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Smoking prevalence in Australia and The Netherlands

A cross-country comparison on the influence of tobacco control policy and education on smoking prevalence

Bachelor thesis

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Abstract

Lung cancer is the deadliest type of cancer, often caused by smoking behaviour. This thesis focusses on tobacco control policy by Australia and The Netherlands. For years, these two countries have tried to bring down smoking prevalence, both successfully in different ways. Where the WHO recently set up a handbook for countries to help bring down smoking prevalence, these two countries already implemented some laws. This research focusses on the question to what extent Australian and Dutch tobacco control policy influenced smoking prevalence in their countries. In addition to this, it was measured to what extent spending time on education influences smoking prevalence. The analysis was conducted by gathering implemented laws and data on years spent on education, which were then tested to see to what extent they influence smoking prevalence. As a result, men and women from both countries respond differently to the implementation of laws. Smoking prevalence among Australian men and Dutch women does not significantly change due to the implementation of any law. Dutch men were only sensitive to the implementation of laws when The Netherlands started implementing their tobacco control policy. Australian women are most sensitive to tobacco control policy, as smoking prevalence significantly changed throughout many time periods. Separately, the increasing years spent on education has a negative effect on smoking prevalence for all researched populations. It can therefore be concluded that implementing tobacco control policy only had a significant effect on Australian women and Dutch men.

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1. Introduction

1.1 Background

In 2020 in The Netherlands, 27.9% causes of death were related to cancer and other malignant neoplasms and is therefore the main cause of death (CBS, 2021). All cancer deaths equal a total of 47.000 deaths, of which 10.070 people died of lung cancer, which makes it the most deadly type of cancer in The Netherlands (Volksgezondheidenzorg.info[a], 2021). The underlying cause of these lung cancer problems is smoking. More than 80% of lung cancer deaths are directly related to smoking, either first-hand or second-hand (American Cancer Society, 2019). Second-hand smoking is even responsible for 1.2 million premature deaths per year and serious cardiovascular and respiratory diseases (WHO[a], 2021). In addition to this, tobacco related health care in The Netherlands cost 2.4 billion euros in 2015 (Volksgezondheidenzorg.info, 2022). A huge amount of money that, based on research by SEO Economisch Onderzoek, is part of the 30 billion euros The Netherlands would have saved if they were to be smoke-free (Medisch Contact, 2016).

A different country that is suffering from, but also trying to tackle smoking is Australia. Since 1973, 7 years before The Netherlands implemented tobacco control policy, they have implemented a policy to discourage smoking which has helped them to also reduce lung cancer deaths as a result. Yet, smoking and lung cancer statistics vary heavily between the two countries. In 2020, Australia's death rates of lung cancer were lower, not only as part of all cancer deaths but also in absolute numbers. Where in The Netherlands 10.070 people died of lung cancer (CBS, 2021), Australia noted 8.739 lung cancer deaths (Cancer Australia[a], 2021). In The Netherlands, lung cancer accounted for 22.3% of all cancer deaths, while in Australia this was only 17.8% of all cancer deaths (AIHW, 2020).

1.2 Tobacco control policy and the role of education

To prevent people from exposure to smoking and provide the foundation for countries to implement and manage tobacco control, the WHO set up a framework with guidelines that governments could use called 'MPOWER' (WHO[b], 2021). This framework maintains that governments should: **m**onitor tobacco use, **p**rotect people from tobacco smoke, **o**ffer help to quit smoking, **w**arn about the dangers of smoking, **e**nforce tobacco advertising, promotion & sponsorship bans and **r**aise taxes on tobacco.

