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Potential health benefits and cost effectiveness of tobacco tax increases and school intervention programs targeted at adolescents in the Netherlands

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Rapport in het kort

Potentiële gezondheidswinst en kosten effectiviteit van accijnsverhogingen op tabaksproducten en interventieprogramma's op scholen gericht op jongeren in Nederland

Bij jongeren kan veel gezondheidswinst behaald worden door te voorkomen dat ze beginnen met roken. Een prijsverhoging van 20% op tabaksproducten verlaagt het aantal jeugdige rokers met bijna 20.000 op de korte termijn. De kosten effectiviteit van accijnsverhogingen wordt geschat op ongeveer € 4.500 per gewonnen QALY. Dit is inclusief medische kosten in gewonnen levensjaren en exclusief een eventuele toename in accijnsopbrengsten. De gezondheidseffecten en kosten effectiviteit van diverse schoolprogramma's zijn nog onzeker.

Bijna 90% van de volwassen (ex-)rokers is gestart met roken voor hun 18^{e}. Vanuit het oogpunt van volksgezondheid is het daarom belangrijk om roken bij jongeren te ontmoedigen. Het doel van dit onderzoek was om de gezondheidswinst en kosteneffectiviteit te bepalen van twee maatregelen om tabaksgebruik onder jongeren te ontmoedigen, namelijk een accijnsverhoging en interventieprogramma's op scholen. De effecten na 1 jaar op het aantal rokers zijn vastgesteld op basis van literatuuronderzoek. Het RIVM Chronische Ziekten Model (CZM) is gebruikt om de lange termijn effecten op de volksgezondheid te schatten.

Voor de schoolprogramma's zijn drie voorbeeldinterventies onderzocht, waarvan de kosten werden bepaald op € 20 tot € 75 per leerling. De schattingen van de gezondheidswinst en kosten effectiviteit als gevolg van de drie school interventies dienen voorzichtig te worden geïnterpreteerd, vanwege grote onzekerheid over de precieze effecten van deze programma's op het rookgedrag van de jeugd. De conclusie van scenario analyses met het CZM is dat bij jongeren veel gezondheidswinst behaald kan worden door te voorkomen dat ze starten met roken. Een accijnsverhoging draagt hieraan bij en is een zeer doelmatige vorm van preventie.

Trefwoorden: kosten effectiviteit analyse; tabaksontmoediging; roken; modellering; primaire preventie; jongeren

Abstract

Potential health benefits and cost effectiveness of tobacco tax increases and school intervention programs targeted at adolescents in the Netherlands

Increasing tobacco taxes is a cost effective measure to reduce smoking among youth. A price increase on tobacco products reduces the number of young smokers by almost 20,000 in the short run. Although, in the end, effects of current price increases on smoking behaviour will fade away, tobacco taxes still are a good strategy to gain health effects since no intervention costs are involved. Cost effectiveness ratios for tobacco tax increases amount to € 4,500 per QALY gained including medical costs in life years gained, but excluding tobacco tax revenues.

This report presents estimates of health gains and cost effectiveness of two types of interventions targeted at smoking reduction among adolescents in the Netherlands: school interventions and tobacco tax increases. Effects in terms of smokers averted were determined from the literature. To translate these effects into health gains and cost effectiveness the RIVM Chronic Disease Model (CDM) is used. This dynamic population model allows estimating effects on smoking related diseases, gains in (quality adjusted) life years and differences in health care costs.

For the school interventions, three different programs were investigated. The intervention costs per participant ranged from € 20 to € 75. Since there is much uncertainty about the effectiveness of the school interventions with regard to daily smoking among adolescents, results of the scenario analyses should be interpreted with caution. The conclusion that can be drawn from the scenario analyses with the CDM is that much health gains can be attained by preventing adolescents from smoking initiation and that tobacco tax increase may contribute to this in a cost effective way.

Key words: cost effectiveness analysis; tobacco control; modelling; primary prevention; adolescents

Voorwoord

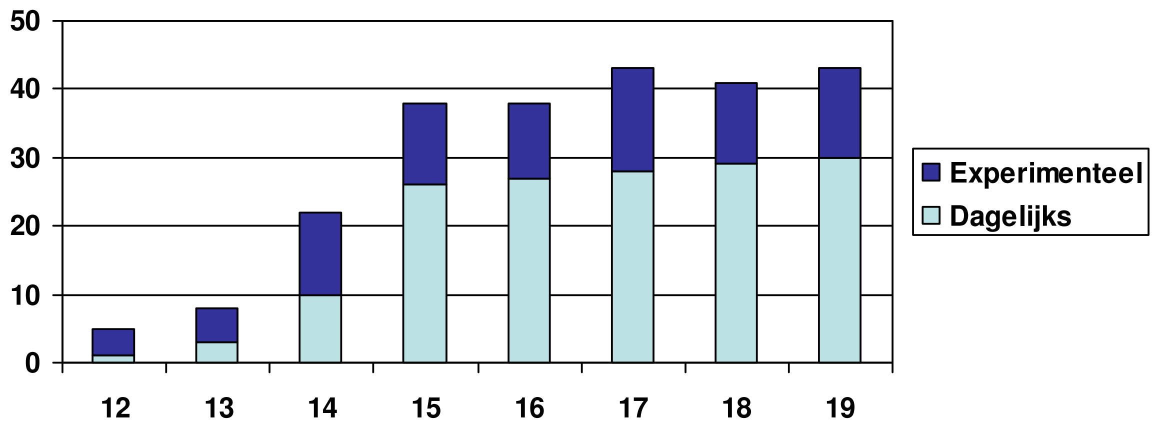
Het onderzoek dat in dit rapport is beschreven is uitgevoerd in het kader van het RIVM onderzoeksprogramma 'Beleidsondersteuning Volksgezondheid en Zorg' (Programma 2). Het is een deelonderzoek binnen het project 'Tabaksontmoediging'(V/260601). Het doel van dit project is om de gezondheidswinst van verschillende interventies te bepalen met het RIVM Chronische Ziekten Model en de kosteneffectiviteit daarvan te evalueren. Interventies gericht op jongeren zoals lesprogramma's en accijnzen staan in dit rapport centraal.

Diverse mensen binnen en buiten het RIVM hebben een belangrijke bijdrage bij het tot stand komen van dit rapport geleverd. We willen als eerste onze dank uitspreken aan de mensen die hebben geparticipeerd in een expertpanel. Over de beschreven interventieprogramma's op scholen hebben de auteurs vaak overleg gevoerd met Nederlandse inhoudsdeskundigen. Onze bijzondere dank gaat daarom uit naar Prof. Dr. Hein de Vries, Dr. Marlein Ausems en Dr. Ilse Mesters (allen werkzaam bij de vakgroep GVO Universiteit Maastricht). Tevens willen we Lany Slobbe en Ardine de Wit van het RIVM bedanken voor het kritisch lezen en becommentariëren van dit rapport.

Contents

Samenvatting

Introductie
Ongeveer 30% van de jongeren in de leeftijd tussen 15 en 19-jaar geeft aan dagelijks te roken. Daarnaast bestaat een groep jongeren die aan het experimenteren is met roken. Dit zijn jongeren die in de afgelopen vier weken ten minste éénmaal gerookt hebben. Figuur 1 laat zien dat het experimenteren met roken begint bij 12- en 13-jarigen. Onder 14-jarigen geeft ruim 20% aan te experimenteren met roken, waarvan bijna de helft dagelijks rookt.
Zowel het percentage dagelijkse rokers als het percentage experimentele rokers onder jongeren is min of meer stabiel gebleven gedurende de afgelopen tien jaar.



Figuur 1: Ppercentage dagelijkse en experimentele rokers onder Nederlandse jongeren in 2004, naar leeftijd (Bron: NIPO-gegevens, STIVORO)

De schadelijke gezondheidseffecten van roken zijn onomstotelijk aangetoond. Daarnaast is bekend dat deze negatieve gezondheidseffecten grotendeels niet acuut optreden, maar pas op de langere termijn. Het aantal jaren dat gerookt is speelt hierbij een rol. Onder volwassenen van middelbare leeftijd is de sterfte onder rokers hoger bij vroege starters, vergeleken met latere starters. Bijna 90% van de volwassen (ex-)rokers is gestart met roken voor hun 18^e. Vanuit het oogpunt van volksgezondheid is het dus belangrijk om roken bij jongeren te ontmoedigen.

Het doel van dit rapport is de potentiële gezondheidswinst en kosteneffectiviteit te schatten van tabaksontmoedigingsbeleid gericht op jongeren. Van twee typen maatregelen wordt de gezondheidswinst geschat, de gevolgen voor de zorgkosten en de kosteneffectiviteit, namelijk:
- accijnsverhogingen op tabaksproducten;
- schoolprogramma's.

Bij de accijnsverhoging is uitgegaan van de recent in Nederland ingevoerde accijnsverhoging van 20%. Als voorbeeld voor schoolprogramma's op scholen werden drie Nederlandse projecten geselecteerd. Met behulp van het RIVM Chronische Ziekten Model (CZM) zijn de effecten op de korte termijn, in termen van veranderingen in het aantal rokers, vertaald naar gezondheidseffecten die optreden op de langere termijn.

Effectiviteit interventies
Het verhogen van accijnzen op rookwaren leidt tot prijsverhogingen die op drie manieren kunnen leiden tot veranderingen in rookgedrag:
- minder niet-rokers starten met roken;
- rokers minderen met roken;
- rokers stoppen met roken.

Het is vrij zeker dat prijsverhogingen leiden tot vermindering van het aantal verkochte sigaretten, maar de opsplitsing van dit effect over deze drie mechanismen is minder goed bekend. Empirische schattingen van de effecten van prijsverhogingen op het rookgedrag van jongeren lopen nogal uiteen.

Van de volgende drie school interventies zijn de gezondheidseffecten en kosteneffectiviteit geschat:
1. In-school interventie: drie klassikale lessen over onder andere de effecten van roken op de gezondheid, normen over roken en het leren om te gaan met invloeden vanuit de omgeving. De kosten van deze interventie werden geschat op € 18,- per deelnemer.
2. Out-of-school interventie: drie op de leerling aangepaste brieven met informatie over stoppen of niet starten met roken. De brieven waren aangepast aan persoonlijke kenmerken van de leerling. De kosten van deze interventie werden geschat op € 50,- per deelnemer.
3. Booster interventie: vijf lessen gegeven door een niet rokende medeleerling in kleine groepen. De lessen richtten zich onder andere op de volgende aspecten: redenen om (niet) te roken, de effecten van roken en het leren om te gaan met invloeden vanuit de omgeving. Verder werd er een niet roken afspraak gemaakt en ontvingen de leerlingen drie tijdschriften (boosters). De kosten van deze interventie werden geschat op € 75,- per deelnemer.

Omschrijving scenario's
Voor de accijnsverhogingen en de drie schoolinterventies geldt dat de effectiviteit op korte termijn, in termen van aantal vermeden rokers, omgeven is door een grote mate van onzekerheid. Daarom hebben we 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. Voor de schoolprogramma's is een belangrijke aanname dat de interventies even effectief zijn bij alle typen rokers, zowel dagelijkse als experimentele rokers. Voor de accijnsscenario's zijn de effecten van een éénmalige prijsverhoging op jongeren van 10-19 jaar geschat.

Voor elke interventie hebben we een zogenaamd 'best guess' scenario geformuleerd. In deze 'best guess' scenario's zijn er als gevolg van de interventies meer jongeren gestopt met roken en/of minder jongeren gestart met roken. De gezondheidswinst en het verschil in zorgkosten zijn geschat door de uitkomsten van het CZM (levensjaren, QALY's[1] en zorgkosten) in de 'best guess' scenario's te vergelijken met een referentiescenario waarin geen aanpassingen zijn gemaakt.

[1] QALY's (Quality Adjusted Life Years) staan voor het aantal levensjaren die zijn gecorrigeerd voor de kwaliteit van leven. Een QALY waarde 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 niet volledige gezondheid.

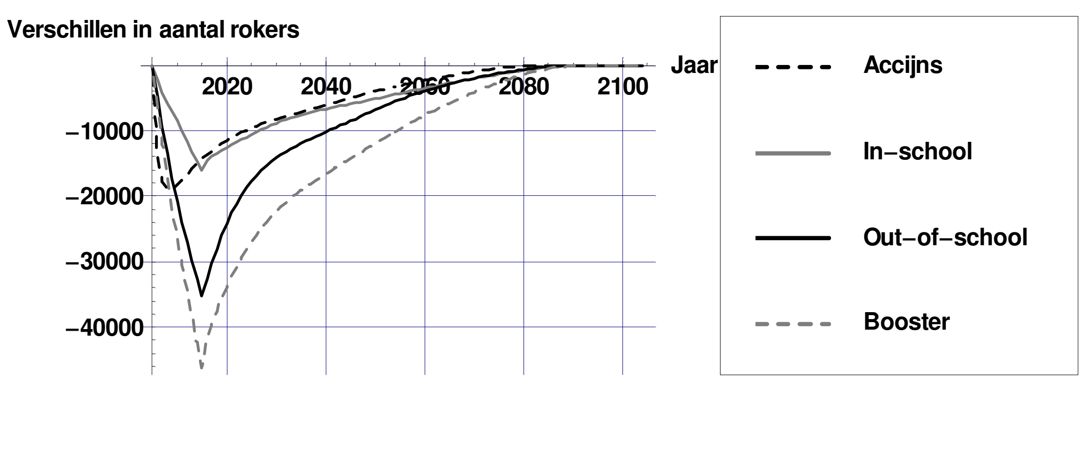
Hier volgt een korte omschrijving van de vier verschillende ‘best guess’ scenario’s:

1. *Accijns scenario*: Een éénmalige accijnsverhoging van 20% veroorzaakt in het eerste jaar een daling van de prevalentie van roken van 7% (is gelijk aan ongeveer 1 procentpunt van alle rokende jongeren) onder jongeren. De helft van de daling is veroorzaakt door een toename van het aantal stoppers en de andere helft door een daling van het aantal starters. In de volgende jaren neemt het effect van de prijsverhoging op rookgedrag onder jongeren langzaam af;
2. *In-school scenario*: Alle brugklassen in Nederland krijgen 10 jaar lang de in-school interventie aangeboden. Dat veroorzaakt ieder jaar een daling van de prevalentie van roken van 2 procentpunt onder brugklassers. Deze daling wordt veroorzaakt door een stijging in het aantal stoppers als gevolg van de interventie;
3. *Out-of school scenario*: Alle brugklassen in Nederland krijgen 10 jaar lang de out-of-school interventie aangeboden. Dat veroorzaakt ieder jaar een daling van de prevalentie van roken van 6 procentpunt onder brugklassers. Deze daling wordt veroorzaakt door een daling in het aantal jongeren dat begint met roken als gevolg van de interventie;
4. *Booster-scenario*: Alle tweede klassen van de middelbare scholen krijgen 10 jaar lang de out-of-school interventie aangeboden. Dat veroorzaakt ieder jaar een daling van de prevalentie van roken van 7 procentpunt onder 14-15 jarigen. De helft van de daling is veroorzaakt door een toename van het aantal stoppers en de andere helft door een daling van het aantal starters.

