Prevention and Risk Equalization:
A Different Prevention Paradox?

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ABSTRACT

Background

Under the Dutch Health Insurance Act, insurers receive money from nominal premiums and from a risk equalization fund. Money stemming from this fund is based on the characteristics of the insureds, such as gender, age and previous health care usage. Risk equalization should decrease the deviations between health care costs and insurer's benefits per insured.

Obesity and smoking cause serious damage to people's health and life expectancy. Prevention of these unhealthy lifestyles is argued to conquer the negative health effects and accompanying health care costs. Health care costs appear to be highest for healthy living people in the long run however. Insurers' financial incentives for prevention are determined by the differences in balances between health care costs and risk equalization benefits among the cohorts. The objective of this study was to determine these financial incentives for insurers for prevention, in a health care system with a mechanism of risk equalization.

Methods and Findings

With a simulation model, lifetime health care costs were estimated for three cohorts (one smoking; one obese; and one non-smoking, non-obese). With the same simulation model, in combination with the contributions from the risk equalization fund, insurer's benefits were estimated for the three cohorts. This way, the balance between health care costs and risk equalization contributions could be assessed.

Lifetime health care costs and risk equalization benefits showed up highest for the healthy living cohort, which could be explained by the highest life expectancy for this cohort. In later stages of life, disease unrelated to smoking and obesity are incurred by this cohort, which explains the high health care costs and accompanying risk equalization benefits. The balances differed between the cohorts, despite the risk equalization mechanisms. For all three cohorts, negative lifetime balances were found. The balance for the healthy living cohort was financially the most attractive for insurers; the obese cohort was least attractive for insurers. These results were found in analyses over the entire lifetime of the cohorts and in per life year analyses. However, the absolute differences in balances were not very large.

Conclusions

The healthy living cohort has financially the most attractive balance of cost and benefits for the insurer. This implies that insurers have an incentive for prevention of smoking and obesity; the balances for these cohorts were less attractive. The incentive for prevention might be limited due to the small absolute differences between the balances.

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1. INTRODUCTION

Unhealthy lifestyles have a negative impact on health. The public's interest for prevention of unhealthy lifestyles is growing the last years, not in the least because of suggestions that unhealthy living also increases health care costs (Sturm, 2002). Although this latter proposition does not seem to be correct, prevention remains attractive for health reasons. Responsibility for prevention can be appointed to several actors, in particular the government and health insurers. If this task is allocated to insurers, these actors should have the right incentives. An important determinant for insurer's incentives for prevention is the financial balance between benefits and costs of their insureds. If this balance is largest for healthy living individuals, insurers would have the right incentive for prevention of unhealthy lifestyles. On the other hand, this also provides them with an incentive to engage in risk selection. As some individuals have lower costs these are thus more attractive to insure than others. Risk selection might threaten solidarity, quality and efficiency of the health care system (Van de Ven et al., 2004). The Health Insurance Act, as of 2006 the core of the Dutch health care system, is therefore designed in such a way that it tries to avoid risk selection (MinVWS, 2007a).

The introduction of the Health Insurance Act in 2006 (and the adjustments of the system in subsequent years) is being watched with great interest by policy makers, especially in the United States (Harris, 2007; Van de Ven & Schut, 2008). Come to think of it, this is not all that surprising, as the health care is claimed to be accessible and affordable for all Dutchmen. In addition, it is argued that risk selection is avoided. The Dutch health care system rests on three anchor points: (1) every citizen is obliged to be insured (universal coverage); (2) insurers are obliged to accept each applicant (open enrollment); and (3) per insurance policy premiums are (per province) equal for all citizens (community rated) (Stam & Van de Ven, 2008a; 2008b). These aspects should guarantee accessible and affordable health care for all citizens (MinVWS, 2007a).

Community rated (instead of a health adjusted) premiums provide insurers an incentive to engage in risk selection, as they can profit from contracting only profitable (young and healthy) individuals. In order to prevent risk selection, a mechanism of risk equalization is used in the Netherlands. With such a mechanism, the insurer receives, in addition to the collected insurance premiums, a risk-adjusted contribution from the national risk equalization fund for each insured. As the predicting power of the risk equalization formula increases, expected profits and losses on subgroups converge. This decreases insurers' incentives to engage in risk selection (Van de Ven et al., 2007; Stam & Van de Ven, 2008b).

Since risk selection is a threat to solidarity, quality and efficiency of the health care system, especially for the elderly and chronically ill, risk equalization is desirable. However, risk equalization might also have some negative effects. If expected financial gains on healthy and unhealthy individuals are equalized, insurers' incentives to improve the lifestyle of their insureds might disappear (Douven, 2005). Why bother to invest money in health of insureds when there are no financial gains to obtain? This paradox between risk equalization and prevention is the very topic of this paper, especially with respect to prevention of obesity and smoking: *What are the financial incentives for prevention of obesity and smoking by health insurance companies in the Netherlands, given the (partly) disease based funding of health expenditure?*

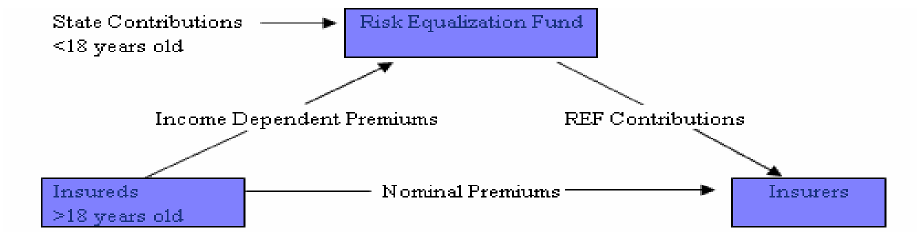
This paper is divided into eight sections. Background information on the risk equalization scheme, smoking and obesity and prevention follows the background section. Subsequently, the methodology used in this research is discussed, followed by a section on the results of the analyses. Next, some further explorations on the results are presented. The discussion considers the methodological aspects of the analyses and provides recommendations for further research. Next, we present the balances for a system with and a system without risk equalization mechanisms. Finally, we conclude what the financial incentives for prevention of obesity and smoking are in the current Dutch health care system.

2. BACKGROUND

Risk Equalization

The Ministry of Health, Welfare and Sport (MinVWS) determines the height of health care costs covered by insurers in the so-called macro budget. The Health Care Insurance Board then determines the nominal insurance premium, through a linear deduction from about half of the total health care costs. Currently, this annual nominal insurance premium is determined at €970, per inhabitant (MinVWS, 2007b). For the purpose of premium competition, insurers can determine, at their own discretion, the height of their premium they charge their customers.[1] Premiums are paid by all adults. The other half of insurers' income stems from the risk equalization fund (REF). Contributions from this fund to insurers are based on expected health care costs, founded on characteristics of the insurer's client population. In essence, insurers are financially compensated for insureds with an increased risk at high health care expenditures. In this way, risk selection is prevented and accessible and affordable health care is guaranteed for all. The REF is filled by means of income dependent contributions by all adult citizens. In addition, the government contributes to the REF for under aged citizens (MinVWS, 2007a; Van de Ven et al., 2007). The financial flows in the Health Insurance Act are given in figure 1.

Figure 1 Funding of the Dutch Health Insurance Act



The 2008 Dutch risk equalization system is based on the following risk adjusters:

(1) Age and gender;
(2) Pharmacy costs groups (PCGs);
(3) Diagnostic costs groups (DCGs);
(4) Socio-economic status and age;
(5) Region-based clusters; and
(6) Source of income and age (Van Vliet et al., 2007).

The direct health indicators PCGs and DCGs serve as proxies for extramural and intramural care, respectively, and are complementary in predicting health care expenses (Van de Ven et al., 2004). The Dutch risk equalization formula is, partly because of the inclusion PCGs and DCGs, accurate in predicting health care expenses per individual (Van de Ven et al., 2004). The risk equalization formula explains approximately 22% of the variance in health care expenses. As the risk equalization system is prospective, and due to the randomness of the incidence of diseases and health care expenses, a precision of 100% is not achievable. Instead, the maximum attainable precision is estimated at 50% (Douven, 2005).

Contributions from the REF are determined ex ante, based on the expected expenditures of insureds. In this respect, PCGs and DCGs are based on health care use in the preceding year. In addition to ex ante risk equalization, also several types of ex post risk equalization mechanisms take place, such as macro-recalculation (equalization of the entire health care

[1] In 2008, annual premiums for individually contracted, Dutch health insurance policies vary from €933.24 to €1,198.44 with an obliged deductible of €150 (www.kiesbeter.nl, 2008)

budget), generic or insurer recalculation (between individual insurers, outside the REF), and high costs equalization (individuals exceeding costs of €20,000 are covered for 90% by the REF and only 10% by the insurer). Ex post equalization is claimed to limit insurers' incentives to be efficient. The Dutch government therefore aims at reducing these types of equalization mechanisms and consequently at increasing insurer's financial accountability (MinVWS, 2007a; Stam & Van de Ven, 2008b). Ideally, the abolition of ex post equalization mechanisms is accompanied by an improvement in the ex ante risk equalization formula.

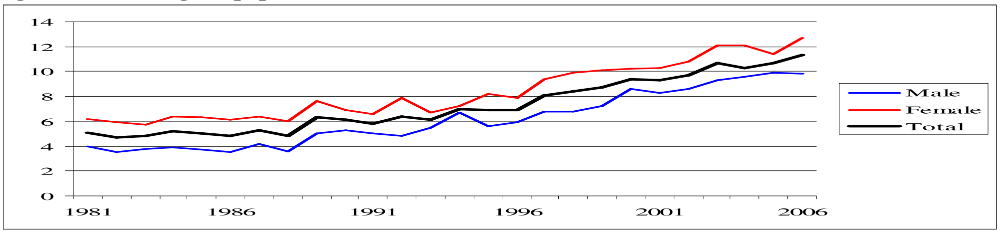
Risk equalization is only applied to the basic insurance package (MinVWS, 2007a). The basic benefits package covers medically necessary health care, and is equal for all insureds with all insurance companies (MinVWS, 2007a). Eye glasses and contact lenses, physiotherapy, as well as dental care for adults, are examples of services that are not covered by the basic package, and instead are incorporated in supplementary insurance packages. Supplementary insurances are not incorporated in the macro budget.

