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Cost-effectiveness of interventions to reduce tobacco smoking in the Netherlands. An application of the RIVM Chronic Disease Model

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Rapport in het kort

Kosteneffectiviteit van tabaksontmoedigingsbeleid in Nederland. Een toepassing van het RIVM Chronische Ziekten Model.

Accijnsverhogingen, massamediale campagnes en individuele ondersteuning bij stoppen met roken zijn alle doelmatige vormen van preventie. Een accijnsverhoging is de meest doelmatige maatregel vanuit het gezondheidszorgperspectief. Deze maatregel levert veel gezondheidswinst op tegen relatief lage kosten voor de gezondheidszorg.

Roken is in Nederland de belangrijkste risicofactor voor voortijdige sterfte en leidt tot veel gezondheidsverlies. Het Ministerie van VWS streeft daarom naar minder rokers. Bij volwassenen richt het beleid zich vooral op de bevordering van het stoppen met roken. Bij jongeren is preventie belangrijk. Dit rapport biedt inzicht in de kosteneffectiviteit van diverse effectieve interventiemogelijkheden bij volwassenen.

Iemand die stopt met roken loopt minder risico op een aan roken gerelateerde ziekte, en zal gemiddeld genomen langer leven. De gezondheidswinst van stoppen met roken is gemeten in zogeheten Quality Adjusted Life Years (QALYs), voor kwaliteit van leven gecorrigeerde levensjaren. Een winst van 1 QALY staat gelijk aan een extra jaar leven in goede gezondheid. In de extra levensjaren zullen ook zorgkosten optreden. Om de doelmatigheid van het tabaksontmoedigingsbeleid te beoordelen vanuit het gezondheidszorg perspectief zijn deze kosten en de kosten van verschillende beleidsmaatregelen afgezet tegen de besparingen bij rookgerelateerde ziektes en de gezondheidswinst.

De kosteneffectiviteit van *massamediale campagnes* ligt dan beneden de €10.000 per QALY en voor een *accijnsverhoging* rond de €5000 per QALY. Een gestructureerd advies door de huisarts is de doelmatigste vorm van *individuele hulp bij stoppen met roken* en kost ongeveer €9000 per QALY. Zonder kosten in gewonnen levensjaren mee te rekenen zijn deze interventies kostenbesparend.
De conclusie is dat maatregelen om het stoppen met roken te bevorderen bij volwassenen doelmatige vormen van preventie zijn, met een gunstige kosteneffectiviteit, zelfs als de kosten in gewonnen levensjaren zijn meegeteld.

Trefwoorden: kosteneffectiviteitsanalyse; tabaksontmoediging; roken; modellering; primaire preventie

Abstract

Cost-effectiveness of interventions to reduce tobacco smoking in the Netherlands. An application of the RIVM Chronic Disease Model.

Introduction Smoking is the most important single risk factor for mortality in the Netherlands and has been related to 12% of the burden of disease in Western Europe. Hence the Dutch Ministry of Health has asked to assess the cost-effectiveness of interventions to enhance smoking cessation in adults.
Objective To evaluate eight interventions for smoking cessation, namely increased tobacco taxes, mass media campaigns, minimal counseling, GP support, telephone counseling, minimal counseling plus nicotine replacement therapy, intensive counseling plus nicotine replacement therapy and intensive counseling plus bupropion.
Methods Costs per smoker were estimated based on bottom-up cost analysis. Combined with effectiveness data from meta-analyses and Dutch trials this gave us costs per quitter. To estimate costs per quality adjusted life year (QALY) gained, scenarios for each intervention were compared to current practice in the Netherlands. A dynamic population model, the RIVM Chronic Disease Model, was used to project future health gains and effects on health care costs. This model allows the repetitive application of increased cessation rates to a population with a changing demographic and risk factor mix, and accounts for risks of relapse and incidence of smoking related diseases that depend on time since cessation. Sensitivity analyses were performed for variations in costs, effects, time horizon, program size and discount rates.
Results: A tax increase was the most efficient intervention with zero intervention costs from the health care perspective. Additional tax revenues resulting from a 20% tax increase were about 5 billion euro. Costs per smoker for a mass media campaign were relatively low (€3,-), and costs per QALY were below €10.000. The effectiveness of these two population measures was uncertain. Costs per smoker for individual cessation support varied from €5 to almost €400. Although all individual interventions had proven effectiveness, the cheapest intervention had an effect that did not differ significantly from current practice cessation rates. Compared to current practice, cost-effectiveness ratios varied between about €8,800 for structured GP stop-advice (H-MIS) to €21,500 for telephone counseling for implementation periods of 5 years.
Discussion and conclusions: All smoking cessation interventions were cost-effective compared to current practice. Comparison of interventions is difficult, especially for population and individual interventions, because they are often applied in combination. Taking that into account, taxes seem to provide most value for money, especially since additional tax revenues outweigh the health care costs in life years gained.

Keywords: cost-effectiveness analysis; tobacco control; smoking; modelling; primary prevention

Voorwoord

Het RIVM heeft voor het Ministerie van Volksgezondheid, Welzijn en Sport de kosteneffectiviteit van het tabaksontmoedigingsbeleid geëvalueerd. Daarvoor zijn de gezondheidswinst en de effecten op de kosten van zorg van verschillende interventies geraamd met het RIVM Chronische Ziekten Model, en gecombineerd met schattingen van de interventiekosten. Dit rapport beschrijft de kosteneffectiviteit van maatregelen om stoppen met roken bij volwassenen te bevorderen. In het bijbehorende rapport 'Potential health benefits and cost effectiveness of tobacco tax increases and school intervention programs targeted at adolescents in the Netherlands' door van Baal en co-auteurs, eveneens verschenen in 2005 (RIVM rapport 260601002) staan de resultaten voor maatregelen bij jongeren.

De twee rapporten samen vormen het antwoord op de kennisvraag 'Potentiële gezondheids- en economische winst bij het realiseren van de huidige en toekomstige beleidsdoelstellingen op het terrein van tabaksontmoediging' (no 2.04-05.4), onderdeel van het RIVM onderzoeksprogramma 'Beleidsondersteuning Volksgezondheid en Zorg'.

Diverse mensen binnen en buiten het RIVM hebben een belangrijke bijdrage geleverd aan het tot stand komen van dit rapport. We willen als eerste onze dank uitspreken aan de mensen die hebben geparticipeerd in het expertpanel. Voor een aantal maatregelen voor individuele ondersteuning bij stoppen met roken hebben we voortgebouwd op onze eerdere berekeningen voor het Partnership Stoppen met Roken. Maureen Rutten en Heleen Hamberg zijn co-auteurs van dat onderzoek. Tevens willen we Monique Jacobs, Monique Verschuren, Claartje Aarts en de mensen van Bureau Rapporten Registratie van het RIVM bedanken voor het kritisch lezen en becommentariëren van dit rapport.

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Samenvatting

Inleiding

Accijnsverhogingen, massamediale campagnes en individuele ondersteuning bij stoppen met roken kosten allemaal minder dan €20.000 per gewonnen (voor kwaliteit van leven gecorrigeerd) levensjaar en zijn daarmee doelmatige vormen van preventie. Alle maatregelen leiden tot minder ziekte en een langere levensverwachting. De levensverwachting neemt toe met de intensiteit en duur van de maatregel.

Roken is in Nederland de belangrijkste risicofactor voor voortijdige sterfte en leidt tot veel gezondheidsverlies. In West-Europa is roken de belangrijkste risicofactor in termen van ziektelast. Roken is gerelateerd aan 12% van de ziektelast in West-Europa. Het Ministerie van VWS streeft naar een verdere daling van het percentage rokers in Nederland tot 25% eind 2007. Bij volwassenen kan dat door stoppen met roken te bevorderen. Inzicht in de kosteneffectiviteit van diverse effectieve interventiemogelijkheden kan VWS ondersteunen in haar tabaksbeleid. De kosteneffectiviteit is geschat voor acht interventies:

- accijnsverhoging,
- massamediale campagnes,
- kort stopadvies,
- stopadvies volgens protocol door de huisarts (H-MIS),
- telefonische counseling,
- kort stopadvies met nicotinekauwgum of –pleisters,
- intensieve counseling met nicotinekauwgum of –pleisters,
- intensive counseling met bupropion.

Daarvoor zijn de gezondheidswinst en de effecten op de kosten van zorg van verschillende interventies geraamd met het RIVM Chronische Ziekten Model (CZM), en gecombineerd met schattingen van de interventiekosten.

Tabel A.1 in Appendix A geeft een overzicht van onderzochte interventies om stoppen met roken te bevorderen die in Nederland beschikbaar zijn. De effectiviteit van deze acht interventies was bewezen. Andere interventies waren niet bewezen effectief na 12 maanden of de effectiviteit was zo laag dat er in modelanalyses geen effect was ten opzichte van het referentiescenario. Hierbij moet wel worden aangetekend dat voor accijnsverhogingen en massamediale campagnes (de interventies op bevolkingsniveau) lagere eisen zijn gesteld aan de zwaarte van het bewijs van effectiviteit. Voor deze interventies is onderzoek met een controlegroep niet mogelijk en is effectiviteit geschat uit internationale tijdreeksanalyses voor accijnzen en een combinatie van tijdsreeksen met gegevens uit Amerikaanse studies voor massamediale campagnes (zie ook Appendix A).

Dat betekent dat voorzichtigheid geboden is bij het vergelijken van resultaten voor maatregelen op bevolkingsniveau en individuele stopondersteuning. Een extra reden daarvoor is dat in werkelijkheid maatregelen meestal in combinatie voorkomen, terwijl ze hier apart

zijn doorgerekend. Het evalueren van combinatiepakketten is daarom een interessant onderwerp voor vervolgonderzoek. Het huidige onderzoek geeft nuttige informatie voor de samenstelling van zulke pakketten met meerdere maatregelen.

Effectiviteit en kosten van de interventies

De kosten per roker voor de maatregelen varieerden van €0 (accijnsverhogingen zijn gratis vanuit het perspectief van de gezondheidszorg) tot bijna €400. De effectiviteit van de maatregelen voor individuele stoopondersteuning is geschat bij gebruik door 25% van de rokers, dat is het percentage wat aangeeft te overwegen om te stoppen. De resultaten op populatieniveau varieerden van maximaal 10.000 minder rokers in een jaar voor een kort stopadvies, tot bijna 300.000 minder rokers voor intensieve individuele stoopondersteuning. Voor de maatregelen op bevolkingsniveau was in de meest optimistische schatting een zelfde daling van ongeveer 300.000 rokers haalbaar, maar die kon ook beperkt blijven tot 25.000 rokers voor massamediale campagnes en 100.000 voor een accijnsverhoging.

Tabel 1 presenteert de effectiviteit, kosten en inhoud van de interventies, zoals gebruikt in de scenarioanalyses. Op basis hiervan zijn de kosten per stopper te berekenen (zie Tabel 2). Het effect van massamediale campagnes op het aantal rokers dat stopt is lastig vast te stellen. De effecten zijn veelal indirect, bijvoorbeeld via het beïnvloeden van de sociale norm. Het lijkt het meest waarschijnlijk om voor het effect van massamediale campagnes uit te gaan van een daling van het percentage rokers tussen de 0,5 en 1,0 procentpunt. Vanwege de onzekerheid bij het bepalen van het precieze effect van massamediale campagnes is de effectrange uitgebreid tot een daling tussen 0,2 procentpunt en 2,1 procentpunt (voor meer details zie paragraaf 2.2 en Appendix A).

Omschrijving en discussie van de scenario's

Voor elke interventie is een zogenaamd 'best guess' scenario opgesteld en doorgerekend met het Chronische Ziekten Model (CZM). In deze 'best guess' scenario's worden de individuele interventies voor een periode van 5 jaar toegepast bij 25% van de rokers. Voor de massamediale campagne (MMC) is geen 'best guess' scenario opgesteld, maar zijn de resultaten berekend voor een mogelijke daling in het percentage rokers tussen de 0,2 en 2,1 procentpunt.

Voor de accijnzen is het 'best guess' scenario als volgt: een éénmalige accijnsverhoging van 20% veroorzaakt in het eerste jaar een daling van de prevalentie van roken van 1,2 procentpunt door een toename van het aantal stoppers. In de volgende jaren neemt het effect van de prijsverhoging op rookgedrag langzaam af. Naarmate rokers langer zijn gewend aan de verhoogde prijs, wordt hun kans om te stoppen minder beïnvloed door de prijsstijging. Voor de individuele ondersteuning gaat het 'best guess' scenario uit van de gemiddelde toename van de stopkans. Die hogere stopkans leidt 5 jaar lang tot meer stoppers, daarna is de stopkans weer als in het referentiescenario.

Tabel 1: Geëvalueerde maatregelen, effectiviteit en kosten per roker

Naam (afkorting)	Effectiviteit (% stoppers na 12 maanden in de interventiegroep.)	Kosten per Roker	Inhoud
Maatregelen op individueel en groepsniveau			
Kort stopadvies (MC)	4,4% (2,5 – 6,2)	€5	Kort eenmalig stopadvies door huisarts of assistent, 1 tot 12 minuten.
Minimaal advies door de huisarts (H-MIS)	7,9% (4,7 – 15)	€26	Advies door huisarts en/of assistent, in 1 of 2 consulten, volgens protocol met 5 stappen.
Telefonische Counseling (TC)	9% (5,8 –12)	€130	Intakegesprek van 30 minuten en 2 tot 8 vervolgtelefoontjes van 15 minuten elk. Gebaseerd op computergestuurde vragenlijst. Verzorgd door STIVORO.
H-MIS met nicotine vervangende middelen (NRT)	13,5% (8,9 – 18)	€180	Kort stopadvies gevolgd door nicotinekauwgum of –pleisters gedurende gemiddeld 8 weken.
Intensieve counseling (IC)+NRT	22% (17 – 27)	€390	Intensieve ondersteuning (40-110 minuten in totaal) door een speciaal hiervoor opgeleide counselor in combinatie met nicotinekauwgum of –pleisters gedurende gemiddeld 12 weken.[1 2]
IC+Bupropion (BU)	17% (13 – 20)	€370	Intensieve counseling in combinatie met het antidepressivum bupropion gedurende gemiddeld 9 weken.
Maatregelen op bevolkingsniveau			
Massamediaal: Nederland start met stoppen/Dat kan ik ook. (MMC)	Prevalentiedaling van 0,2 tot 2,1 procentpunt na 1 jaar, daarna geen effect op stopkansen.	€3	Brede media-aandacht via televisie, kranten, brochures en aanplakborden in abri's. Verwijzing naar diverse vormen van ondersteuning.
Accijnsverhoging	Prevalentiedaling van 3 tot 10% in jaar na accijnsverhoging, daarna langzaam uitdoven effect.	€0	Accijnsverhoging op tabaksproducten.

Tabel 2: Kosten per stopper

Maatregel (zie Tabel 1 voor afkortingen)	Kosten per stopper ('best guess' scenarios)
MC	€ 1.000
H-MIS	€ 600
TC	€ 4.300
H-MIS+ NRT	€ 2.200
IC+NRT	€ 3.000
IC+BU	€ 3.000
MMC	€ 25 - € 280
Accijns	€ 0

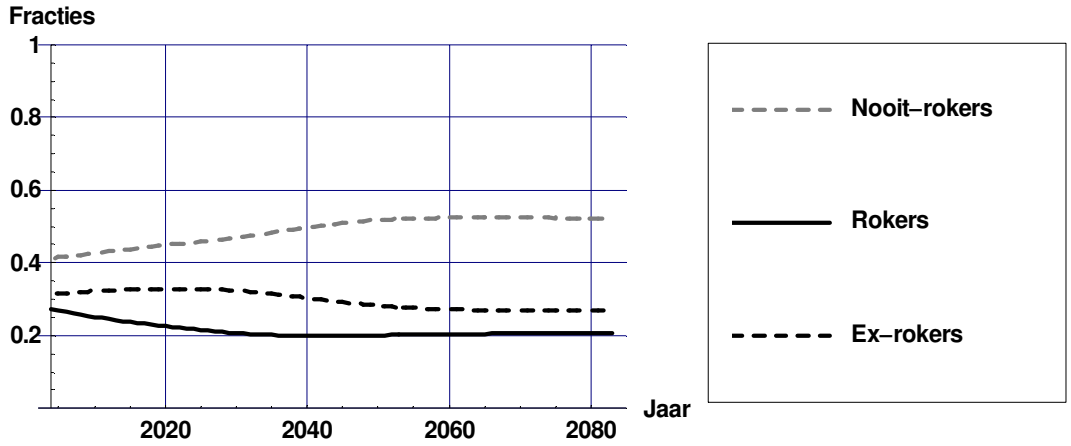
Voor de accijnsverhogingen en massamediale campagnes is de effectiviteit op korte termijn, in termen van lagere aantallen rokers, omgeven door veel onzekerheid. Bij de individuele interventies is de effectiviteit in termen van stopkansen minder onzeker. Bij die interventies ontstaat onzekerheid bij het overzetten van de stopkansen uit de internationale literatuur naar de Nederlandse situatie voor de scenarioberekeningen.

Uiteindelijk zijn voor alle interventies meerdere scenario's geformuleerd die verschillen in de grootte van het veronderstelde effect op het aantal rokers. Die zijn te vinden in de hoofdtekst van het rapport. In de tabellen in deze samenvatting zijn de onzekerheidsranges alleen aangeven voor de belangrijkste resultaten.

Het RIVM Chronische Ziekten Model is een dynamisch populatiemodel dat voor een langere periode de incidentie van 14 aan roken gerelateerde ziektes berekent aan de hand van leeftijds- en geslachtsspecifieke rookcijfers en de ontwikkelingen daarin. Daarmee schat het model de prevalentie van ziektes, de gemiddelde kwaliteit van leven, de sterfte en de kosten van zorg. Projecties met het CZM leveren ramingen van de gezondheidswinst per jaar in termen van gewonnen, voor kwaliteit van leven gecorrigeerde, levensjaren (QALYs),[a] én ramingen van de effecten op de kosten van zorg. Deze zijn geschat door de uitkomsten van het CZM te vergelijken met een referentiescenario waarin geen aanpassingen zijn gemaakt. Voor deze kennisvraag is het CZM verbeterd, zodat de kans op terugval na stoppen en de risico's op rookgerelateerde aandoeningen bij ex-rokers nu langzaam afnemen in de tijd. Ook zijn alle belangrijke invoergegevens herzien. Meer uitleg over het model staat in Appendix C.