Door de schoolinterventies 10 jaar lang aan te bieden aan alle brugklassen of tweede klassen van de middelbare school zijn de cumulatieve effecten van de schoolinterventie scenario’s vergelijkbaar met de accijnsscenario’s omdat de aantallen jongeren blootgesteld aan de schoolinterventies ongeveer even groot zijn als het aantal jongeren dat de prijsverhoging heeft meegemaakt. In gevoeligheidsanalyses is bekeken in hoeverre de resultaten gevoelig zijn voor aannames die zijn gemaakt in de ‘best guess’ scenario’s.

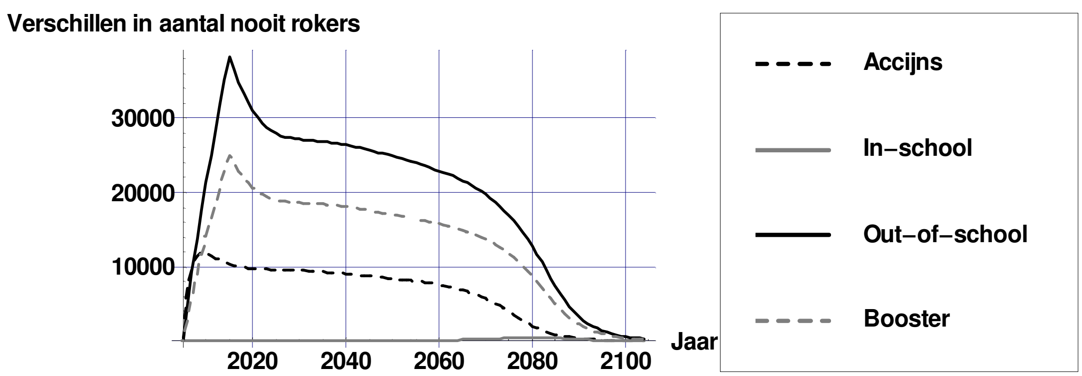
Resultaten

Figuur 2 geeft de verschillen in het aantal rokers weer tussen het referentiescenario en de verschillend ‘best guess’ scenario’s. Het aantal rokers daalt door de interventies. Na afloop van de interventies neemt het verschil in het aantal rokers langzaam af, doordat of gestopte jongeren later weer opnieuw beginnen of niet-rokers later alsnog beginnen met roken.

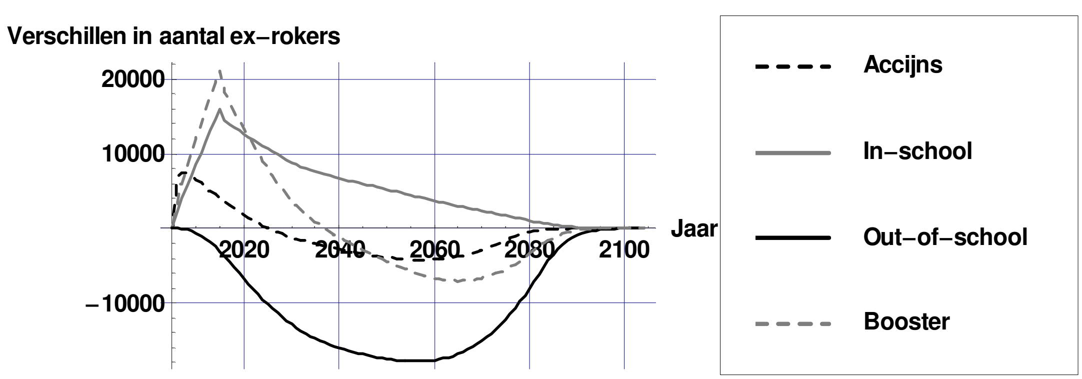


Figuur 2: Verschillen in het aantal rokers ‘best guess’ scenario’s t.o.v. het referentiescenario

Verschillen in het aantal rokers worden veroorzaakt door een toename van het aantal nooit-rokers (omdat minder jongeren beginnen met roken) en/of toename van het aantal ex-rokers (omdat meer jongeren stoppen met roken). Figuren 3 en 4 geven de verschillen in respectievelijk het aantal nooit-rokers en ex-rokers weer. Bij het out-of-school scenario wordt het verschil in aantal rokers veroorzaakt door minder starters oftewel een stijging in het aantal nooit-rokers (Figuur 3). Omdat in dit scenario minder jongeren beginnen met roken kunnen er dus minder rokers stoppen wat resulteert in een daling van het aantal ex-rokers (Figuur 4). Het in-school scenario heeft geen invloed op het aantal nooit-rokers (Figuur 3) omdat deze interventie uitsluitend resulteert in meer stoppers (Figuur 4). Het accijns- en boosterscenario resulteren in meer stoppers én minder starters.

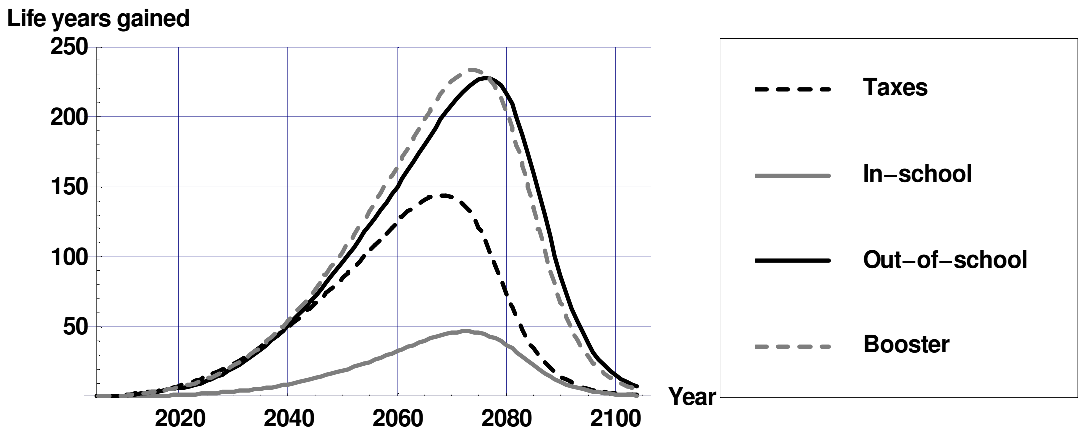


Figuur 3: Verschil in het aantal nooit-rokers 'best guess' scenario's t.o.v. het referentiescenario

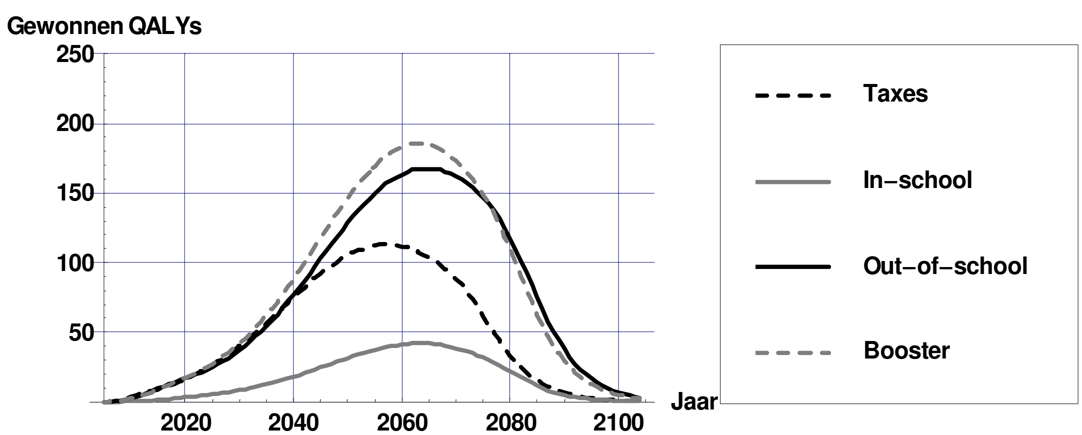


Figuur 4: Verschil in het aantal ex- rokers 'best guess' scenario's t.o.v. het referentiescenario

De gezondheidswinst als gevolg van de interventies wordt geschat door het aantal levensjaren/QALY's in het referentie scenario af te trekken van het aantal levensjaren/QALY's in het 'best guess' scenario. Figuren 5 en 6 geven de geschatte gezondheidswinst in gewonnen levensjaren en QALY's weer.[2] Door de interventies daalt het aantal rokers, wat zorgt voor een daling in rookgerelateerde ziekten na een aantal jaren. Dit zorgt ervoor dat de kwaliteit van leven en levensverwachting toeneemt. Vergelijking van Figuur 5 en 6 laat zien dat op korte termijn meer winst in kwaliteit van leven wordt 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 ook bij niet- en ex-rokers op oudere leeftijd de kwaliteit van leven afneemt, door het optreden van vervangende ziektes.



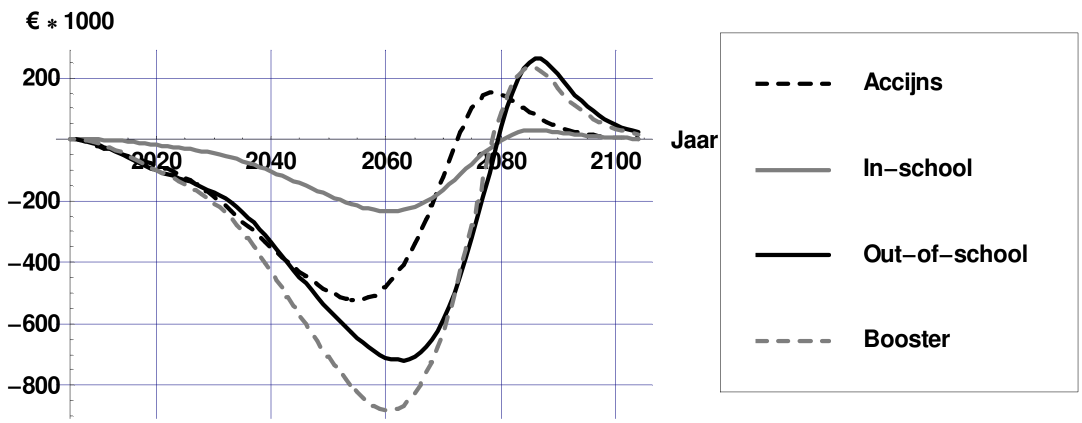
Figuur 5: Gewonnen levensjaren 'best guess' scenario's t.o.v. het referentiescenario



Figuur 6: Gewonnen QALY's 'best guess' scenario's t.o.v. het referentiescenario

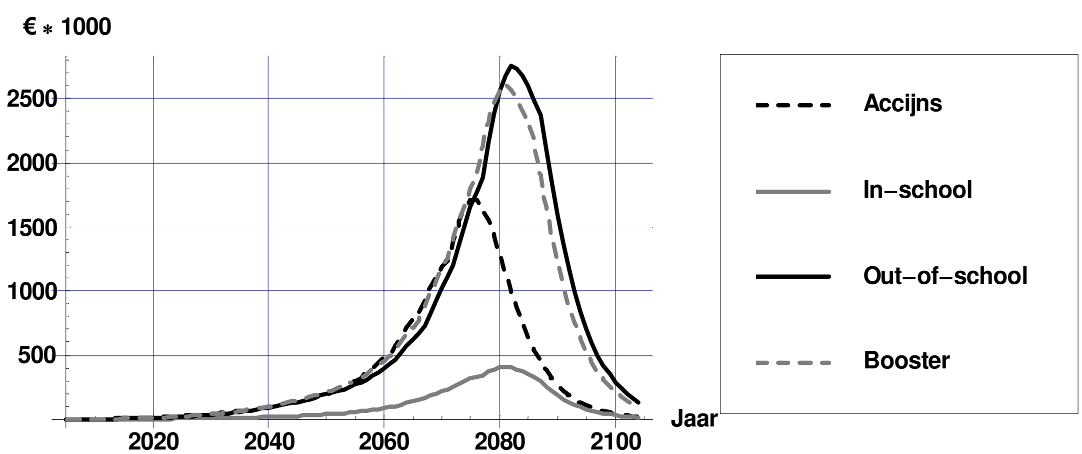
[2] In alle figuren zijn effecten die optreden in de toekomst met 4% per jaar gedisconteerd. Disconteren houdt in dat kosten en effecten in de toekomst minder worden gewaardeerd dan kosten en effecten in het heden.