The effectiveness of laws that are in line with the MPOWER framework have already been proved on several occasions. The importance of implementing location bans already proved to be of effect in Scotland, as research by Ashley et al. (2011) showed that smoking in indoor places plummeted as a result of an indoor smoking ban. Similar to the work in Scotland, research by Bell et al. (2009) showed that location bans reduced second-hand smoking. Furthermore, a review by Hammond (2013) of previous research on the effect of health warnings on cigarette packs showed that depending on their size and design, they significantly help people to prevent or quit smoking. Enforcing tobacco advertising, promotion & sponsorship bans was proven to be of importance by Madkour et al. (2014), who found that if smokers and non-smokers were exposed tobacco advertising or promotions, it would lead to a higher smoking prevalence. Finally, research by Chaloupka et al. (2012) proved that raising tobacco taxes is highly effective, as smoking prevalence among current smokers decreased and prevented potential smokers from smoking.

Some measures from the WHO framework have already been implemented by both Australia (Department of Health, 2018) and The Netherlands (Willemsen, 2018), as visible in table 1. From 1973 onwards, Australia implemented several nation-wide laws that are in line with 'MPOWER', while The Netherlands implemented such laws since 1980. The implemented laws range from advertisement restrictions to a complete ban on smoking in certain places. Both countries have laws with similarities in content, but a point of interest is that The Netherlands implemented many of those similar laws about 5 years later than Australia.

Australia	The Netherlands
Until 1973: no laws	Until 1980: no laws
1973: cigarette packs should contain a health warning	1980: ban on tobacco advertising on radio and television
1976: ban on tobacco-related advertisements on radio and television	1982: health warnings on cigarette packs
1986: phased in ban on smoking in workplaces and public places	1990: ban on smoking public buildings and properties
1990: ban on advertisements in print media	1995: ban on advertising on billboards
1990: legal age to buy tobacco set at 18 years old	1996: ban on advertising in cinemas
1992: increase in tobacco excise	2002: ban on tobacco-related advertising and promotion
1993: Tobacco Advertising Prohibition Act, including more tobacco-related advertising bans	2002: selection of pre-defined health warning to be displayed on tobacco packaging
1994: phased in ban on smoking in restaurants	2003: legal age to buy tobacco set at 16 years old
1995: text-only health warnings on tobacco packaging	2004: ban on smoking in workplaces
1997: National Tobacco Campaign, including discouraging advertisements	2007: public tobacco advertising limited to pre-defined guidelines
1998: phased in ban on point-of-sale tobacco advertising	2008: ban on smoking in the hospitality sector
2006: graphic health warnings on packaging of most tobacco products	2011: smoking allowed in small bars without personnel
2010: 25% increase in tobacco excise	2014: legal age to buy tobacco raised to 18 years old
2011: ban on point-of-sale display of tobacco products	2014: ban on smoking in all bars
2012: plain packaging, and updated and expanded graphic health warnings	2016: graphic health warning on tobacco packages
2013: 4-year annual 12.5% increase in tobacco excise	2017: ban on the display of tobacco products at point-of-sale
2015: phased in ban on smoking in out-door eating areas	
2017: 4-year annual 12.5% increase in tobacco excise	

Table 1: an overview of Australian and Dutch tobacco control policy (Department of Health, 2018; Willemsen, 2018)

Many laws are in accordance to 'MPOWER', but an implemented law by both countries that is not included in 'MPOWER', is to raise the legal age to buy tobacco. Research by Verdonk-Kleinjan et al. (2008) on the effect of an age raise in The Netherlands in 2003 concluded that the percentage of adolescents buying tobacco decreased with 15.5 percent-point after an age raise.

An additional factor that needs consideration is the role of education, which is measurable and applicable to everyone. As Escobedo & Peddicord (1996) already found among different US cohorts, smoking prevalence substantially declined among those who attended a higher level of education. Therefore, it would be of importance to obtain a higher level of education in order to achieve a lower smoking prevalence.