Als basis voor de ramingen dient een referentiescenario dat is geschat op basis van recente NIPO cijfers (zie Figuur 1). De gemiddelde stopkans bij volwassenen was 5%. Dat is in dezelfde orde van grootte als in de literatuur is te vinden voor de kans op succes bij een stoppoging zonder verdere ondersteuning. Het huidige aanbod van de meeste maatregelen is veel lager dan in de interventiescenario's, die uitgaan van een aanbod aan 25% van de rokers. Gegevens over het huidige gebruik van maatregelen zijn lastig te vinden. In een eerdere analyse werd dit geschat op minder dan 1,5% van de rokers. Dat geldt uiteraard niet voor accijnsverhogingen en massamediale campagnes. Beide zijn in het recente verleden toegepast. Hoewel het referentiescenario is gebaseerd op gegevens over de jaren 2001, 2002 en 2003 kunnen we toch niet uitsluiten dat daarin effecten doorwerken van de campagnes in 1999/2000 en in 2003/2004 en van de accijnsverhoging in februari 2004. Daarnaast was er andere regelgeving. Dit zou kunnen betekenen dat ons referentiescenario aan de optimistische kant is. Dat heeft verder weinig invloed op de basisramingen van de kosteneffectiviteit en op de geschatte gezondheidswinsten, omdat die uitgaan van verschillen tussen interventiescenario's en het referentiescenario.

[a] QALYs staan voor het aantal levensjaren die zijn gewogen voor de kwaliteit van leven (QALYs: Quality Adjusted Life Years). Een QALY gewicht van 0 is gelijk aan dood en 1 aan volledig gezond. Waarden van een QALY tussen 0 en 1 betekenen dat een levensjaar is doorgebracht in onvolledige gezondheid. Het totaal aantal gewonnen QALYs is een maat voor de winst in zowel kwaliteit als kwantiteit van leven.

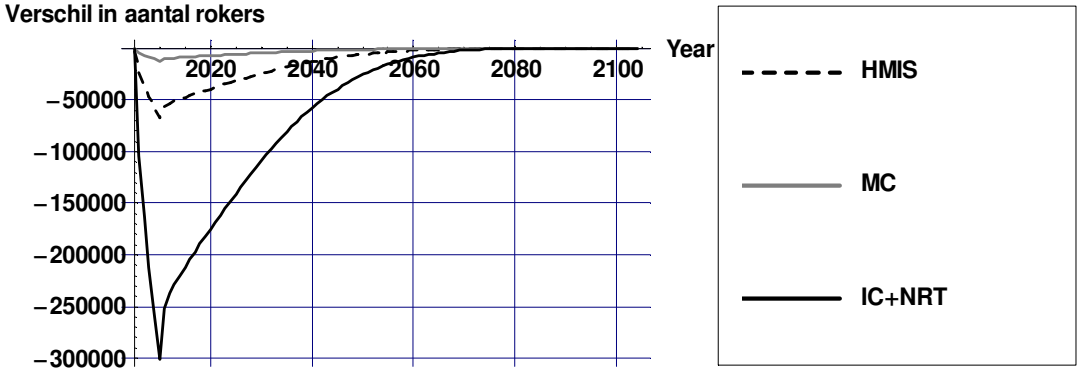


Figuur 1: Modelprojecties van het referentiescenario: nooit-rokers, rokers en ex-rokers als fractie van de populatie van 15 jaar en ouder

Resultaten en discussie van de uitkomsten

Alle maatregelen hebben een kosteneffectiviteit beneden de €20.000 per QALY. De doelmatigheid is voorzichtig geschat. In de resultaten zijn de effecten op alle kosten van zorg meegenomen, inclusief de extra kosten voor ziektes die ontstaan in de gewonnen levensjaren.

Figuur 2 geeft de verschillen in het aantal rokers weer tussen het referentiescenario en het 'best guess' scenario voor 'minimal counseling' (MC, kort stopadvies), gestructureerd stopadvies door de huisarts (H-MIS), en intensieve counseling in combinatie met nicotine vervangende middelen (IC+NRT).



Figuur 2: Verschillen in het aantal rokers voor 'best guess' scenario's vergeleken met het referentiescenario

Het aantal rokers daalt door de interventies. Na afloop van de interventies neemt het verschil in het aantal rokers langzaam af, doordat gestopte rokers weer opnieuw beginnen en nieuwe rokers bijkomen. Voor de andere interventies is er een vergelijkbaar verloop in het aantal rokers. In Tabel 3 staat het maximale verschil in het aantal rokers per maatregel, zoals geraamd door het Chronische Ziekten Model.

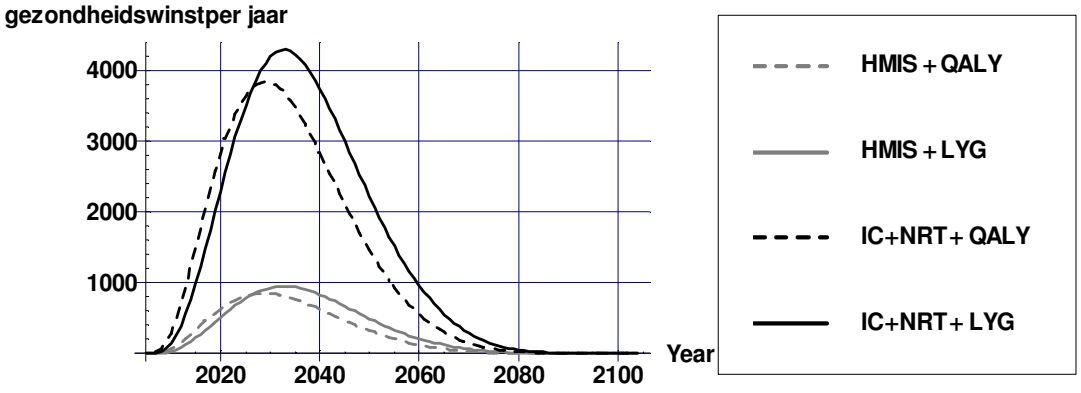
Tabel 3: Maximum jaarlijks verschil in rokers tussen interventiescenario en referentiescenario

Naam (afkorting zie tabel 1)	Maximum aantal rokers wat extra stopt in een jaar
MC	12.000
H-MIS	68.000
TC	72.000
H-MIS+NRT	200.000
IC+NRT	300.000
IC+BU	290.000
MMC	25.000 tot 280.000
Accijns	140.000

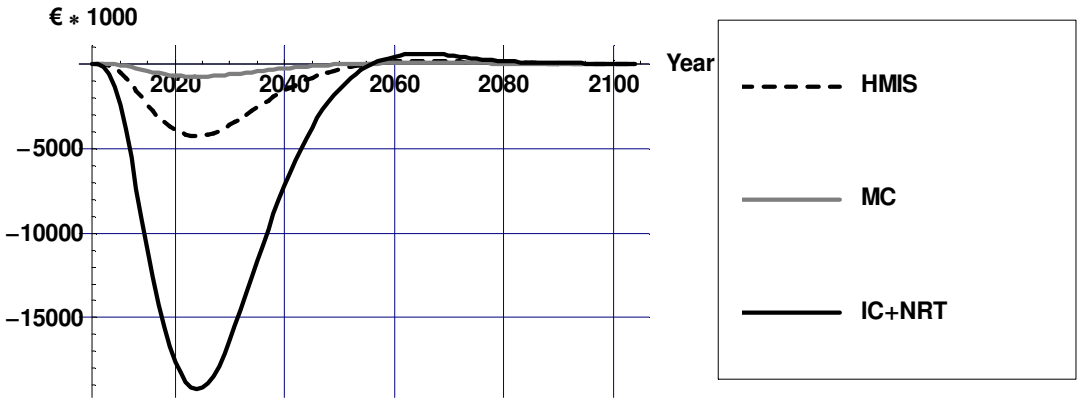
De **gezondheidswinst** van de maatregelen is geschat door het aantal levensjaren/QALYs in het referentiescenario af te trekken van het aantal levensjaren/QALYs in het 'best guess' scenario. Figuur 3 geeft weer hoe de gezondheidswinst verdeeld is over de tijd voor de H-MIS (gestructureerd stopadvies door de huisarts) en voor intensieve counseling met nicotine vervangende middelen (IC+NRT).[b] Door de interventies daalt het aantal rokers, dit zorgt voor een daling in rookgerelateerde ziekten na een aantal jaren. De kwaliteit van leven en de levensverwachting nemen toe . Voor alle andere interventies vertoont de gezondheidswinst een vergelijkbaar verloop, met de grootste winst na ongeveer 30 jaar. De hoogte van de maximale gezondheidswinst varieert. Het meeste resultaat is uiteraard zichtbaar bij effectievere maatregelen. Op korte termijn wordt winst in kwaliteit van leven geboekt door het vermijden van rookgerelateerde ziekten: mensen worden niet ziek. Dat vertaalt zich pas op iets langere termijn in een winst in levensjaren: mensen overlijden later. De winst in levensjaren is op langere termijn hoger dan de winst in kwaliteit van leven, omdat op oudere leeftijd de kwaliteit van leven afneemt, door het optreden van vervangende ziektes.

Figuur 4 toont het verschil in **zorgkosten van rookgerelateerde ziekten** ten opzichte van het referentiescenario. Voor alle kosten rekenen we in euro's, met het prijsniveau van 2004. Voor de andere interventies vertoont de hoogte van de kosten een vergelijkbaar tijdsverloop. De daling in rookgerelateerde ziekten zorgt voor een daling in de zorgkosten daarvan. Omdat sommige rookgerelateerde ziekten (bijvoorbeeld hart en vaatziekten) ook sterk van de leeftijd afhangen, is er na ongeveer 60 jaar een kleine toename in de kosten.

[b] In de figuren 3 tot en met 7 zijn effecten die optreden in de toekomst met 4% per jaar gedisconteerd. Disconteren houdt in dat kosten en effecten in de toekomst minder worden gewaardeerd dan kosten en effecten in het heden.

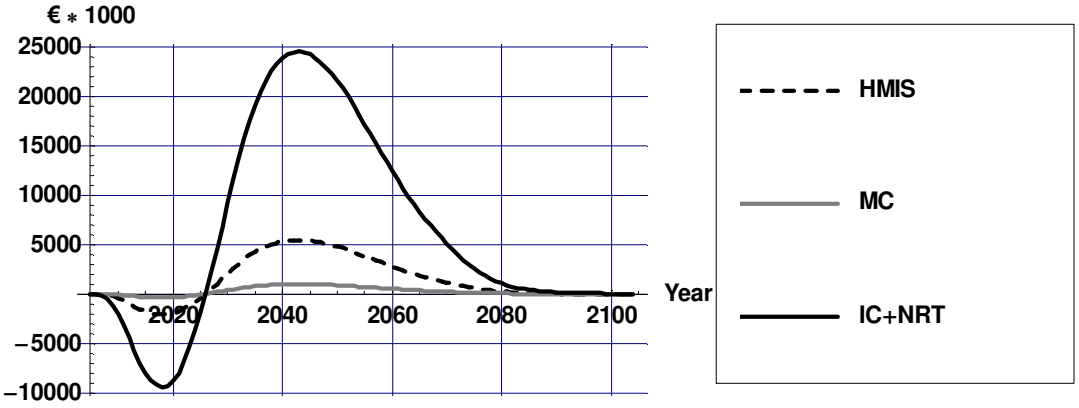


Figuur 3: Gezondheidswinst in LYG en QALYs voor 'best guess' scenario's vergeleken met het referentiescenario



Figuur 4: Verschil in kosten van rookgerelateerde ziekten in 'best guess' scenario's vergeleken met het referentiescenario

Figuur 5 toont het verschil in **totale zorgkosten**. Tot ongeveer 25 jaar na implementatie van de interventies zijn de totale zorgkosten lager in het interventiescenario vergeleken met het referentiescenario. Uiteindelijk overheersen de kosten van niet aan roken gerelateerde ziekten in gewonnen levensjaren. Dat komt dan vooral door hoge kosten in de verre toekomst.
De interventiekosten voor MMC en voor de individuele stopondersteuning gedurende de looptijd (1 of 5 jaar) zijn niet in de figuren ingetekend. Ze staan wel in Tabel 4 die een overzicht geeft van de totale effecten op kosten en gezondheid. Deze totalen zijn berekend door de gedisconteerde kosten en effecten in alle jaren bij elkaar op te tellen.



Figuur 5: Verschil in totale zorgkosten in 'best guess' scenario's vergeleken met het referentiescenario (exclusief interventiekosten

Tabel 4: Totale effecten op gezondheid en kosten (netto contante waarde, over 100 jaar, 4% disconto, prijsniveau 2004)

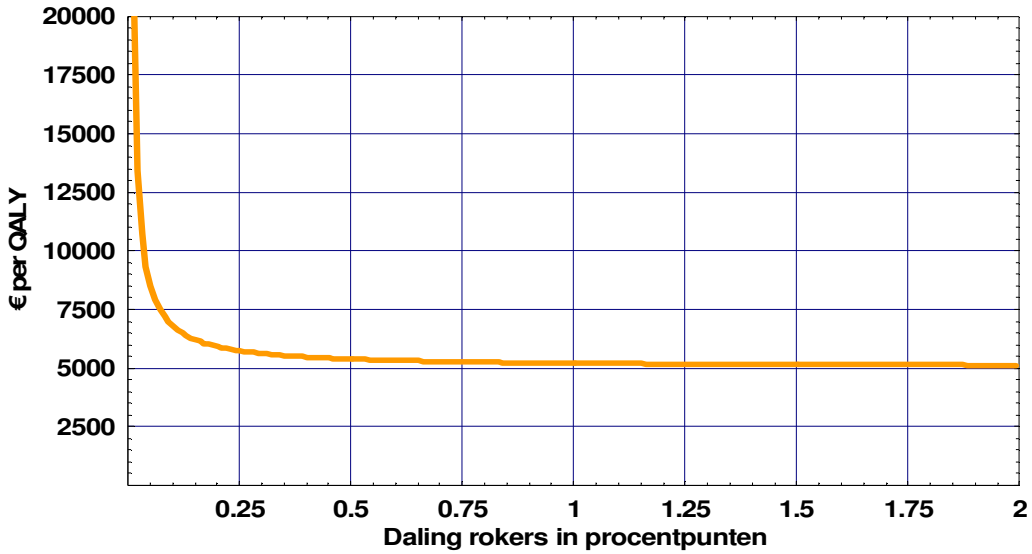
Maatregel	Interventiekosten /accijnsopbrengst (*1,000,000)	Besparingen rookgerelateerde ziekten (*10^6)	Effect op totale kosten van zorg (*10^6, exclusief interventiekosten)	Gewonnen levensjaren	Gewonnen QALYs
MC	€ 19	- € 20	€ 250	6.000	5.000
H-MIS	€ 96	- € 100	€ 140	31.000	27.000
TC	€ 470	- € 110	€ 150	33.000	29.000
H-MIS+NRT	€ 660	- € 290	€ 410	92.000	80.000
IC+NRT	€ 1.400	- € 440	€ 620	140.000	120.000
IC+BU	€ 1.300	- € 420	€ 590	130.000	115.000
MMC	€ 6 tot 8	- €280 tot - € 30	€ 40 tot € 380	8.000 tot 86.000	7.000 tot 75.000
Accijns	- € 5.200	- € 230	€ 320	72.000	63.000

Door deze gegevens met elkaar te combineren zijn de kosten per gewonnen levensjaar en per gewonnen QALY geschat. In Tabel 5 staan de kosten per gewonnen QALY voor 'best guess' scenario's. Meer details zijn te vinden in de hoofdtekst en de appendices. De uiteindelijke doelmatigheid is voorzichtig geschat door in de resultaten de effecten op alle kosten van zorg mee te nemen, inclusief extra kosten voor ziektes die ontstaan in de gewonnen levensjaren.

Tabel 5: Kosteneffectiviteitsratio's voor de lange termijn (100 jaar, 4% disconto, prijsniveau 2004)

Maatregel (afkortingen zie tabel 1)	Interventie-kosten per QALY	Interventiekosten minus besparingen in zorgkosten voor rookgerelateerde ziekten per QALY	**Interventiekosten plus totale zorgkosten per QALY**
MC	€ 3.900	€ 200	**€ 9.100**
H-MIS	€ 3.600	Kosten besparend	**€ 8.800**
TC	€ 16.000	€ 12.600	**€ 21.500**
H-MIS+NRT	€ 8.200	€ 4.500	**€ 13.400**
IC+NRT	€ 11.000	€ 7.700	**€ 16.600**
IC+BU	€ 11.000	€ 7.700	**€ 16.600**
MMC	€ 25 tot € 280	Kosten besparend	**€ 5.200 tot € 6.100**
Accijns	€ 0	Kosten besparend	**€ 5.100**

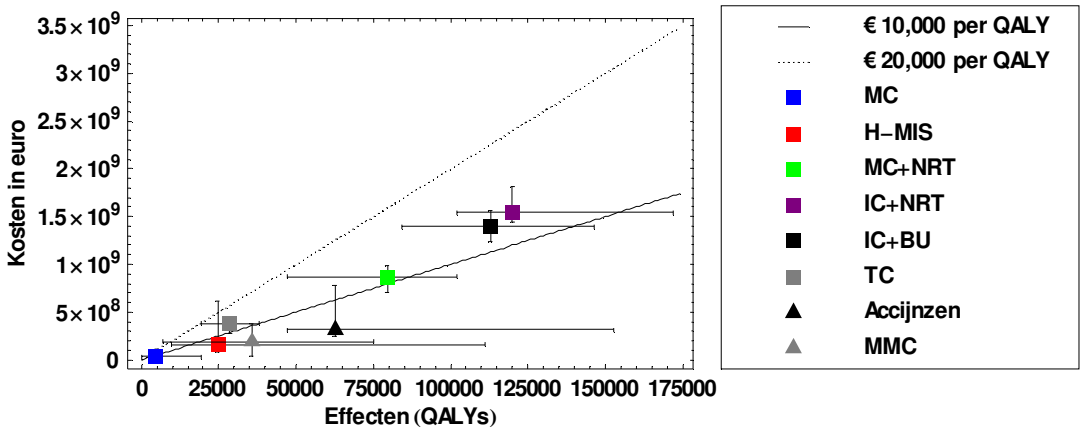
In gevoeligheidsanalyses is bekeken of de resultaten gevoelig zijn voor aannames in de 'best guess' scenario's. Figuur 6 toont de kosten per gewonnen QALY voor massamediale campagnes, uitgezet tegen mogelijke effecten van een campagne op het aantal rokers in het jaar na de campagne.