Obesity and Smoking as Risk Factors

Lifestyle factors smoking and obesity increase the risk of developing several diseases. In addition, they lower life expectancy (Van Baal et al., 2006a). Obesity is particularly, though not solely, associated with lower *quality* of life, because of obese people's increased risk to develop chronic, but non-lethal diseases. Smoking, in contrast, is particularly, yet again not solely, related to lower expected *length* of life; related diseases often have low survival probabilities (Van Baal et al., 2006b).

Obesity most often results from an imbalance between food consumption and physical activity (OECD, 2005; Visscher & Schoemaker, 2007a). Figure 2 shows that the prevalence of obesity (defined as BMI[2]>30) in the Netherlands has more than doubled over the last three decades. This tendency has been observed in most developed countries (OECD, 2005; Visscher & Bemelmans, 2007). Obesity is often accompanied with a number of (expensive) diseases, of which type II diabetes is most pronounced. However, musculoskeletal and cardiovascular diseases and certain cancers are also often direct physical consequences of obesity. In addition, obesity can lead to psychological problems and social exclusion. Moreover, life expectancy for obese people is 4.5 years lower than for non-obese people (MinVWS, 2006; Van Baal et al., 2006a; Visscher & Schoemaker, 2007b; Van Baal et al., 2008a).

Figure 2 Percentage of population obese in the Netherlands



Source: OECD (2008)

Smoking is the largest cause of mortality and morbidity in the Netherlands, causing over 85% of all lung cancer and 30% of other types of cancer prevalence. COPD and cardiovascular diseases are also consequences of smoking. Furthermore, smoking is estimated to decrease life expectancy with 7 years. In addition to the damaging effects on a smoker's own health, the health of a smoker's environment is also affected (De Hollander et al., 2006; Van Baal et al., 2006a; MinVWS, 2006; Van Baal et al., 2008a). Figure 3 shows that the national smoking

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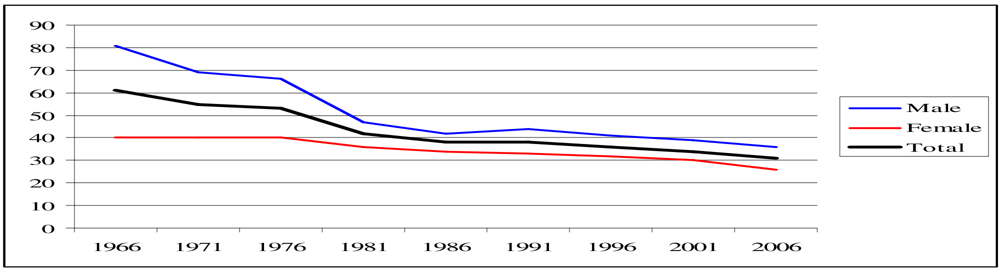
[2] $BMI = \frac{weight(kg)}{height^2(m)}$

prevalence in the Netherlands has been halved over the last 35 years. This trend has been more evident in the male than in the female population (OECD, 2008). The decrease in the number of smokers is partially due to different types of prevention activities (Feenstra et al., 2005). However, because of the non-negligible effects on health, the Dutch government remains focused on reducing smoker prevalence rates.

Figure 3 Percentage of population smoking in the Netherlands



Source: OECD (2008)

Prevention and Health Care Costs

In principle, unhealthy behavior is avoidable and changeable (Schaapveld, 1999). Public health policy on prevention in the Netherlands is therefore prioritized on changing unhealthy lifestyles, including smoking and obesity (MinVWS, 2006; 2007c). The costs and effectiveness of various prevention programs targeted at reducing smoking and obesity are beyond the scope of this paper. What *is* interesting in the context of this paper however, are the effects of prevention on (health care) costs and (risk equalization) benefits for the insurer. Various policy documents assume that prevention of unhealthy behavior leads to a lower disease prevalence, and hence results in lower health care expenditures (Health Council of the Netherlands, 2003; OECD, 2005; MinVWS, 2008). In this respect, smoking and obesity account for 3.7% and 2.0% of total Dutch health care costs, respectively (Van Baal et al., 2006b; 2008b). This reasoning is not complete however. As healthy living people have higher life expectancies, they incur costs over a longer period of time. These additional costs are particularly the result of the occurrence of diseases related to old age. Although short term health care costs are lower for healthy living individuals, their total lifetime health care costs are usually higher. While prevention will generate health gains, in the end prevention thus results in higher health care costs (Barendregt et al., 1997; Van Baal et al., 2006b; 2008a; 2008b), especially when long term care is included in the costs figures. However, as health gains have merits in their own, higher costs do not imply that prevention is not worthwhile. This observation only emphasizes that the decision on prevention should not be based solely on financial costs and benefits.

A prominent problem in the funding of prevention programs is the so-called prevention paradox. This issue has to do with the annual mobility of insureds, and the different timing of costs and benefits of prevention. Short term investments of insurers in prevention will only be attractive when the benefits of prevention (better health of their insureds) are guaranteed. However, as investments in prevention are coupled to increases in premiums, insureds have an incentive to change to an insurer with a lower premium, once the insured has participated in the prevention program. As an insurer has no guarantee that it will obtain the benefits from its investments, its incentive to make these investments in prevention will disappear.

Funding of the Dutch Health Care System

The majority of health care costs is financed by health insurance companies (50.8%, including co-payments and deductibles). In addition, the health care system is funded by the Dutch Exceptional Medical Expenses Act (AWBZ), contributing 32% of total health care costs. The remaining 17% is financed by the government and other sources (Slobbe et al., 2003).

The macro budget comprises all costs relevant for insurers under the risk equalization system. This budget is composed of several elements, which all have specific treatments of ex ante and ex post risk equalization. The element ‘variable hospital costs’ is the largest component of the budget (39.1%). The element ‘other performances’, concerning transport, the general practitioner, and nursing care for instance, is another major part of the macro budget (35.7%). A third component is ‘constant hospital costs’, which has a very specific risk equalization mechanism. As of 2008, a fourth element of the macro budget is added: the curative mental health care (MinVWS, 2007b). Supplementary insurances are not part of the macro budget. In the Netherlands, about 10% of insurers’ income stems from supplementary insurance packages (Vektis, 2007). This money is mostly spent on contact lenses and eye glasses (Slobbe et al., 2003).

3. METHODOLOGY

This study examines the financial incentives for prevention in the Dutch ex ante risk equalization scheme for insurers. Therefore, analyses are carried out from the perspective of the insurer. This implies that only the costs and benefits that are relevant for insurers are taken into account; health care costs financed out of the AWBZ or by the government are not incorporated in the analyses. Spillovers to other sectors are not taken into consideration either. Costs and benefits are therefore lower than studies that examine the entire health care system.
To estimate the effects of the Dutch risk equalization scheme on insurer’s incentives for prevention, this study examines the differences between insurer’s costs and benefits for unhealthy living (smoking or obese) and healthy living people (non-obese, non-smokers). This is done by means of a simulation model. The group with the largest positive balance (benefits minus costs) is financially the most attractive for the insurer. Differences between the three cohorts are compared on a cross-sectional basis, over insureds’ entire lifespan, and per average life year.

Chronic Disease Model

In this study we used data from the RIVM Chronic Disease Model (CDM). The CDM is a simulation model that uses three cohorts each consisting of 500 men and 500 women, who are either: (1) smoking; (2) obese; or (3) healthy living people. There are no transitions between cohorts over time: healthy people will never start smoking and will never become obese, and vice versa. All men and women are initially 20 years of age. The model uses smoking and obesity as risk factors to simulate the prevalence of 22 related diseases, such as various types of cancer and cardiovascular diseases, diabetes and COPD (the CDM-related diseases are given in appendix A). In addition, mortality is simulated in this model. Mortality rates are highest for smokers and lowest for healthy living individuals. After 100 simulations of 1 year there are no survivors left in any of the three cohorts (Van Baal et al., 2008a). This is not surprising, as people’s age is 120 at that point of the simulation. In addition to related diseases, people also suffer from unrelated diseases, (diseases that are not associated with smoking or obesity such as mental disorders and most infectious diseases to name a few). The risk of developing such diseases is, as these are unrelated, equal in all three cohorts. The prevalence of unrelated diseases is only dependent on the numbers of survivors in the cohorts.

Data

The CDM provides data on the survival and prevalence rates for the related diseases in the three cohorts. The contributions corresponding with the risk adjusters in 2008 are given in Van Vliet et al. (2007). In addition, data from the Health Care Insurance Board, on the volumes of PCG and DCG classifications in the Netherlands was used. The National Medical Registration (2005) on clinical discharges was used to determine the unrelated and related proportions of DCGs. Prevalence rates for several diseases were drawn on from the National Public Health Compass and other sources. Finally, the results of the Costs of Illness study from 2003 were used, coupled to the estimated 2008 macro budget (MinVWS, 2007b).

Risk Equalization Contributions

The analyses use three out of the six risk adjusters of the Dutch system, namely the demographic risk adjuster (age, gender) and the two direct health proxies PCGs and DCGs. Together, these three risk adjusters predict 17% of the variance in total health care expenditures, whereas all six risk adjusters of the Dutch risk equalization formula explain 22% of this variance (Van de Ven et al., 2004). Risk equalization contributions are given in Van Vliet et al. (2007). For all risk adjusters, contributions are categorized according to type of care. This is done for the purpose of ex post equalization, which is not (equally) applied to all types of health care. Ex post equalization is not incorporated in these analyses. Contributions for the different types of health care are therefore summed over types of care for each risk adjuster. To find total REF contributions for all risk adjusters per individual, the contributions for the separate risk adjusters are summed (negative contributions for DCG0 and PCG0 are subtracted). [3]

The first risk adjuster consists of male and female age-classes (eighteen 5-years classes and one 90+ class). The corresponding equalization contributions range from €817.85 to €3,259.53 for men and from €893.50 to €2,826.25 for women (Van Vliet et al., 2007). The heights of the risk equalization contributions for the demographic risk adjuster are given in appendix B.

Under the Health Insurance Act all insureds are classified into one or more of 21 pharmacy costs groups. 20 PCGs are ordered according to 20 specific diseases, for which certain medications are prescribed (for at least 180 days a year). PCG1 (glaucoma) is linked to the lowest PCG contribution (€333.98). PCG20 (growth hormones) corresponds with the highest PCG contribution (€21,057.45). The additional PCG (PCG0) captures those individuals who are not embodied in any of the disease-based PCGs. PCG0 serves as a reference group, and contains 84% of the population. PCG0, which thus contains healthy individuals, corresponds with a negative contribution (€-312.77). Insurers thus have to make a payment into the REF, rather than receiving additional money, for individuals classified in PCG0 (Van Vliet et al., 2007), i.e. even the nominal premium more than compensates the financial risk of the insurer for healthy individuals. The risk equalization contributions for the PCG risk adjuster are given in appendix C.