1.3 Academic & societal relevance

For decades, smoking has been among the main risk factors of death world-wide (Our World in Data, 2021). As the death rates from Australia and The Netherlands already indicate, lung cancer causes

around ten thousand deaths per year, even though both Australia and The Netherlands pursue a discouragement policy toward smoking. Smoking was the biggest cause of death in The Netherlands in 2017 (Our World in Data, 2021), even though Cleary et al. (1996) reported in the US in 1996 about lung cancer deaths that the best cure is prevention. Research shows that policy interventions can be effective, but there is still a gap on tobacco control policy and finding measures that work. Besides that, there has not been conducted a country comparison between Australia and The Netherlands. This would be very interesting considering the fact that Australia and The Netherlands implemented many similar laws, but almost never at the same time. By comparing the two countries, it becomes clear to what extent Australian and Dutch tobacco control policy have been effective. Add to this the multi-billion costs that come from smoking, and you have a problem that is on the one hand very problematic, but on the other hand incredibly money-saving if solved.

From an academic view, there is also still a lot to play for. Where in The Netherlands the chance to survive for longer than 5 years with lung cancer was 12.2% in the 90's, this had increased to 20% in 2011-2015 (Volksgezondheidenzorg.info[a], 2021). Unfortunately, this is still a very low number, especially compared to other types of cancer. To gain time and find better ways to cure this disease, it is important to put a halt to smoking, the main cause of lung cancer.

1.4 Research questions

Smoking is a problem that causes many deaths in Australia and The Netherlands. The aim of this research is to investigate the influence of the Australian and Dutch government on smoking prevalence by their tobacco control policy, especially in context with the time difference. It will also be tested against the macro level factor 'mean years of education', after which conclusions can be drawn.

Therefore, the central research question reads as followed:
"To what extent have Australian and Dutch tobacco control policy influenced their national smoking prevalence?"

Consequently, the sub-questions that follow from this are:

1. What effect have Australian and Dutch tobacco control policy had on smoking prevalence?
2. What effect has the level of education had on smoking prevalence?

1.5 Structure of the thesis

This thesis consist of six chapters. The subject of this thesis was introduced in chapter one. The theoretical framework, where core concepts are discussed, is in chapter two. This chapter will end with the conceptual model that follows from it. The third chapter contains the methodology, discussing the way the research was conducted. In chapter four, the results of this analysis are presented. Chapter five includes the discussion, where methodological challenges and a reflection on the research process are presented. The conclusions that can be drawn from the results and consequent policy recommendations are in chapter six.

2. Theoretical framework

2.1 Smoking epidemic model

In 1994, a model that described the cigarette epidemic was developed by Lopez et al. (1994), which is shown in figure 2. In this model, a country's population goes through four stages. In stage one, there is an increase in male smokers, but a very low level of female smokers. In stage two, the male population that smokes increases heavily and starts to reach its top, while women smoke more as well. Smoking related death rates among men start to increase as well, while this is barely measured among women. In stage three, the number of male smokers has reached its top after which it decreases. Female smoking prevalence starts to reach its top as well after which it declines, while female death rates increase. In stage 4, the percentage of male and female smokers still decreases and the gap starts to narrow down. The percentage of male deaths reaches its stop and will decrease, while female deaths still rise. Based on the peak amount of sold cigarettes and the moment lung cancer deaths peaks in the smoking epidemic model, a pattern seems to become visible. With a time difference of 3 to 4 decades between the two, we can say that it takes about that time for a person to die of lung cancer from the moment he or she starts to smoke.