Figuur 6: Kosteneffectiviteit van massamediale campagnes als functie van het effect op het aantal rokers

Al bij een relatief klein effect ligt de kosteneffectiviteit van een massamediale campagne beneden de €10.000 per gewonnen QALY. De doelmatigheid is dan redelijk groot, omdat de kosten van een campagne in termen van kosten per roker tamelijk laag zijn (rond de € 3). Alleen als campagnes nauwelijks effect zouden hebben schiet de kosteneffectiviteitsratio omhoog want dan wordt het geld voor niets uitgegeven. In tegenstelling tot de kosteneffectiviteit is de totale gezondheidswinst in de bevolking uiteraard wél afhankelijk van het effect van een massamediale campagne. Het maximale aantal gewonnen QALYs varieert tussen de 7.100 en 75.000 (zie Tabel 4), bij een daling van de rokersprevalentie van respectievelijk 0,2 en 2,1 procentpunten.

Figuur 7 presenteert de ramingen van de totale kosten en gezondheidseffecten in een figuur met op de horizontale as de cumulatieve gezondheidswinst en op de verticale de extra kosten ten opzichte van het referentiescenario. De 'best guess' schattingen staan hierin samen met een onzekerheidsmarge. Hoe meer een maatregel rechts-onderin staat, hoe doelmatiger hij is (meer effecten en minder kosten). De twee lijnen duiden de kosteneffectiviteitswaarden aan van € 10.000 per QALY (de doorgetrokken lijn) en € 20.000 per QALY (de stippellijn). De figuur laat zien dat de verschillen in de kosteneffectiviteit van de verschillende maatregelen niet heel groot zijn en dat de onzekerheidsmarges elkaar deels overlappen. De onzekerheidsmarges in de effecten van de populatiemaatregelen zijn groot. De goedkoopste maatregelen (accijnzen, MMC, MC en H-MIS) lijken tevens het meest doelmatig, met in het algemeen waarden beneden de € 10.000 per QALY. De intensievere vormen van individuele ondersteuning bij stoppen met roken (TC, MC+NRT, IC+NRT en IC+BU) hebben waarden tussen de € 10.000 en € 20.000 euro per QALY. De verschillen zijn echter klein, zeker als de onzekerheid in acht wordt genomen.



Figuur 7: Cumulatieve kosten en effecten met onzekerheidsmarges

Om de uitkomsten in perspectief te plaatsen geeft Tabel 6 een overzicht van resultaten uit de literatuur voor andere preventiemaatregelen waarvoor Nederlandse gegevens beschikbaar waren. Deze kunnen het beste worden vergeleken met de middelste kolom van Tabel 5, omdat kosten in gewonnen levensjaren meestal niet zijn meegerekend. Ook dan is voorzichtigheid altijd geboden bij het vergelijken van verschillende kosteneffectiviteitsratio's, omdat er grote verschillen kunnen zijn in tijdstip en methode van berekeningen. Daarnaast moet de onzekerheid rond de schattingen niet vergeten worden. Het is daarom beter om te denken in ordes van grootte, dan te kijken naar kleine verschillen in de kosteneffectiviteit.

Tabel 6: Kosteneffectiviteit voor enkele preventiemaatregelen

Preventiemaatregel	Kosteneffectiviteit	Bron en opmerkingen
Laag intensieve ondersteuning stoppen met roken	**<0 tot 10.000**	**Dit rapport**
Intensieve ondersteuning stoppen met roken	**10.000 tot 30.000**	**Dit rapport**
Maatregelen op bevolkinsniveau tegen roken	**<0 tot 1000**	**Dit rapport**
Behandeling hoge bloeddruk met bèta-blokkers en anti-diuretica in laag-gemiddeld risico	1000-10.000	[3]
Idem met ACE remmers	10.000-100.000	[3]
Rijksvaccinatieprogramma	<0	[3]
Griep-vaccinatie bij ouderen	1.000-10.000	[4 5 6]
Pneumokokken vaccinatie ouderen	10.000-100.000	[4 7]
Cholesterol test plus dieet advies	1000-10.000	[3]
Statines bij HVZ-patiënten	10.000-100.000	[3]
Statines voor primaire preventie	15.000-25.000	Volgens oude richtlijn, met merkmedicatie.[8]
Borstkankerscreening	1.000-10.000	[3]
HPV- bij baarmoederhalskankerscreening	5.000-50.000	[5 9]
Defribillator bij brandweer en politie	10.000-50.000	[5 10]

Conclusie

In dit rapport hebben we de gezondheidswinst en kosteneffectiviteit geschat van acht maatregelen om stoppen met roken bij volwassenen te bevorderen. Met het CZM waren niet alleen de kortetermijneffecten op het aantal rokers te bepalen, maar ook de langetermijn-gezondheidswinst en -effecten op de kosten van zorg. Daarmee was de kosteneffectiviteit van de maatregelen in euro's per gewonnen levensjaar en QALY te bepalen.

Alle maatregelen hebben kosten per QALY beneden de €20.000. De verschillen in doelmatigheid tussen de maatregelen zijn klein (zie Figuur 7). Een accijnsverhogingen is de doelmatigste maatregel. Deze maatregel is gratis vanuit het gezondheidszorgperspectief. De kosteneffectiviteit van accijnsverhogingen is ongeveer € 5.100 per gewonnen QALY. Dit is inclusief medische kosten in gewonnen levensjaren en exclusief een eventuele toename in accijnsopbrengsten. De geschatte additionele accijnsopbrengsten als gevolg van een prijsverhoging compenseren ruimschoots de medische kosten in gewonnen levensjaren. Daarnaast kunnen de opbrengsten gebruikt worden om andere stoppen-met-roken maatregelen te financieren. De kosteneffectiviteit van massamediale campagnes ligt beneden de €10.000 per gewonnen QALY. De kosten van een campagne, ongeveer 7,5 miljoen euro, zijn per roker tamelijk laag (rond de €3). De kosten van de individuele stopondersteunende maatregelen lopen uiteen van €5 per roker voor een kort stopadvies tot bijna €400 voor intensieve counseling met nicotinevervangers of bupropion. De basisschattingen voor de kosten per gewonnen QALY voor kort stopadvies (MC), gestructureerd stopadvies door de huisarts (H-MIS), telefonische counseling (TC), MC met nicotinevervangende middelen, intensieve counseling (IC) met nicotinevervangende middelen en IC met bupropion zijn achtereenvolgens € 9.100, € 8.800, €21.500, € 13.400, €16.600 en €16.600. Daarmee zijn de twee goedkoopste maatregelen, MC en H-MIS, ook de doelmatigste individuele interventies, maar de verschillen in doelmatigheid zijn klein.

1. Introduction

Smoking is a leading cause of preventable morbidity and mortality in terms of increased risks of many diseases, loss of quality of life and loss of life-years. In the Netherlands, smoking is the single determinant with the highest burden of disease, being related to about 15% of mortality and morbidity.[3] The World Bank estimated that 6% to 15% of total health care costs were attributable to smoking in high income countries. [11]
For many smokers, it is hard to quit smoking on will power alone. Only 3-7% of the smokers who attempt to stop smoking on will power are still abstinent after one year.[12-14] A wide range of policy measures and therapies is available to increase this rate, varying from price increases by taxation, media campaigns, or self-help manuals, to intensive individual counseling combined with pharmaceutical therapies.[14] The percentage of sustained quitters ranges from 4% up to 22%, while the additional percentages of quitters compared to a 'do-nothing' option range from 0.5% to 13%.[15-19]
Tobacco control potentially decreases the burden of disease substantially. Tobacco control policy will aim to reduce the number of smokers, either by increasing smoking cessation or by decreasing the initiation of smoking. Most smokers start when they are young. The majority of smokers have started before age 20. Tobacco control targeting at adults will hence focus on smoking cessation. This will be the topic of the current report. Tobacco control targeting at adolescents has been evaluated in Van Baal et al.[20]
In addition to the health advantages of smoking cessation, policy makers will also be interested in intervention costs and effects on the costs of care, both for the various measures in comparison to each other and for tobacco control in general in comparison to other prevention policies.

The present report aims to examine cost-effectiveness of smoking cessation interventions at the individual level, for instance counseling and nicotine gum, and those targeting all adults, for instance tobacco tax increases. Extra attention was paid to effects on healthcare costs. Different cessation interventions were compared to current practice to report incremental cost-effectiveness ratios. The purpose of the study was to support the Dutch Ministry of Health in its tobacco control policy. A computer simulation model, the RIVM Chronic Disease Model (CDM), was used to project the future gains in life-years, QALYs, and the savings in healthcare costs that result from a decrease in the incidence of smoking-related diseases, as well as the increases in the costs of care as a result of reduced mortality. The strength of the model is that it is dynamic, which allowed us to apply increased cessation rates on a repetitive basis to a population whose mix of age, gender and smoking prevalence changed annually. The model accounts for relapse, and assumes this depends on time since cessation. Smokers as well as former smokers run an increased risk for smoking related diseases, with the risks of former smokers depending on time since cessation.

Chapter 2 describes the cessation interventions and the methods used. Chapter 3 describes how smoking cessation for different age groups results in health gains and affects costs of care. Chapter 4 presents the results in terms of health gains, costs and cost-effectiveness. Finally, chapter 5 concludes with a discussion of our results.

2. Methods

2.1 Selection of interventions

The selection of interventions was based on current availability in the Netherlands and presence of sufficient evidence for effectiveness and costs. We started with a list of available smoking cessation programs. Then we did a literature review, searching for Dutch trials and international meta-analyses, especially Cochrane reviews, to find out whether evidence of effectiveness existed. We excluded all interventions with effectiveness rates below 3% of continuous abstinence at 12 months, since this is below the quit rate on will power alone. In the literature this rate varied between 3-7%.[12-14] Finally, we presented our list to an expert panel, asking them to indicate missing interventions, and adjusted our selection accordingly. Appendix A presents a full description of the interventions selected, together with an overview of interventions mentioned by experts that were excluded and the reasons why. Table 2.1 below lists the selected interventions.

Table 2.1: Selected interventions

Intervention	Abbreviation	Short description
Individual cessation support		
Minimal counseling 'kort stopadvies'	MC	Short counselling by GP or assistant, in a single consult, 1 to 12 minutes duration
GP counseling as in the 'H-MIS'	H-MIS	Counselling by GP and/or assistant, in 1 to 2 consults, following 5 steps from a protocol
Telephone counselling	TC	An intake call of 30 minutes and 2 to 8 follow-up calls of each 15 minutes, based on a (computerized) questionnaire completed by the potential quitters.[1 2]
Minimal counselling + nicotine replacement therapy	MC+NRT	Short counselling followed by nicotine gum or patches for a period of on average eight weeks.
Intensive counselling + nicotine replacement therapy	IC+NRT	Intensive counselling (40-110 minutes in total) by a trained counselor (for instance lung nurse) combined with NRT for a period of on average 12 weeks.
Intensive counselling + bupropion	IC+BU	Intensive counselling in combination with Bupropion for a period of on average 9 weeks
Interventions at the population level		
Mass media campaign	MMC	Publicity via television, radio and newspapers, broad provision of leaflets, billboards and educational messages.
Tax increase	TI	A tax increase on tobacco products that translates into a price increase.

Interventions can be divided into interventions at the population level and individual cessation support. The former refer to mass media campaigns, regulations and tax increases, implemented at a countrywide scale and targeting all adult smokers. Theoretically, individual cessation support could also be implemented countrywide, but these interventions use a personalized approach, and they can also be used on a much smaller scale. Furthermore, they may be tailored to specific groups of smokers, for instance, heavily addicted smokers, or smokers with a chronic disease.

Interventions of both types cannot be compared without taking into account a number of caveats. The effectiveness of interventions at the population level is harder to estimate and surrounded by more uncertainty. Individual cessation support interventions can be evaluated in clinical trials, but in lack of a control group that is not possible for interventions at the

population level. For interventions at the population level, the size of the target group is clear. In contrast, for individual cessation support, the target group and how to reach them is not always clear. Costs to engage the target group or for training counselors are not usually included in the intervention costs. Finally, both types of interventions are often applied in combination. For instance, mass media campaigns are used to refer smokers to telephone counseling that is offered at the same time. In this report we did not look at combination policies, but evaluated the interventions separately. The costs and effects of combination policies will be the topic of further research.

2.2 Effectiveness in terms of increased cessation

Effectiveness of the interventions was estimated from Dutch and international literature.

Individual cessation support
We used Cochrane reviews, other meta-analyses and Dutch trial data to estimate 12 month continuous abstinence rates for the interventions at the individual level. We updated our earlier estimates,[21] including more recent studies. If we used a Cochrane review, we only included data from studies with 12 months continuous abstinence rates. Therefore, we recalculated the pooled effectiveness estimates, using a random effects model. We computed both the average cessation rate in the intervention groups and the average difference between the intervention and the control group. We also computed 95% confidence intervals. All estimates were presented to a panel of experts asking for comments.

Interventions at the population level
For interventions at the population level, we estimated effects on the percentage of smokers in a year.
For mass media campaigns, we combined national prevalence data with an estimate of the net effect of mass media campaigns based on international literature, to estimate baseline values and an uncertainty range for the effects of mass media campaigns. Finally, we presented these to experts, and asked their opinion about the effectiveness of mass media campaigns.
By increasing tobacco taxes, the prices of cigarettes will rise (provided that tobacco producers do not decrease their selling price). Increasing tobacco prices may affect smoking behavior in three different ways (see Figure 2.1)

- current smokers decrease the quantity of cigarettes consumed;
- more current smokers quit smoking;
- less non-smokers start smoking.

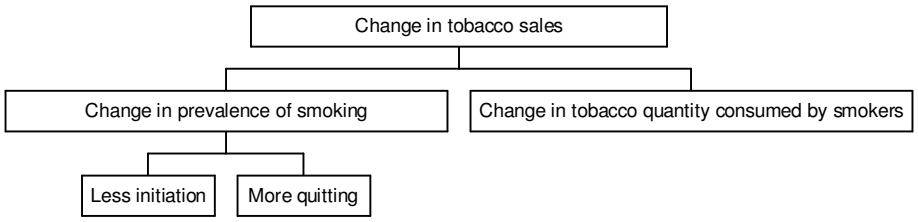


Figure 2.1: Mechanisms causing changes in tobacco sales

Historical time series of smoking behavior have been related to price developments. To estimate the health effects of price increases, effects on the prevalence of smoking are needed. The price elasticity of the demand for tobacco equals the relative change in the demand for tobacco divided by the relative change in the price of tobacco. As long as this elasticity is below 1, it implies that tax revenues will increase if taxes increase, since any 10% increase in prices leads to a less than 10% decrease in the demand for tobacco. Total price elasticity was decomposed into effects on the amount of cigarettes smoked per person and effects on smoking prevalence. For adults, we focused on the effects of tax increases on smoking cessation.[22-27] Again, the resulting estimates were presented to experts for comments.

2.3 Intervention costs

The costs of the different smoking cessation interventions were evaluated from the health care perspective and measured in euros. We used consumer price indices to adjust all cost to a 2004 price level. In addition, costs and savings in all years after year 1 of the intervention were discounted at 4%.[28]

Individual cessation support
Intervention costs were based on bottom up estimates of real resource use and costs per unit. We updated our earlier cost estimates and added estimates for minimal counseling.[21] Resource use was estimated from a description of the interventions as found in practice guidelines. For pharmacotherapy, we based resource use on the compliance data in the original trials selected from the Cochrane reviews, so that they matched with the effectiveness estimates. Resource use was then multiplied with unit costs to find intervention costs. Further details can be found in Appendix B.

Interventions at the population level
The annual accounts of STIVORO and their report about the 'Dat kan ik ook' campaign were the main sources for data on the costs of the two mass media campaigns. Full details can be found in Appendix B.
We assumed that tax measures imposed no costs from the health care perspective. Possible costs related to tobacco taxes are costs of regulation and control. These costs will be born by the Ministry of Finance. They are usually more than matched by tax revenues. Tax revenues of the year 2004 (1.94 billion euro)[29] were used to project differences in tax revenues due to price increases.

2.4 Long term effects in the RIVM Chronic Disease Model

To extrapolate from additional quitters to effects on health care costs, life years gained and QALYs gained, the RIVM Chronic Disease Model (CDM) was used (see Figure 2.2).[30] The model simulated the long term effects of increased smoking cessation rates on smoking prevalence and incidence, prevalence, mortality and costs of fourteen smoking-related diseases, i.e. coronary heart disease (myocardial infarction and other coronary heart disease), chronic heart failure, stroke, COPD, diabetes, lung cancer, stomach cancer, larynx cancer, oral cavity cancer, esophagus cancer, pancreas cancer, bladder cancer and kidney cancer, as well as on total mortality, morbidity and health care costs. The start year of the simulations was 2005. More details on the model can be found in Appendix C and in several background reports.[31-37] The model has been applied in several other analyses of smoking policy.[21 38-43]
As a reference scenario, the CDM was used for projections with constant rates of smoking initiation, cessation, and relapse for each age and gender category. These projections may be

interpreted as the result of current practice (see Figure 2.3). We estimated the age- and gender specific prevalence of smokers, former smokers and never smokers in the population from the NIPO data over 2004.[44] Cessation, initiation and relapse rates were estimated from the NIPO data over 2002 and 2003.[45 46] We excluded 2004 from these estimates, since in this year a tax increase, a mass media campaign, and new regulations on smoking at work and in public transport were introduced.