All insureds are also categorized into one of 14 diagnostic costs groups in the Dutch health care system. Insureds with multiple DCG classifications are categorized into the highest DCG. DCGs are costs-homogenous, in contrast to the disease-based PCGs. DCG classifications are based on diagnoses from clinical discharges. Similar to PCG classifications, the reference group DCG0 contains those individuals that are not captured by any other DCG (MinVWS, 2007a). 98% of the Dutch population is classified in this DCG0 group. DCG0 is also linked to a negative contribution (€-98.24). REF contributions for the other DCGs range from €1,521.43 to €52,930.57 (Van Vliet et al., 2007). Appendix D gives the risk equalization contributions for the DCG risk adjuster.

Related Diseases

Prevalence rates of diseases related to smoking or obesity are estimated in the CDM. All other diseases are assumed to be unrelated to smoking or obesity in these analyses. The related diseases are classified according to ICD-9 classifications (4 digits).

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[3] Risk equalization contributions per simulation year are computed as follows for the three cohorts:
Risk equalization contribution per simulation year = (Demography contribution * number of persons of corresponding age and sex) + (PCG contribution * number of persons with corresponding PCG-classification) – (PCG0 contribution * number of PCG0 persons) + (DCG contribution * number of persons with corresponding DCG-classification) – (DCG0 contribution * number of DCG0 persons)

Data from the Dutch Health Care Insurance Board (2007) on predicted volumes of PCG classifications per disease in the Netherlands for 2008 was compared to the Dutch disease prevalence rates. This way, the number of PCG classifications per patient was calculated. This number was coupled to the prevalence rates in the CDM, and the number of PCGs for each of the related diseases was calculated.

Under the Health Insurance Act diseases are categorized into 13 DCG classes with approximately equal expected costs. In principle, DCGs thus entail multiple diseases. The relation between these diseases and DCG classification is given in the DCG 2008 table (CVZ, 2004), which links ICD-9 codes to DCG classes. With the use of clinical discharge data from the National Medical Registration (2005), the ratio of DCG classification and disease was computed. This resulted in the number of DCGs per patient. Then, this number was combined with the disease prevalence rates from the CDM, and the volumes of DCGs in the three cohorts were found.

Unrelated Diseases

The prevalence of unrelated diseases is independent of smoking and obesity. The relative occurrence of PCGs and DCGs in the population was therefore assumed equal in the three cohorts. Differences in the number of survivors in the cohorts are reflected in the absolute number of people that suffer from certain unrelated diseases, and hence classified in a specific PCG or DCG. The shares of related and unrelated PCG and DCG classifications were computed in order to find the number of unrelated PCGs and DCGs for each cohort.

The PCG disease classifications are more aggregated than the CDM disease classifications. With the prevalence of the related (CDM) diseases and total (PCG) diseases, the share of related diseases in total diseases was determined. Prevalence rates were extracted from the National Public Health Compass (2008) and other sources, such as the Second National Study (Van der Linden et al., 2004) and the Dutch Heart Foundation (Van Leest et al., 2005). The proportion of unrelated PCGs was used to find the number of unrelated PCGs per inhabitant. This number of unrelated PCGs per capita was then used on the number of survivors in the three cohorts to find the total number of unrelated PCGs in the cohorts. Only five of the 20 PCG classifications were related to the CDM diseases. The other 15 PCGs were therefore considered as unrelated diseases completely.

The National Medical Registration (2005) provides information on the volume of DCGs and the volumes of related (CDM disease), and unrelated (non-CDM disease) DCGs. This ratio was linked to the predicted total number of DCGs from the data of the Health Care Insurance Board (2007). The proportion of unrelated DCGs was used to find the number of CDM-unrelated DCGs per person. The per capita proportion was then used to find the number of unrelated DCGs in the three cohorts.

The numbers of unrelated PCGs and DCGs were corrected for age and sex, as a relation between these demographic factors and disease prevalence is assumed. Since the data on volumes of DCGs and PCGs in the Netherlands from the Health Care Insurance Board (2007) does not distinguish between age and sex, this relation would otherwise not be accounted for. The related PCGs and DCGs were not corrected for age and sex, as the CDM already includes age and sex as risk factors on prevalence rates of the CDM (related) diseases.

Disease-free Proportion

For insureds classified as DCG0 and/or PCG0, insurers have to donate money to the REF. It was therefore necessary to determine the volumes of PCG0 and DCG0 classified persons in each cohort. For each disease, the share of the remaining population in the cohorts that did not suffer from that particular disease was computed. The number of people without diseases was calculated by multiplying all these disease-free fractions with the number of survivors in the cohorts. As PCG and DCG disease classifications differ, the PCG0 and DCG0 volumes in the same cohort vary in size.

Costs of Illness

The Cost of Illness study (2003) allocates total health care costs in the Netherlands to diseases on the basis of hospital admissions and nursing days. This dataset distinguishes between financial sources (insurers, AWBZ, government and other sources), so health care costs for insurers can be separated from total costs of health care. Our study used the costs of illness dataset to determine insurers' health care costs per cohort. In this dataset, costs of both related and unrelated diseases are taken into account. Related costs depend on the prevalence rates of the diseases in the CDM; unrelated costs are dependent on the number of survivors in the cohorts.

For consistency, health care costs for insurers as used in the Cost of Illness study of 2003 were corrected for the demography of the 2008 Dutch population. Subsequently, total health care costs for the Netherlands on which the Costs of Illness study is based was set equal to the 2008 macro budget for health care costs for insurers in the Netherlands (MinVWS, 2007b). The macro budget was determined at €30.5 billon for 2008. The risk equalization contributions are based on this macro budget, and are therefore consistent with the size of this estimated budget. The macro budget only comprises insurer's health care costs within the Health Insurance Act; it therefore only comprises health care costs within the basic benefits package. Constant hospital costs and curative mental health care costs are components of the macro budget that were not incorporated in the CDM. These elements were therefore removed from the macro budget before equalizing Cost of Illness figures with the macro budget. This way, constant hospital costs and curative mental health care costs are not incorporated in the analyses; so that this was study is based on a total expenditure of €22.8 billion.

It was unnecessary to correct for time differences with inflation rates, as both the macro budget and the risk equalization contributions use 2008 as base year.

4. RESULTS

Costs

Over the entire lifespan, health care costs show up highest for healthy living insureds (table 1 section A). Healthy living people die older, and therefore incur costs over a longer period of time. Additional costs for healthy living people are especially associated with diseases related to old age. Unhealthy living people simply do not live long enough to incur these CDM-unrelated diseases. This is shown in figure 4, in which positive values depict higher costs for healthy living cohorts. Until just over the age of 70, health care costs are lowest for the healthy living cohort. Higher costs for the unhealthy cohorts are due to the high prevalence of related diseases in those cohorts. In the long run, the healthy living cohort becomes most costly. This is due to the higher life expectancy of healthy living people, and the accompanying diseases.

Figure 4 Additional costs for healthy living cohort compared to smoking and obese cohorts

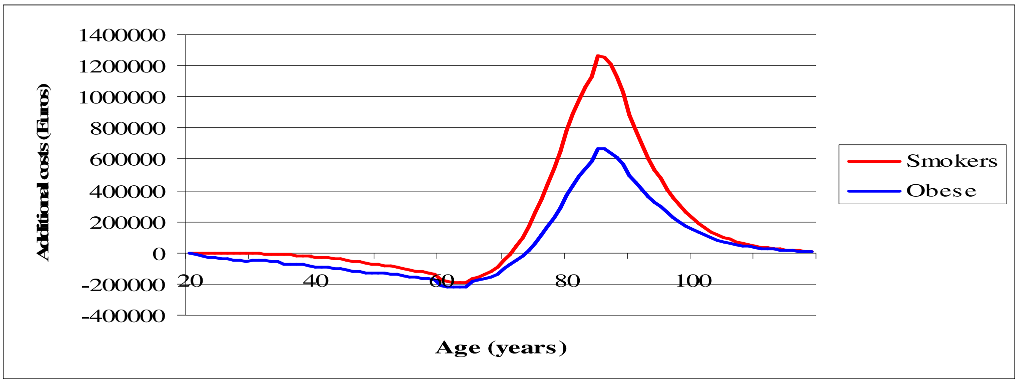
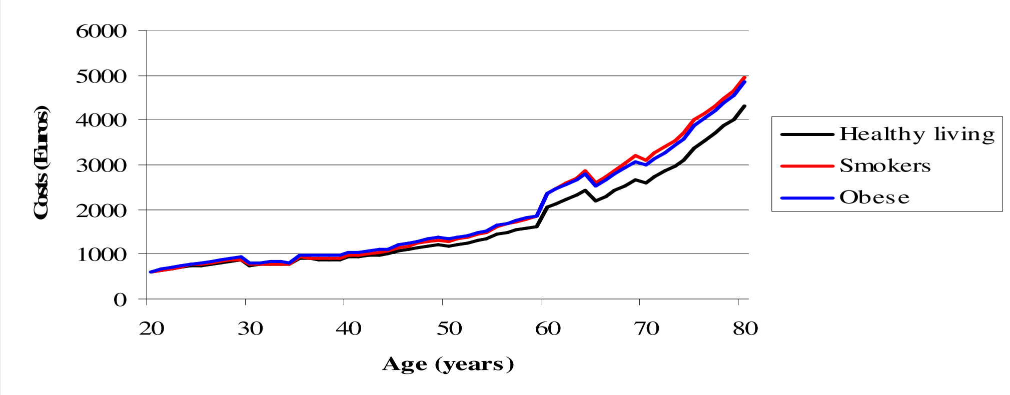


Figure 5 shows that until the age of 40 health care costs per survivor are approximately equal among the three cohorts. From then on, costs per survivor are highest for smokers and lowest for healthy living people. If smokers/obese live to the age of 80, they are (on average) about €500 more expensive than healthy living survivors of the same age, from the perspective of the insurer. The contradiction with the figure 4 is explained by the correction for life expectancy in this analysis. Figure 5 only incorporates costs for the insurer; health care costs financed by all other sources such as AWBZ (which finances long-term care for instance) are not depicted in this figure. Van Baal et al. (2008a) do incorporate all health care costs in their analyses. Their graph is similar to figure 5 below, although the values they find, especially at old age, are larger.