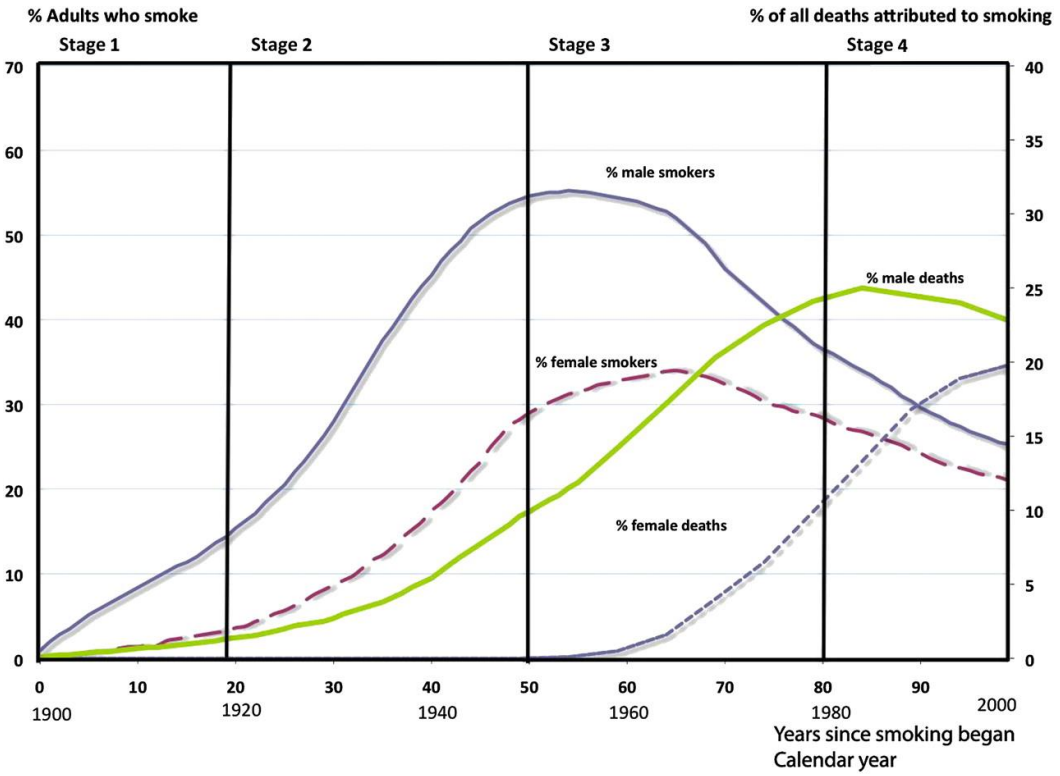

Figure 1: The smoking epidemic model (Thun et al., 2012)

As the smoking epidemic model gives a good guide to check the position of a country and what might be expected, it is perfect for this research to compare Australia and The Netherlands. It can be checked to see in what stage the countries are and to what extent the implementation of tobacco control policy has influenced smoking prevalence and lung cancer deaths.

Furthermore, there is a gender difference. Women tend to smoke later than men and in smaller numbers. This gender difference can be explained by multiple reasons. For a long time, a woman who smokes was considered to be taboo in Western-Europe. It was related to fallen women and the occupational symbol of prostitution (Marsh, 1997). However, this changed with the invention of the mass produced cigarette. From that moment onwards, smoking was promoted as a symbol of emancipation that shows the social and economic status of women (Amos & Haglund, 2000). Another

important factor was the First World War, where women emancipated towards manly behaviour, including smoking (Koetzle 1994, cited by Marsh, 1997). This expanded in the centuries after the First World War, when tobacco companies systematically marketed their products for more and more women. Over time, advertisements became more sophisticated, smoking prevalence among women increased and smoking even became the norm for women in some parts of the world (Christen & Christen, 2003).

2.2 Conceptual model

Theoretically, people are able to stop smoking at any point of time, but the longer they smoke the higher their chance to get lung cancer (Volksgezondheidenzorg.info[b], 2021). As people often start smoking as a minor, it is important to implement policies that affect people as young as possible.

Based on the literature above, this thesis proposes the conceptual model as visualised in figure 2. In this conceptual model, the population consists of two types of persons: smoking & non-smoking, no matter if they are male or female. Throughout their life they spend a certain amount of time on education and can encounter interventions by governments. These interventions can be based on 'MPOWER' or a raise in legal age to buy tobacco. Over time, these interventions can influence both types of persons. The amount of years spent on education is also of influence to all groups. A combination of government intervention and an increase in the mean years spent on education leads to a stagnating or decreasing smoking prevalence. As a result, lung cancer deaths as % of total deaths will stagnate or decrease. Either of the measures alone will have a similar but smaller effect. Only if there is no government intervention and no change in the mean years spent on education, no change in smoking prevalence will occur. Then, lung cancer deaths continue to increase as time passes.