Figuur 7 geeft het verschil in zorgkosten van rookgerelateerde ziekten ten opzichte van het referentiescenario weer. 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, nemen de kosten naar verloop van tijd weer toe. Voor alle kosten rekenen we in euro's en met het prijsniveau van 2004.



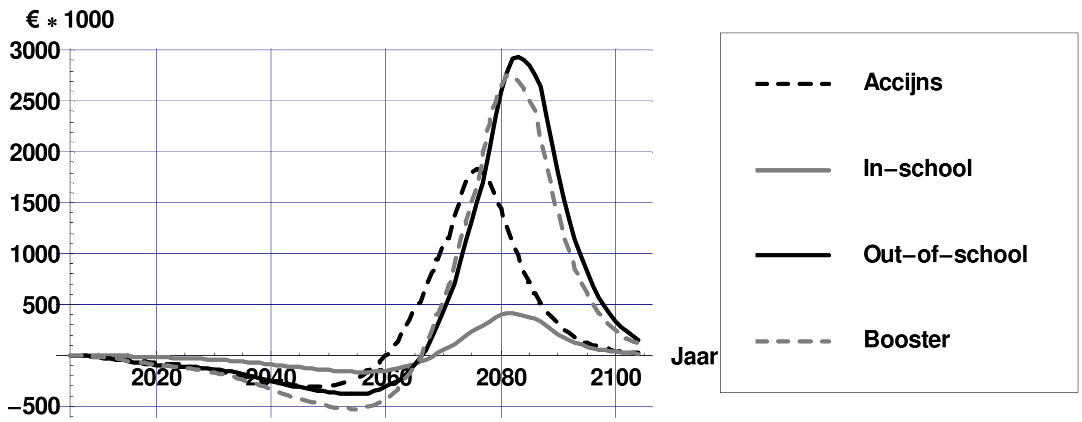
Figuur 7: Verschil in kosten van rookgerelateerde ziekten'best guess' scenario's t.o.v. het referentiescenario

Figuur 8 geeft de kosten van de overige ziekten weer. Doordat de levensverwachting toeneemt, stijgen de kosten van niet aan roken gerelateerde ziekten.



Figuur 8: Verschil in kosten van niet aan roken gerelateerde ziekten in gewonnen levensjaren 'best guess' scenario's t.o.v. het referentiescenario

Figuur 9 laat zien dat het verschil in totale zorgkosten uiteindelijk wordt gedomineerd door de kosten van niet aan roken gerelateerde ziekten in gewonnen levensjaren. Dat komt vooral door hoge kosten in de verre toekomst. Tot ongeveer 60-70 jaar na implementatie van de interventies zijn de totale zorgkosten lager in het interventiescenario vergeleken met het referentiescenario. De interventiekosten voor de schoolprogramma's over hun looptijd van tien jaar staan niet in deze figuur. Bij de accijnsinterventie zijn deze kosten er niet.



Figuur 9: Verschil in totale zorgkosten 'best guess' scenario's t.o.v. het referentiescenario (exclusief interventiekosten)

Tabel 1 geeft een samenvatting van de resultaten voor de verschillende 'best guess' scenario's weer.

Tabel 1: Samenvatting resultaten 'best guess' scenario's

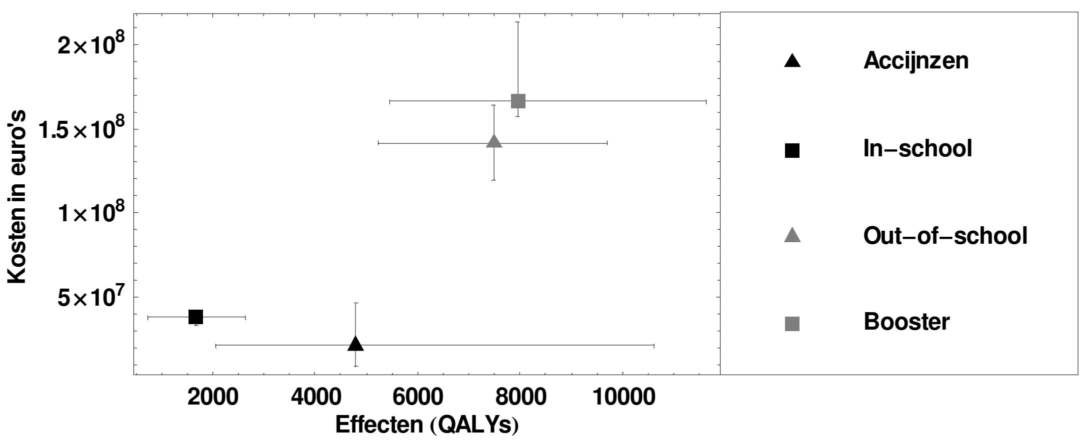
Scenario	Accijns	In-school	Out-of-school	Booster
Verschil in het aantal rokers na 10 jaar	14.000	16.000	35.000	46.000
Cumulatieve interventie kosten [a b]	0	35,5	102,0	150,0
Interventiekosten per vermeden roker [b]	0	1.600	2.200	2.900
Cumulatief gewonnen levensjaren [b]	5.300	1.600	8.500	8.600
Cumulatief gewonnen QALYs [b]	4.800	1.700	7.500	8.000
Interventiekosten per gewonnen levensjaar [b]	0	€ 22.200	€ 12.000	€ 17.500
Interventiekosten per gewonnen QALY [b]	0	€ 21.100	€ 13.600	€ 18.900
Cumulatief verschil in zorgkosten rookgerelateerde ziekten [a b]	-15,4	-7,3	-21,8	-26,8
€ per gewonnen levensjaar [b]	Cost saving	€ 17.700	€ 9.400	€ 14.400
€ per gewonnen QALY [b]	Cost saving	€ 16.800	€ 10.700	€ 15.500
Cumulatief verschil in totale zorgkosten [a b]	+21,4	+2,5	+39,5	+32,6
€ per gewonnen levensjaar [b d]	€ 4.100	€ 23.800	€ 16.700	€ 21.300
€ per gewonnen QALY [b d]	€4.500	€ 22.600	€ 18.900	€ 23.000

[a] € 1.000.000 [b] gedisconteerd met 4% [c] Interventie kosten en besparingen in kosten van rookgerelateerde ziekten zijn meegenomen [d] Interventie en het verschil in totale zorgkosten zijn meegenomen.

Op basis van de 'best guess' scenario's is de in-school interventie het minst doelmatig te noemen als we kijken naar de kosten per gewonnen levensjaar of QALY. Echter, bij het in-school scenario zijn de interventiekosten per vermeden roker het laagst. Dit komt omdat op lage leeftijden er nog weinig jongeren dagelijks roken en we in het in-school scenario hebben verondersteld dat de interventie alleen effect heeft op het aantal stoppers. Omdat veel stoppers later opnieuw beginnen met roken, wordt er weinig gezondheidswinst geboekt waardoor in termen van kosten per levensjaar/QALY dit scenario minder doelmatig is te noemen dan in termen van interventie kosten per vermeden roker.

Interventies die effect hebben op het aantal beginnende rokers een grotere doelgroep bereiken. Omdat aan accijnzen geen interventiekosten zijn verbonden is dit de doelmatigste interventie. Bij de berekeningen hebben we geen rekening gehouden met een eventuele toename in accijnsopbrengsten. Dit zou de doelmatigheid van accijnsverhogingen nog verder verhogen.

Figuur 10 laat de cumulatieve kosten en gezondheidseffecten voor de verschillende scenario's zien, samen met de onzekerheidsmarges rondom de kosten en effecten. De onzekerheid omtrent de veronderstelling over de effectiviteit van de schoolinterventies is moeilijk te kwantificeren en is daarom niet weergegeven in Figuur 10. Die onzekerheid zal de onbetrouwbaarheid van de resultaten voor de schoolinterventies doen toenemen, zodat er eigenlijk bredere intervallen rondom de effecten zouden moeten staan.



Figuur 10: Cumulatieve kosten en effecten met onzekerheidsmarge

Conclusie

In dit rapport hebben we de gezondheidswinst en kosten effectiviteit geschat van accijnsverhogingen en drie schoolinterventies als middel om roken te ontmoedigen bij jongeren. Omdat de effectiviteitcijfers van de schoolinterventies alle betrekking hadden op experimenteel roken en de schattingen van de effectiviteit van accijnsverhogingen nogal uiteenlopen hebben we diverse aannamen moeten maken om de gezondheidswinst te schatten. Hierdoor zijn de gepresenteerde resultaten niet 'hard' maar eerder indicatief voor de potentiële gezondheidswinst die valt te behalen als deze interventies worden geïmplementeerd.

Met het CZM konden we niet alleen korte termijn effecten op het aantal rokers bepalen, maar ook de lange termijn gezondheidswinst en effecten op de kosten van zorg. Daarmee konden we de kosteneffectiviteit van de maatregelen in euro’s per gewonnen levensjaar en QALY bepalen. Op basis van onze scenario analyses met het CZM trekken we de conclusie dat accijnsverhoging een doelmatige interventie is om het aantal rokende jongeren te laten dalen. De kosten effectiviteit van een accijnsverhoging komt neer op ongeveer € 4.500 per gewonnen QALY. Dit is inclusief medische kosten in gewonnen levensjaren en exclusief een eventuele toename in accijnsopbrengsten. Zonder medische kosten in gewonnen levensjaren mee te rekenen bespaart deze interventie medische kosten. Concluderend kunnen we stellen dat accijnsverhogingen een zeer doelmatige vorm zijn van preventie. Tevens hebben de scenario’s laten zien dat preventie van roken tot grotere gezondheidswinst leidt dan stoppen met roken bij jongeren.

1. Introduction

This report describes the potential health gains, and the implications thereof for future health care costs, of implementation of tobacco control interventions targeted at adolescents (10-to-19-year old). The aims are to describe the potential importance of interventions in adolescents in terms of health gains and to estimate the cost-effectiveness of several tobacco control interventions targeted at adolescents. A separate report for interventions targeted at adults is scheduled for the end of 2005. There are three reasons why the effects of tobacco cessation interventions are estimated separately for adolescents:

- Interventions targeted at preventing initiation of smoking can be analyzed in adolescents, but not in adults since most people start smoking before the age of 20. Thus, scenarios can be created that have effect on the start rates in never-smokers, instead of quit rates in current smokers;
- In general, since smoking behaviour among adolescents is dynamic and unstable, effectiveness figures of tobacco cessation interventions in adolescents will have a larger uncertainty range than interventions in adults;
- The time horizon for assessing public health impact needs to be longer, since health gains in adolescents will become visible only a long period after the implementation of the intervention. This adds to the uncertainty of modeling (health) effects in this population.

At the start of this project we presented our main assumptions and our selection of interventions to several experts, and asked their opinion about these assumptions, our selection of interventions and their effectiveness. Appendix A summarizes the opinions of experts that are relevant for this report. To sketch a background Chapter 2 describes trends in smoking among youth in the Netherlands and potential health benefits of not-smoking are discussed. Chapter 3 discusses the effectiveness of tobacco tax increases and the selected school interventions. In Chapter 4, the RIVM Chronic Disease Model (CDM) and the methods to estimate health gains and cost effectiveness are described. Chapter 5 discusses the assumptions used to set up the scenarios modeled with the CDM. Chapter 6 discusses the results of the different scenarios. Finally, Chapter 7 concludes with a discussion of our results.

2. Smoking among youth in the Netherlands

2.1 Smoking prevalences and trends among youth

In 2004, prevalence rates of daily smokers were about 3% among the 13-year-old, 10% among the 14-year-old, 26% among the 15-year-old and 30% among the 19-year-old according to TNS/NIPO research [1]. Besides daily smoking, a relatively high percentage of the youth does smoke occasionally or is experimenting with tobacco only. In the international literature, this group is referred to as ‘experimenters’ or ‘puffers’. This group can be identified by the question ‘did you smoke in the past four weeks?’. In 2004, this question was answered positively by 8% of the 13-year-old, by 38% of the 15-year-old and by 43% of the 19-year-old [1] (Figure 2.1).

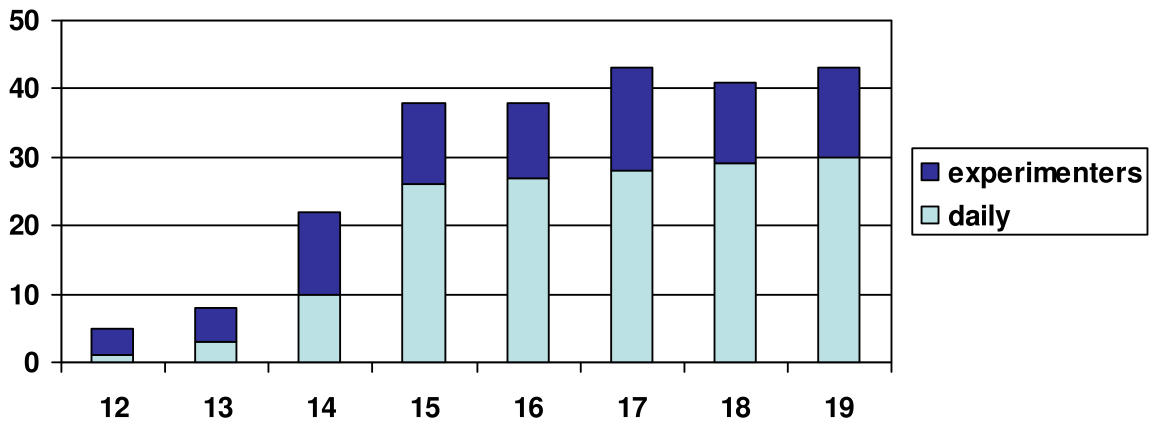


Figure 2.1: Prevalence rates of daily smoking and experimenting for Dutch adolescent in 2004 (Source: STIVORO. Roken, de harde feiten: Jeugd 2004)

The prevalence rates of daily smoking are almost identical for boys and girls. Among the 10- to-12-year-old less than 10% is experimenting with smoking, while 89% of the adult (ex-)smokers report that they tried their first cigarette before the age of 18. Hence, most people start smoking or experimenting with smoking between the ages of 13 and 18 years. Among the 17-to-19-year-old, about 70% reports that they ‘ever’ smoked a cigarette. This shows that experimenting with cigarettes in youth does not necessarily lead to continued daily smoking in later adult life. Among the 20-to-24-year old, the prevalence rates of daily smoking are 32% in men and 23% in women. Hence, for men these are similar to the 19-year-old, but for women the prevalence rates are decreased.