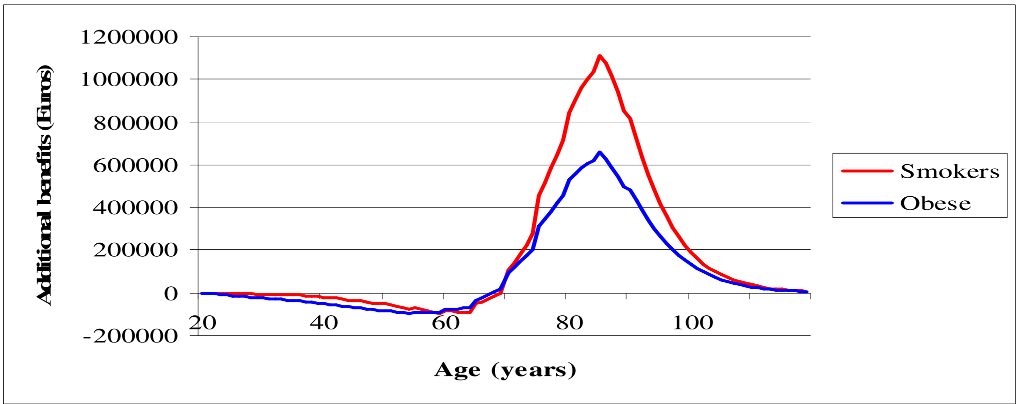
Figure 5 Health care costs per survivor



Revenues

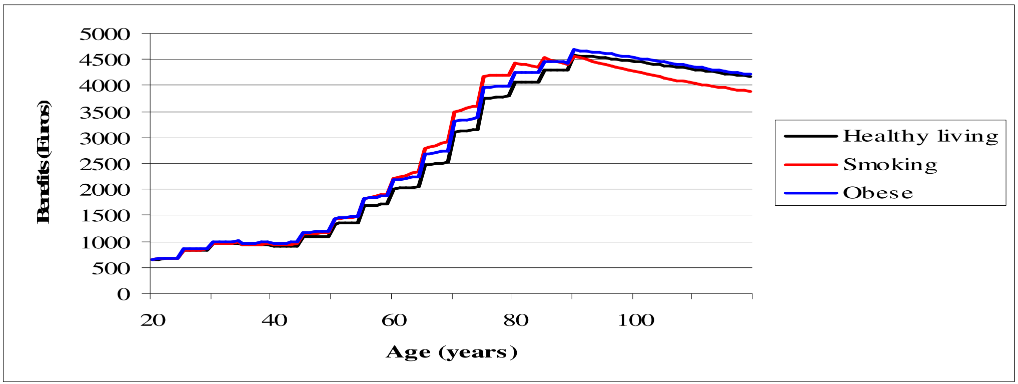
Lifetime benefits for the insurer are highest for the healthy living cohort. Again, this follows from the high life expectancy for this cohort; insurers accrue REF contributions on healthy living people over the longest period. The demographic risk adjuster (age, gender) accounts for 88% of total REF benefits. Figure 6 shows the pattern of benefits of the cohorts over age, in which positive values indicate higher benefits for the healthy living cohort than for the unhealthy living cohorts of at the same age. Differences in benefits between the cohorts follow similar patterns as do costs (shown in figure 4). Until the age of 70, benefits for the healthy living cohort are below those of the smoking and obese cohort. In the remaining 50 years on the analyses, benefits are highest for the healthy living cohort. The positive difference in this latter period is much larger than the negative difference in the former period. This implies that benefits over the entire lifespan are larger for the healthy living cohort than for the unhealthy living cohorts. This is also shown in table 1.

Figure 6 Additional benefits for healthy living cohort compared to smoking and obese cohorts



Benefits out of the REF per survivor are given in figure 7. Until the age of 40, benefits are approximately equal for all three cohorts. From the age of 40 until the age of 90, equalization contributions increase with age. Insurers receive most benefits for smoking survivors and least for healthy living survivors between these ages. At the age of ninety, benefits are at the maximum of €4,500 per survivor, and almost equal for all cohorts. From the age of ninety onwards, benefits are least for smoking survivors and highest for obese survivors. Over the entire lifespan, benefits are lowest for healthy living survivors.

Figure 7 Risk equalization benefits per survivor



In correspondence with figure 7, figure 8 also shows that benefits for smoking survivors are higher than those for healthy living survivors until the age of 90. Benefits for obese survivors are always higher than for healthy living survivors. Until the age of 70, the difference in benefits between healthy living survivors and unhealthy living survivors increases.

Figure 8 Additional benefits for healthy living survivors compared to unhealthy living survivors

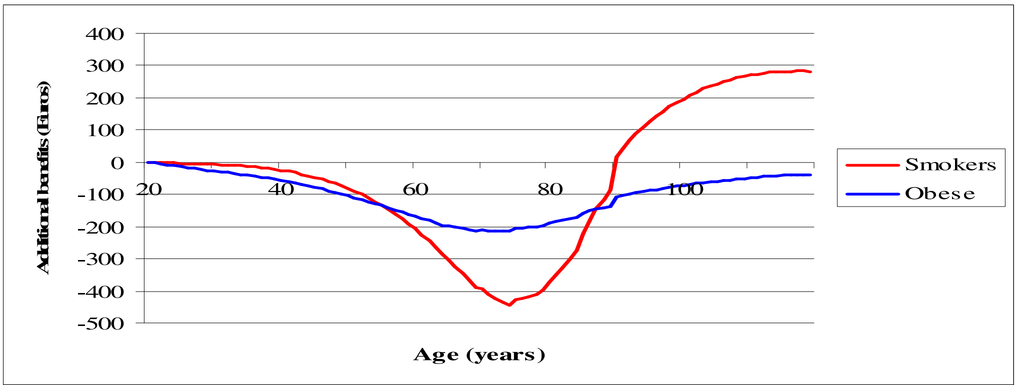


Figure 9 shows that until the age of 75 differences in benefits between smoking survivors and healthy living survivors increase. In this period, insurers receive most REF benefits on smoking survivors. This is due to benefits for related PCGs and related DCGs. After age 75, expected benefits for healthy living and smoking survivors converge. After the age of 90, healthy living survivors are compensated more than smoking survivors. This is particularly due to the benefits for unrelated PCGs and to a lesser extent to smaller paybacks on PCG0 individuals and benefits for unrelated DCGs.

Figure 9 Composition additional benefits for smoking survivors compared to healthy living survivors according to risk adjusters

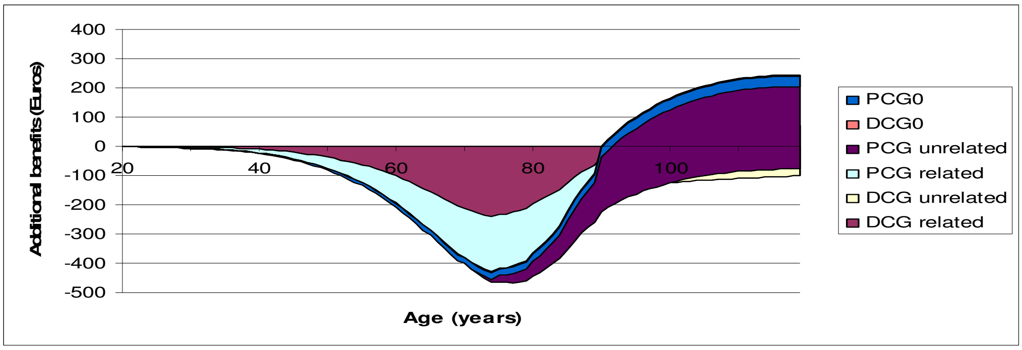
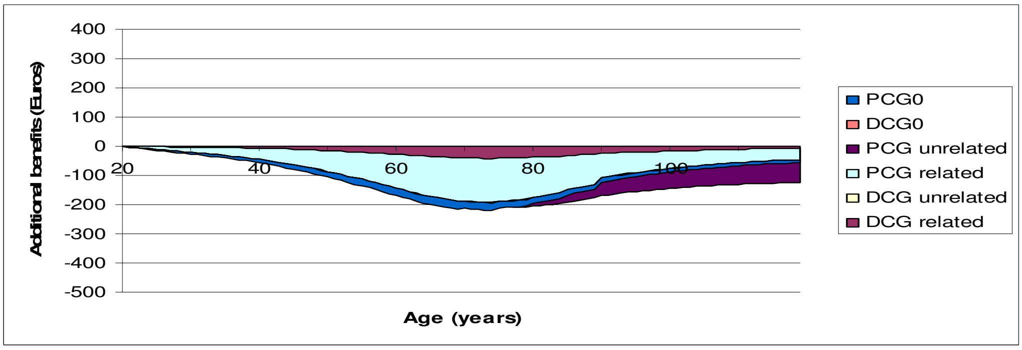


Figure 10 shows that benefits for obese survivors are higher than benefits for healthy living survivors at all ages. This is mainly the result of differences in related PCG benefits. Unrelated PCG and related DCG benefits and smaller paybacks on PCG0 individuals explain the remaining differences in benefits between the cohorts. Compared to figure 9 on the difference between the smoking survivors and the healthy living survivors, the related PCG contributions are approximately equal. The unrelated PCG contributions and related DCG contributions are much more prominent in the previous figure compared to figure 10.