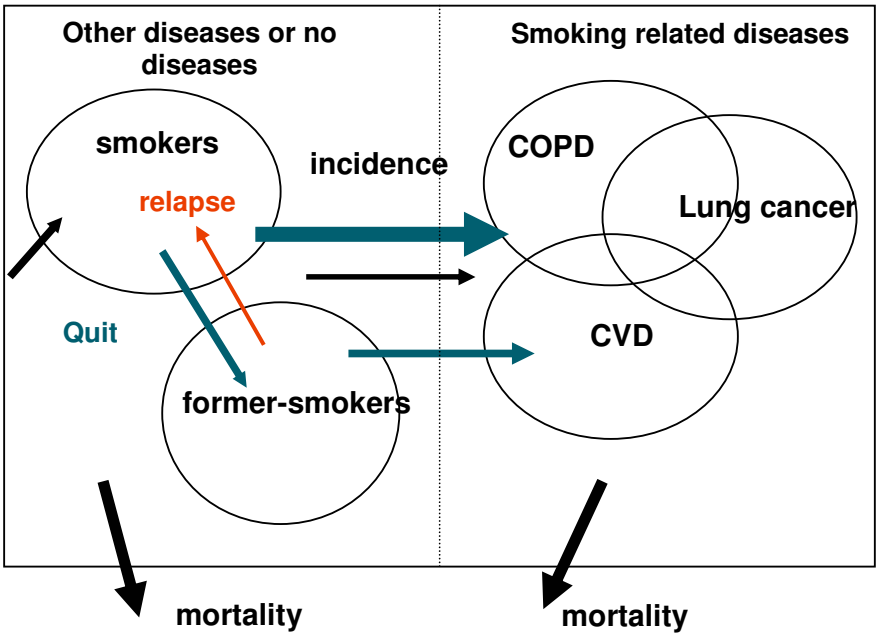


Figure 2.2: The modeling of smoking in the CDM

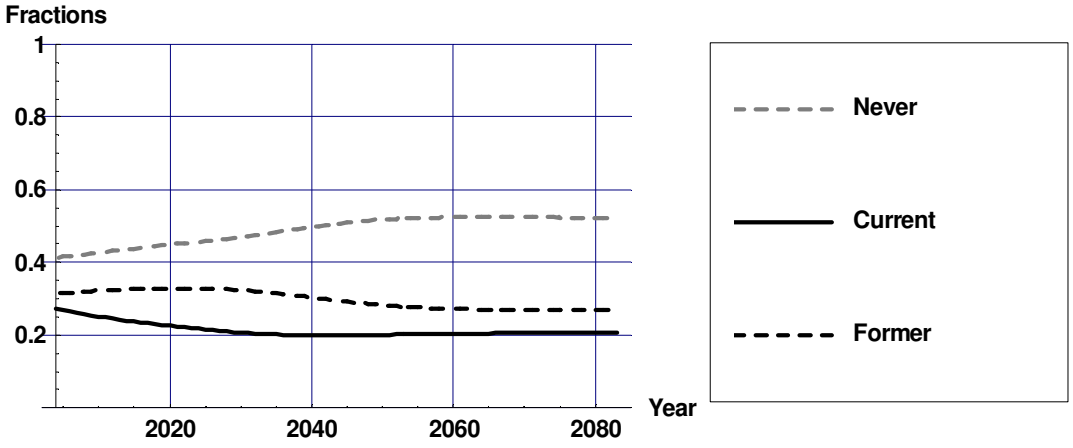


Figure 2.3: Model projections for the percentage of smokers, former smokers and never smokers in the current practice scenario (population of 15 year and older)

To evaluate the long term effects of cessation policy, intervention scenarios were compared to the current practice scenario. Intervention scenarios assumed that starting from the base year (2005) an intervention was implemented for periods of either 1, 5, or 10 years.

Individual cessation support

The individual interventions were assumed to reach 5%, 10%, 25%, of the smokers each year. The interventions by assumption increased cessation rates during the implementation period, resulting in a decrease of current smokers and an increase of former smokers. Two variants were compared. The first used the pooled absolute cessation rates from the intervention groups and divided these by the weighted average over age and gender of current practice cessation rates (weights were the number of smokers in each age and gender category), to find an intervention specific factor. This factor was then used to multiply the age and gender specific cessation rates for all smokers aged 20 years and over. In the second variant, the pooled difference in cessation rates between the intervention and control groups in the trials was used. We assumed an additive effect and applied this to the age specific cessation rates in the CDM.

Interventions at the population level

For the population interventions, effects were estimated in terms of prevalence rates of current smokers. For the intervention scenarios, smoking cessation rates were increased in the base year to fit to the assumed reduction in the percentage of current smokers. In the intervention scenarios we added a constant to current practice cessation rates. By doing this, it was assumed that the relative decrease in the percentage of smokers is equal in all age groups. Start, and relapse rates were kept at their current practice levels. For mass media campaigns, for all years after the base year, cessation rates were assumed to return immediately to their current practice levels. For tax increases, cessation rates were assumed to return slowly to their current practice levels, with a delay factor. The delay factor determines how fast cessation rates return to current practice level. In the scenarios presented in the main text the delay factor equals 0.5 which implies that every year the difference in cessation rate between current practice and intervention scenario is halved.[c] In sensitivity analyses the delay factor is varied. Model outcomes were the numbers and percentages of current smokers, never smokers and former smokers, prevalence of diseases, and population numbers.

Comparing population numbers in the intervention scenarios and current practice scenarios, results in yearly differences in the number of persons alive, or in other words, the number of life years gained. Combining disease prevalence with data from the Dutch Burden of Disease Study[47] and taking account of comorbidity, the model also projects the yearly amount of QALYs lived, that is, the life years corrected for quality of life losses as a result of disease. Comparison of intervention and current practice scenarios results in QALYs gained. The details of the computations, and especially how we took account of comorbidity were described in a background report.[48]

Average cost of care per patient were estimated based on a comprehensive overview, the Dutch Cost of Illness Study,[49] that assigned all expenditures in Dutch health care of different providers and sectors (General practitioners, hospitals, nursing homes, ambulance costs, etcetera) to different diseases or disease categories. The Cost of Illness study presented totals per disease, not per patient. We combined these with prevalence data to estimate age and gender specific costs per patient for each smoking related disease.

Finally, average total age and gender specific costs were corrected for these diseases, to find average age and gender specific costs for all remaining diseases.[48] This allowed us to present effects on the costs of smoking related diseases, the costs of all other diseases and, adding these, on total health care costs.

[c] For instance, if the first year after the tax increase the cessation rate in the intervention scenario equals 0.1 and in the current practice scenario 0.05, the second year the cessation rate in the intervention scenario equals 0.075, the third year 0.0625 etc.

2.5 Cost Effectiveness

Finally, different short and long term cost-effectiveness ratios were estimated.
To find short term cost-effectiveness ratios, the intervention costs were divided by the short term effects in terms of additional quitters, or a reduced number of smokers. The outcomes are costs per quitter, and costs per avoided smoker. These ratios could be estimated without the CDM.
To find long term cost-effectiveness ratios, the differences in model outcomes between intervention and current practice scenarios, that is life years gained (LYG), QALYs gained, and effects on health care costs, were added over all years within the time horizon to find incremental net present values. Net present values of total intervention costs were computed, applying costs per smoker to the smokers that had an intervention during the implementation period. Different long term cost-effectiveness ratios could be formulated: first, intervention costs per LYG or QALY gained, second intervention costs minus savings in smoking related diseases per LYG or QALY gained, and third intervention costs plus total effects on health care costs per LYG or QALY gained. Future costs and effects were discounted at the Dutch standard annual percentage of 4%.[28] The time horizon was 100 years. All cost data were presented in euro, for price level of 2004.

Sensitivity analyses
The cost-effectiveness ratios, especially the long term variants were the result of complicated computations, requiring a number of assumptions and combining data from different sources with varying degrees of certainty. As a result, formal confidence intervals, like those presented in clinical trials, or even in meta-analyses, can not be computed for our cost-effectiveness ratios. Nevertheless, we tried to give insight into the uncertainty of our results. For the individual cessation support, we had 95% confidence intervals for their short term effectiveness, and we estimated minimum and maximum values for the intervention costs per smoker. For the population interventions, we estimated ‘best case’ and ‘worst case’ scenarios, based on minimum and maximum effects.
We also did a series of one way sensitivity analyses to test the effects of several methodological assumptions, varying discount rates, time horizon, the number of participants in individual interventions, additive or multiplicative effects for individual interventions, the implementation period, the decay rate of tax increase, and the age groups targeted (see Table 4.6).

3. Age specific effects of cessation on health gains for three example scenarios

This section is intended as an intermezzo, to help understand the results that will be presented in section 4. The projections of the Chronic Disease Model will be presented for three example scenarios, explaining how additional quitters lead to health gains and how this affects the costs of care, for different age groups.

To demonstrate the effects of smoking cessation intervention, we will present outcomes of three example scenarios:
1. 1,000 extra quitters in the year 2005 compared to current practice aged 20-44;
2. 1,000 extra quitters in the year 2005 compared to current practice aged 45-64;
3. 1,000 extra quitters in the year 2005 compared to current practice aged 65+.

Figure 3.1 displays difference in the number of smokers of these three scenarios compared to the current practice scenario. In all scenarios approximately half of the 1,000 extra quitters relapse within a year. However, after one year differences between the scenarios emerge: in the scenarios targeted at older smokers more of the extra quitters die.

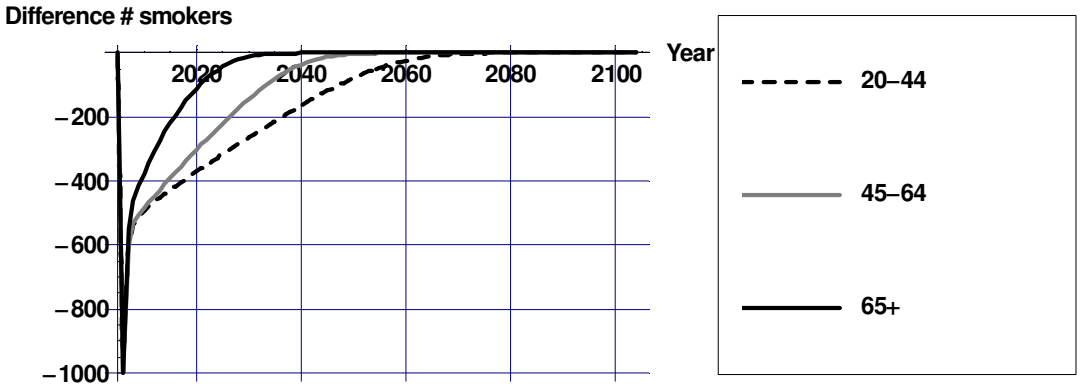


Figure 3.1: Differences in number of smokers for example scenarios 1, 2 and 3 compared to current practice

Figures 3.2 and 3.3 display the life years and QALYs gained over time. In contrast to other figures in this report, in these figures future effects have not been discounted, to accentuate differences. The reduction in the number of smokers results in a decrease in the incidence of smoking related diseases which causes a gain in life years and QALYs compared to current practice. For the quitters aged 20-44 health gains occur later than for the older age groups since relative risks for most smoking related disease are highest between ages 50-65. The smallest effects occur for the scenarios that resulted in more quitters aged 65+. This is because some of the quitters already have died and because relative risks on smoking related diseases decrease with older ages. Furthermore, health gains for younger cohorts are stretched over a longer period. The health gains approach zero as the cohorts that quit smoking become extinct. The timing of this is of course different for the different age groups. Comparing

Figures 3.2 and 3.3 shows that in the beginning there is more gain in quality of life than length of life caused by the reduced incidence of smoking related diseases. However, in the long run the gain in life years is larger than the gain in QALYs as a result of substitute diseases that decrease quality of life in life years gained.

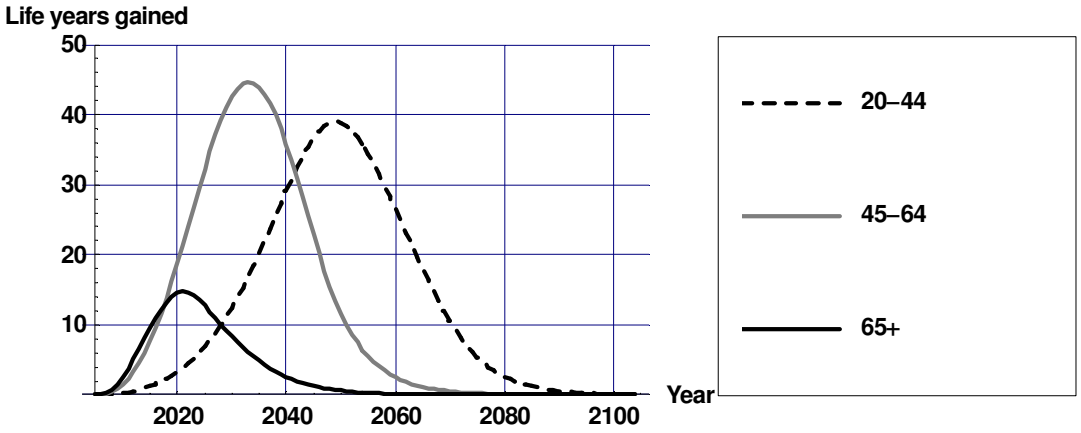


Figure 3.2: life years gained over time (life years not discounted)

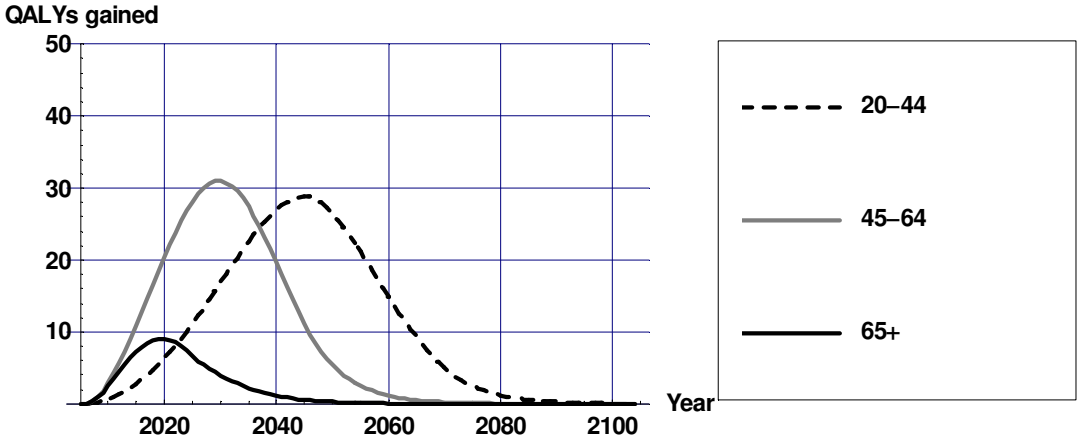


Figure 3.3: QALYs gained over time (QALYS not discounted)

Figures 3.4 and 3.5 display the difference in health care costs of smoking related diseases and of diseases not related to smoking, respectively. The decrease in the incidence of diseases causally related to smoking results in a decrease in health care costs of those diseases. However, the gain in life years causes an increase in the prevalence of all diseases, both those related to smoking and those not related to smoking.

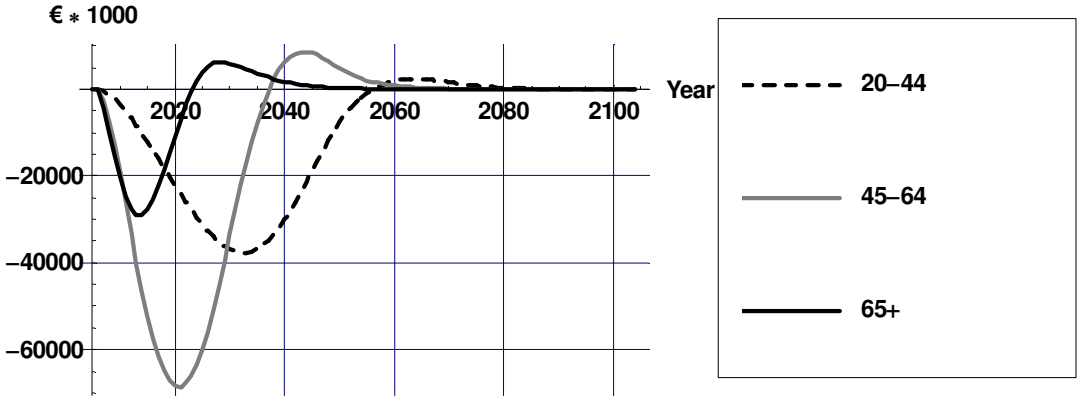


Figure 3.4: difference in health care costs of smoking related diseases over time (4% discount rate)

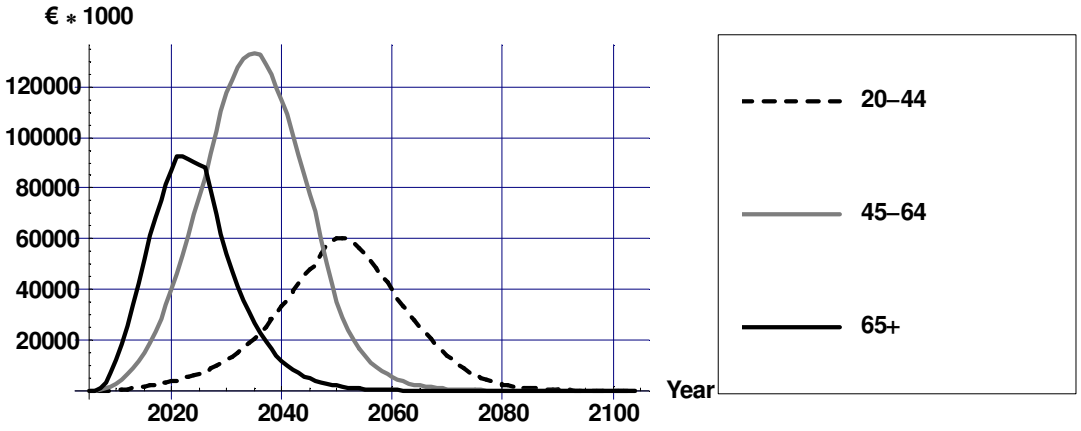


Figure 3.5: Difference in health care costs of diseases not related to smoking over time (4% discount rate)

Figure 3.6 displays the total difference in health care costs over time. From this figure it can be seen that the savings in health care costs of smoking related diseases are outweighed by increases in the health care costs of diseases not related to smoking in life years gained. This is mainly due to high costs at the end of the time horizon. Cost savings were obtained over the first 10, 25, and 40 years respectively, from a reduction in smoking related diseases. The period of cost savings is longer for younger age groups, since more health gains can be obtained if people stop earlier. However, if smokers live longer they have a higher lifetime chance to develop chronic, expensive, not lethal diseases like dementia. This effect is more pronounced for cessation at older ages. Furthermore, the additional health care costs in life years gained occur further away in the future for younger quitters than for older quitters and therefore these costs are more heavily discounted and have less effects, as can be seen from the shifts and decreases in the tops in Figure 3.5.