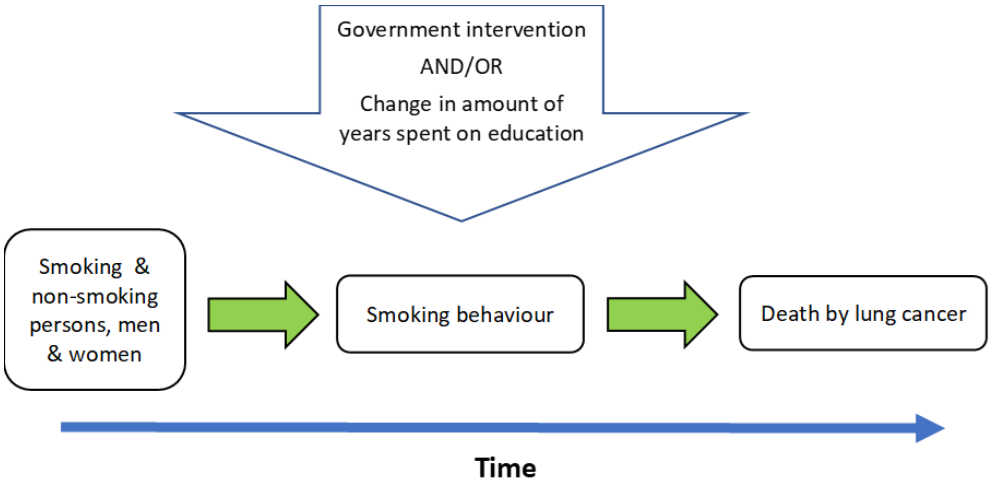

Figure 2: the conceptual model that has been used in this research

2.3 Hypotheses

Based on the literature and conceptual model, it is expected that implementing laws has a negative effect on smoking prevalence. As a result, lung cancer deaths as % of total deaths will stagnate or decline. The amount of influence of a law will depend on the moment of implementation and differs per gender. The speed with which laws influence smoking prevalence will differ per country and per gender as well, as the presence of external factors like the mean years in education might delay the efficiency of new laws.

3. Methodology

As this analysis focusses on how smoking prevalence is influenced by laws and the years spend on education, data on these variables was collected. This data needed to be edited to make it useable for visual and statistical purposes. Firstly, the data is used to describe Australian and Dutch progression within the smoking epidemic model. Secondly, the same data is being used for statistical analysis to identify to which extent tobacco control policy and the changing mean years people spent on education influenced smoking prevalence.

3.1 Data and the dataset

To set the starting point from which data was needed, it is necessary to define in which year the first laws were implemented. The years between the implementation of laws differs between Australia and The Netherlands and a period before the implementation was needed for the measurement of the effects of laws. Therefore, it was decided to set the starting point at 1965, as from that year onwards, data was available for most variables. The description of data, without interpolation, that was later on used for statistical analysis, is presented in table 2.

Divided by gender, data on smoking prevalence, lung cancer deaths, the mean years of education was gathered from different databases. This was inevitable, as it was not possible to retrieve all data from the same database or organisation. However, every variable is retrieved from the same database, except for data on lung cancer deaths as data on this variable was more concise if it was retrieved from different databases. The exact Australian and Dutch laws are used as from table 1.