Figure 10 Composition additional benefits for obese survivors compared to healthy living survivors according to risk adjusters



Balance

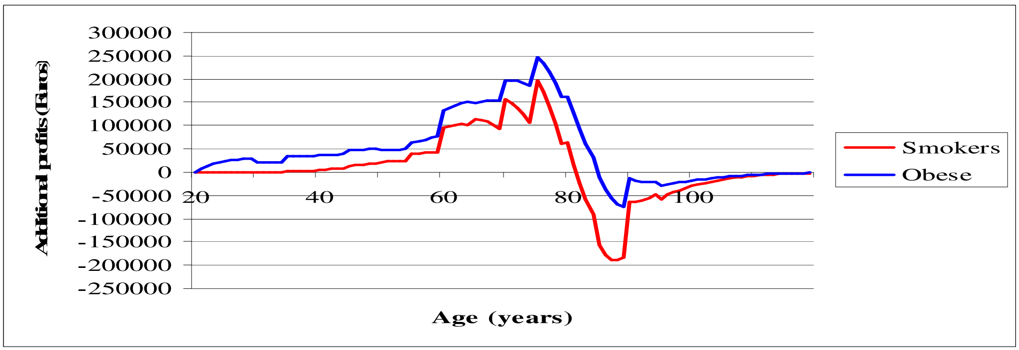
The balances (benefits minus costs) follow the same pattern for the three cohorts. These results are shown in figure 11, in which positive balances indicate that benefits exceed costs. The saw-toothed patterns are the result of the use of age-classes at the benefits side of the analyses. Until the age of 80, the balances for the three cohorts are alternately positive and negative. Between the ages of 60 and 65, there is a large negative balance for all three cohorts. Between the ages of 65 and 75 balances are predominantly positive, especially for the healthy living cohort. The balances are negative for all three cohorts in period between the ages of 80 and 110. From then on, the differences between benefits and costs are approximately zero in all three cohorts.

The lifetime balances for all three cohorts are negative, as all three cohorts suffer more costs than benefits are generated. The negative balances at low ages and between the ages of 80 and 100 are larger than the balances in the profitable periods. Explanations for the negative lifetime balances are discussed in the following sections of the paper. However, the differences in balances between the three cohorts are the most important outcomes of these analyses. Until the age of 80, the healthy living cohort has the highest balance of the three groups. Thereafter, the smoking cohort shows to be the most profitable. Over the entire lifetime, the healthy living cohort is most attractive for the insurer (table 1), as the healthy living cohort's balance is least negative of the three.

Figure 11 Total balance (benefits minus costs) for the three cohorts

Until the age of 82, the healthy living cohort is more profitable than the smoking cohort of the same age (figure 12). From then on, the healthy living cohort is relatively less attractive than the smoking cohort for insurers. However, the balances are much closer than in the first period, in which the healthy living cohort is more attractive. The obese cohort is financially least attractive for insurers until the age of 85. From that age on, the balance of the obese cohort is higher than the balance of the healthy living cohort.

Figure 12 Additional profits healthy living cohort compared to smoking and obese cohorts



At all ages, an insurer loses more money on smoking and obese survivors than on healthy living survivors. At the maximum, an insurer loses €350 more on an unhealthy living survivor, compared to a healthy living survivor of the same age (figure 13). The difference increases until the age of 80 for obese and until the age of 90 for smoking survivors respectively.

Figure 13 Additional profits for healthy living survivor compared to smoking and obese survivors

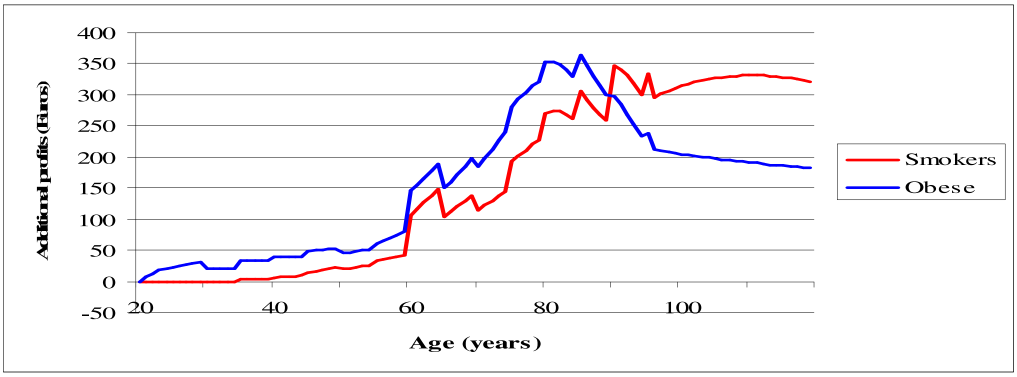


Table 1 (section A) shows that over the entire lifespan an insurer loses money on all three cohorts. Health care costs for the 3000 people in the analyses are 3.2% larger than risk equalization contributions for those people. An insurer can expect to lose €1,617 on a healthy living person; €2,719 on a smoking person; and €6,457 on an obese person (if these persons join at age 20 and remain insured until death). As losses are smallest for healthy living people these are, over their entire lifespan, financially most attractive for insurers. Obese people are financially least attractive.

Healthy living people are also more attractive when differences in costs and benefits per life year are examined. Per life year, insurers lose €22 more on smokers than on healthy living persons. Compared to healthy living people, additional losses per life year on obese people are even larger: €83 per life year. Relative differences are larger for the per life year balances than for the lifetime balances as a result from differences in life expectancy, which are taken into account in the table 1 (section B).

Table 1 Total revenues, total costs and balances for the three cohorts (in Euros)

	Per person revenues	Per person costs	Difference per person
A. Lifetime			
Healthy living	121,503.38	123,120.85	-1,617.47
Smokers	103,715.89	106,434.58	-2,718.68
Obese	111,663.46	118,120.48	-6,457.02
B. Per life year (on average)			
Healthy living	1,886.30	1,911.41	-25.11
Smoking	1,807.42	1,854.80	-47.38
Obese	1,864.67	1,972.50	-107.83

Subgroup Top 10: Short-term Financial Attractiveness

Table 1 (section A) shows the balances for people joining at age 20 and remaining insured until they die. A time horizon of 100 years, as used in these analyses, might be too long for private insurance companies. In addition, there is an annual open enrolment period, which implies that insureds switch insurance companies every year, and is likely to reduce insurer's time horizons even more. A shorter time horizon might therefore be more appropriate for insurers. The healthy and unhealthy living survivors are divided into age classes of 5 years to examine insurer's short-term incentives. The comparison of balances per survivor for the classes in the three cohorts resembles their relative short-term attractiveness.

Table 2 shows different subgroups ranked according to financial attractiveness per survivor. Classes ranked 1 to 18 have a positive balance. Except for the youngest survivors (aged 20-35) are short-term balances for healthy living survivors always lower than for unhealthy living survivors. For these classes, balances for healthy living survivors are very close to the balances of the more profitable smoking survivors. The balances for the unhealthy living individuals are close to those of the balances of healthy living individuals until the ages of 60. After the age of 60, the balances for the healthy living survivors are much more attractive than the balances for the unhealthy living survivors. For the rest of the groups costs exceed benefits. Lifestyle appears to be an important determinant of financial attractiveness; 5 out of the 10 highest ranked groups are healthy living survivors. As also shown in figure 11, healthy living survivors aged 65 to 69 are financially most attractive. Survivors aged 25 to 29 appear to be financially highly attractive for insurers as well, regardless if these survivors smoke or not. From the ages above 80 none of the subgroups are attractive; losses are large on these subgroups. This is especially true for unhealthy living survivors.

Table 2 Ranking of attractive subgroups based on balances per survivor (in Euros)

Age	Rank	Healthy living survivors	Rank	Smoking survivors	Rank	Obese survivors
20-24		-22.73		-22.38		-34.38
25-29		18.43		18.58		-8.36
30-34	3.	198.60	2.	199.45	4.	177.38
35-39		32.11		29.16		-1.78
40-44		-63.61		-71.21		-102.78
45-49		-58.31		-76.59		-108.76[a]
50-54	9.	81.81		59.53		33.55
55-59	5.	171.32	7.	134.28	8.	101.62[a]
60-64		-192.79		-319.70[b]		-359.58[b]
65-69	10.	79.14		-41.01[b]		-93.09[b]
70-74	1.	278.74	6.	149.00[b]		66.19[c]
75-79		69.40		-141.80[c]		-233.63[c]
80-84		-471.94		-741.25[c]		-816.88[c]
85-89		-951.48		-1,232.05[c]		-1,282.32[c]
90+		-791.41		-1,114.95[c]		-999.90[c]

[a] Difference compared to healthy living survivor > €50; [b] Difference compared to healthy living survivor > €100; [c] Difference compared to healthy living survivor > €200.

5. FURTHER EXPLORATIONS

Our analyses show that for the three cohorts, insurer's costs are 3.2% larger than insurer's benefits. At first glance, this is a strange finding. Risk equalization would imply balanced costs and benefits. There are, however, two likely explanations for the negative balances found in our analyses.

First of all, just like our analyses the Dutch risk equalization scheme is in reality not balanced as well. That is, on average there is an annual loss on each insured. In 2007, insurers in the Netherlands faced total health costs that were 4.3% larger than their income (CVZ, 2008). The Health Care Monitor presents an annual loss of €30.99 per insured in the risk equalization system in the Netherlands for 2006 (Vektis, 2007). To a certain extent, these figures on the national level thus correspond with our findings.

As the risk equalization system is designed to equalize costs and benefits for the Dutch population as accurate as possible, a second likely explanation stems from the difference in demographics between the Dutch population and the CDM. In the CDM the cohorts are of equal size. This implies that there initially are twice as much unhealthy living than healthy living people in the model. In addition, there are no under-20 year olds. Moreover, in a cohort approach there are no new entrants. The typical rectangular Dutch population pyramid cannot be reproduced in a cohort approach.
Table 3 points out the sensitivity of the results with respect to the demographic composition in the cohorts. If all people in the cohorts are initially aged 50 instead of 20, all cohorts become less attractive for insurers compared to the balances shown in table 1. This is because profitable young ages are no longer included in the analyses and can therefore not compensate for unprofitable old ages. Over the entire lifetime, the smoking cohort is financially the most attractive when the initial age is increased to 50. The ranking of the balances per life year remains unchanged, although the relative differences between the cohorts diminish.

Table 3 Total revenues and costs per person with initial age 50 (in Euros)

	Per person revenues	Per person costs	Difference per person
A Lifetime			
Healthy living	98,514.09	105,369.62	-6,855.53
Smokers	81,586.02	87,486.63	-5,900.61
Obese	87,967.25	98,689.03	-10,721.78
B Per life year (on average)			
Healthy living	2,801.68	2,996.65	-194.97
Smoking	2,841.93	3,047.47	-205.54
Obese	2,822.77	3,166.82	-344.05

Socioeconomic Risk Adjuster

Smoking and obesity are both related to socioeconomic status (SES). In the Dutch risk equalization formula, insurers are compensated for insureds with low SES, whereas for insureds with high SES there is a mandatory payback into the REF (as with PCG0 and DCG0 insureds). The height of the REF contributions for the risk adjuster SES is dependent on age. The risk equalization contributions for the SES risk adjuster are given in appendix E.