There is no clear downward or upward trend in daily smoking among youth since 1992. The highest prevalence of daily smoking seems to have occurred in 1996, and prevalence rates in 2002 are equal to the prevalence rates in 1992 (Figure 2.2).

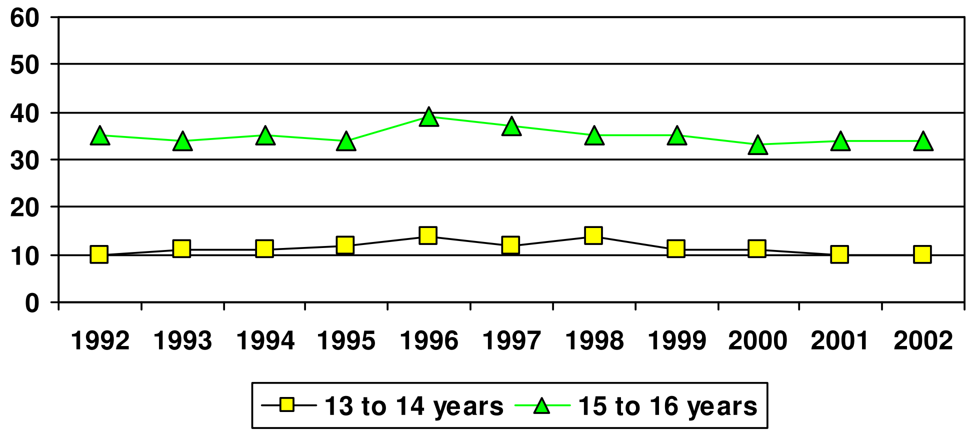


Figure 2.2: Prevalence rates of daily smoking among adolescents since 1992

Figure 2.3 shows prevalence rates for ‘experimenting with smoking’ since 1992. Just like ‘daily smoking’ there is no clear downward or upward trend in ‘experimental smoking’.

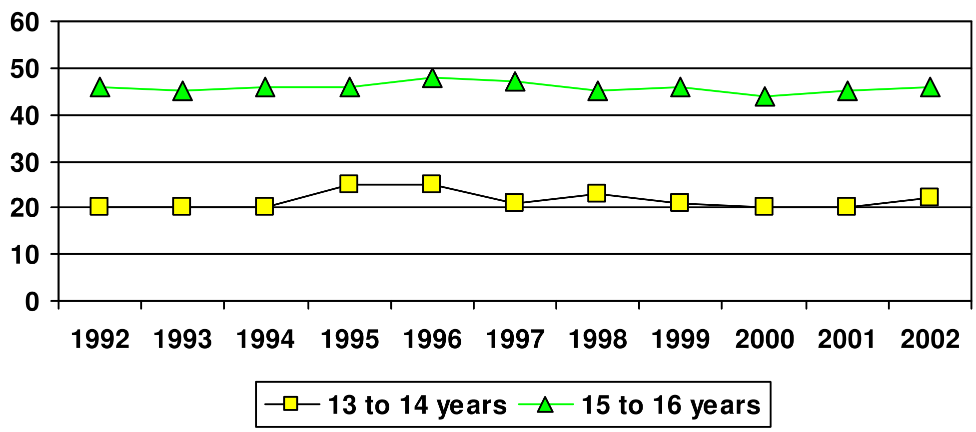


Figure 2.3: Prevalence rates of experimental smoking among adolescents since 1992

Compared to other countries the smoking behavior of the Dutch 15-year-old seems to be quite similar. A WHO cross-national study investigated the prevalence rates of smoking among youth in several countries in 2001 and 2002. Table 2.1 presents the prevalence rates among the 15-year old. Smoking is defined as ‘tobacco smoking at least once a week’. Table 2.1 shows that the prevalence rate is higher than in Denmark, lower than in Germany, and similar to Belgium and the United Kingdom. In this research, the prevalence rate for The Netherlands (23.4%) seems to be low when compared to the TNS/NIPO data for the same age group in the same year. According to TNS/NIPO data the percentage of daily, instead of weekly, smokers is 28% in this age group.

Table 2.1: Prevalence rates of smokers[1] among 15-year old (in 2001/2002)

	Boys	Girls	Total
Belgium	23.1	23.8	22.8
Denmark	16.7	21.0	18.9
Germany	32.2	33.7	33.0
Netherlands	22.5	24.3	23.4
United Kingdom	20.3	27.4	24.1

Source: Health behaviour in school-aged children: a WHO cross-national study (HBSC), 2002 (www.who.dk).
[1]: defined as 'tobacco smoking ≥ 1 time a week'

2.2 Potential health benefits of prevention

Among adolescents, a great potential impact can be expected of interventions targeted at preventing smoking, since most people start smoking for the first time when they are young. Figure 2.4 display the initiation probability of daily smoking estimated using STIVORO data.

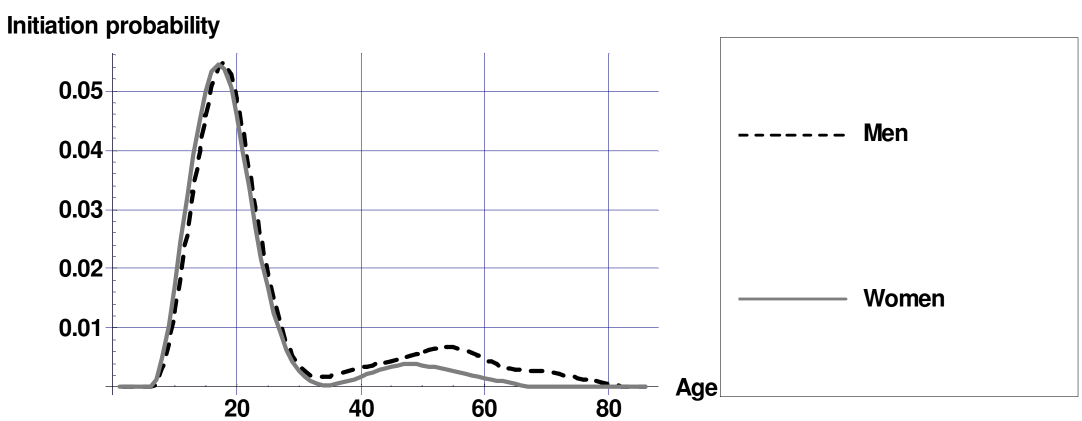


Figure 2.4: Initiation probabilities for daily smoking specified by gender

Figure 2.4 shows that the probability to initiate daily smoking is highest around the age of 18. At this age, more than 5 out of 100 adolescents start daily smoking. In older ages, the number of persons that start daily smoking is consistently below 1 per 100.

From a public health point of view, prevention of smoking is especially important for at least two reasons. First, the majority of smokers who try to quit smoking will start again. Hence, it is very difficult to quit smoking at older ages, and therefore targeting at young people may be a wise approach. Second, the risk of mortality among 45-to-54-year-old smokers is almost twice as high in persons who started smoking before the age of 15, compared to persons that started after the age of 25. The duration of smoking is thus an important predictor of premature mortality, and preventing adolescents to start at an early age is therefore very fruitful [2].

3. Description of the interventions

3.1 Tobacco taxes and its' price elasticity

Increasing tobacco taxes can affect smoking behaviour in three different ways:
- current smokers decrease the quantity of cigarettes consumed;
- more current smokers quit smoking;
- less non-smokers start smoking.

By increasing tobacco taxes, the prices of cigarettes will rise (provided that tobacco producers do not decrease their selling price). In reaction to the price increase, some smokers will lower the amount of cigarettes they consume and some might even quit smoking. Moreover, higher prices may deter people from initiating smoking. Since most people start smoking when they are young (see Chapter 2), it is worthwhile to investigate whether tobacco taxes are effective in deterring young people from smoking. Furthermore, the additional advantage of using tobacco taxes for tobacco control is that from a government perspective they are a cheap intervention since it is possible to reduce smoking and at the same time to generate more tax revenues.

The effectiveness of price increases cannot be determined using a randomized controlled trial. Instead, historical time series of smoking behaviour have been related to price developments during this period. To measure the effects of price on the demand of tobacco, economists estimate so-called price elasticities. 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. An extensive literature exists on the price elasticity of the total demand for tobacco. It is estimated that for western countries the elasticity lies somewhere between -.3 and -.5 which means that a 10% increase in prices leads to a 3 to 5% decrease in the demand for tobacco [3,4]. Empirical studies on the effects of prices on the demand for tobacco usually only look at the reactions of total demand for tobacco because of price changes. However, to estimate health effects of price increases effects on the prevalence of smoking are needed, preferably divided into effects on the number of current smokers (quitters) and on the number of new smokers (starters).

Ross and Chaloupka found that smoking prevalence among adolescents reacted more heavily to price changes than smoking prevalence among adults [5]. They estimated a smoking prevalence elasticity for adolescents of -.35 which implies that a 20% increase in the price of tobacco, decreases smoking prevalence among adolescents with 7%. In a study by Harris and Chan it was found that smoking prevalence among young adolescents was more sensitive to price changes than among older adolescents [6]. Their smoking prevalence elasticity estimates ranged from -.83 (for ages 15-17) to -.52 (ages 18-20).

Changes in the smoking prevalence are the result of changes in smoking initiation among non-smokers and changes in quit rates among smokers. However, studies about the cause (i.e. more quitting or less initiation) of the price sensitivity among adolescents are scarce and point in different directions. This can be explained by the fact that there are several stages that can be distinguished before a never-smoker becomes a nicotine addict. Thus, the classifications into for instance starters and quitters is not always clear-cut. Several studies did not find significant effects of price changes on smoking initiation [7-10]. However, a recent study [11] showed that if one controls for gender price increases decreases initiation among boys but not among girls. The authors explained their findings by arguing that girls start smoking as a way to counteract weight gains and therefore are less responsive to price changes. Most studies about quitting behaviour among smoking adolescents show that the number of quitters increase as price increases [7,8,10,12].

3.2 School interventions

In order to select school interventions that have been proven to be effective in reducing smoking prevalence among adolescents a literature search was conducted (details of the literature search are described in Appendix B). Only school interventions that have been evaluated in the Netherlands have been included. In compliance with the inclusion criteria (see Appendix B), three interventions were selected:

1. The in-school intervention by Ausems *et al.* (2004) in vocational schools [13], hereafter referred to as the in-school intervention;
2. The out of school intervention by Ausems *et al.* in vocational schools [13], hereafter referred to as the out-of-school intervention;
3. The intervention by Dijkstra *et al.* targeted at all school levels [14] hereafter referred to as the booster intervention.

The three interventions were performed in Dutch schools. The in-school intervention studied by Ausems *et al.* (2004) was part of the healthy school program, a large program in Dutch schools to promote a healthy lifestyle in adolescents. The three interventions were based on the 'social influence resistance model'. In the social influence approach, the social environment of the individual is considered to be an important factor. Therefore, training of skills to protect against negative social influences is one of the key components of this approach. Many studies conclude that this is the most effective approach and that therefore in the prevention of smoking in adolescents the social influence approach has to be used [15,16]. Hereafter each intervention is described in more detail.

3.2.1 The in-school intervention

The in-school intervention consisted of three lessons, each lasting about 50 minutes, for which student and teacher manuals were available. The first lesson explained the ingredients of tobacco and the physical and mental consequences of smoking, while the second discussed norms concerning smoking and the third emphasized the pressures to smoke and the skills that are helpful in resisting cigarettes [13].

Smoking behavior was measured using self-reports. Respondents who indicated having smoked during the past month were classified as current smokers. The in-school intervention was most effective in smoking cessation: after 1 year 29.4% of all current smokers as measured at baseline continued smoking versus 42.2% in the control group. The fact that in both control and intervention group more than half of those adolescents classified as smokers, quit after one year illustrates the dynamics in smoking among adolescents. The chance of continuing smoking is significant smaller than in the control group (Odds ratio = 0.49 (0.29-0.84)). The odds of smoking initiation showed no significant difference (OR=0.52 (0.23-1.18)). The costs of the in-school intervention were estimated at € 18,- per participant assuming that a class consists of 30 students. A detailed description of the cost analysis can be found in Appendix C.

3.2.2 The out-of-school intervention

The out-of school intervention consisted of three tailored letters with smoking prevention messages, which were sealed in envelopes and mailed to students' homes at three-week intervals. The content of the letters were tailored to individual characteristics, using a pre-test questionnaire. The pretest questionnaire on attitudes, social norms, self-efficacy, smoking intention, and smoking behavior was used to create a database file containing personal information. A computer program combined the database file with the message file using decision rules that linked students' answers to personal messages. The first letter (eight versions) contained information regarding students' beliefs about smoking in general, and short-term and social consequences of smoking. The second letter (32 versions) discussed the influence of the social environment and the intentions not to smoke in the future. Boys and girls received different messages and cartoons. The third letter (two versions) described refusal techniques and included an exercise about cigarette refusal [13]. Smoking status was measured in the same way as in the in-school intervention.