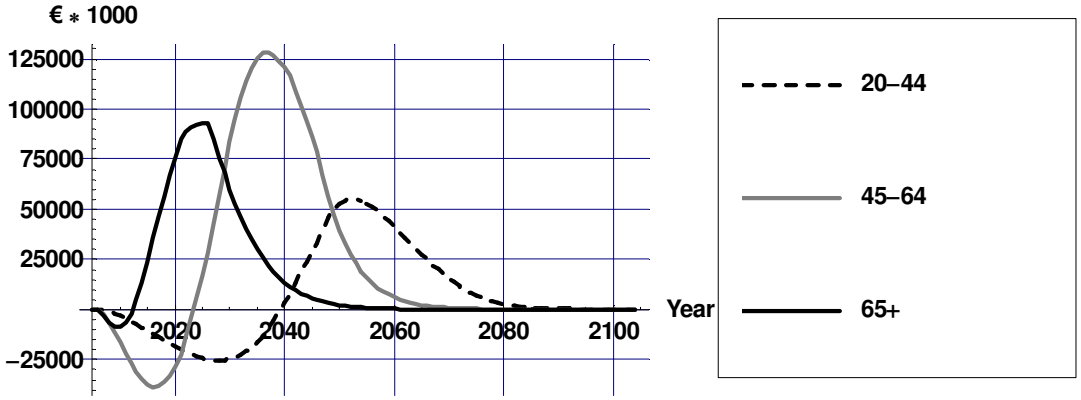


Figure 3.6: Difference in total health care costs over time (intervention costs not included, discount rate 4%)

Table 3.1 displays a summary of the results expressed per additional quitter for the three example scenarios. Taking into account relapse, quitting at a younger age (20-44) results in the highest gain in life expectancy (1.25 years). Therefore, most health gains can be achieved by targeting 20-64 aged. Causing old smokers (65+) to quit results in the smallest gain in life expectancy (0.30 years). Furthermore, the gain in quality of life compared to gain in life years is least favorable for old ages (0.15/0.30 for 65+ compared to 1.00/1.25 for 20-44). The highest savings in healthcare costs of smoking related diseases can be obtained by encouraging middle aged smokers (45-64) to quit smokers. However, they will also cause the highest increase in medical costs for diseases unrelated to smoking. Differences in health care costs divided by gain in the number of QALYs or life years gained shows that leaving interventions costs aside smoking cessation interventions targeted at younger smokers are most cost-effective.

Table 3.1: Results per additional quitter in different age groups

Age group	**20-44**	**45-64**	**65+**
Gain in life expectancy	1.25	1.15	0.30
Gain in health adjusted life expectancy	1.00	0.80	0.15
Difference in health care costs of smoking related diseases [a]	- € 1,000	- € 1,100	- € 200
Difference in health care costs of all other diseases [a]	+ € 1,700	+ € 3,200	+ € 1,700
Difference in total health care costs [a]	+ € 700	+ € 2,100	+ € 1,500
€ per LYG [a b]	€ 2,800	€ 5,300	€ 10,600
€ per QALY gained [a b]	€ 2,900	€ 6,300	€ 16,900

[a] Discounted at 4% [b] Difference in total healthcare costs divided by gain in discounted (health adjusted) life expectancy.

4. Results

4.1 Short term effects of interventions

Individual cessation support
Table 4.1 below presents the effectiveness of the individual interventions and their sources.

Table 4.1: Effectiveness of interventions for individual smokers

Intervention (abbreviations see Table 2.1)	cessation rate in intervention group (95% confidence interval)	difference in cessation rates between intervention and control group (95% confidence interval)	Intervention in control group	Source
MC	4.4% (2.5 – 6.2)	0.9% (0.3 – 2.2)	No advice	10 RCTs[15]
H-MIS	7.9% (4.2 – 15)	4.8% (1.1 – 12)	No advice	Dutch trial[16]
TC	9% (5.8 – 12)	2.4% (1.1 – 3.7)	Minimal intervention	11 RCTs[19]
MC+NRT	14% (8.9 – 18)	4.6% (2.5 – 6.7)	MC + placebo	17 RCTs[17]
IC+NRT	22% (17 – 27)	6.3% (4.0 – 8.5)	IC + placebo	26 RCTs[17]
IC+BU	17% (13 – 20)	7.3% (3.9 – 11)	IC + placebo	9 RCTs[18]

Interventions at the population level
For *mass media campaigns*, based on US data, the net effect of mass media campaigns was estimated as 0.5 to 0.7 times the observed effect in time series (see Appendix A). In the Netherlands, smoking prevalence rate decreased during the period 97-99 to 00-01 with 2.2 percentage points (from 33.7% to 31.5%) and during the period 2001-03 to 2004 with 2.0 percentage points (from 30% to 28%). Correction leads to an estimated net effect of 1.0-1.4 percentage points for the Dutch MMC. The absolute net effect in the USA was between 0.4 and 0.7 percentage point a year. The 'most probable effect' range of a MMC was then assumed to be between 0.5 and 1.0 percentage point. A (theoretical) minimum effect was established by multiplying the estimated effect in the Dutch situation (1.0 percentage point) by 0.2, based on Hu and co-authors.[50] A (theoretical) maximum may be the gross decrease of 2.1 percentage points, which occurred during the campaign years in the Netherlands. To stress the uncertainty of these estimates results were computed over the whole range of effectiveness.
For *tobacco taxes*, major reports concluded that at least half of the decrease in tobacco sales could be explained by a decrease in smoking prevalence.[11] Since most smokers are adults, this will mainly be a result of more quitting.[22-27] We assumed that the total price elasticity of demand for tobacco was between –0.3 and –0.5[11,51] and that the effect was largest immediately after the price increase, with cessation rates gradually returning to their old level (see Appendix A). Furthermore, we assumed that smokers of all ages were equally responsive to prices. A price increase of 20% was used, since this is roughly the price increase of cigarettes in the Netherlands in the beginning of 2004. Three different scenarios were formulated:

- *'best case' scenario*: total price elasticity of demand for tobacco equals - 0.5 and is completely caused by a drop in the prevalence of smoking. The amount of cigarettes smoked by those who continue smoking does not change. Thus, the price increase of 20% leads to decrease in the prevalence of smoking of 10% (about 2.8 percentage points).
- *'best guess' scenario*: price elasticity equals - 0.4 and is for 50% caused by a drop in smoking prevalence. The remaining 50% of the decrease in tobacco sales is caused by less consumption by continuing smokers. Thus, the price increase of 20% leads to decrease in the prevalence of 4% (approximately 1.2 percentage points).
- *'worst case' scenario*: price elasticity equals - 0.3 and is for 50% caused by a drop in prevalence. The remaining 50% is the result of less consumption by continuing smokers. Thus, the price increase of 20% leads to decrease in prevalence of 3% (approximately 0.9 percentage point).

4.2 Costs of interventions

Interventions at the individual level
Table 4.2 presents the baseline estimates for the costs of the interventions. Details, together with minimum and maximum values can be found in Appendix B.

Interventions at the population level
The total STIVORO costs of the campaigns 'Dat kan ik ook' and 'Nederland start met stoppen' were estimated at €6.3 and €6.4 million, respectively. Details can be found in Appendix B. In both campaigns, the largest part of the budget was used for media coverage and publicity (83%). The additional budget was used for measures to support individuals in their quit attempt.
For tobacco taxes, we used zero interventions costs. Costs of regulation and control fall outside the health care perspective and will be more than covered by tax revenues.

4.3 Long term effects of interventions, the CDM outcomes

This section presents the scenarios' long term effects as projected by the RIVM Chronic Disease Model (CDM). Subsequently, the following outcomes will be discussed: effects on the number of smokers, the amount of life years gained (LYG), the amount of quality adjusted life years gained (QALYs), the savings in healthcare costs that result from a decrease in the incidence of smoking-related diseases, and effects on the total costs of care as a result of reduced mortality.

Effects on smokers
Figure 4.1 illustrates the difference in the number of smokers for a 5 year implementation of three types of individual cessation support compared to the reference scenario. For all individual interventions, the maximum decrease in the number of smokers ranged between 12,000 for MC to over 300,000 for IC+NRT (the total number of smoking adults is about 4,000,000). For mass media campaigns effects varied from 25,000 to 280,000 and for tobacco taxes from 100,000 to 340,000. All these numbers refer to baseline scenarios.

Table 4.2: Resource use, unit costs and costs per smoker for interventions at the individual level (euro, price level 2004)

Intervention (abbreviations see Table 2.1)		Units	Unit price	Costs
MC				
	GP time (minutes)	2	2.04	4
	Material (brochures)	1	1.07	1
	Total			**5**
GP counseling (H-MIS)				
	GP time (minutes)	12	2.04	25
	Material (brochures)	1	1.07	1
	Total			**26**
TC				
	Counsellor time (minutes)	120	1.07	128
	Total			**128**
MC+ NRT				
	GP time (minutes)	12	2.04	25
	Material (brochure)	1	1.07	1
	Medication (DDD)	65	2.42	157
	Total			**183**
IC+NRT				
	Physician time (minutes)	2	3.70	7
	Counselor time (minutes)	90	0.81	73
	Medication (DDD)	80	2.42	193
	Material	1	1.07	1
	Overhead consults (per minute)	90	1.26	113
	Total			**388**
IC+BU				
	Physician time (minutes)	2	3.70	7
	Counselor time (minutes)	90	0.81	73
	Medication (DDD)	63	2.81	177
	Material	1	1.07	1
	Overhead consults (per minute)	90	1.26	113
	Total			**371**

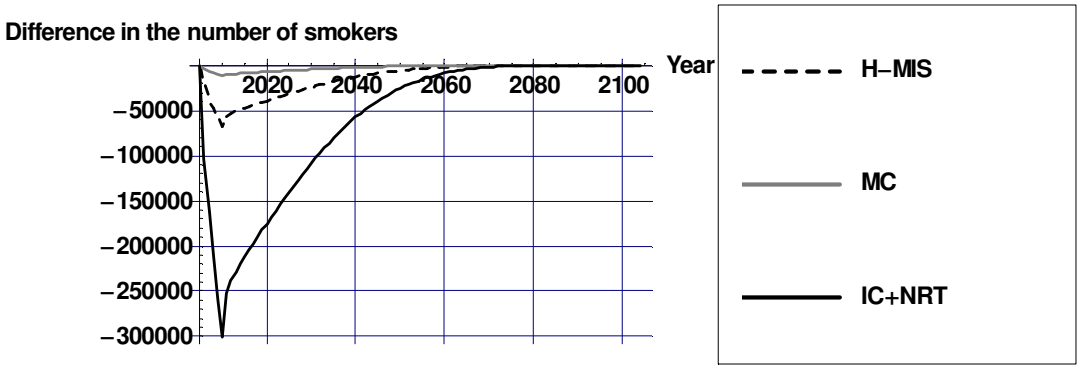


Figure 4.1: Differences in number of smokers for 5 year implementation of minimal counseling, H-MIS and intensive counseling combined with nicotine replacement therapy compared to current practice

In the individual cessation support scenarios the number of smokers decreases during the implementation period, but immediately after the implementation period start and quit rates return to their current practice levels by assumption. This results in a gradual disappearance of the decline in the number of smokers, due to relapse and mortality. The same holds for the mass media campaign. In the tax scenario, the effect on cessation rates was assumed to disappear more gradually over the years after the price increase, resulting in a more gradual return to old smoking levels

Effects on health

Figure 4.2 displays life years and QALYs gained over time for a 5 year implementation of intensive counseling combined with nicotine replacement therapy and for structured GP counseling (H-MIS). The reduction in smoking causes a decrease in the incidence of smoking related diseases which causes a gain in life years and QALYs compared to current practice. The largest health effects occur about 30-35 years after the intervention when the smokers that received the intervention have become on average middle aged. The health gains approach zero as the cohorts that received the intervention die. Over the first 25 years the gain in quality of life is larger than the gain in length of life. This is caused by the reduced incidence of smoking related diseases. However, in the long run the gain in life years is larger than the gain in QALYs, because substitute diseases decrease quality of life in life years gained.

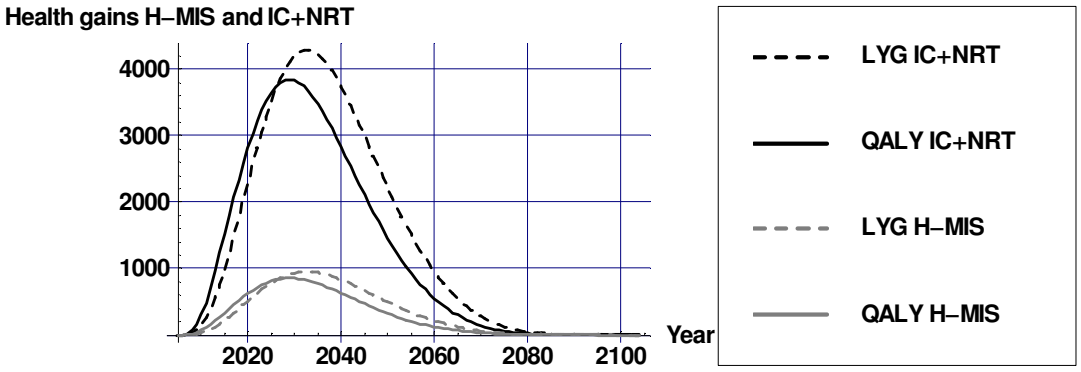


Figure 4.2: Life years gained (LYG) and QALYs gained over time for a 5 year implementation of HMIS and IC+NRT compared to current practice.

Effects on health care costs

For three individual cessation support interventions, Figures 4.3 and 4.4 illustrate the difference in health care costs of smoking related diseases and in the total costs of care, respectively. The decrease in the incidence of smoking related diseases results in a decrease in health care costs of those diseases. However, the gain in life years causes an increase in the prevalence of all diseases, both those directly related to smoking and all other diseases. If former smokers live longer therefore they have a higher lifetime chance to develop chronic, expensive, non lethal diseases like dementia. The result is a reduction in total health care costs over the first 25 years, followed by a sharp cost increase. The intervention costs during the first five years were not included in this figure. Yearly intervention costs varied between €4 million and €320 million (See also Appendix D).

For the case of a tax increase, assuming that the tobacco producers do not adjust their prices in reaction to the tax increase, the net present value of additional tax revenues was estimated at approximately 5 billion euro. This outweighed the additional health care costs in life years gained.
The tables in Appendix D present total intervention costs, total health effects, and total effects on health care costs for all interventions, adding health gains and costs over the time horizon of 100 years. Health effects varied from 5,000 to 120,000 QALYs or 6,000 to 140,000 LYG, on a total population of about 16 million people, with about 3 million smokers aged 20 to 70 years. Chapter 3 showed that the health effects per quitting smoker were about 1 life year and 0.75 QALY. This is the average gain that a smoker may obtain, being very careful, accounting for the risk of relapse, and using a slow and gradual decrease in risk levels for disease. Total discounted effects on health care costs varied from €25 million to €620 million or €2 to €41 per capita in the Dutch population.

