	26300	26300	26300	26300	26300	26300	0
	Women	0	26300	26300	26300	26300	26300	26300	25326	26300	26300	26300	26300	26300	26300	26300	26300
cancer of breast	Men	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Women	1780	1780	1537	1744	1584	1478	1073	1122	1122	1207	1203	1366	1322	971	1068	396
cancer of prostate	Men	0	0	0	0	0	1725	2300	2260	2300	2300	2273	2232	2247	2131	2029	0
	Women	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
cancer of larnynx	Men	2456	2482	2535	2517	2533	2474	2347	2386	2336	2332	2333	2211	1842	2094	2100	650
	Women	2600	2470	2261	2287	2257	2285	2106	2335	2252	2188	2155	1973	2094	1919	2167	1950
cancer of urinybladder	Men	0	0	4560	3420	4560	4560	4560	4560	4560	4560	4560	4560	4560	4560	4560	0
	Women	0	1800	1800	1800	1800	1800	1800	1733	1800	1800	1800	1800	1800	1800	1800	1800
cancer of kidney	Men	0	0	2250	1688	2250	2250	2250	2250	2250	2250	2250	2250	2250	2250	2250	0
	Women	0	2250	2250	2250	2250	2250	2250	2167	2250	2250	2250	2250	2250	2250	2250	2250
cancer of pancreas	Men	0	0	0	0	13600	13600	13600	13600	13600	13600	13600	13600	13600	13600	13600	0
	Women	0	0	13600	13600	13600	13600	13600	13600	13600	13600	13600	13600	13600	13600	13600	13600
cancer of oral cavity	Men	6422	6491	6630	6584	6626	6470	6138	6241	6109	6100	6102	5783	4818	5475	5492	1700
	Women	6800	6460	5913	5981	5904	5977	5508	6106	5890	5721	5636	5160	5478	5019	5667	5100
cancer of endometrium	Men	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Women	6400	6080	5565	5629	5557	5625	5184	5747	5544	5385	5304	4857	5156	4724	5333	4800
cancer of cervix	Men	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Women	0	0	2895	1985	2372	1842	2450	1890	1650	4725	4410	3600	3780	2100	6300	0
cancer of ovary	Men	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Women	0	0	4000	4000	4000	4000	3857	4000	4000	4000	3909	4000	4000	4000	4000	0

Appendix 4

Diseases	Gender	Age															
		20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-85	86-90	91-95	95+
AMI_	Men	0.23	1.31	1.81	5.17	10.94	22.00	33.14	48.61	68.82	85.62	102.25	132.80	146.41	147.99	115.96	76.05
	Women	0.24	0.43	0.92	1.35	3.07	6.83	8.00	14.00	22.76	36.74	53.05	67.81	91.62	92.02	74.37	53.49
other_CHD	Men	0.76	0.90	3.23	10.11	24.77	55.60	98.22	166.87	233.72	315.77	361.34	364.86	252.67	119.59	93.71	61.45
	Women	0.88	0.83	1.23	3.84	8.89	19.43	36.37	60.90	100.18	147.10	187.72	187.10	158.61	77.11	62.32	44.82
CHF	Men	0.19	0.53	0.66	2.65	5.07	12.01	29.43	60.64	89.21	139.69	181.60	259.93	346.74	351.54	352.29	325.69
	Women	0.29	0.51	0.77	2.58	6.65	9.06	22.30	39.43	74.34	104.20	169.91	242.62	294.00	339.87	310.76	184.36