The out-of school intervention was effective in smoking prevention: after 1 year 25% started smoking and after 1.5 years 27.2% (versus 40.9 and 47.9% in the control group). These percentages can be interpreted as probabilities to initiate 'experimental' smoking and cannot be compared to probabilities to initiate daily smoking as discussed in Chapter 2 (see Figure 2.4). The chance of continuing smoking differs not significantly from the control group: (OR=0.67 (0.29-1.56)). The chance of starting experimental smoking is smaller compared to the control group (Odds ratio = 0.42 (0.18-0.96)). The costs of the out-of school intervention were estimated at € 50,- per participant (see Appendix C).

3.2.3 The booster intervention

The intervention studied by Dijkstra *et al.* (1999) consisted of five weekly peer-led lessons of 45 minutes each in small groups of four or five students. The peer-leader was a non-smoking student from the same class as the students. The first lesson focused on the reasons why people do or do not smoke. The second lesson dealt with the short-term effects of smoking. The third lesson focused on resisting peer pressure and acquiring skills to resist pressure. The fourth lesson discussed how to react when bothered with smoke, indirect pressure to smoke from adults and advertisements, and measures from the government against smoking. The last lesson focused on alternatives to smoking, making the decision to smoke or not and a commitment to non-smoking behavior. Thereafter the study population received boosters. Three magazines were developed and distributed by teachers. In the magazines, well-known national and international singers and sports personalities served as non-smoking role models and gave their opinion on smoking. Information was given on the effects of smoking, passive smoking etcetera [14]. Teachers coordinated the lessons, stimulated students and assisted peer-leaders. Teachers received one hour training from health educators [14].

The booster intervention resulted in a significant lower increase in the amount of smokers. After 12 months, the amount of smokers increased with 5.6% in the intervention group versus 12.6% in the control group. After 18 months, the amount of smokers increased with 9.7% versus 14.9% in the control group. It was not measured whether this was the result of less initiation or more cessation in the control group. Respondents who indicated having smoked during the past month were classified as current smokers. The costs of the booster intervention were estimated at € 75,- per participant (see Appendix C).

4. Modeling interventions

4.1 The RIVM Chronic Disease Model

To estimate health gains in the long run as well as cost effectiveness for the interventions discussed in the previous Chapter the RIVM Chronic Disease Model (CDM) is used. The CDM has been developed as a tool to describe the morbidity and mortality effects of autonomous changes of and interventions on chronic disease risk factors taking into account integrative aspects [17]. The CDM models the entire Dutch population, following the life course of birth cohorts over time. The model contains several risk factors including cholesterol, systolic blood pressure, smoking, activity level, and Body Mass Index. It models 28 chronic diseases: acute myocardial infarction, other coronary heart disease, stroke, and chronic heart failure, COPD, asthma, diabetes mellitus, dementia, osteoarthritis, dorsopathy, osteoporosis and 15 different forms of cancer. The mathematical model structure is called a multi-state transition model and is based on the life table method. The model states defined are the risk factor classes (e.g. never smokers, current smokers and former smokers) and disease states (e.g. with or without COPD). State transitions are possible due to changes between classes for any risk factor, incidence, remission and progress for any disease, and mortality. The model describes the life course of cohorts in terms of changes between risk factor classes and changes between disease states over the simulation time period. Risk factors and diseases are linked through relative risks on disease incidence. That is, incidence rates for each risk factor class are found as relative risks times baseline incidence. All model parameters and variables are specified by gender and age. The time step used for modeling is 1 year. The main model outcome variables are incidence, prevalence and mortality numbers specified by disease, and integrative measures such as total and quality-adjusted life years.

Demographic input data in the CDM came from Statistics Netherlands [18], data on the incidence, prevalence and mortality of the modeled diseases were based on Dutch General Practice registrations, national administrative data (Municipal Base Administration, GBA), hospital admission data (LMR, National Medical Registry), mortality registries (Statistics Netherlands), and time series data from CMR Nijmegen [19]. Health care costs in the CDM were based on the Costs of Illness in the Netherlands study [20,21] and quality of life weights on Dutch and international burden of disease studies [22-24].

4.2 Smoking in the CDM

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 [25]. 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+ [26]. These estimates were based on STIVORO data (2002-2003) [27,28]. Most men and women start smoking between 10 and 25 years of age (see Figure 2.4). 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. The probability to start smoking after having stopped, decreases the longer one has stopped.

Smokers as well as former smokers run an increased risk for smoking related diseases [2], with the risks of former smokers depending on time since cessation [29]. Hence, more quitters lead to a reduction in the incidence of smoking related diseases, which reduces morbidity and mortality. Using the model, [13,30,31]the long term effects of increased smoking cessation rates or decreased initiation rates can be simulated on the smoking prevalence and incidence, prevalence, mortality and costs of fourteen smoking-related diseases, myocardial infarction, 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 can be simulated [32,33].

4.3 Estimating health effects and cost effectiveness

Estimating the health effects and cost effectiveness of an intervention with the CDM is done by comparing the costs and effects of an intervention scenario with a so-called current practice scenario [34]. In the current practice scenario the parameters of the CDM are not altered and can be interpreted as the scenario with a continuation of current health care policy. Future smoking prevalence rates are the result of transitions between smoking statuses. In the intervention scenario, some parameters of the models are adjusted to reflect the effects of the intervention. For instance, in a smoking cessation intervention, stop rates of smokers can be increased in the CDM [35]. A smoking prevention intervention (like some of the school interventions) can cause a decrease in the initiation probability of smoking among youth. This will decrease the number of smokers, which causes a decrease in the incidence, and thus the prevalence of smoking related diseases. This causes a gain in (healthy) life expectancy. Cost effectiveness ratios can be computed by dividing the difference in health care costs between the intervention and reference scenario by the difference in life years/QALYs between the intervention and reference scenario.

We will present cost effectiveness ratios in four different ways, so that the cost effectiveness can be compared with outcomes of other studies:

1. intervention costs per averted smoker: representing the short term cost-effectiveness of the different interventions;
2. intervention costs per life year /QALY gained;
3. intervention costs plus savings in the costs of smoking related diseases per life year /QALY gained;
4. intervention costs plus the total difference in health care costs per life year/QALY gained.

It should be mentioned that the last ratio is the most important and this is the only one that can be compared with health care interventions not aimed at smoking cessation [34].

5. Scenarios

5.1 Introduction

As discussed in Chapter 4, the CDM models transitions between three smoking classes: never smokers, current daily smokers and former smokers. Scenarios are defined by temporarily adjusting the transition rates between those classes. However, the effectiveness of the interventions as reported in Chapter 3 can not translated directly into scenarios modeled with the CDM. For instance, the effectiveness of the school interventions was reported in terms of 'experimental' smoking instead of 'daily' smoking. This Chapter describes the assumptions that are needed to translate the effectiveness of the interventions discussed in Chapter 3 to scenarios modeled with the CDM. For all interventions we formulated so-called 'best guess' scenarios. Table 5.1 displays a short description and assumptions of all four 'best guess' scenarios.

Table 5.1: Short description of the best guess scenarios

Scenario name	Taxes	In-school	Out-of-school	Booster
Type of intervention	Tobacco tax increase	In-school intervention	Out-of-school intervention	Booster intervention
Implementation	20% increase in price in the year 2005	all 7th grade high schools for 10 years	all 7th grade high schools for 10 years	all 8th grade high schools for 10 years
Effect on quitting and/or initiation	More quitters and less initiation	More quitters	Less initiation	More quitters and less initiation
Intervention costs per participant	€ 0	€18	€50	€75

In the following two paragraphs, the assumptions for the different 'best guess' scenarios are discussed in more detail. In sensitivity analyses we tested the robustness of the results for several assumptions made in these 'best guess' scenarios (see Appendix D for definition and results of the sensitivity analyses).

5.2 Tobacco taxes scenario

The empirical findings regarding the effectiveness of tobacco taxes on youth smoking behaviour vary quite a bit (see Chapter 3). In our 'best guess' scenario we will use the estimate of the prevalence elasticity from the study of Ross and Chaloupka which equals -.35 [5]. This implies that in our example of a 20% price increase, prevalence after one year has dropped with 7%. It is assumed that half of the drop in the prevalence of smoking is the result of less initiation and the other half is caused by more quitters. In a sensitivity analyses the effects of a maximum and minimum estimate of the prevalence elasticity are also estimated (see Appendix D).

We model a price increase of 20% since this is roughly the price increase of cigarettes in the Netherlands in the beginning of 2004. Furthermore, it is assumed that the price increase exerts the most influence immediately after the price increase and that start and stop rates gradually return to their old level. In sensitivity analysis it is tested how results are influenced if start rates and stop rates return faster or slower to their old level.

Although tobacco tax increases will affect also smoking behaviour of adults, we will only present the results of the price increases on current adolescent smoking population (all Dutch citizens aged 10-19) in this report.[3] This gives a good benchmark in terms of health gains to compare with the school interventions.

5.3 School scenarios

The effects on smoking status of the three different school interventions were all measured by the question 'Have you smoked during the last month?'. As described in Chapter 2, the prevalence rates of smoking differ enormously depending on the type of smoking status that is measured, daily smoking or experimental smoking. The effects of the interventions referred to experimental smoking status, not to daily smoking status. The prevalence rates, transition rates and relative risks of current and former smokers in the CDM are those of daily smokers and thus we needed to make assumptions about the effects of the interventions on daily smoking status. Figure 5.1 displays the prevalence of daily smoking divided by the prevalence of experimental smoking. The fraction of adolescents that indicates to smoke daily of all adolescents that indicate to have smoked during the past month increases with age. At low ages, most smokers are only 'experimental' smokers. However, approximately 70% of all smokers aged 18 are daily smokers.

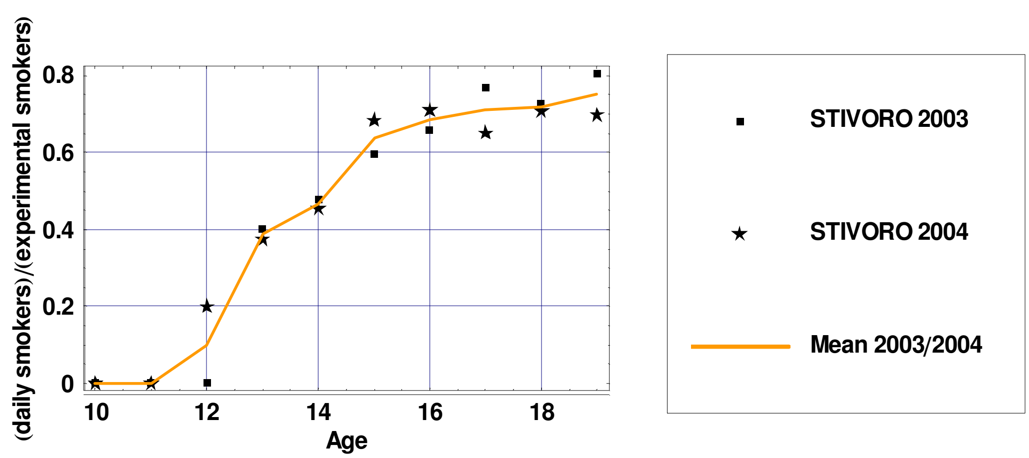


Figure 5.1: Ratio of daily /experimental smokers by age

To translate the effectiveness of the school interventions which were measured using experimental smoking status into effects on daily smoking the ratios of daily smokers/experimental smokers were used (see Figure 5.1). Thus, if an intervention was successful at reducing experimental smoking prevalence by 10% at 13 years we assumed that the daily smoking prevalence was reduced by roughly 4 % since about 40% of all

[3] In the report for interventions targeted results of tobacco tax increases for the complete Dutch population are presented (scheduled for the end of 2005).

experimental smokers are daily smokers in that age group. For the school scenarios, we first calculated the difference in prevalence rates of experimental current smoking between the intervention and control group after 1 year for all interventions. To obtain effects of the interventions on daily smoking, the effects on experimental smoking status after 1 year were multiplied by the ratios as displayed in Figure 5.1. For the out-of-school scenario it was assumed that the difference was the result of less initiation and for the in school intervention it was assumed that the difference in smoking prevalence is the result of more quitters. For the booster scenario, we assumed that half of the drop in smoking prevalence was the result of less initiation and the other half of more quitters among smokers.

It was assumed that all school interventions were implemented on all school types in the Netherlands. Although the in-school and out-of-school have only been evaluated on vocational schools there is no a priori reason why they could not be effective in other school types. To enable comparison of cumulative effects with the tax scenarios, for which we estimated effects on all current adolescents aged 10-19 years, in our school scenarios we assumed that the school interventions were implemented for ten years on all high schools in the Netherlands. For the in school and out-of school scenarios it was assumed that the intervention was implemented on all seventh grades. In the booster scenario it was assumed that all eight grades received the intervention.

6. Results

6.1 Introduction

In this Chapter only results of the 'best guess' scenarios are presented. It should be kept in mind that there is much uncertainty about the effectiveness of the interventions. In Appendix D results of the sensitivity analysis can be found that address some of the issues with respect to the uncertainty of the effectiveness of the interventions. However, not all uncertainty could be addressed in the sensitivity analysis. For the school scenarios, uncertainty about the assumption regarding the effectiveness with respect to daily smoking is hard to quantify.

6.2 Effects on never, current and former smokers

Figure 6.1 displays difference in the number of smokers of the 'best guess' scenarios compared to the current practice scenario. The maximum difference in the number of smokers for the different scenarios ranges from approximately 15,000 for the in-school scenario to 45,000 for the booster scenario (the total number of smokers among adolescents currently is about 200,000). The booster scenario results in the largest drop in the number of smokers. In the school scenarios, the number of smokers increases immediately after the ten year implementation period of the school interventions. After this period, start and quit rates return to their current practice levels by assumption. In the tax scenario, a few years after the price increase the number of smokers gradually starts to rise again because smokers who have quit, start again or never smokers start smoking at a later age.