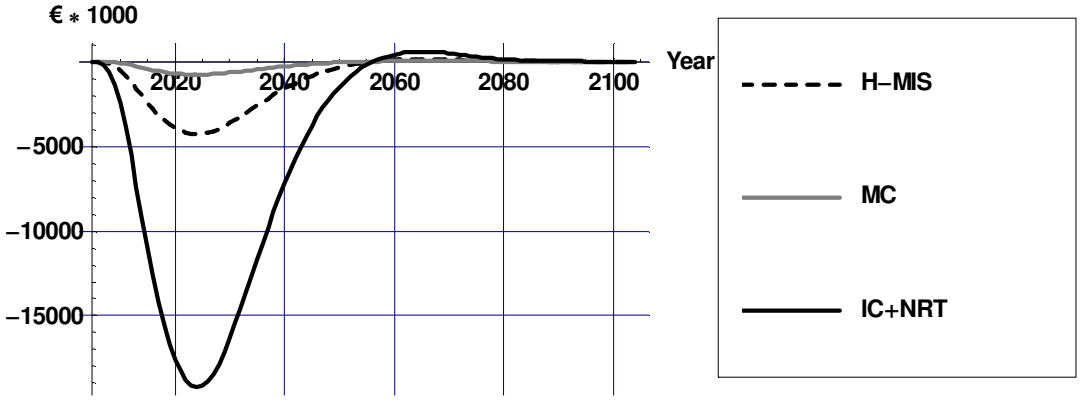


Figure 4.3: Difference in health care costs of smoking related diseases over time (4% discount rate)

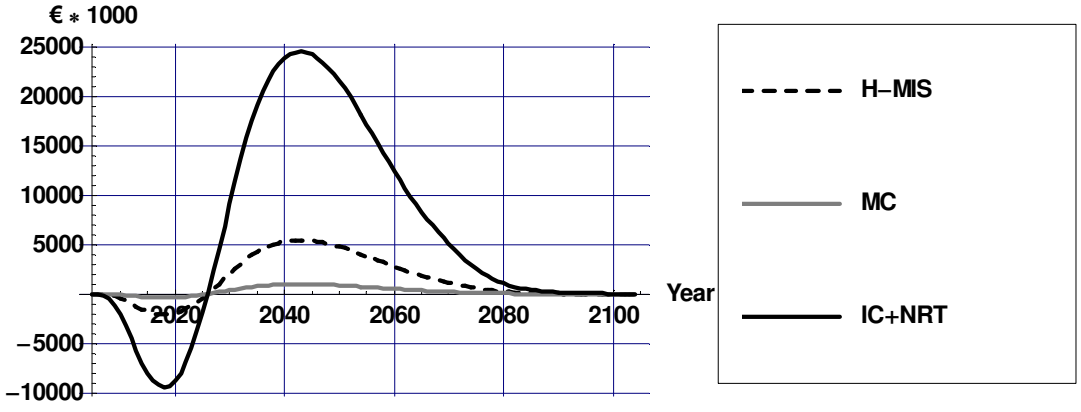


Figure 4.4: Difference in total health care costs over time (intervention costs not included, discount rate 4%)

4.4 Cost effectiveness

Finally, various cost effectiveness ratios were computed, combining the measures of health gains (number of quitters, LYG and QALYs), with measures of costs (Intervention costs, effects on smoking related diseases, and total cost effects). The ratios are presented in Tables 4.3, 4.4 and 4.5, for 'best guess' estimates together with the uncertainty intervals around costs per QALY, more details can be found in Appendix D.
Intervention costs per quitter or QALY were of course by assumption lowest for tax increases, namely zero. For MMC costs per quitter varied between €25 and €280, and intervention costs per QALY varied between €100 and €1,000. For individual cessation support, 'best guess' costs per quitter ranged from €900 for H-MIS to €4,300 for TC, while intervention costs per QALY ranged from €3,600 to €16,300. Including savings in costs of care for smoking related diseases, tax increases, MMC, and H-MIS were cost-saving interventions, while all others remained below €15,000 per QALY. Accounting for total health care costs, costs per QALY ranged from €5,100 for taxes to €21,500 for telephone counseling. These numbers refer to costs per QALY based on additive effects and can be found in the tables below. In addition, the tables in appendix D also present results for multiplicative effects. The figure in appendix D shows how the costs per QALY for mass media campaigns varied with its assumed effectiveness. The range in costs per QALY given in Table 4.3 can be found in this figure for an effect of 0.2 to 2.1 percentage points. Since additional tax revenues outweigh health care costs in life years gained, tax increases are cost saving if these additional tax revenues are taken into account.

Figure 4.5 presents total costs and effects in the cost-effectiveness plane, together with uncertainty ranges for the interventions. The two lines picture cost-effectiveness values of € 10,000 and € 20,000 per QALY. The ranges only include uncertainty about costs and effects, not the results of the univariate sensitivity analyses. These are presented in Table 4.6, for a selection of interventions, and for total costs per QALY only. Full details can be found in Appendix D.

Table 4.3: Summary of cost effectiveness results, interventions at the population level [a]

Intervention (abbreviations see Table 2.1)	Tax increase, worst case	Tax increase, best guess	Tax increase, best case	Mass media campaign
Intervention costs per quitter	0	0	0	€ 25 to € 280
Intervention costs per LYG	0	0	0	€ 100 to € 900
Intervention costs per QALY gained	0	0	0	€ 100 to € 1,000
Costs per LYG, causally related care only [b]	Cost saving	Cost saving	Cost saving	Cost saving
Costs per QALY gained, causally related care only [b]	Cost saving	Cost saving	Cost saving	Cost saving
Costs per LYG [c]	€ 4,400 (Cost saving)[d]	€ 4,400 (Cost saving)[d]	€ 4,500 (Cost saving)[d]	€ 4,500 to € 5,300
Costs per QALY gained [c]	€5,100 (Cost saving)[d]	€ 5,100 (Cost saving)[d]	€ 5,100 (Cost saving)[d]	€ 5,200 to €6,100

[a] Costs and effects discounted at 4%, price level 2004. [b] That is, interventions costs plus savings in costs of care for smoking related diseases. [c] That is, interventions costs plus difference in total health care costs. [d] Including additional tax revenues.

Table 4.4: Summary of cost-effectiveness results, low intensity interventions at the individual level, with uncertainty for selected outcomes given in brackets [a]

Intervention (abbreviations see Table 2.1)	MC	H-MIS	TC
Intervention costs per quitter	€1,000 (€ 300 to inf [d])	€ 900 (€200 to €2,600)	€ 4,300 (€3,200 to €13,000)
Intervention costs per LYG	€ 3,400	€ 3,100	€ 14,100
Intervention costs per QALY gained	€3,900 (€ 1,000 to inf)	€ 3,600 (€ 800 to €10,000)	€ 16,300 (€ 12,000 to €49,000)
Costs per LYG [b]	€200	Cost saving	€ 10,900
Costs per QALY gained [b]	€200	Cost saving	€ 12,600
Costs per LYG [c]	€ 7,900	€ 7,600	€ 18,500
Costs per QALY gained [c]	€9,100 (€ 6,100 to inf)	€ 8,800 (€6,000 to €15,000)	€ 21,500 (€ 17,000 to € 34,000)

[a] Costs and effects discounted at 4%, price level 2004 [b] That is, interventions costs plus savings in costs of care for smoking related diseases [c] That is, interventions costs plus difference in total health care costs. [d] inf = infinite. For minimal counseling, the uncertainty on effectiveness included the possibility that the intervention was not effective, resulting in infinite costs per QALY.

Table 4.5: Summary of cost-effectiveness results, high intensity interventions at the individual level, with uncertainty for selected outcomes given in brackets [a]

Intervention (abbreviations see Table 2.1)	H-MIS+NRT	IC+NRT	IC+BU
Intervention costs per quitter	€2,200 (€ 1,700 to € 3,700)	€ 3,000 (€ 2,000 to € 3,500)	€ 3,000 (€2,300 to €4,100)
Intervention costs per LYG	€7,100	€ 9,800	€ 9,800
Intervention costs per QALY gained	€8,200 (€6,400 to € 14,000)	€ 11,400 (€7,800 to €13,000)	€ 11,400 (€8,800 to €16,000)
Costs per LYG [b]	€3,900	€ 6,600	€ 6,700
Costs per QALY gained [b]	€4,500	€ 7,700	€ 7,700
Costs per LYG [c]	€11,600	€ 14,300	€ 14,300
Costs per QALY gained [c]	€13,400 (€12,000 to € 19,000)	€ 16,600 (€13,000 to € 19,000)	€ 16,600 (€14,000 to €21,000)

[a] Costs and effects discounted at 4%, price level 2004 [b] That is, interventions costs plus savings in costs of care for smoking related diseases [c] That is, interventions costs plus difference in total health care costs.

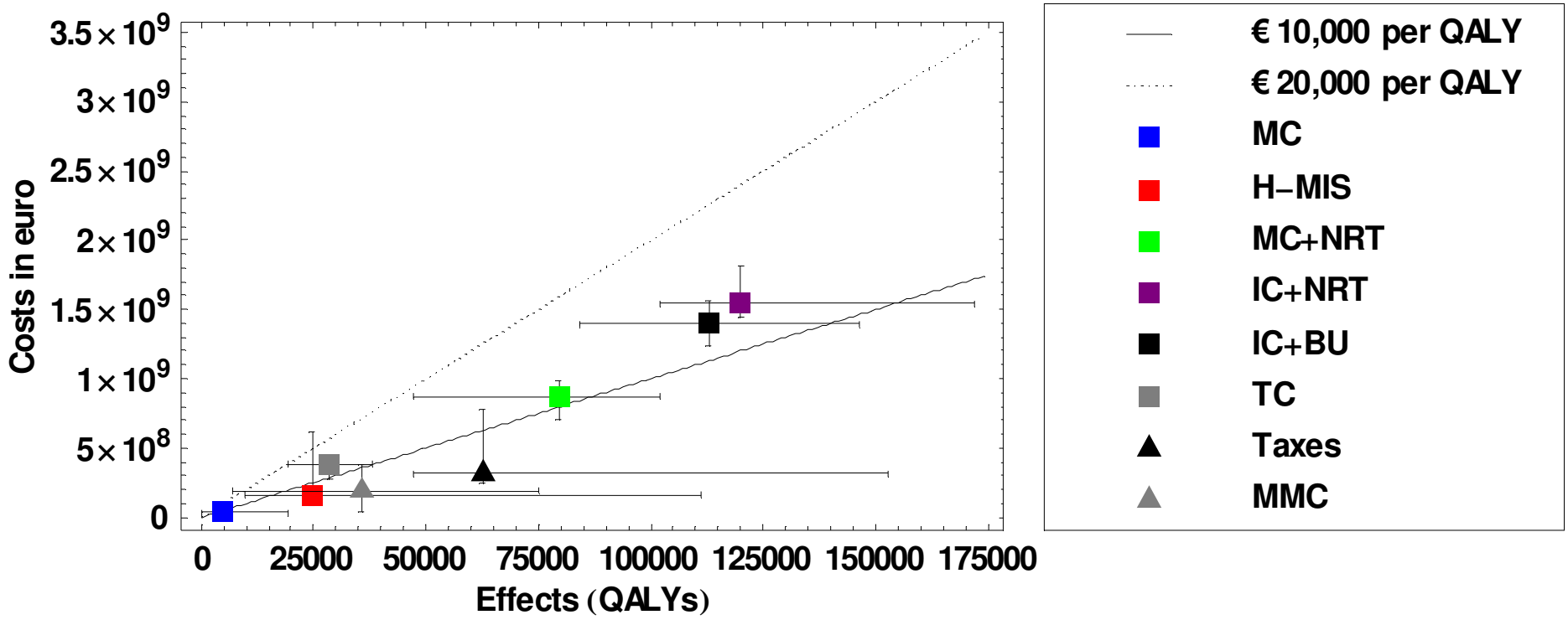


Figure 4.5: Ranges for total costs and effects in the cost-effectiveness plane

Table 4.6: Selected results of univariate sensitivity analyses, effects on total costs per QALY gained (abbreviations see Table 2.1, all figures in euro per QALY, price level 2004, baseline estimates in bold)

Variable varied	Values	IC+NRT	H-MIS	MC	Tax increase, 'best guess'	MMC [i]
Discount rates	**4, 4[ii]**	**16,600**	**8,800**	**9,100**	**5,100**	**5,200**
	3, 3	12,100	8,000	8,200	6,100	6,200
	0, 0	13,400	1,1000	11,100	9,800	9,800
	5, 5	12,800	6,900	7,200	4,200	4,400
	4, 0	3,500	2,100	2,100	1,400	1,600
	4 , 1.5	5,800	3,500	3,600	2,400	2,600
Time horizon	**100[iii]**	**16,600**	**8,800**	**9,100**	**5,100**	**5,200**
	60	16,200	8,300	8,700	4,600	4,900
	40	16,300	6,600	7,000	2,300	2,500
	20	41,700	11,000	12,300	Cost saving	Cost saving
Number of	**25**	**16,600**	**8,800**	**9,100**	-	-
participants[iv]	10	16,600	8,800	9,100	-	-
	max[v]	16,500	8,800	9,100	-	-
Additive/	**Add**	**16,600**	**8,800**	**9,100**	-	-
Multiplicative	Mult	14,500	9,400	[vi]	-	-
effects						
Decay rate for	**0.5**	**-**	**-**	**-**	**€ 5,100**	-
taxes	0.75	-	-	-	€ 5,200	-
	0.25	-	-	-	€ 5,100	-
Implementation	**5**	**16,600**	**8,800**	**9,100**	-	-
period	10	16,800	9,000	9,300	-	-
	1	16,400	8,600	8,900	-	-

[i] Results for an effect of 1 percentage point.
[ii] Discount rate for costs, followed by discount rate for health effects.
[iii] Time horizon in years.
[iv] Percentage of adult smokers aged 20-70 years reached.
[v] Maximum thinkable number of participants, estimated at 90% for TC, 70% for all low intensity interventions delivered by GPS and 30% for all high intensity interventions.
[vi] For minimal counseling, using multiplicative effects, the effectiveness in the intervention scenario was not different from the current practice scenario, and hence costs per QALY would be infinite.

5. Discussion and conclusions

5.1 Main findings

The current report presented estimates of health effects and cost-effectiveness of interventions to increase smoking cessation among adults. Health effects and cost effectiveness of six different individual cessation support interventions, of tobacco taxes, and mass media campaigns were estimated and compared.

Of the individual interventions, structured GP advice (H-MIS) was the most efficient intervention with a cost effectiveness of €8,800 per QALY. Four of the remaining interventions had cost-effectiveness ratios below €20,000, and the fifth, telephone counseling, had a ratio of €21,500. A definite value for the effectiveness of mass media campaigns was hard to find, and the opinions of experts varied. Therefore, in the cost-effectiveness analyses, we computed the results for a broad range of reductions in the percentage of current smoking, between 0.2 to 2.1 percentage points. Total incremental costs per QALY were below €10,000 over this entire range. For tobacco tax increases, we found a cost-effectiveness of €5,100 per QALY. Since the price elasticity of demand for tobacco is below 1, tax revenues will increase as a result of a tobacco tax raise. Additional tax revenues outweighed the additional health care costs in life years gained. Thus, if additional tax revenues were included tax increases are cost saving.

The cost-effectiveness ratios of the intervention at the population level were low and robust to changes in effectiveness, and costs. The results for individual cessation support varied somewhat with effectiveness and intervention cost estimates, but remained below €20,000 per QALY over the ranges of costs and effects that were used in the sensitivity analyses, the exceptions being telephone counseling (TC) and minimal counseling (MC). These ratios were robust for changes in the implementation period, and the number of participants. All cost-effectiveness ratios changed as a result of a different choice of discount rates or time horizon, which was to be expected, given the differences in the timing of intervention costs, health care cost savings, increased health care costs, and health gains. Intervention costs, and cost savings occur immediately, while health gains peak at about 25 years after the interventions, and the increase in health care costs from care in life years gained occurs farthest into the future and are hence heavily discounted. Cumulative health gains were of course not robust to different effectiveness assumptions. Any reduction in effectiveness implied a similar reduction in health gains.

In chapter 3 we demonstrated that most health gains could be obtained by encouraging young adults to quit. Taking into account relapse, the youngest group of adult smokers (between 20 and 44 years) on average gained about 1.25 years in life expectancy and 1 year in health adjusted life expectancy (QALYs). Furthermore, differences in health care costs divided by the number of QALYs or life years gained showed that, assuming identical interventions costs and effectiveness, smoking cessation interventions targeted at these young adult smokers were most cost effective. The RIVM Chronic Disease Model computed a difference in life expectancy between a smoker and a never smoker of 7.7 for men and 6.3 for women. Taking account of slow and gradual decrease in the risk levels for disease and relapse of former smokers, the actual gain that can be obtained by cessation is about 1 life year. Prevention of smoking through interventions for adolescents leads to larger potential total health gains than cessation.[20]

5.2 Comparing the effectiveness of the different interventions

The outcomes of the scenarios presented in this study should be interpreted with due caution. Even though we used the same methodology as much as possible, not all of them can be compared to each other without caveats. The most important problem here was that effectiveness estimates came from different sources. This does not need to be a problem when looking at cost-effectiveness ratios, but comparing total costs and effects is not easy. The interventions evaluated were not mutually exclusive, because, in principle, they could be combined with each other. Therefore, computing incremental ratios for one over the other is in general not informative. These ratios might be computed for the individual cessation support interventions. Leaving out dominated scenarios, and assuming that 25% of smokers is a reasonable number of participants, the incremental ratio for intensive counseling (IC) plus pharmacotherapy (nicotine replacement therapy (NRT) or bupropion (BU)) compared to low intensity counseling (H-MIS) was about € 19,000 per QALY.

For IC+NRT, IC+BU, MC, MC+NRT and TC, meta-analyses which combine the results of various trials were used to compute pooled 12 months continuous abstinence rates. For the H-MIS we based our effectiveness estimates on a single trial. However, this was a Dutch trial. Therefore, the results may be better comparable to the Dutch situation than the outcomes of meta-analyses of foreign studies. The H-MIS seemed more intensive than MC, which was included as a separate intervention. The trials reviewed for IC+NRT and IC+BU were held in self-selected smokers. Countrywide implementation, without the monitoring involved in the evaluation studies, in a large group of smokers and not only those willing to participate in a study, probably means a lower effectiveness. For MC, H-MIS, MC+NRT and TC the interventions were given to an unselected population of smokers, and hence the stop rates would be more representative of effectiveness.

Mass media campaigns are effective in generating support for tobacco control policies and they support and trigger other initiatives.[52] However, it is hard to establish their effect on smoking prevalence and this outcome was needed to evaluate their health gains and cost-effectiveness. In this report we used a combination of foreign literature and simple before/after comparisons to estimate an effectiveness range. A number of experts were consulted but their opinions were quite divergent and did not add more certainty to our estimates. By using a broad range of effects, we stressed the difficulty to estimate the precise effects of mass media campaigns on smoking prevalence. The cost-effectiveness analyses clarified that the incremental costs per QALY of a mass media campaign were below €10,000 for the minimum estimated effect of 0.2 percentage points, and lower. It should be noted that an effect of 0.2 percentage points still implies that 25,000 smokers quit. Furthermore, as mentioned before, although the cost-effectiveness of mass media campaigns is hardly influenced by the absolute effect, the absolute health gains in the population are affected.

The effectiveness of tobacco tax increases was estimated based on international literature. The only study that used Dutch data on tobacco sales and tobacco prices in the Netherlands estimated a total price elasticity of -1, somewhat higher than most foreign studies.[53] However, since no studies using Dutch data exist that estimated effects of price increases on smoking prevalence we decided to use the evidence base of foreign studies.

5.3 Methodological issues

We performed a health-economic evaluation from the health care perspective. It concentrated on effects of interventions on health and health care costs and compared these with intervention costs. We did not present effects on productivity costs and on the personal costs of smokers. Especially the latter can result in large savings, since quitters save the costs of buying cigarettes. Furthermore, effects of smoking cessation on passive smoking and on the course of disease for those already ill were not taken into account.