The socioeconomic risk adjuster, as incorporated in the Dutch risk equalization formula, is absent in our analyses however, as the CDM does not provide data on SES. To examine the influence of this risk adjuster on the result of the analyses, additional data on the relation between SES and the prevalence of obesity and smoking was obtained from the National Public Health Compass (Van der Lucht & Picavet, 2006a; 2006b). Unfortunately, this data is only available at an aggregated level, in the sense that it does not discriminate for age or gender. In addition, education is taken as a proxy for income. The latter is the determinant for the classification of the socioeconomic risk adjuster in the Dutch risk equalization system.

Table 4 shows that the healthy living cohort is no longer the most attractive financially for insurers with the inclusion of the SES risk adjuster in the model. The balances for the unhealthy living cohorts are improved, whereas the balance for the healthy living cohort diminishes in attractiveness for insurers. The difference between total lifetime costs and lifetime benefits decreases with 1.2%. This is not surprising, as there are twice as many unhealthy living people as healthy living people in the analyses. The influence of the SES risk adjuster on the total balance between costs and benefits is limited because of the inclusion of the direct health measures PCG and DCG, which incorporates differences in health care usage because of socioeconomic status as well.

Table 4 Total revenues and costs per person including SES risk adjuster (in Euros)

	Per person revenues	Per person costs	Difference per person
A Lifetime			
Healthy living	119,377.49	123,120.85	-3,743.36
Smokers	105,896.63	106,434.58	-537.95
Obese	115,757.72	118,120.48	-2,362.76
B Per life year (on average)			
Healthy living	1,853.29	1,911.41	-58.11
Smoking	1,845.42	1,854.80	-9.37
Obese	1,933.04	1,972.50	-39.46

Discounting

The height of the discount rate that health insurers use in their analyses is unknown. In addition, it is not sure whether insurers work with time horizon as long as 100 years. Therefore, our analyses use undiscounted figures. Incorporating a discount rate leads to different results, which are shown in table 5. The size of both costs and benefits decrease substantially when a discount rate is taken into account. Balances for the healthy living and smoking cohorts turn positive and losses on the obese cohort decrease substantially. The ordering of the cohorts remains unchanged, although relative differences between cohorts decrease. Per life year, table 5 (section B), smokers and obese are only €363 and €1,128 less profitable than the healthy living respectively.

In this analysis, costs and benefits are discounted with the same discount rate, as they both deal with monetary values. The inclusion of a discount rate of 4% at both the costs and benefits side implies that costs are no longer larger than benefits; instead benefits are 0.2% larger than costs. This is due to the fact that the unprofitable period after the age of 80 is discounted heavily compared to the profitable period at younger ages.

Table 5 Discounted (4%) total revenues and costs per person (in Euros)

	Per person discounted revenues	Per person discounted costs	Discounted difference per person
A Lifetime			
Healthy living	28,628.01	28,071.13	556.88
Smokers	27,607.77	27,413.67	194.11
Obese	28,524.93	29,095.85	-570.92
B Per life year (on average)			
Healthy living	444.44	435.79	8.65
Smoking	481.11	477.73	3.38
Obese	476.34	485.87	-9.53

6. DISCUSSION

Data

Different data sources were necessary in order to link the CDM data to the reality of the Dutch risk equalization scheme. This leads to potential differences in base years, which are corrected for where possible. The use of multiple data sources might also result in differences in definitions, compositions, and measurement methods of relevant data, which might influence the results of the analyses.

The REF contributions are based on the macro budget and the Costs of Illness study is based on figures from Statistics Netherlands. For consistency, the figures from the Costs of Illness study were therefore linearly scaled back to the macro budget level. This might be problematic, as the figures from Statistics Netherlands are composed differently than the macro budget. The costs defined by Statistics Netherlands are larger mainly because of the inclusion of deductibles and supplementary insurances (for eye glasses, physiotherapy, and adult dental care) in the budget definition. These are not incorporated in the macro budget, as they are not appropriate for the height of the REF contributions. Linearly scaling back the Costs of Illness numbers, thus incorrectly includes deductibles and supplementary insurances in the costs. The results might therefore be influenced by these dissimilarities. This effect might especially be present for the obese cohort, as obese people might be using more benefits from the supplementary package than the other cohorts. As supplementary insurance packages are thus wrongfully included in the analyses, the deviation between costs and benefits diminishes if this inconsistency in definitions could be corrected for.

In addition, some assumptions had to be made concerning the data. As the CDM does not provide data on an individual level, the number of diseases per individual could not be determined. In order to determine the number of PCG0 and DCG0 individuals, the disease free proportions of all diseases were multiplied. This way, some notion of comorbidity was taken. In reality, the comorbidity is often larger than the statistical correlation used in our analyses. This implies that the disease-free fraction of the population was underestimated; actual PCG and DCG classification are concentrated among fewer people, and more people are disease-free in reality. As the numbers of PCG0 and DCG0 individuals were underestimated, so were the corresponding (negative) contributions.

The aggregated data level leads to another inconsistency between the analyses and reality. In the Health Insurance Act, insureds can maximally be categorized into one (the highest) DCG. This could not be reproduced in the CDM, because of the absence of data at the individual level. Insureds were therefore categorized in all DCGs they belonged to according to their diseases. This led to an overestimation of the REF contributions for DCGs. As only a small proportion of the population is classified in a disease-based DCG (2% of the Dutch population) the impact on the results might be limited. However, the overestimation of DCG classifications would lead to an overestimation of DCG-based REF contributions, and an underestimation of DCG0 paybacks.

To estimate the effect of the risk adjuster SES additional data sources were used. We used education as a proxy for SES, and had to assume that income classes and educational classes are similar. In addition, the data available did not discriminate for age and sex. Preferably, the data would have been more specific to gain better insight of the influence of SES on the results. However, the data used does provide the direction in which this risk adjuster influences the balance between costs and benefits for insurers for the three cohorts.

Risk Equalization Contributions

Figure 11 shows large fluctuations of the balances of the three cohorts over time. These fluctuations are the result of the age classes that are used in the height of the risk equalization contributions. Health care costs follow continuous patterns over time. Consequently, the balances are often positive at the beginning of an age class, and negative at the end of an age class. To remove these unnatural patterns, the contributions dependent on age classes could be replaced with continuous risk equalization contributions.

There are however also age classes for which there is only a positive or negative balance. Perhaps, the contributions for these age classes should be adjusted, in order to avoid long periods with only positive or negative balances.

Risk Equalization Formula in Our Models

This research only considered the three most important risk adjusters (demography, PCG and DCG), which collectively explain 17% of the total 22% in the variance of health care expenditures. As the CDM is a simulation model, it does not provide data on region, social economic status or source of income (the other risk adjusters). Although the relation between these social factors and unhealthy lifestyles has been demonstrated in several publications (Van Lindert et al., 2004), these three risk adjusters could therefore unfortunately not be incorporated in these analyses. Although REF contributions for the social risk adjusters count up to zero on a national level, the demography in this research deviates from the population in the Netherlands, as discussed before. The exclusion of these risk adjusters in our analyses can therefore lead to biased results. This is also suggested by the provisory inclusion of the risk adjuster SES in the previous section, through which balances changed in favor of the unhealthy living cohorts. However, these findings might be due to a large degree to the relative abundant presence of unhealthy living people in our study. The influence on the total difference between costs and benefits appeared only marginal, which emphasizes that the most important risk adjusters are already incorporated in the analyses. Since health care utilization is also related to socioeconomic factors, the direct health proxies PCGs and DCGs incorporate a large share of the explanatory power of the social risk adjusters.

Another component of risk equalization that is not been encountered in our analyses is ex post risk equalization. Although Dutch policymakers aim to cut down on these ex post risk equalization mechanisms, currently these mechanisms are very important in the Dutch risk equalization scheme. Ex post risk equalization could however not be included in these analyses, particularly because of the aggregation level of the data from the CDM. Data at individual level is needed to incorporate ex post mechanisms in future research. This would increase the resemblance between the models used and reality.

Chronic Disease Model

The chronic disease model is based on a number of assumptions. The equal sizes of the cohorts at the start of the simulations imply that there are twice as many unhealthy living individuals than there are healthy living people. This does not resemble reality; in the Netherlands about 28% of the population smokes, and about 12% of the population is obese (Willemsen & Van Leent Loenen, 2007; Visscher et al., 2007). The initial numbers of males and females is also equal.

In year zero, all cohorts start with 1000 people at age 20. The previous paragraph already pointed out the influence of the initial age on the results. An implication of a starting age of 20 is that there are no children in the cohorts. For obesity in particular, this is a limitation of the model. The number of obese children has increased significantly over the last decade (Van den Hurk et al., 2006; MinVWS, 2006). Obese children have an even larger risk at developing type II diabetes or psychosocial problems at later stages of their lives than people who develop obesity after childhood (Visscher & Schoemaker, 2007b). Prevention of obesity is, consequently, often targeted at the youngest part of the population (MinVWS, 2006). Future research might therefore examine insurer's financial incentives for prevention of childhood obesity.

Another assumption made in the analyses is that all diseases that are not in the CDM are classified as unrelated to smoking and obesity. However, research showed diseases other than those in the CDM are correlated with these lifestyles. Some of these diseases are compensated for by the REF. This leads to potential underestimation of benefits for smokers and obese people. However, the most influential related diseases are in the CDM (Van Baal, 2008a).

Changes in behavior

Another assumption of the CDM is that there are no transitions between the cohorts. In reality, people of course do change lifestyles. Although their expected health care costs change as a result of the lifestyle change, this does not happen instantaneously. Instead, the risk of developing related diseases diminishes gradually. Because of this transitional phase, health care costs of related diseases decreases slowly as well. The heights of REF contributions are altered too, because of the changes in disease prevalence rates in the population. Negative PCG0 and DCG0 contributions will converge to zero, as more healthy people will compensate for fewer PCG and DCG classified insureds.

Prevention in the Netherlands

It should be noted that the purpose of risk equalization is to prevent risk selection, not to stimulate insurers to engage in prevention. The research question used in the analyses might therefore be too provocative. However, health gains – either by prevention or other health care activities – are a goal of the health care system where the risk equalization system is part of. Prevention (especially the funding of it) is a serious issue in the debates concerning the Health Insurance Law in the Netherlands. The research question therefore examines an important aspect of the Dutch health care system.