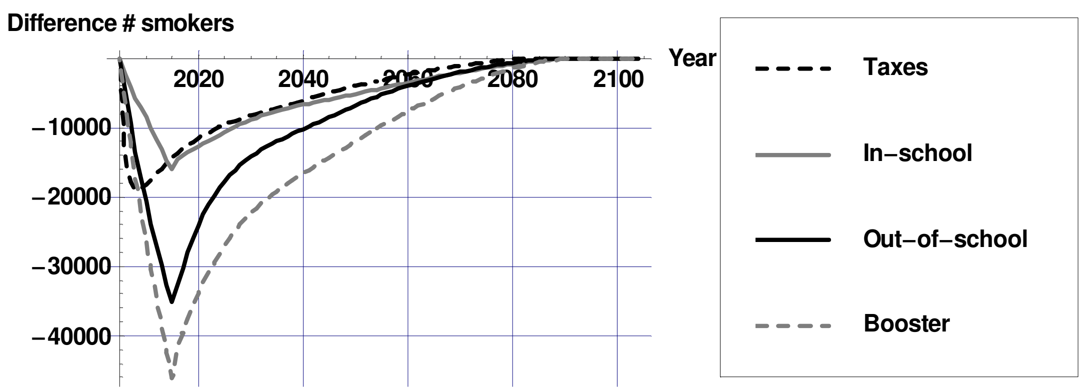


Figure 6.1: Differences in number of smokers 'best guess' scenarios compared to current practice

To explain the differences in the number of smokers Figure 6.2 and 6.3 display the differences in the number of never smokers and former smokers. The out-of-school scenario reduces the number of adolescents who start smoking, thereby increasing the number of never smokers, and decreasing the number of smokers and thus also the number of former smokers. For the in-school scenario, it was assumed that the intervention only increased the number of quitters which decreases the number of smokers and increases the number of former smokers. Hence, by assumption the number of never smokers is not affected in the in-school scenario. Results of the tax and booster scenarios are caused by both mechanisms.

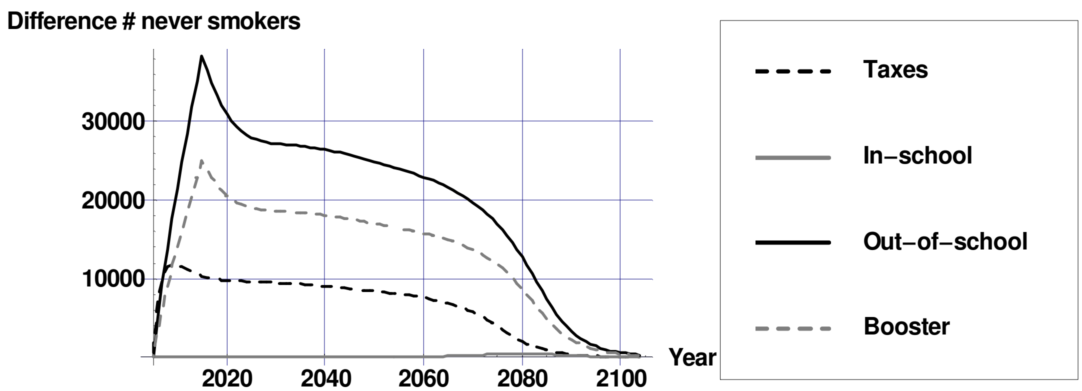


Figure 6.2: Differences in number of never smokers 'best guess' scenarios compared to current practice

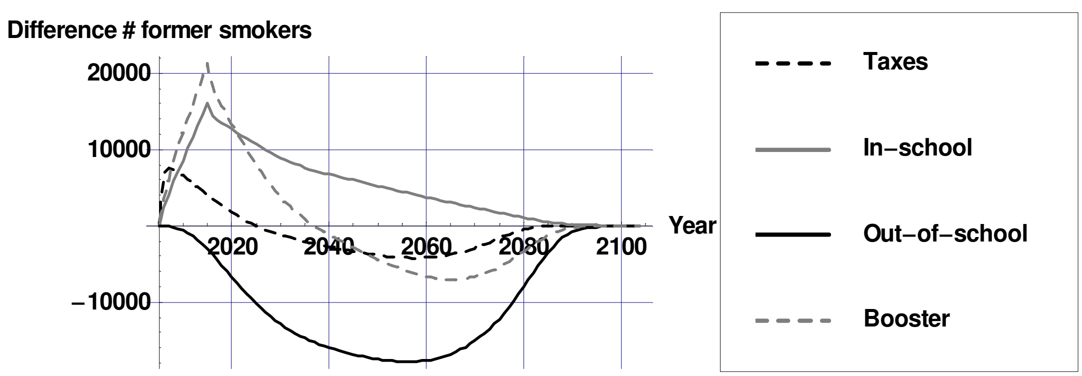


Figure 6.3: Differences in number of former smokers 'best guess' scenarios compared to current practice

6.3 Health gains

Figures 6.4 and 6.5 display the life years and QALYs gained over time. In all figures costs and effects are discounted at 4% to follow Dutch guidelines for pharmaco economic research [36]. 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. The largest effects occur some 60-70 years after the intervention when the school population that received the intervention becomes middle aged. The health gains approach zero as the cohorts that receive the school intervention become extinct. Comparing Figures 6.4 and 6.5 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 QALYs as a result of substitute diseases that decrease quality of life in life years gained.

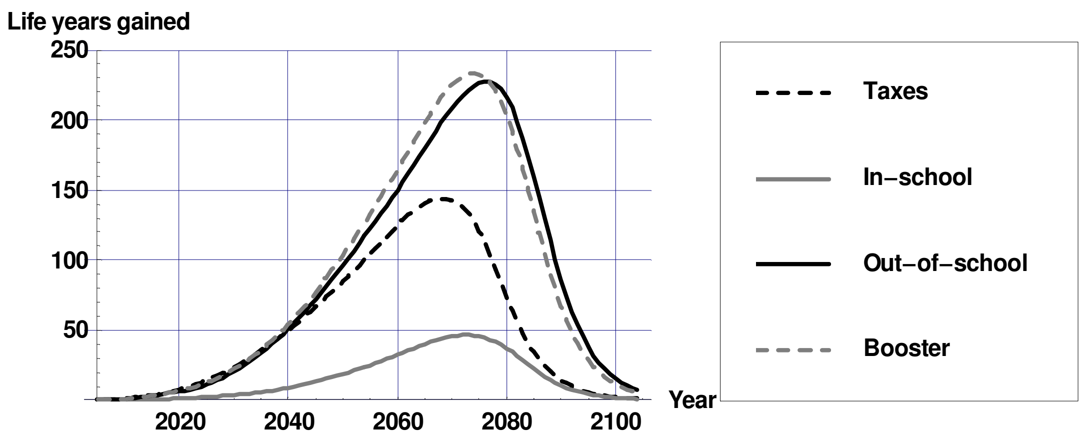


Figure 6.4: Life years gained over time (life years discounted with 4%)

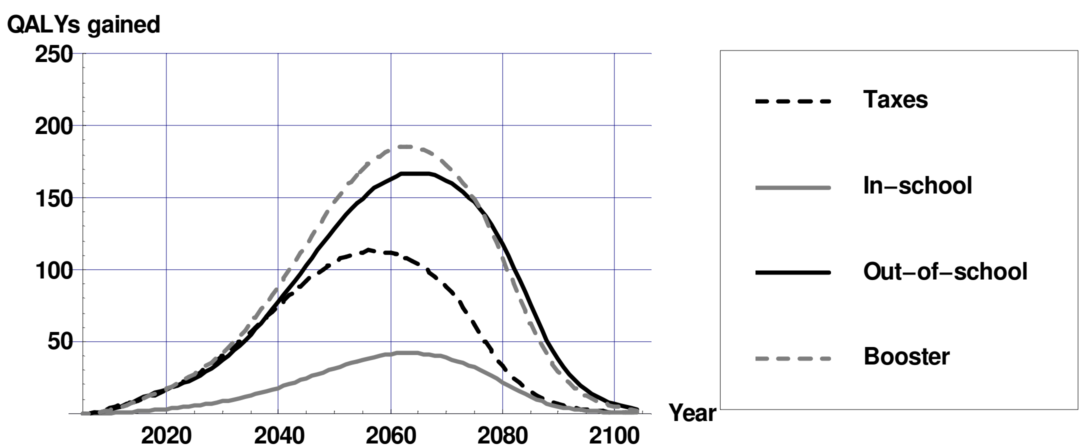


Figure 6.5: QALYs gained over time (QALYS discounted with 4%)

6.4 Effects on health care costs

Figure 6.6 displays the difference in health care costs of smoking related diseases and Figure 6.7 of diseases not related to smoking. The decrease in the incidence of causally to 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 related to smoking and those not related to smoking (Figure 6.7). For the tax scenario after approximately 65 years costs of smoking related diseases start rising again. For the school scenarios, this happens a few years later since the implementation period of the school interventions is 10 years and the effects on the number of smokers of the school interventions are identical these 10 years. In the taxes scenario it is assumed that the effects on smoking prevalence are strongest the first year after the 20% price increase.

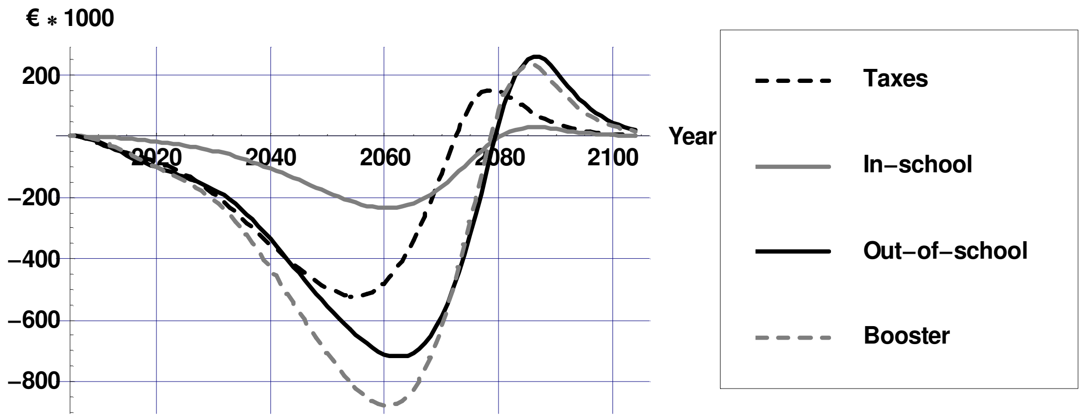


Figure 6.6: Difference in health care costs of smoking related diseases over time (4% discount rate)

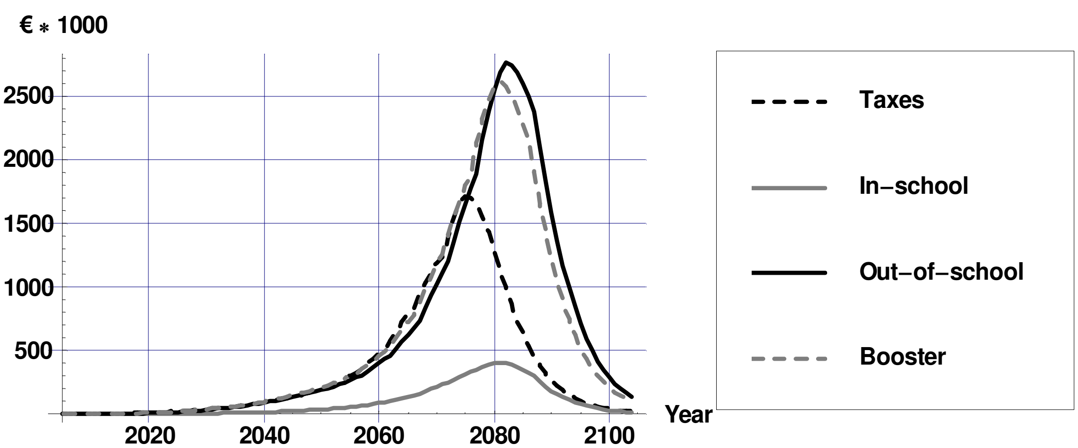


Figure 6.7: Difference in health care costs of diseases not related to smoking over time (4% discount rate)

Figure 6.8 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 60 years, from a reduction in smoking related diseases. However, if smokers live longer therefore they have a higher lifetime chance to develop chronic, expensive, not lethal diseases like dementia. The intervention costs during the first ten years for the school programs are not included in this figure.