Current practice use of five individual cessation support interventions was estimated to be less than 1.5% of all smokers in 2000.[21] Hence, we assumed that the effect of the individual interventions on current practice levels was minor. For the population interventions we also assumed zero use in current practice. The current practice scenario was based on empirical data over the period 2001-2003. Although we excluded the years 2000 and 2004, still the effects of mass media campaigns which were implemented during this period, could have influenced these data. Hence, our current practice scenario may overestimate the downward trend in smoking in the absence of a mass media campaign. However, this does not matter for the health gains, cost effects, and cost-effectiveness ratios, which were based on a comparison of the current practice and intervention scenarios.

The costs estimates of individual cessation support did not include the development costs of the programs, or the costs to reach 25% of all smokers. However, cost-effectiveness ratios were not very sensitive to changes in the percentage of smokers reached. Of course, total health gains were sensitive to such changes. About 75% of all smokers visit their GP each year. For the IC interventions, supply by referring outpatients could reach 38% of all adults who visit a specialist in a year. Therefore, for these interventions, as well as for telephone counseling, the percentage reached will be determined by available capacity of professionals. As long as unit costs would not increase substantially for increased capacity, our cost estimates covered these costs.

5.4 Comparison to other studies

Reviews of the cost-effectiveness of smoking cessation intervention in the literature showed costs per life-year gained that varied between about €200 and €10,000 when converted into Dutch currency using Purchasing Power Parity rates and updated to the year 2000 with consumer price indices.[21] Several more recent reviews and evaluation studies were found on smoking interventions at the individual level[54-57] and two were found for evaluating mass media campaigns similar to the Dutch campaigns.[58,59] Outcomes of these studies should be interpreted very carefully, because the transfer of results from economic studies between countries is difficult, especially if different discount rates were applied in the evaluations. Most studies simply compared intervention costs to health outcomes, and ignored effects on the costs of care. Furthermore, they usually assumed quitters would remain former smokers and did not account for relapse in former smokers after more than 12 months of continuous abstinence. A cost-effectiveness study that used a similar methodology was conducted by Tengs et al.[60] for a school based smoking education program targeted at adolescents, with the Tobacco Policy Model.

Ronckers et al.[54] reviewed cost-effectiveness studies of smoking cessation interventions, and tried to standardize the outcomes. For counseling alone compared to usual care a mean cost-effectiveness ratio of $3,200 per LYG was presented. Costs only included intervention costs.

Song et al.[55] evaluated adding pharmacotherapy to advice or counseling alone. Costs per LYG were about $2,000 for NRT, and $1,500 for bupropion. The impact of smoking cessation on long-term medical expenditure was not considered. Cornuz et al.[56] determined cost-effectiveness ratios of pharmacotherapy compared to GP counseling. The cost per LYG for counseling only was about € 600. The CE ratios for pharmacological treatments varied from €2,000 to €7,000 per LYG. Most cost effective were bupropion and nicotine patches. Only direct medical costs were included. Javitz et al.[57] determined the differential cost effectiveness of bupropion in combination with behavioral interventions. Cost per life year and QALY were below $1,100, based on intervention costs only. Ratcliffe et al.[58] describe the evaluation of a Scottish mass media campaign. The long-term health benefits were estimated using the model Prevent. Estimates of the cost per life year gained ranged from to about €600 to €1200 (discount rate of 6% on costs). Hassard et al.[59] evaluated the cost-effectiveness of Australia's National Tobacco Campaign which started in 1997. Ignoring cost offsets, costs were $3,000 per life year gained. To summarize, intervention costs per LYG were in the order of magnitude of a few thousand euros or dollars. Our own findings confirmed this. The intervention costs per LYG were slightly higher than most results in the literature, because we took account of relapse and slowly decreasing risks of former smokers, thus carefully estimating health gains.

The current evaluation is more complete than most evaluations as published in scientific literature, which mostly presented intervention costs per quitter, QALY of LYG. Furthermore, our evaluation covered a broad range of interventions, evaluating them all in a similar way. The RIVM Chronic Disease Model was used to compare intervention scenarios with a current practice scenario. This model has the advantage that it accounts for duration dependent relapse of quitters, and smoking prevalence is the result of age dependent start, and cessation rates, combined with relapse rates. Furthermore, our evaluations were very complete in the presentation of effects on health care costs, including both the savings for smoking related diseases and the additional costs of health care resulting from an increase in life expectancy. For the total costs of smoking, Barendregt et al.[61] found that smoking reduction results in a substitution of health care costs from cheap lethal smoking related diseases towards expensive, less lethal non-smoking related diseases in life years gained, using the Prevent model. This effect was confirmed in our results. However, even adding health care costs of diseases not related to smoking in life years gained, the cost-effectiveness ratios were still rather low, with the highest ratio being around €21,500 per QALY for TC. Most costs in added life years occur far in the future and are therefore heavily discounted. Our results presented three different cost-effectiveness ratios, allowing insight into the effects of intervention costs, savings in the costs of smoking related diseases, and additional costs for care in life years gained.

5.5 Policy implications

We demonstrated that large health gains can be achieved by relatively small investments. All interventions resulted in cost-effectiveness ratios below €20,000 per QALY gained. Furthermore, although the effectiveness of population interventions was more uncertain than individual interventions, they seemed a good investment since intervention costs were either absent (tobacco taxes) or very low (MMC). Moreover, tax increases generate additional tax revenues and these might be used to finance other tobacco control activities.

A ‘comprehensive approach’ is generally viewed as necessary in tobacco control policy. [62-66] According to some experts this includes the implementation of a mass media campaign. It has been reported that mass media education combined with increased taxes is more effective than tax measures only (for instance in Massachusetts). The opinion of several of the experts which were consulted during this project confirmed this, but others were more skeptical about the contribution of mass media campaigns.

It has been mentioned by the experts consulted that the problem in comparing the interventions is that they may be intended for different target groups. Selecting the single most efficient intervention would be problematic. Furthermore, to compute meaningful incremental ratios for increasingly ambitious policy goals requires mutually exclusive intervention packages. Hence, an interesting topic for further research is the evaluation of realistic combination packages, including several interventions. The results above help to select promising interventions for inclusion in such packages.

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Appendix A Selection of interventions

Table A.1: List of interventions for smoking cessation in adults

	Effectiveness[vii]	Available in the Netherlands	Remarks
Individual cessation support			
Minimal counseling ('Kort stopadvies')	4%	Yes	
GP counseling (H-MIS)	8%	Yes	
Telephone Counseling	8%	Yes	
H-MIS plus Nicotine Replacement Therapy (NRT)	13%	Yes	
H-MIS plus Bupropion (BU)	No evidence	Yes	Insufficient evidence of effectiveness
Intensive Counseling (IC)	Insufficient evidence	Yes	In a Cochrane review, only two out of 21 studies reported 12 months sustained abstinence in a general population of smokers, and one of these showed no significant effect compared to brief counseling. Many trials included pharmacotherapy.
IC+NRT	22%	Yes	
IC+BU	17%	Yes	
Minimal counseling by dentist (T-MIS)	Too low	No	The largest study on this intervention was an American study. It found 12 months abstinence rates of 2.6% in the intervention group.[67]
'Tailored advice (internet)'	Probably too low.	Yes	Topic for further research.
Self-help (written material)	Too low	Yes	
Group course	Insufficient evidence	Yes	
Outpatient stop smoking clinic ('Rookstoppoli')	Insufficient evidence	Yes	This specific intervention is relatively new and we could not identify sufficient evidence to estimate a percentage of quitters. To some degree it is similar to the interventions IC+BU and IC+NT that have been evaluated.
Acupuncture	No evidence	Yes	
Allen Carr	No evidence	Yes	
Various other alternative methods	No evidence	Yes	
Minimal counseling by pharmacy (A-MIS)	Insufficient evidence	No	
Minimal counseling by midwife (V-MIS)	Insufficient evidence	Yes	A Dutch study found a percentage of quitters of 15% 6 weeks after giving birth (this is about 9 months after the intervention).[68] However, relapse prevention after this time may be difficult as shown by an American study, that found insignificant effects.[69]
Minimal counseling by cardiologist in clinic (C-MIS) or outpatient (P-MIS)	Insufficient evidence	Yes	C-MIS: Correcting for baseline differences, the percentages of stoppers at 12 months did not differ significantly in a Dutch study.[70] P-MIS: The percentages of stoppers at 12 months did not differ significantly in a Dutch study.[71]
Interventions at the population level			
Mass Media Campaigns	0.2 – 2.1[viii]	Yes	Effectiveness as percentage point decrease in percentage of smokers.
Refund of support to quit		No	Not evaluated in this project. Topic for further research.
Taxes	3-10%[ix]	Yes	Prevalence decreases in year after tax increase, thereafter the effect slowly disappears.
Prohibition of smoking at work		Yes	Not evaluated in this project. Topic for further research.

[vii] Effectiveness in intervention group after 12 months
[viii] Effectiveness as percentage point decrease in percentage of smokers
[ix] Effectiveness as percentual decrease in percentage of smokers

Effectiveness of Mass media campaigns

USA data allowed comparison to the USA average, to correct gross prevalence reductions for autonomous trends. The relative reductions in California and Massachusetts, where mass media campaigns were implemented, ranged between 9% and 23%, while the 'autonomous secular' trend in the USA was a relative reduction of about 11% during the period 1989-1993 and 3% during the period 1990-1996. Leaving out the strange results of the 94-96 campaign in California, the *relative net reduction* from the campaigns may be estimated by subtracting the USA trend from the trends in the campaign states, and ranged between 6% and 12%.[72] Dividing the net reduction by the gross reduction, correction factors were estimated at 0.5 to 0.7. These were then used to multiply Dutch gross effects in order to tentatively translate gross to net effects. Furthermore, the *absolute net reductions* in USA states with campaigns were 0.4 to 0.7 percentage points a year.

Figure A.1 shows the prevalence rates of current smokers in The Netherlands at a population level since 1990.

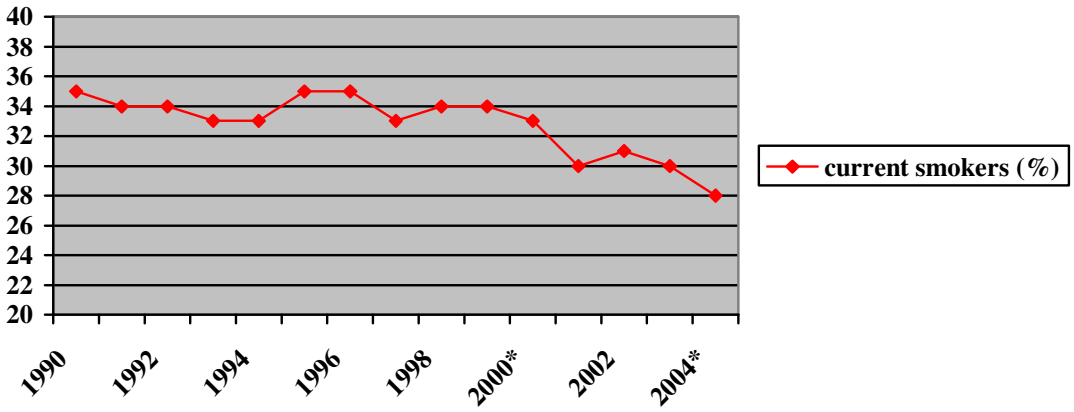

*Figure A.1: Percentage of current smokers since 1990 in The Netherlands (campaign years are marked *).*

From the period 97-99 to 00-01 the smoking prevalence rate decreased by 2.2 percentage points (from 33.7% on average in 97-99 to 31.5% on average in 00-01). This is a relative reduction of 6.5%. This reduction may be seen as the 'maximum possible effect' of the millennium campaign 'Dat kan ik ook', if the whole decrease in prevalence is ascribed to the campaign. Between 2001 and 2003 the prevalence rates stabilized around 30%. In the first semester of 2004, the smoking prevalence rate decreased to 27%, while the estimated smoking prevalence for 2004 is 28%. Hence the maximum possible effect of the 'Nederland start met stoppen campaign' would be 2 percentage points. The 'average' maximum effect of the two campaigns then amounts to 2.1 percentage points. These reductions clearly overestimate the effects. Correction with the factor of 0.5-0.7 derived above leads to an estimated net effect of 1.0-1.4 percentage points for the two Dutch campaigns. Combined with the absolute net effect found for campaigns in the USA (0.4 to 0.7 percentage point a year) this leads to a range of 'most probable effect' between 0.5 and 1.0 percentage point. A (theoretical) minimum is established by multiplying the estimated effect in the Dutch situation (1.0 percentage point) by 0.2. This is based on Hu and co-authors,[50] who suggested that 20% of the effects can be ascribed to mass media campaigns, in case of simultaneous implementation of other (tax) measures. To summarize, most likely mass media campaigns can reduce the prevalence rate of current smokers by 0.5 to 1.0 percentage points. A (theoretical) minimum is a decrease in prevalence rate of current smokers by 0.2 percentage points, and a theoretical maximum for effectiveness is 2.1 percentage points. The opinions of the experts did not add more certainty to these estimates.

Appendix B Cost estimates

Mass media campaigns

The annual accounts report the cost of all STIVORO programs, covering the whole program period, i.e. development of the campaign, its implementation, and evaluation. Additionally the annual STIVORO accounts present overhead cost. A proportion of the overhead cost was ascribed to the mass media campaigns. The fraction of overhead costs that was in a particular year ascribed to the mass media campaign equaled the fraction of the program budget that was spent on the mass media campaign. This strategy offers a lump sum estimate of the cost of the mass media campaigns (see Table B.1).

The total costs can be grouped into two cost categories: 1) money spent at population level, and 2) money spent at the individual level. A vast part of the budget was used to run the national campaigns and aimed to stimulate people to undertake a quit attempt. The remainder of the budget (17%), was used for a variety of measures that aimed to increase the success rate of quit attempts by offering support to individuals who aimed to quit (e.g. by means of brochures, telephone helpline, e-mail counseling, group therapy, television course).

One additional cost category needs to be analyzed: the cost of free publicity. Aside from the media coverage that was paid for by STIVORO (i.e. broadcast of the television game shows, publicity on television, publicity in newspaper and magazine articles), the campaign also received free publicity from the television stations who directly promoted the shows, or media who indirectly paid attention to it (for example trough discussing the health effects of smoking). The number of news papers articles, television promotions etcetera was counted, and a monetary value of 50% of commercial tariffs was used, assuming that part of the free publicity is accounted for in commercial tariffs.

Table B.1: Undiscounted cost of the two campaigns; no indexation applied

	Year [a]	'Dat kan ik ook'	'Nederland start met stoppen'
Program budget	1	25,000	50,000
	2	2,314,000	50,000
	3	2,314,000	4,550,000
	4	-	1,365,000
	Total	4,628,000	6,000,000
Overhead	1	7,400	17,000
	2	528,000	14,000
	3	776,000	592,000
	4		297,000
	Total	1,311,000	919,000
Free publicity	1	6,100	10,000
	2	566,000	10,000
	3	566,000	948,000
	4		284,000
	Total [b]	1,133,000	1,250,000
Total	**Health care payer**	**5,939,000**	**6,919,000**
	Societal perspective	**7,072,000**	**8,169,000**

a. 'Dat kan ik ook' ran from 1998 to 2000; 'Nederland start met stoppen' ran from 2001 to 2004, including a 1 and 2 years start-up period respectively.

b. The monetary value of free publicity for 'Dat kan ik ook' was estimated at €1.1 million (STIVORO). We assumed the costs would be spread over the years in the same patterns as the other costs. The monetary value of free publicity for 'Nederland start met stoppen' was assumed to be slightly higher than the free publicity in 'Dat kan ik ook', because of the longer program duration and increased television exposure.

Individual cessation support

General Practitioner costs in the minimal GP counseling intervention were calculated using the standard cost of a GP consultation from the Dutch guidelines for cost calculations in pharmaco-economic research.[73] Those costs included overhead costs and costs of assistants. A GP consultation was assumed to last 12 minutes and costs per minute were calculated. Material costs for self-help manuals were added separately.[74] For the pharmacological costs, average costs per defined daily doses (DDD) were used. These were estimated as a weighted mean of the different brands of the two most important types of nicotine replacement therapy, gum and patches [75 76] and for bupropion.[18 76] Costs of adverse effects were assumed to be negligible. For intensive counseling and telephone counseling, the salary of a counselor (respiratory nurse, or trained counselor at STIVORO, respectively) per unit of time was multiplied with counseling time. The costs of the counselor were calculated by using the method as described in Oostenbrink et al.,[73] adding overhead costs to monthly mean gross salaries per professional category and using the amount of working hours in one year to calculate unit costs per hour, assuming a productivity of 70 percent. The standard costs of a lung physician consultation [77] were used to find the costs of a two minutes stop advice. Material costs for self-help manuals were added separately.

Table 4.2 above presented the baseline cost estimates. Minimum and maximum values are given in Table B.2 below.