CVA	Men	1.08	2.24	3.60	5.36	9.74	17.85	29.72	52.51	75.07	110.81	157.33	207.37	293.17	299.77	248.74	169.87
	Women	1.42	2.58	3.27	6.73	11.25	18.79	24.24	28.73	48.10	69.66	96.00	148.36	233.88	275.52	260.09	152.85
asthma	Men	6.06	6.37	7.32	7.80	7.35	8.43	4.85	5.84	4.97	7.13	5.49	4.39	3.55	6.21	5.73	2.31
	Women	11.05	11.57	10.88	13.21	12.55	10.60	10.15	10.25	12.05	10.91	10.37	9.78	8.00	6.28	5.89	4.06
COPD	Men	1.17	1.29	2.46	4.80	9.10	16.64	24.11	41.47	70.24	121.05	209.75	272.85	278.80	220.26	203.39	81.92
	Women	1.23	1.61	1.80	4.82	10.19	22.85	28.60	41.14	64.36	92.32	117.21	104.59	92.64	68.20	63.97	44.12
diabetes	Men	5.67	8.10	8.99	10.84	16.98	25.37	36.36	61.63	82.06	88.97	105.32	112.03	115.93	131.29	90.61	52.92
	Women	7.22	9.53	9.67	11.47	15.09	21.34	27.43	41.54	60.34	77.94	98.41	131.16	131.86	130.77	82.31	62.94
dementia	Men	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.19	0.52	1.28	7.78	15.23	23.89	39.71	22.59	0.00
	Women	0.00	0.33	0.00	0.00	0.00	0.00	0.36	0.19	1.29	1.18	2.86	10.33	14.34	25.29	30.33	26.97
atrhrosis of the hip	Men	0.38	0.65	1.72	2.29	4.25	8.45	16.75	26.02	37.32	56.15	87.74	87.42	88.39	59.14	45.63	0.00
	Women	0.52	0.80	1.80	2.59	4.48	10.22	24.08	44.91	77.99	130.84	210.28	230.26	216.21	138.64	80.25	62.60
arthrosis of the knee	Men	0.38	0.65	1.72	2.29	4.25	8.45	16.75	26.02	37.32	56.15	87.74	87.42	88.39	59.14	45.63	0.00
	Women	0.52	0.80	1.80	2.59	4.48	10.22	24.08	44.91	77.99	130.84	210.28	230.26	216.21	138.64	80.25	62.60
arthrosis other	Men	0.38	0.65	1.72	2.29	4.25	8.45	16.75	26.02	37.32	56.15	87.74	87.42	88.39	59.14	45.63	0.00
	Women	0.52	0.80	1.80	2.59	4.48	10.22	24.08	44.91	77.99	130.84	210.28	230.26	216.21	138.64	80.25	62.60
dorsopathies	Men	13.08	21.71	32.96	44.91	56.55	57.14	58.65	64.32	57.07	60.60	76.42	75.30	74.11	61.74	51.76	38.84
	Women	24.62	36.71	47.56	55.34	68.16	71.22	75.52	72.64	74.06	82.02	96.85	111.17	99.49	85.31	69.04	55.16
osteoporosis	Men	0.17	0.19	0.12	0.23	0.30	1.21	1.62	2.51	3.01	5.58	9.85	14.68	17.20	19.53	14.12	32.80
	Women	0.00	0.32	0.24	0.29	1.13	1.87	5.79	11.68	20.13	28.63	41.61	51.93	63.71	47.79	38.83	8.82
cancer of lung	Men	0.22	0.30	0.17	0.86	1.80	6.42	13.60	23.10	35.97	66.29	91.41	90.01	76.78	43.67	21.53	27.15
	Women	0.00	0.00	0.15	0.85	3.18	8.24	11.67	13.92	20.52	27.56	27.02	24.67	11.33	4.81	5.13	0.00

cancer of rectum	Men	0.08	0.03	0.23	0.83	0.49	2.76	5.34	10.20	14.59	24.01	30.51	42.09	38.77	37.61	22.71	19.44
	Women	0.00	0.07	0.30	0.57	1.23	2.05	2.86	7.31	8.50	14.79	16.39	19.46	26.35	27.38	18.33	14.82
cancer of colon	Men	0.31	0.23	0.15	0.95	1.70	2.11	7.47	12.11	21.54	35.70	46.55	74.81	84.53	91.49	55.25	47.29