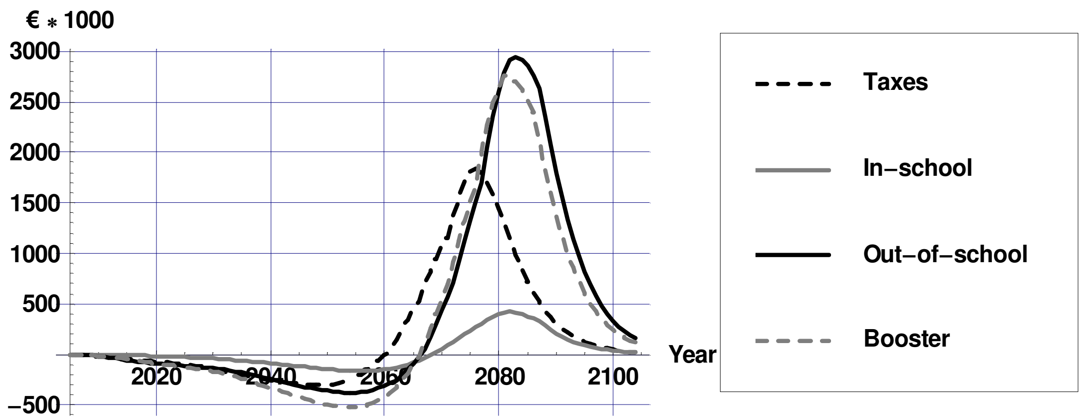


Figure 6.8: Difference in total health care costs over time (intervention costs not included, discount rate 4%)

6.5 Cost utility ratios

Table 6.1 (next page) summarizes the results for the 'best guess' scenarios. The intervention costs per averted smoker are lowest for the in-school and highest for the out-of-school intervention. More health gains are achieved in the scenarios that have effect on smoking prevention compared to the scenarios in which effects on the number of quitters are assumed. This is because a lot of quitters start smoking again at a later age, and at a young age the target group is larger for interventions that have effect on smoking initiation compared to quitting. Therefore, intervention costs per QALY gained for out-of-school scenario were almost half those for the in-school scenario. The costs for the booster scenario were in between. Since tax increases had no intervention costs, it was not possible to calculate the intervention costs per LYG or QALY. However, since there is an increase in total health care costs, it was possible to calculate a cost effectiveness ratio by dividing the difference in health care costs by the incremental health effects gained. If only savings in the costs of smoking related diseases were taken into account, taxes were cost saving, while if total health care costs were included, costs per LY/QALY gained were € 4,000 and € 4,500, respectively. For the school programs, costs per LY/QALY gained were lower than the intervention costs per LY/QALY gained, counting only smoking related diseases. If the total difference in health care costs was taken into account, the out-of-school intervention was most cost effective, but the cost-effectiveness ratios of all school interventions did not differ much and were much higher than those for tax increases. The cumulative life years/QALYs gained ranged from 1,600/1,700 to 8,600/8,000. The cumulative health effects were higher for scenarios in which effects on the number of starters were modeled. This can be explained since a lot of former smokers start again after having stopped. Furthermore, the life expectancy of never smokers is higher than that of former smokers. Since health care costs increase with age the cost utility ratio for the start scenarios is higher than for the stop scenarios.

Table 6.1: Summary of results

Scenario name	Taxes	In-school	Out-of-school	Booster
Difference # smokers after 10 year	14,000	16,000	35,000	46,000
Cumulative intervention costs [a b]	0	35.5	102.0	150.0
Intervention costs per averted smoker	0	1,600	2,200	2,900
Cumulative Life years gained [b]	5,300	1,600	8,500	8,600
Cumulative QALYs gained [b]	4,800	1,700	7,500	8,000
Intervention costs per LY gained [b]	0	€ 22,200	€ 12,000	€ 17,500
Intervention costs per QALY gained [b]	0	€ 21,100	€ 13,600	€ 18,900
Cumulative difference in health care costs of smoking related diseases [a b]	-15.4	-7.3	-21.8	-26.8
€ per LY gained [b c]	Cost saving	€ 17,700	€ 9,400	€ 14,400
€ per QALY gained [b c]	Cost saving	€ 16,800	€ 10,700	€ 15,500
Cumulative difference in total health care costs [a b]	+21.4	+2.5	+39.5	+32.6
€ per LY gained [b d]	€ 4,100	€ 23,800	€ 16,700	€ 21,300
€ per QALY gained [b d]	€4,500	€ 22,600	€ 18,900	€ 23,000

[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

Figure 6.9 (next page) displays the total costs and effects for the school and tax scenarios with uncertainty ranges regarding the effectiveness of the interventions. Costs and effects in Figure 6.9 are discounted with 4%. For the school scenarios, only the uncertainty of the interventions with respect to experimental smoking is translated into daily smoking. Uncertainty about the assumption regarding the effectiveness with respect to daily smoking is not taken into account

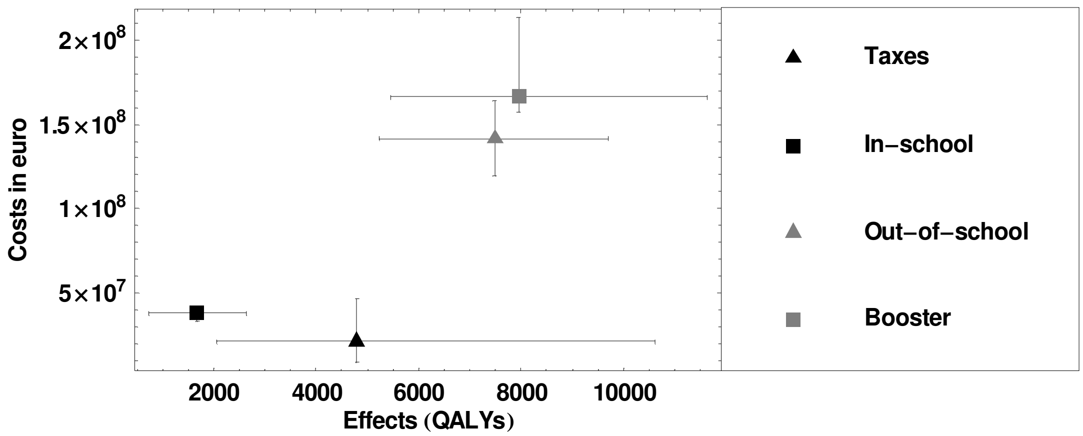


Figure 6.9: Total costs and effects for all scenarios with uncertainty range (costs and effects discounted at 4%)

Figure 6.9 shows that in the scenarios that prevent young people from smoking result in more health gains. Furthermore, from the healthcare perspective, tax increases are the cheapest smoking cessation intervention thinkable. Although this is clear, the estimates of the total health effects of a tax increase would gain from better empirical data on the effect of price increases on start and stop rates. The cost effectiveness of the different interventions does not differ significantly from each other. The effects of the different interventions depend heavily on the assumptions.

In Appendix D the outcomes of sensitivity analysis are given. The sensitivity analyses shows that cumulative health effects and cumulative differences in health care costs are very sensitive for variations in time horizon and effectiveness since the high health care costs in life years gained occur only after 60 to 100 years. Although cost effectiveness ratios of tobacco taxes are insensitive towards variations in effectiveness, those of the school intervention are not. This can be explained by the fact that there is a one to one relation between cumulative health gains and cumulative differences in health care costs (excluding intervention costs): more health gains, more savings in smoking related diseases, more medical costs in life years gained. Since intervention costs are zero for tobacco taxes, the costs effectiveness ratio is insensitive for variations in effectiveness. However, for the school interventions, a drop in the effectiveness means that the intervention costs are divided by a lower amount of life years/QALYs gained resulting in an increase of the cost effectiveness ratio.

7. Conclusion and discussion

The current report presented estimates of health effects and cost effectiveness of interventions to reduce smoking among adolescents. Health effects and cost effectiveness of three different school interventions were estimated and compared with the effects of tobacco tax increases on youth smoking. Comparison of the different interventions shows that tobacco tax increases are the cheapest intervention to discourage smoking among adolescents. Furthermore, we found that scenarios with effects on smoking prevention result in more health gains than scenarios that have effect on the number of smokers who quit. In the lowest age groups, the number of daily smokers is quite low as was shown in Section 2. Therefore, prevention of initiation has a larger target group in those age classes. Furthermore, cessation may not last, due to relapse.

The outcomes of the scenarios presented in this study should be interpreted with caution and can not be directly compared with cost effectiveness studies of tobacco control interventions targeted at adults. First of all, smoking behaviour among adolescents is less stable than among adults. Since cost effectiveness analysis requires assumptions about the effectiveness on smoking behaviour in the long run any assumption regarding smoking behaviour among adolescents is somewhat uncertain. Secondly, the evidence base of tobacco control measures targeted at adolescents is much weaker than those of adults. For the effectiveness of tobacco taxes with respect to adolescents specific studies on the effect of tobacco taxes on smoking cessation or smoking are scarce and results are mixed. Furthermore, studies in adults measure daily smoking. However, for the school-based interventions in adolescents, studies only present results on experimental smoking. To estimate cost effectiveness, we needed results on daily smoking. In lack of information on the difference in effectiveness between the two groups, we had to assume that the effectiveness of the school interventions on daily smoking was the same as that on experimental smoking. This assumption is crucial for the results. If the school interventions only influence smoking behaviour of experimental smokers and not that of daily smokers, health gains would vanish and cost effectiveness ratios would, of course, be infinitely high.

Another reason why the evidence for the scenarios presented in this report is much weaker than those of individual interventions targeted at adults is the absence of evidence of effectiveness in meta-analyses. For cessation interventions in adults, for instance nicotine replacement therapy, meta-analyses, which combine the results of various trials, present effectiveness data in terms of 6 and 12 months continuous abstinence. For the school-based interventions, a recent Cochrane review concludes that *'there is a lack of high-quality evidence about the effectiveness of combinations of social influences and social competence interventions, and of multi-modal programmes that include community interventions'* [37]. Therefore, we based our analyses on Dutch interventions using this approach. This implies that our effectiveness estimates were based on single trials and not on meta-analyses. However, they were based on Dutch trials. Therefore, the results may be better comparable to the Dutch situation than the outcomes of meta-analyses of foreign studies.

The current evaluation is more complete than most evaluations as published in scientific literature, which present intervention costs per QALY or life year gained [38]. All interventions were evaluated in a similar way, using the RIVM Chronic Disease Model to compare intervention scenarios with a current practice scenario. The fact that quitters may relapse and overall that smoking prevalences result of age dependent start, cessation and relapse rates is often ignored in other cost-effectiveness evaluations. An advantage of the RIVM-Chronic Diseases Model is that this can be taken into account. Furthermore, our approach adds an estimation of the effects on health care costs, both the savings for smoking related diseases and the additional costs of health care resulting from an increase in life expectancy. We found that the additional health care costs in life years gained are larger than the savings in the costs for smoking related diseases. Just like Barendregt *et al.*, we also found that smoking reduction results in a substitution of health care costs from cheap lethal causal to smoking related diseases towards expensive, less lethal non-smoking related diseases in life years gained [39,40]. However, we found that although adding health care costs of diseases not related to smoking in life years gained do not increase the cost effectiveness ratios for the school interventions dramatically since these costs occur far away in the future and hence are heavily discounted.

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. For tobacco taxes, we assumed intervention costs were zero, that is, we ignored possible costs of information and regulation involved in a tax increase. We ignored both costs and revenues of a tax increase, since these occur outside the health care sector. For the same reason, we did not present effects on productivity costs and on the personal costs of smokers. Furthermore, effects of smoking cessation on passive smoking and on the course of disease for those already ill are not taken into account. Since it is reasonable to expect that the costs of a tax increase are outweighed by the additional revenues, the factors that have been left out imply that our estimates are conservative and cost-effectiveness may be better, if these effects are included. The effects of the school interventions were based on trials. Countrywide implementation, without the monitoring involved in the evaluation studies, in all schools and not only those willing to participate in a study, probably means a lower effectiveness. In addition, the costs of the interventions did not include the development costs of the programs, for instance the costs of the software to make individualized letters.

A similar cost-effectiveness study of school based prevention programs is one conducted by Tengs *et al* [41]. Tengs *et al.* evaluated from the societal perspective the short- and long-term costs, health gains, and cost-effectiveness of delivering intensive school-based tobacco use prevention program to every 7th and 8th grade students in the United States. They created a computer simulation model called Tobacco Policy Model. Over a 25-year period the cost per QALY would range from $24,000 to $600,000. And over a 50-year period will range from $4,900 to $340,000 per QALY, due to the (fourfold) increase in medical savings. They also included differences in total health care costs.

As mentioned several times in this report, effectiveness figures in terms of daily smoking for interventions targeted at smoking reduction among adolescents are scarce. This might be due to the fact that most interventions that are evaluated are targeted at adolescents aged 12-15. However, most adolescents start daily smoking at later age (with a peak at age 19, see Figure 2.4). Therefore, we suggest that future research should devote more attention in developing and evaluating interventions targeted at ‘older’ adolescents.

The RIVM Chronic Disease Model has also been used to estimate the cost effectiveness of interventions aimed at weight reduction and increases in physical activity [42]. Main conclusion of that research was that prevention of overweight and obesity is a cost effective method to obtain health gains. The same conclusion also holds for increasing tobacco taxes.

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Appendix A: Summary of expert opinions

List of remarks relevant for this report, translated from Dutch by the authors of this report (including reactions of the authors)

- 'Why is the study by Crone *et al.* (2003) not included in your report?'
This study was found in the literature search, but was excluded because the effect of the intervention after one year was no longer significant.

- 'How is it possible to estimate a range for national implementation of a school intervention?'
To make it possible to compare the school interventions with the tax interventions we assumed that the school interventions were implemented for 10 years on all high schools in the Netherlands

- 'One trial done by myself (published in 1992 and 1994) is not mentioned in your report.'
We only searched for literature over the period 2000-2005. That's why this trial was not included.

- 'Computer tailoring is a very effective intervention for the cessation or prevention of smoking in adolescents.'
We included this type of intervention in our report, mentioned as the out-of school intervention.

- 'Why are some other Dutch school interventions excluded from this report?'
At the start of our literature search we studied several reviews and a Cochrane review. This resulted in several Dutch interventions, the most of them were excluded because of a lack of long term evidence, or because the interventions did not only focus on smoking prevention but for example on alcohol use as well.

- 'I recommend a combination of school interventions (lessons, the focus on parents and boosters during every school year).'

Appendix B: Selection of school interventions

A literature search was conducted on school-based interventions for prevention or cessation of smoking in adolescents. Medline and Cochrane Reviews were searched over the period 2000-2005. In Medline the following key terms were used:
Dutch and foreign studies:
- "school-based" and
- "smoking" and
- "prevention"

Dutch studies:
- "school-based" and
- "smoking" and
- "prevention" and
- "Netherlands" or "Dutch"

Titles and abstracts were scanned for relevance. The resulting articles were read and references were tracked. Besides that, other sources have been searched: (1) Tobacco Control, (2) STIVORO annual reports (1998-2003) (3) a review by Stivoro about smoking in adolescents aged 16 years and older [43], (4) a state of the art report by Van Schayck *et al.* [44] about research on smoking cessation interventions, and (5) a review by Willemsen *et al.* [45].