The costs and effectiveness of prevention programs are beyond the scope of these analyses. However, in decision making on prevention, these components are obviously taken into account. Prevention will only be financially attractive for insurers when an increase in profits obtained on formerly unhealthy living insureds compensates for the costs of the prevention program. The differences of per life year balances between the cohorts are quite small, as shown in table 1 (section B). Consequently, the incentive for prevention is also limited; many prevention programs might costs more than the €22 (respectively €83) that is saved on smokers (respectively obese people).

In addition to financial incentives, there might be other motives for prevention. Governments might have paternalistic preferences and strive for the highest health states of their citizens. Insurers might engage in prevention out of marketing motives to attract customers. Not to forget people's own interest in avoiding unhealthy behavior. Clearly, various actors can be made responsible for (the finance of) prevention of unhealthy behavior.

7. INFLUENCE OF RISK EQUALIZATION

Hypothetical Absence of Risk Equalization

The functioning of the Dutch risk equalization system as applied under the current Health Insurance Act is examined in the preceding paragraphs. It is also interesting to study the balances for the three cohorts in a hypothetical situation where all risk equalization contributions are replaced by nominal premiums. This way, a health care system with risk equalization can be compared to a health care system without risk equalization. This way, the consequences of risk equalization on insurers' incentives for prevention can be examined.

In this analysis, nominal premiums are set equal per life year in all three cohorts, regardless of age, gender, and lifestyle of the insured. The level of the nominal premium was conducted by dividing total health care REF benefits over all years lived by all people in the three cohorts. This way, the difference between total lifetime costs and total lifetime benefits over the three cohorts was equal to the difference found in the preceding analyses (total lifetime costs exceeding total lifetime benefits with 3.2%). The nominal premium was determined at €1,854.25. Costs in the three cohorts remained unchanged compared to the situation with risk equalization mechanisms.
The results are shown in table 6. Smokers are financially most attractive for insurers, for the entire lifespan of insureds (table 6, section A) as well as when life expectancies are controlled for (table 6, section B). The obese cohort is financially least attractive for insurers. In this hypothetical health care system, insurers thus only have financial incentives for prevention of obesity; incentives for prevention of smoking are not present.

Table 6 Benefits and costs after replacement of REF contributions with a nominal premium (in Euros)

	Per person revenues	Per person costs	Difference per person
A Lifetime			
Healthy living	119,439.47	123,120.85	-3,681.37
Smokers	106,403.50	106,434.58	-31.08
Obese	111,039.76	118,120.48	-7,080.72
B Per life year (on average)			
Healthy living	1,854.25	1,911.41	-57.15
Smoking	1,854.25	1,854.80	-0.54
Obese	1,854.25	1,972.50	-118.24

Introduction of Risk Equalization

When risk equalization mechanisms are introduced in the health care system, financial incentives for prevention change. In the Dutch health care system with risk equalization mechanisms in use, there are financial incentives for prevention of both smoking and obesity, as shown by the results in the preceding paragraphs. Compared to a system with only nominal premiums, risk equalization thus creates the incentive for smoking prevention. The last column of table 7 shows that the incentive for prevention of obesity is increased with the incorporation of risk equalization mechanisms, as insurers' losses on the obese cohort are larger in a system with risk equalization.

Table 7 Influence of risk equalization mechanisms on financial incentives for prevention over the entire lifespan (in Euros)

	Without risk equalization		With risk equalization		
	Difference per person	Compared to healthy living	Difference per person	Compared to healthy living	Increase in incentive
Healthy	-3,681.37		-1,617.47		
Smokers	-31.08	+3,650.30	-2,718.68	-1,101.22	4,751.52
Obese	-7,080.72	-3,399.35	-6,457.02	-4,839.55	1,440.21

Table 7 points out another interesting finding. For the healthy living cohort and the obese cohort, the absolute differences between lifetime costs and lifetime benefits is smaller in a system with risk equalization than in the system without risk equalization. This implies that the incentive for risk selection is smaller in a system with risk equalization. For smokers, however, insurers' incentives for risk selection is larger in a system that is based on risk equalization, as the absolute difference between lifetime costs and benefits is larger than in a system solely financed by nominal premiums.

8. CONCLUSIONS

Our analyses show that insurers can expect differences in health care costs and risk equalization benefits between healthy living; smoking; and obese people. At all ages, costs are higher for both smoking and obese survivors than for healthy living survivors, due to higher prevalence rates of diseases related to these lifestyles. REF benefits per smoking survivor are higher than benefits per healthy living survivor until the age of 90. For an obese survivor an insurer receives more REF benefits than for a healthy living survivor, regardless of age. Benefits are higher, again because of the higher prevalence of obesity related diseases, which are compensated for by the REF.
However, life expectancy is also lower for the unhealthy living people. Aggregated over the entire lifetime, both costs and benefits are therefore highest for the healthy living cohort. As healthy living people live longer, they sustain more unrelated diseases. Costs accompanying these diseases are compensated for by the REF.

Differences between costs and benefits also differ between cohorts, despite the presence of the risk equalization scheme. Our analyses show that over the entire lifespan costs are 3.2% larger than benefits for all cohorts. Negative balances do not confirm expectations, as risk equalization implies balanced costs and benefits over the entire population. The results of the analyses should therefore be interpreted with care. However, the most important outcomes of these analyses are the differences between the cohorts.
The negative balances imply that the cohort with the smallest negative balance (smallest loss), is financially the most attractive for the insurer. The analyses show that *over the entire lifespan* the healthy living cohort is financially most attractive for insurers. As both smoking and obesity are less profitable, there is a financial incentive for prevention for insurers. Over the entire lifetime, losses for smokers are 70% larger than for healthy living people. On obese people, insurers can expect to lose over the entire lifetime four times as much as on healthy living people. The financial incentive for prevention of obesity thus is more prominent, as losses on the obese cohort are largest. The analyses show that *per life year* healthy living people are the least unprofitable and therefore financially most attractive too. The relative differences in balances are even larger when this correction for life expectancy is incorporated. However, absolute differences in life year balances are small. These small absolute differences might decrease insurer's incentives for prevention; the costs of these programs will often be larger than the potential benefits to be gained.

The analyses over the entire lifespan only consider one aspect on insurers' incentives. Insurers are likely to have a time horizon less than the 100 years simulated in these analyses; a time horizon of only a few years is more plausible instead. Therefore, insurers' short-term financial incentives for prevention are examined with balances for survivors in age classes of 5 years. These analyses show that lifestyle is an important determinant of financial attractiveness for insurers; five of the top ten most attractive subgroups are healthy living survivors. The age class 25-29 is financially very attractive for insurers too, almost irrespective of the lifestyle of the surviving insureds. Balances for healthy living survivors are almost always – except for the youngest subgroups – higher than those of unhealthy living survivors of the same age. Insurers' incentives for prevention are thus highly relevant in the short term too.
Old ages seem to be a determinant of financial unattractiveness; losses are largest for survivor over the age of 80, especially for those with unhealthy lifestyles.

It should be noted that the incentive for prevention can also be seen as an incentive for risk selection. The result that incentives for risk selection remain present in the Dutch equalization system despite the risk equalization scheme is also found in the analyses of Stam and Van de Ven (2006; 2008).

The negative balance of total costs and total benefits over the three cohorts is likely to be explained by two factors. One element is that there is an imbalance between benefits and costs in the actual Dutch risk equalization system. This negative balance on the national level is even larger than the imbalance found in our analyses. Another possible explanation is the difference in demographic composition of the models used in our analyses and the demography of the actual Dutch population.
In addition, some risk adjusters were not incorporated in our models, and ex post risk equalization mechanisms were absent as well. Future research might incorporate these mechanisms to better resemble the Dutch equalization system. Another direction for further research is to match the CDM demography to that of the actual Dutch population.

Implications for Insurers and Policy

The analyses show that the insurer's financial incentive for prevention is present for both smoking and obesity. This seems to be true for the long term as well as for the short term. However, these incentives are small because of the small absolute deviations in balances between the healthy and unhealthy living cohorts. On the other hand, risk selection might be an alternative for insurers to obtain the most profitable people. Although risk selection is prohibited under the Health Insurance Act, insurers can select their customers on more subtle manners than via premium differentiation. The provision of supplementary insurances is argued to be an efficient method for risk selection.
As the purpose of prevention is to increase societal health, perhaps the finance of prevention should be allocated to the collective level, instead to privately owned insurers (Klazinga, 2006). A national, collectively financed, prevention fund is suggested as the solution for the prevention issue. Insurers can draw upon this fund to finance prevention programs with proven effectiveness. The prevention paradox would be avoided, as the financing of prevention would then be transferred from the individual insurer to the collective level. This would also end practices of cost ineffective prevention programs financed by insurers that are often claimed to be only part of marketing campaigns (Klazinga, 2006; Polder, 2007).

The presence of risk equalization mechanisms in the current Dutch health care system as examined in our analyses leads to incentives for prevention of obesity and smoking for health insurers. These incentives are even larger than in a hypothetical system based entirely on nominal premiums. Interestingly, the incentive for risk selection of smokers is larger in a system with risk equalization than in a system solely financed by nominal premiums.
Improving the explanatory power of the risk equalization system will decrease the deviations between the balances of the healthy living and unhealthy living cohorts. A consequence of such a reduction of these deviations is that it will decrease insurers' incentives for risk selection. On the other hand, incentives for prevention might be reduced as well; the balances of unhealthy and healthy living will converge, which makes the insurer more indifferent for the lifestyle of its insureds. From this perspective, refining the risk equalization system would thus *decrease* insurer's incentives for prevention; a different prevention paradox is at hand.