	Women	0.00	0.20	0.53	0.68	1.23	2.61	6.03	10.94	17.35	25.71	35.42	56.16	67.43	58.36	39.06	31.60
cancer of stomach	Men	0.00	0.00	0.14	0.57	0.92	1.47	2.91	6.12	10.33	16.20	22.33	26.31	31.59	27.08	26.60	0.00
	Women	0.00	0.00	0.29	0.39	0.73	1.35	2.07	3.07	4.85	6.98	8.43	11.69	13.65	16.73	10.69	21.50
cancer of oesophagus	Men	0.00	0.00	0.17	0.39	0.50	2.19	3.39	7.46	10.68	12.20	13.01	16.32	13.97	7.21	10.08	0.00
	Women	0.00	0.10	0.86	0.16	0.29	0.77	1.60	4.98	3.04	4.92	3.90	5.48	5.09	4.36	3.37	4.71
cancer of breast	Men	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Women	0.27	0.82	3.03	7.39	12.80	22.87	30.13	36.28	37.54	47.37	47.05	40.22	48.44	47.03	26.24	17.89
cancer of prostate	Men	0.00	0.00	0.00	0.00	0.00	0.46	2.89	10.57	31.17	54.82	64.43	89.84	115.77	138.67	112.16	0.00
	Women	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
cancer of larnynx	Men	0.00	0.03	0.07	0.08	0.36	0.39	1.36	2.69	4.64	4.70	6.48	6.52	9.49	5.20	6.05	3.15
	Women	0.00	0.00	0.14	0.20	1.60	1.81	1.34	2.63	1.21	1.35	2.21	1.05	1.08	0.45	0.31	0.21
cancer of urinybladder	Men	0.00	0.00	0.13	0.25	0.93	2.11	4.66	9.22	15.52	30.12	42.64	60.10	67.54	85.22	84.63	0.00
	Women	0.00	0.07	0.06	0.10	0.19	0.38	0.83	0.90	1.59	2.06	3.61	4.15	4.48	5.46	2.64	3.42
cancer of kidney	Men	0.00	0.00	0.02	0.15	0.40	0.90	1.97	2.00	3.50	5.42	8.06	8.38	6.21	5.77	5.73	0.00
	Women	0.00	0.06	0.05	0.04	0.42	0.36	1.21	2.00	3.71	3.51	4.16	4.75	3.58	1.67	0.81	1.04
cancer of pancreas	Men	0.00	0.00	0.00	0.00	0.88	1.44	1.51	3.58	6.51	9.07	9.76	10.05	12.61	9.49	4.82	0.00
	Women	0.00	0.00	0.01	0.01	0.02	0.04	0.10	0.12	0.21	0.40	0.58	1.07	1.00	1.72	0.94	1.01
cancer of oral cavity	Men	0.16	0.08	0.41	0.79	0.78	2.09	3.50	4.59	6.32	6.39	6.08	6.69	7.73	10.40	12.10	6.30
	Women	0.06	0.07	0.19	0.11	0.32	0.77	1.22	2.10	1.71	2.30	2.05	2.37	3.41	4.21	2.92	2.01
cancer of endometrium	Men	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Women	0.01	0.18	1.66	0.76	2.13	5.20	8.29	21.29	25.45	30.93	47.37	45.15	57.37	60.42	53.10	98.40
cancer of cervix	Men	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Women	0.00	0.00	5.34	3.54	5.08	3.29	5.04	3.50	2.83	1.88	2.18	2.97	2.88	0.80	2.94	0.00
cancer of ovary	Men	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Women	0.00	0.00	0.67	0.75	2.05	3.02	4.79	8.84	9.98	15.68	13.71	13.69	12.98	0.00	17.97	0.00
total costs per capita	Men	704.78	766.54	898.74	1011.84	1225.14	1477.52	1820.23	2402.32	2974.36	3873.90	5003.16	6026.18	6878.53	7026.78	6991.94	6602.37
	Women	1317.19	1785.01	2088.28	1848.99	1738.54	1971.84	2247.88	2563.87	2959.78	3588.49	4408.59	5190.00	6014.09	5966.51	5923.05	5546.76