The resulting full text articles were read and selected by using the following inclusion criteria:
- preference was given to studies that were done in Dutch settings and these studies can be supported by studies from foreign countries;
- (if possible) a distinction was made in effects on smoking prevention and smoking cessation;
- evidence of long-term effects (1 year and longer) [44];
- the intervention had to be based on the social influence approach. This approach can be defined as a combination of health education (health risks and the negative consequences of smoking) and skills training in protection against social influences [44] .

This literature search resulted in three Dutch studies and several foreign studies. The three Dutch studies evaluated four different programs. Cuijpers *et al.* [46] formulated 7 quality criteria for school-based interventions: the effectiveness has to be proven; interactive methods are superior; the 'social influence model' is the best; the agreement not to smoke and the intention not to smoke; combination with a community intervention increases the effect; using peer-leaders is the best; the use of life skills will increase the effect. The Dutch studies and some important foreign studies are described in table B1 and table B2, respectively.

In a Cochrane review, 76 RTC were identified [37]. Of these, 16 were categorized as category one (most valid). From these 15 studies were social influence interventions, of which 8 showed some positive effect of intervention on smoking prevalence, 7 failed to detect an effect on smoking prevalence.

Table B1: Results of literature search: Dutch studies

Author and year	N, subjects, setting	Intervention	Results
[13]	Vocational school (students) It0[a]= 9 (525) It2[b]= 9 (434) Ot0[c]= 8 (513) Ot3[d]= 5 (265)	In-school intervention (I) Out-of-school intervention (O)	See the main text for a full description of this study
[14]	High school students N= 32 schools and 538 students Nt4= 526 (18 months)	Boosters intervention	See the main text for a full description of this study
[47]	Nint= 1444 Ncontr= 1118 average age= 13y 26 Dutch schools	3 lessons on knowledge, attitudes, and social influence, followed by a class agreement not to start or to stop smoking for five months and a class based competition	Intv. group 9,6% of non-smokers started C group 14,2% of non-smokers started OR=0.61 (0.41-0.90) to uptake smoking in the I group compared to C group (after 5 months). One year after the intervention the effect was no longer significant

[a] number of participating schools and students in the in-school intervention at pre-test

[b] number of participating schools and students in the in-school intervention at post-test 2 (12 months)

[c] number of participating schools and students in the out-of-school intervention at pre-test

[d] number of participating schools and students in the out-of-school intervention at post-test 3 (18 months)

Table B2: Results of literature search: Foreign studies[*]

Author and year	N, subjects, setting	Intervention	Results
[48]	351 students 6 public high schools 1) N0=201 2) N0=128 3) N0= 22 Average age= 15,5	1)Tobacco Education Group (TEG): designed for adolescents not yet thinking about quitting 2) Tobacco Awareness Program (TAP) for adolescents who want to quit 3) control group	Compared to the control group both intervention groups significantly decreased tobacco use. 1) 12% quit rate 2) 15% quit rate In 2 years
[49]	74 students Large public high school	Group 1) a 6-week, 8-session, classroom-based, smoking cessation curriculum designed for adolescents (n=35) Group 2) an informational pamphlet on how to quit smoking with promise of the classroom curriculum in 3 months (n=39)	<u>After 26 weeks</u> 1) Smoke-free 34% 2) Smoke-free 27%
[50]	335 smokers 18 schools 1) N=139 2) N=120 3) N=76	1) clinic-only group 2) clinic plus a school-as-community component 3) standard care control	17% of the smokers in the clinics quit smoking for at least the last 30 days at 3 month follow up (5 months after the program quit day), compared to only 8% of the control condition smokers. Addition of 2) to 1) did not improve the cessation rates over the clinic alone.
[51]	770 ninth-grade students in 8 (junior) high schools	10 lessons given by trained health educators, to 1234 students of grade 7 (junior high school), 2 boosters were given to the students grade 8 (after 1 year) and the effects were measured when the students were in grade 9.	Intervention group: in two years cigarette use increased from 37% to 53% and weekly use increased from 6% to 10% Control group: in two years cigarette use increased from 35% to 58% and weekly use increased from 4% to 13%

* More foreign studies were found, but only the most important ones (for this study) are described here

Appendix C: Calculation of intervention costs

The costs of the interventions were estimated based on implementation over a longer period and at many schools. In that case, the starts up costs per participant are negligible. These are once-only costs before implementation of the intervention, like development costs. The costs were calculated by identifying the different types of costs in the intervention (e.g. material costs and labor costs), and the resource use in the interventions (e.g. duration of sessions). Some assumptions were made, when information was incomplete, this is presented in Table C1 below.
The usage was multiplied by the unit price. Unit prices were collected from the national education union, from Oostenbrink *et al.* [52] and other resources. Costs are formulated per participant. The calculation assumes optimal implementation of the intervention, that is all the lessons and materials are included.

Table C1: Resource use and costs smoking interventions in adolescents

Intervention	**Resource usage**	**Unit costs**	**Costs per participant**	**Assumptions**
In-school intervention	150 minutes time teacher (3 lessons* 50 minutes)+ 1 manual per student.	Time teacher Manual	€17,73	Group size was 30 students
Out-of school intervention	60 minutes time teacher (60 minutes fill in questionnaire) 60 minutes time research assistant (15 minutes entering the questionnaires and 3*15 minutes to match and send the letters) 1 questionnaire 3 letters and postage costs	Time teacher Time research assistant Questionnaire Letter	€50,98 (excl. software costs)	Time research assistant: - to match is 15 minutes - to enter the questionnaire is 15 minutes
In-school and boosters	285 minutes time teacher (5 lessons * 45 minutes+ 60 minutes training teachers) 60 minutes time health educator (to train teachers) 1 manual per student 1 manual per teacher 1 non-smoking contract 1 brochure video 3 magazines per student.	Time teacher Time health educator Manual Contract Brochure Video Magazine	€73,57	Costs of one magazine equals the costs of one brochure plus € 0,50

Appendix D: Results sensitivity analysis

For each intervention we presented the results of the 'best guess' scenarios in Chapter 6. In this Appendix, results of the sensitivity analysis are presented. For each intervention, effects are presented for a minimum and maximum estimate of effectiveness of the intervention. Furthermore, effects of variations in discount rate and time horizon are presented. For the tobacco taxes it is also investigated how sensitive the results are for variations in the duration and strength of the tobacco tax increase on smoking behaviour. In all 'best guess' scenarios effects and costs were discounted at 4% and the time horizon was 100 years.

In the tax scenarios it is assumed that the effect of the price increase on smoking transitions is temporarily and that the transitions gradually return to their 'current practice' level. The pace at which this happens is reflected in the parameter *d.* In the 'best guess'scenario *d* equals .5 which implies that every year after the price increases the prevalence elasticity is divided into half. Thus if the prevalence elasticity equals- .35 and the price increase equals 20%, the first year after the price increase the prevalence of smoking equals 7%, the year after that 3.5%, the year thereafter 1.75% etc. After 10 years after the effects of the price increase are reduced to a minimum. If *d* equals .25 the effects on smoking behaviour die out faster. In our sensitivity analysis we varied *d* and Figure D1 shows the difference in the number of smokers for difference values of *d* (*d*= .25, *d*=.5 en *d*=.75) compared to the current practice scenario if the prevalence elasticity equals -.35 and the price increase equals 20%.

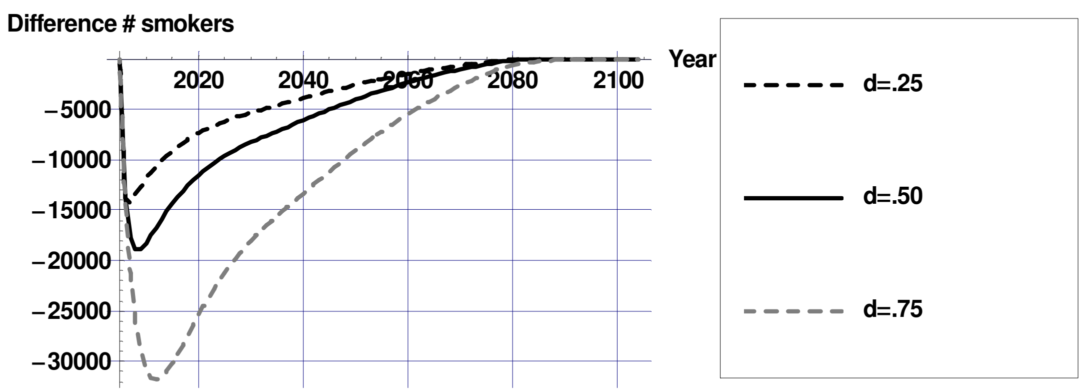

Figure D1: Effect of parameter d on the number of smokers in tax scenarios

As a maximum estimate of the prevalence elasticity we will take the estimates of the study by Harris and Chan [6]. They found that the prevalence elasticity decreased as age among adolescents increases. For the minimum estimate of the effectiveness we will assume that adolescents are equally responsive with respect to prices as adults and we will follow the conclusion by the World Bank and a recent meta analysis [3,4]: the total price elasticity lies between -.3 and -.5 and can minimally be explained by 50% through a reduction in smoking prevalence. This means that the minimum prevalence elasticity equals -0.15. In the minimum scenarios it is assumed that tobacco taxes exert the same influence on smoking on adolescents of all ages. Table D1 displays the outcomes for the sensitivity analysis for the tobacco taxes intervention. The cost effectiveness ratios are not sensitive for the effectiveness and the parameter *d* but the cumulative do depend heavily on them. Furthermore, both ratios and cumulative effects are very sensitive for time horizon and discount rate.

Table D1: Results sensitivity analysis taxes scenario

	€ per QALY gained	**€ per life year gained**	**Cumulative QALYs gained**	**Cumulative life years gained**	**Difference in health care costs (€ 1,000,000)**
'Best guess' scenario	4,500	4,100	4,800	5,300	21.4
Effectiveness:					
Minimum	4,400	4,100	2,100	2,300	9.1
Maximum	4,400	4,000	10,600	11,600	46.8
Parameter *d*					
d=.25	4,500	4,100	3,300	3,600	14.6
d=.75	4,400	4,000	9,000	9,800	39.4
Discount rate					
Cost and effects 0%	12,300	8,800	40,000	55,800	489.8
Costs: 6%; effects: 1.5%	200	100	17,100	21,900	3.2
Time horizon					
25 years	Cost saving	Cost saving	300	200	-7.7
75 years	2,500	2,400	4,600	4,800	11.3

For the school scenarios we used the confidence intervals as reported in the original articles to create confidence intervals around our 'best guess' scenarios. For all school scenarios we tested sensitivity for intervention costs by increasing or decreasing the intervention costs by 10%. Table D2, D3 and D4 display the results of the sensitivity analyses for the school scenarios. All cost effectiveness ratios of the school scenarios are most sensitive to variations in time horizon. However, again, it should be mentioned that the confidence intervals around the effectiveness also assume that interventions are equally effective in reducing daily smoking as experimental smoking.

Table D2: Results sensitivity analysis in-school scenario

Scenario name	Interventions costs per Life year gained	€ per QALY gained	Cumulative QALYs gained	Cumulative life years gained	Difference in health care costs
'Best guess' scenario	22,200	22,600	1,700	1,600	2.5
Effectiveness:					
Minimum	50,600	49,600	700	700	1.1
Maximum	14,200	15,000	2,600	2,500	3.9
Intervention costs					
+10%	24,400	24,700			
-10%	20,000	20,500			
Discount rate					
Cost and effects 0%	1,700	9,600	17,100	20,800	128.6
Costs: 6%; effects: 1.5%	4,700	5,100	6,800	7,600	-0.4
Time horizon					
25 years	1,300,000	528,000	70	30	-0.3
75 years	27,400	21,700	1,500	1,300	-2.3

Table D3: Results sensitivity analysis out-of-school scenario

Scenario name	Interventions costs per Life year gained	€ per QALY gained	Cumulative QALYs gained	Cumulative life years gained	Difference in health care costs
'Best guess' scenario	12,000	18,900	7,500	8,500	39.5
Effectiveness:					
Minimum	17,100	24,800	5,200	5,900	27.6
Maximum	9,300	15,800	9,700	11,000	51.3
Intervention costs					
+10%	13,200	20,300			
-10%	10,800	17,500			
Discount rate					
Cost and effects 0%	900	14,900	82,100	119,300	1,1119
Costs: 6%; effects: 1.5%	2,400	3,400	31,600	42,100	5.9
Time horizon					
25 years	714,000	299,000	300	140	-1.7
75 years	16,100	16,100	6,500	6,400	1.7

Table D4: results sensitivity analysis booster scenario

Scenario name	Interventions costs per Life year gained	€ per QALY gained	Cumulative QALYs gained	Cumulative life years gained	Difference in health care costs
'Best guess' scenario	17,500	23,000	8,000	8,600	32.6
Effectiveness:					
Minimum	25,000	31,600	5,400	5,900	22.2
Maximum	12,000	17,000	11,600	12,600	48.0
Intervention costs					
+10%	19,200	24,800			
-10%	15,800	21,100			
Discount rate					
Cost and effects 0%	1,300	13,600	82,300	113,700	97.1
Costs: 6%; effects: 1.5%	3,700	4,700	32,400	41,100	3.8
Time horizon					
25 years	714,000	419,000	400	150	-1.7
75 years	16,100	21,200	7,100	6,800	0.4