Table B.2: Minimum and maximum values for resource use and associated intervention costs (price level 2004)

Intervention (abbreviations see Table 2.1)		**Unit price**	**Minimum**		**Maximum**	
			Units	Costs	Units	Costs
MC						
	GP time (minutes)	€ 2.04	1	€ 2	20	€ 41
	Material	€ 1.07	0	€ 0	1	€ 1
	Total			**€ 2**		**€ 42**
H-MIS						
	GP time (minutes)	€ 2.04	3	€ 6	20	€ 41
	Material	€ 1.07	1	€ 1	1	€ 1
	Total			**€ 7**		**€ 42**
TC						
	Counselor time (minutes)	€ 1.07	90	€ 96	150	€ 161
	Total			**€ 96**		**€ 161**
MC+ NRT						
	GP time (minutes)	€ 2.04	3	€ 6	20	€ 41
	Material	€ 1.07	1	€ 1	1	€ 1
	Medication (DDDs)	€ 2.42	49	€ 119	141	€ 341
	Total			**€ 126**		**€ 383**
IC+NRT						
	Physician time (minutes)	€ 3.70	2	€ 7	2	€ 7
	Counselor time (minutes)	€ 0.81	40	€ 32	110	€ 89
	Material	€ 1.07	1	€ 1	1	€ 1
	Medication (DDDs)	€ 2.42	70	€ 169	93	€ 225
	Overhead (minutes)	€ 1.26	40	€ 50	110	€ 136
	Total			**€ 252**		**€ 459**
IC+BU						
	Physician time (minutes)	€ 3.70	2	€ 7	2	€ 7
	Counselor time (minutes)	€ 0.81	40	€ 32	110	€ 89
	Material	€ 1.07	1	€ 1	1	€ 1
	Medication (DDDs)	€ 2.81	49	€ 138	84	€ 236
	Overhead (minutes)	€ 1.26	40	€ 50	110	€ 136
	Total			**€ 228**		**€ 470**

Appendix C Current Practice Scenario

We simulated changes in smoking prevalence rates and the resulting changes in incidence rates of smoking-related chronic diseases, using the Chronic Disease Model. This dynamic multistate life table model describes the life course of parallel Dutch population cohorts annually over time. The model basically consists of a demographic module that is linked to several disease-specific modules. In contrast to models that follow a cohort of people over time and report the impact of a one-time application of a smoking cessation intervention on morbidity and mortality, the chronic disease model is a dynamic population model. It models yearly changes from aging, birth, migration and mortality based on data from Statistics Netherlands.[29] The prevalence of risk factors (in this study smoking) is not stable either, because the transitions between the three smoking classes of never, current and former smokers are modeled annually. The net annual cessation rate depends on the changing mix, influenced by interventions and by demographic trends. The disease-specific modules are epidemiological models of risk-factor-specific incidence, prevalence and mortality of several chronic diseases. When estimating mortality, the model takes account of competing death risks, combining the results from the various disease-specific modules with the demographic module. The model has Markov properties. This means that, conditional on sex, age, and risk factor class (never, current and former smoker), the health states one year ahead are independent of the past health states. This implies for example that the probability to quit smoking does not depend on the duration of smoking, i.e. within an age and gender category, people have the same probability to quit smoking. The class of former smokers is further divided into 22 yearly classes to allow relapse and risk of smoking related diseases to depend on time since cessation. The model is further based on the assumption of conditional independence, i.e. conditional on the risk factor class, disease incidence and mortality rates are assumed to be mutually independent. This implies for example, that given age and gender, the probability for a smoking COPD patient to get lung cancer is the same as the probability for a smoking person without COPD. However, as there are more smokers and former smokers among COPD patients than among non-COPD patients, an average COPD patient has a higher risk of getting lung cancer and, consequently, a higher risk of dying from it. The model was described in more detail elsewhere and has previously been used to evaluate the effects of hypothetical smoking cessation scenarios. However, the current studies were the first to apply the new features of time since cessation dependent relapse and disease risk.

Input data for fifteen smoking-related diseases comprises data on the incidence, prevalence, and mortality rates of the diseases[32 33], risk ratios for incidence for current and former smokers[3] and quality of life weights for life-years with these diseases.[78 47] For example, one life year with lung cancer is equal to 0.57 QALY. Conditional on smoking status, the model calculated the risk of having more than one smoking-related disease. To do so, it multiplied age, gender and smoking class specific prevalence rates. It was further assumed that the quality-of-life weight for a combination of diseases was equal to the multiplied effect of both diseases.[48]
Health care costs for these diseases were obtained from a Dutch cost-of-illness study that allocated total direct costs of health care using a top-down approach.[49] These fifteen diseases accounted for about 10% of the total costs of health care in the Netherlands in 1999. The data were combined with prevalence estimates from the Chronic Disease Model to arrive at costs per person per year.[79]

In the Chronic Disease Model, prevalence rates in the start year of current and former smokers among the Dutch population by gender and 5-year age class were based on yearly population monitoring studies of STIVORO of the year 2004. Start, cessation and restart rates

in the current practice scenario were estimated for each 5-year age and gender class from 10-14 years of age to 85+. These estimates were based on STIVORO data (2002-2003).[45 46] Most men and women start smoking between 10 and 25 years of age. The cessation rates approximate 12-month continuous abstinence rates. The average smoking cessation rate of the current practice scenario across all age and gender classes was 5.1% and among adolescents 3.2%. Relapse rates in the model reflect former smokers starting to smoke again after having been abstinent in the previous year and are a function of the time since smoking cessation. Figure 16 displays the estimated 'relapse' curve for former smokers as a function of time since smoking cessation. On the x-axis time since smoking cessation is displayed in months. The y-axis presents the percentage of quitters that has not yet relapsed. The area above the curves can be interpreted as the fraction of quitters that have started again after having stopped. The areas under the curves are the successful quitters. The probability to start smoking after having stopped, decreases the longer one has stopped. Within 6 months more than 50% of all quit attempts failed. Smokers that have quit more than 3 years will almost never start again. In the long run 25% to 30% of all quit attempts are successful.

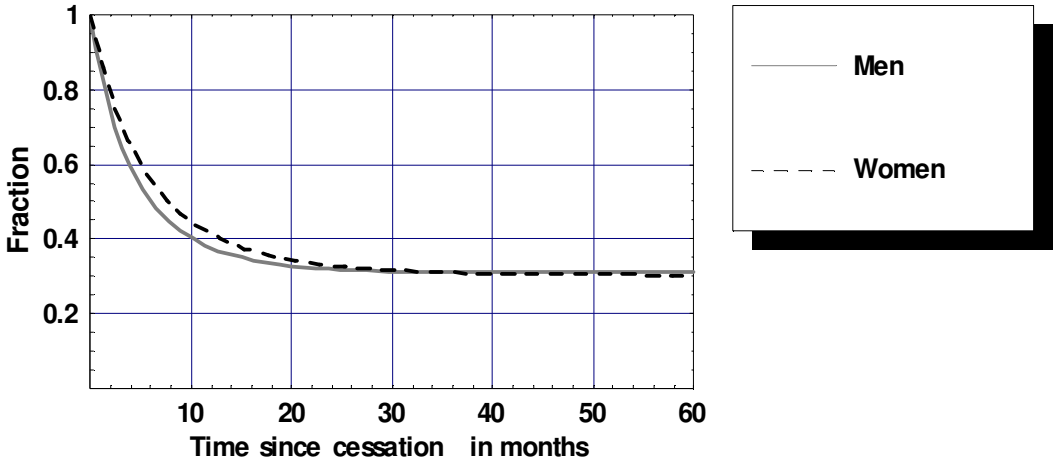

Figure C.1: Relapse curve former smoker as a function of time since cessation

Smokers as well as former smokers run an increased risk for smoking related diseases, with the risks of former smokers depending on time since cessation. Hence, more quitters lead to a reduction in the incidence of smoking related diseases, which reduces morbidity and mortality.

Appendix D Details on cost effectiveness results

Figure D.1 plots the costs per QALY for MMC as a function of effectiveness. Tables D.1 to D.6 provide further results for the cost-effectiveness and sensitivity analyses.

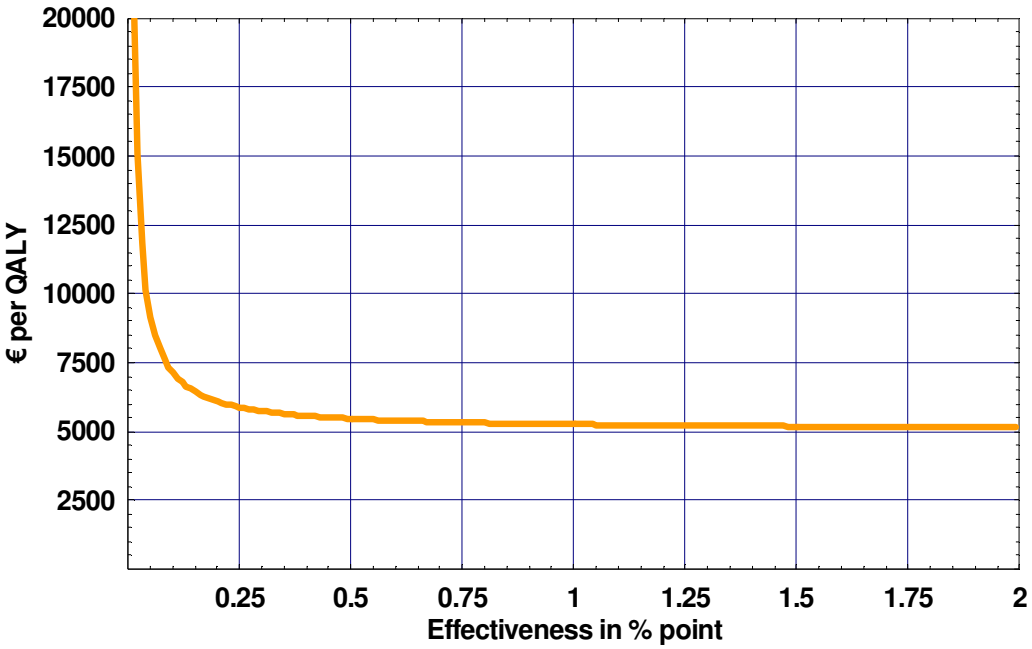

Figure D.1: Cost effectiveness ratios as a function of effectiveness (additional total health care costs per QALY gained, intervention costs included)

Table D.1: Summary of results, interventions at the population level

Intervention (abbreviations see Table 2.1)	**Taxes, worst case**	**Taxes best guess**	**Taxes, best case**	**Mass media campaigns**
Maximum difference # smokers	100,000	140,000	340,000	25,000-280,000
Total effect from tax revenues[a] / Total intervention costs [a b]	-5,900	-5,200	-5,500	6-8
Intervention costs per quitter	0	0	0	€ 25 to € 280
Cumulative LYG [b]	54,000	72,000	176,000	8,200 to 86,300
Cumulative QALYs gained [b]	47,000	63,000	153,000	7,100 to 75,000
Intervention costs per LYG [b]	0	0	0	€ 100 to € 9,00
Intervention costs per QALY gained [b]	0	0	0	€ 100 to € 1,000
Cumulative savings in health care costs of smoking related diseases [a b]	-180	-230	-570	+27 to +279
Costs per LYG [b c]	Cost saving	Cost saving	Cost saving	Cost saving
Costs per QALY gained [b c]	Cost saving	Cost saving	Cost saving	Cost saving
Cumulative difference in total health care costs [a b]	+240	+320	+780	+36 to +377
Costs per LY gained [b d]	€ 4,400	€ 4,400	€ 4,500	€ 4,500 to € 5,300
Costs per QALY gained [b d]	€5,100	€ 5,100	€ 5,100	€ 5,200 to €6,100
Costs per LY gained, including tax revenues [b d]	Cost saving	Cost saving	Cost saving	-
Costs per QALY gained, including tax revenues [b d]	Cost saving	Cost saving	Cost saving	-

[a] * € 1.000.000 [b] discounted at 4% [c] Interventions costs and savings in smoking related diseases taken into account [d] Interventions costs and difference in total health care costs into account

Table D.2: Summary of results, low intensity interventions at the individual level, additive effects

Intervention (abbreviations see Table 2.1)	MC	H-MIS	TC
Maximum difference # smokers	12,000	68,000	72,000
Total intervention costs [a b]	€ 19	€ 97	€ 470
Intervention costs per quitter	€ 1,000	€ 950	€ 4,300
Cumulative LYG [b]	5,600	31,000	33,000
Cumulative QALYs gained [b]	4,800	27,000	29,000
Intervention costs per LYG [b]	€ 3,400	€ 3,100	€ 14,000
Intervention costs per QALY gained [b]	€ 3,900 (1,000 to inf [e])	€ 3,600 (800 to 10,000)	€ 16,000 (12,000 to 49,000)
Cumulative savings in health care costs of smoking related diseases [a b]	- € 18	-€ 99	-€ 106
Costs per LYG [b c]	€ 200	Cost saving	€ 10,900
Costs per QALY gained [b c]	€ 200	Cost saving	€ 12,600
Cumulative difference in total health care costs [a b]	+€ 25	+€ 138	+€ 148
Costs per LY gained [b d]	€ 7,900	€7,600	€ 18,500
Costs per QALY gained [b d]	€ 9,100 (6,100 to inf)	€ 8,800 (6,000 to 15,300)	€ 21,500 (17,400 to 54,100)

[a] * € 1.000.000 [b] discounted at 4% [c] Interventions costs and savings in smoking related diseases taken into account [d] Interventions costs and difference in total health care costs into account [e] inf = infinite. For minimal counseling, the uncertainty on effectiveness included the possibility that the intervention was not effective, resulting in infinite costs per QALY.

Table D.3: Summary of results, low intensity interventions at the individual level, multiplicative effects

Intervention (abbreviations see Table 2.1)	MC	H-MIS	TC
Maximum difference # smokers	0	61,000	98,000
Total intervention costs [a b]	€ 19	€ 97	€ 470
Intervention costs per quitter	Inf [e]	€ 1,000	€ 3,200
Cumulative LYG [b]	0	27,000	43,000
Cumulative QALYs gained [b]	0	23,000	37,000
Intervention costs per LYG [b]	Inf	€ 3,600	€ 11,000
Intervention costs per QALY gained [b]	Inf	€ 4,200	€ 13,000
Cumulative savings in health care costs of smoking related diseases [a b]	0	-€ 86	-€ 140
Costs per LYG [b c]	Inf	€ 400	€ 7,700
Costs per QALY gained [b c]	Inf	€ 500	€ 9,000
Cumulative difference in total health care costs [a b]	0	+€ 120	+€ 190
Costs per LY gained [b d]	Inf	€ 8,100	€ 15,000
Costs per QALY gained [b d]	Inf	€ 9,400	€ 18,000

[a] * € 1.000.000 [b] discounted at 4% [c] Interventions costs and savings in smoking related diseases taken into account [d] Interventions costs and difference in total health care costs into account [e] Inf = infinite. For minimal counseling, the uncertainty on effectiveness included the possibility that the intervention was not effective, resulting in infinite costs per QALY.

Table D.4: Summary of results, high intensity interventions at the individual level, additive effects

Intervention (abbreviations see Table 2.1)	H-MIS+NRT	IC+NRT	IC+BU
Maximum difference # smokers	200,000	300,000	290,000
Total intervention costs [a b]	€ 660	€ 1,400	€ 1,300
Intervention costs per quitter	€ 2,200	€ 3,000	€ 3,000
Cumulative LYG [b]	92,000	139,000	133,000
Cumulative QALYs gained [b]	80,000	120,000	115,000
Intervention costs per LYG [b]	€ 7,100	€ 9,800	€ 9,800
Intervention costs per QALY gained [b]	€ 8,200	€ 11,000	€ 11,000
	(6,400 to 14,000)	(7,800 to 13,400)	(8,800 to 15,700)
Cumulative savings in health care costs of smoking related diseases [a b]	- € 290	- € 440	- € 420
Costs per LYG [b c]	€ 3,900	€ 6,600	€ 6,700
Costs per QALY gained [b c]	€ 4,500	€ 7,700	€ 7,700
Cumulative difference in total health care costs [a b]	+€ 410	+€ 620	+€ 590
Costs per LY gained [b d]	€ 11,600	€ 14,300	€ 14,300
Costs per QALY gained [b d]	€ 13,400	€ 16,600	€ 16,600
	(11,500 to 19,200)	(13,000 to 18,600)	(14,000 to 20,900)

[a] * € 1.000.000 [b] discounted at 4% [c] Interventions costs and savings in smoking related diseases taken into account [d] Interventions costs and difference in total health care costs into account

Table D.5: Summary of results, high intensity interventions at the individual level, multiplicative effects

Intervention (abbreviations see Table 2.1)	H-MIS+NRT	IC+NRT	IC+BU
Maximum difference # smokers	200,000	380,000	270,000
Total intervention costs [a b]	€ 660	€ 1,400	€ 1,300
Intervention costs per quitter	€ 2,100	€ 2,300	€ 3,200
Cumulative LYG [b]	89,000	170,000	120,000
Cumulative QALYs gained [b]	77,000	150,000	100,000
Intervention costs per LYG [b]	€ 7,400	€ 8,000	€ 11,000
Intervention costs per QALY gained [b]	€ 8,500	€ 9,300	€ 13,000
Cumulative savings in health care costs of smoking related diseases [a b]	-€ 290	-€ 540	-€ 380
Costs per LYG [b c]	€ 4,200	€ 4,800	€ 7,800
Costs per QALY gained [b c]	€ 4,800	€ 5,600	€ 9,000
Cumulative difference in total health care costs [a b]	+€ 400	+€ 760	+€ 540
Costs per LY gained [b d]	€ 12,000	€13,000	€16,000
Costs per QALY gained [b d]	€ 14,000	€ 15,000	€ 18,000

[a] * € 1.000.000 [b] discounted at 4% [c] Interventions costs and savings in smoking related diseases taken into account [d] Interventions costs and difference in total health care costs into account

Table D.6: Additional results of univariate sensitivity analyses (abbreviations see Table 2.1, all figures in euro per QALY, price level 2004, baseline values in bold)

Variable varied	values	TC	H-MIS+NRT	IC+BU
Discount rates	**4 , 4**[x]	**21,500**	**13,400**	**16,600**
	3, 3	14,600	10,500	12,100
	0, 0	14,900	12,400	13,400
	5, 5	16,400	10,400	12,900
	4, 0	4,300	2,900	3,500
	4 , 1.5	7,200	4,900	5,800
Time horizon	**80**[xi]	**21,500**	**13,400**	**16,600**
	60	21,300	13,000	16,300
	40	22,300	12,400	16,300
	20	61,400	29,300	41,900
Number of	**25**	**21,500**	**13,400**	**16,600**
participants[xii]	10	21,500	13,400	16,600
	max[xiii]	21,500	13,400	16,600
Implementation	**5**	**21,500**	**13,400**	**16,600**
period	10	21,800	13,700	16,900
	1	21,300	13,200	16,400

[x] Discount rate for costs, followed by discount rate for health effects
[xi] Time horizon in years
[xii] Percentage of adult smokers aged 20-70 years reached
[xiii] Maximum thinkable number of participants, estimated at 87% for TC, 66% for all low intensity interventions delivered by GPs and 33% for all high intensity interventions.