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Appendix A: Diseases modeled in the Chronic Disease Model and the relation of these diseases to smoking and obesity

	Related to smoking	Related to obesity
Cardiovascular Disease		
Acute myocardial infarct (AMI)	+	+
Angina Pectoris	+	+
Chronic Heart Failure	+	+
Stroke (CVA)	+	+
Cancer		
Lung	+	
Stomach	+	
Oesophagus	+	
Pancreas	+	
Oral Cavity	+	
Larynx	+	
Uriny Bladder	+	
Kidney	+	+
Rectum		+
Colon		+
Breast		+
Prostate		+
Endometrium		+
Other		
COPD	+	
Diabetes	+	+
Arthrosis of the hip		+
Arthrosis of the knee		+
Dorsopathies (low back pain)		+

Source: Van Baal et al. (2008a)

Appendix B: Risk equalization contributions for the risk adjuster age and gender

Men

Age	Variable Hospital	Transport	General Practitioner	Paramedic	Pharmacy	Obstetrics	Maternity Care	Devices	Dentist
0-4	787,39	26,30	139,47	46,46	240,29	0,00	0,00	54,62	13,96
5-9	420,67	18,13	109,50	87,20	212,38	0,00	0,00	59,07	83,32
10-14	384,11	20,10	100,36	32,81	217,22	0,00	0,00	56,51	106,30
15-19	412,93	24,59	100,75	24,91	226,25	0,00	0,00	47,62	131,82
20-24	407,73	22,25	95,76	13,17	220,10	0,00	0,00	39,63	57,47
25-29	415,68	21,07	96,04	13,03	227,71	0,00	0,00	41,38	2,94
30-34	433,92	20,90	100,34	13,14	243,04	0,00	0,00	43,43	3,81
35-39	480,04	22,10	105,34	15,38	269,58	0,00	0,00	48,42	4,71
40-44	515,17	24,20	108,37	16,57	287,11	0,00	0,00	51,64	6,28
45-49	604,99	27,45	111,72	19,66	321,12	0,00	0,00	62,19	8,81
50-54	708,91	31,55	114,97	21,35	342,27	0,00	0,00	71,12	11,56
55-59	886,09	36,76	119,32	26,62	388,01	0,00	0,00	88,04	15,83
60-64	1043,69	40,75	121,01	25,16	413,29	0,00	0,00	96,53	20,16
65-69	1334,20	59,46	131,89	28,60	480,75	0,00	0,00	142,60	28,48
70-74	1632,01	74,61	143,60	30,50	525,33	0,00	0,00	168,19	29,05
75-79	1878,84	100,92	159,02	33,22	560,28	0,00	0,00	209,22	24,66
80-84	1874,96	124,21	184,14	37,36	596,31	0,00	0,00	260,01	18,29
85-89	1783,34	144,00	221,18	41,47	627,78	0,00	0,00	334,48	12,75
90+	1669,86	167,07	279,23	43,27	634,65	0,00	0,00	453,76	11,69

Women

Age	Variable Hospital	Transport	General Practitioner	Paramedic	Pharmacy	Obstetrics	Maternity Care	Devices	Dentist
0-4	653,33	23,24	131,94	31,56	228,14	0,00	0,00	51,86	13,40
5-9	372,51	15,42	107,72	49,23	212,23	0,00	0,00	53,84	82,55
10-14	372,27	17,77	101,11	30,26	224,46	0,00	0,00	55,49	108,97
15-19	438,96	23,40	119,22	32,94	260,37	2,16	1,32	49,85	132,80
20-24	515,23	21,30	117,63	16,49	292,36	31,49	53,34	41,95	57,35
25-29	681,34	24,09	120,80	15,13	296,85	89,06	194,04	44,69	2,78
30-34	767,99	23,42	124,21	15,44	295,37	104,62	251,78	45,35	2,83
35-39	680,80	21,03	123,82	17,58	319,43	45,44	115,23	49,23	3,58
40-44	602,17	21,12	123,26	20,42	332,43	6,39	16,89	54,00	5,57
45-49	663,36	25,26	127,58	26,75	370,52	0,00	0,00	67,55	10,25
50-54	753,73	28,59	130,60	33,60	393,43	0,00	0,00	83,09	17,06
55-59	857,34	32,02	133,35	40,39	433,46	0,00	0,00	104,08	24,52
60-64	935,82	33,49	137,10	43,83	460,25	0,00	0,00	116,95	29,43
65-69	1073,77	44,61	147,76	47,19	488,68	0,00	0,00	150,04	35,60
70-74	1282,67	55,20	162,60	55,95	519,09	0,00	0,00	182,22	34,87
75-79	1448,74	76,28	181,14	67,95	543,07	0,00	0,00	242,70	26,13
80-84	1460,96	97,42	208,56	77,59	551,68	0,00	0,00	313,33	16,89
85-89	1414,94	120,09	241,64	84,57	562,63	0,00	0,00	390,89	11,49
90+	1173,15	132,49	287,18	84,89	575,80	0,00	0,00	513,30	9,02

Source: Van Vliet et al. (2007)

Appendix C: Risk equalization contributions for the risk adjuster pharmacy cost groups (PCG)

	Variable Hospital	Transport	General Practitioner	Paramedic	Pharmacy	Obstetrics	Maternity Care	Devices	Dentist
PCG0	-114,46	-6,53	-8,52	-4,82	-154,41	0,25	0,47	-24,21	-0,54
Glaucoma	89,59	4,05	6,09	1,33	221,44	0,54	1,25	9,68	0,01
Thyroid Gland Disorder	222,58	4,53	11,19	5,21	94,34	-1,52	0,93	33,67	3,11
Mental Disorders	49,65	20,69	18,89	7,20	398,88	-4,83	-11,48	20,46	6,49
High Cholesterol	202,17	-1,36	10,12	1,36	354,32	0,79	1,48	-36,12	2,90
Diabetes type IIb	251,54	11,18	23,46	9,29	293,60	-0,20	-0,29	105,25	-3,60
Chronic Non-Specific Lung Disease	518,61	32,11	65,14	26,90	661,75	-1,22	-2,22	66,13	3,50
Diabetes type IIa	494,07	9,78	27,66	6,21	825,80	0,57	1,27	73,72	-2,69
Epilepsy	466,63	65,25	62,11	58,63	628,06	-3,76	-5,54	173,81	3,73
Crohn's Disease/Colitis Ulcerosa	452,06	-7,16	41,90	0,93	633,19	-3,26	-2,30	77,12	2,27
Heart Disorders	1178,12	84,95	73,00	29,94	479,40	0,61	1,03	106,47	-2,78
Rheumatism	1075,86	21,02	59,65	167,17	2230,39	-1,93	-3,47	124,74	3,18
Parkinson's Disease	793,74	73,75	98,40	502,18	1688,90	0,96	2,09	376,87	8,82
Diabetes type I	913,17	52,32	58,71	21,45	1032,99	-2,17	-3,01	1046,59	-2,79
Transplantations	553,56	-6,04	33,59	23,87	2792,95	-6,34	-10,66	93,75	1,73
Cystic Fibrosis/Pancreas Disorders	1417,08	52,92	44,67	78,57	4940,30	-0,75	-1,15	399,19	13,36
Brain/Spine Disorders	1012,10	161,09	100,85	658,27	6570,08	-6,00	-12,06	1353,53	8,83
Cancer	3419,62	182,12	89,67	-27,49	6356,96	0,83	1,37	387,10	-6,69
HIV/AIDS	1634,87	3,18	62,50	-16,12	11615,69	-1,23	-1,77	-30,40	13,98
Kidney Disorders	8316,15	602,69	53,23	-7,09	4444,21	0,38	0,69	21,47	-8,48
Growth Hormones	1062,91	66,72	45,38	86,40	19393,84	-1,24	-2,44	391,52	14,36

Source: Van Vliet et al. (2007)

Appendix D: Risk equalization contributions for the risk adjuster diagnostic cost groups (DCG)

	Variable Hospital	Transport	General Practitioner	Paramedic	Pharmacy	Obstetrics	Maternity Care	Devices	Dentist
DCG0	-71,50	-5,09	-1,59	-1,63	-13,15	0,02	0,03	-5,30	-0,03
DCG1	1148,28	29,55	67,55	120,60	108,46	-0,11	0,20	44,31	2,59
DCG2	1560,68	100,35	55,82	21,47	354,07	-1,02	-2,36	75,16	1,68
DCG3	1845,15	130,25	63,40	17,93	402,36	-0,55	-1,01	154,49	1,09
DCG4	2030,05	202,82	83,63	114,67	570,91	-0,58	-0,78	220,18	3,06
DCG5	2704,80	163,81	67,50	34,87	367,91	-0,78	-0,83	211,06	0,16
DCG6	3367,47	162,50	68,74	38,53	429,27	-1,66	-2,73	307,12	-1,34
DCG7	3732,24	224,95	97,65	111,07	1025,58	-2,33	-5,16	345,13	-1,22
DCG8	4517,13	379,12	65,64	143,26	1227,16	0,84	1,54	569,93	-0,98
DCG9	4699,06	341,18	105,02	106,09	1110,97	-1,01	-2,44	1025,89	12,53
DCG10	5754,09	561,97	149,88	101,89	2411,77	-1,27	-2,94	757,31	1,87
DCG11	6571,84	585,68	220,69	100,86	2004,16	-0,71	-2,78	542,85	-0,72
DCG12	8220,57	483,43	123,17	235,55	3174,76	-1,08	-2,50	757,09	2,02
DCG13	47646,37	3832,65	31,03	35,14	1082,18	-1,87	-4,40	312,39	-2,92

Source: Van Vliet et al. (2007)

Appendix E: Risk equalization contributions for the risk adjuster socio-economic status (SES)

	Variable Hospital	Transport	General Practitioner	Paramedic	Pharmacy	Obstetrics	Maternity Care	Devices	Dentist
SES									
>15 occupants									
0-14	-14,35	30,26	-8,61	-8,06	-78,68	0,00	0,00	8,02	3,22
15-64	-14,35	30,26	-8,61	-8,06	-78,68	-4,96	-11,89	8,02	3,22
65+	15,85	74,19	6,93	62,13	144,46	0,00	0,00	224,71	-10,02
SES 1-3									
0-14	6,32	0,88	1,64	3,78	-2,41	0,00	0,00	0,07	5,52
15-64	35,61	2,54	1,90	-0,95	-3,76	4,22	8,23	1,69	1,88
65+	284,31	32,11	9,68	7,07	29,44	0,00	0,00	44,01	-0,53
SES 4-7									
0-14	-9,24	-1,01	-1,24	-3,34	1,92	0,00	0,00	-0,03	-4,06
15-64	10,82	1,16	0,88	0,12	3,41	2,60	7,31	2,82	0,44
65+	-50,91	-6,91	0,23	-4,78	-14,44	0,00	0,00	-9,54	0,22
SES 8-10									
0-14	0,12	-1,60	-4,00	-7,70	7,29	0,00	0,00	-0,42	-14,40
15-64	-37,13	-3,81	-2,13	0,75	0,85	-5,77	-13,63	-4,48	-1,92
65+	-110,80	-20,11	-7,97	-4,93	-14,72	0,00	0,00	-43,73	1,31

Source: Van Vliet et al. (2007)