Data on smoking prevalence for Australia and The Netherlands is from the OECD (OECD, 2021). It was measured from 1965-2019, with missing data in several years. Australia suffers from somewhat irregular, but mostly 3-year gaps, while for The Netherlands it was not measured every year between 1966-1978, but annually afterwards. Data on lung cancer deaths for Australia is from 'Cancer Australia' (Cancer Australia[b], 2021) and was measured from 1968-2019. For The Netherlands this is from 'Volksgezondheid en Zorg' (Volksgezondheidenzorg.info[c], 2021), who measured this from 1980 onwards. Data on the mean years of education for 20-24 year olds for Australia and The Netherlands is from the Wittgenstein Centre (Wittgenstein Centre, 2021) and measured every 5 year from 1965 onwards. Australian laws were retrieved from the Department of Health of the Australian government (Department of Health, 2018). Dutch laws were retrieved from the book 'Tobacco Control Policy in The Netherlands' by M.C. Willemsen (2018).

	Valid N	Missing values	Minimum value	Maximum Value
Smoking prevalence of Australian men	18	37	12.4 %	55.0 %
Smoking prevalence of Australian women	18	37	10.0 %	32.5 %
Smoking prevalence of Dutch men	47	8	17.7 %	81.0 %
Smoking prevalence of Dutch women	47	8	13.1 %	42.0 %
Mean years of education for Australian men	11	44	9.69	13.13
Mean years of education for Australian women	11	44	9.04	13.19
Mean years of education for Dutch men	11	44	9.51	12.00
Mean years of education for Dutch women	11	44	7.67	11.54

Table 2: a description of used data for statistical analysis from 1965-2019

As visible in table 2, the dataset suffers from incomplete data for most variables. To estimate the value of a year in which no data was available, that value was interpolated. This was done by measuring the average difference of values per year in a data gap, which was then added to the earliest year with data and multiplied by the amount of years from the earliest year if the gap contained multiple years without data.

3.2 Operationalization

In Australia, tobacco control related laws were implemented since 1973. Until 2019, 18 of such laws are considered to be of influence to smoking prevalence. In The Netherlands, tobacco control related laws were implemented since 1980. Until 2019, 16 of such laws are considered to be of influence to smoking prevalence. A more concise description of these laws for both countries was presented in table 1. All laws could be divided in 11 time periods, based on the year in which they were implemented (table 3). As some laws were implemented right after each other or relatively close after each other, they are placed in the same time period. After the implementation of a law, the short term effect can be measured by comparing the difference in smoking prevalence at the begin and end of the time period.

	Australia	The Netherlands
Time period 1	1965-1972	1965-1979
Time period 2	1973-1975	1980-1981
Time period 3	1976-1985	1982-1989
Time period 4	1986-1989	1990-1994
Time period 5	1990-1993	1995-2001
Time period 6	1994-1997	2002-2003
Time period 7	1998-2005	2004-2007
Time period 8	2006-2009	2008-2010
Time period 9	2010-2011	2011-2013
Time period 10	2012-2014	2014-2015
Time period 11	2015-2019	2016-2019

Table 3: an overview of the division of time periods for Australian and Dutch tobacco control policy

Based on the laws in table 1, the laws can also be put into 6 categories (table 4). The first law in 1973 was in regard to the category ‘Health warnings’. This entails that a certain type of warning relating health and tobacco had to be printed on tobacco products. Laws within that category were also implemented in 1995, 2006 & 2012. The second category consists of laws with regard to advertising bans. Such a ban entails that advertising, sponsoring or promotion of tobacco was from that moment onwards limited to rules or forbidden at all. Laws in this category were implemented in 1976, 1990, 1992, 1998 & 2011. The third category consists of laws with regard to a ban on smoking in certain places. Laws in this category were implemented in 1986, 1993, 1994, 1997 & 2015. The final category is with regard to a raise in the legal age to buy tobacco. The only law in this category was implemented in 1990.

In The Netherlands, laws were implemented since 1980. The first law was in regard to the category ‘advertising bans’. Laws within that same category were implemented in 1995, 1996, 2002, 2007 & 2017. The second category consists of laws with regard to health warnings. Laws in this category were implemented in 1982, 2002 & 2016. The third category consists of laws with regard to a location bans. Laws in this category were implemented in 1990, 2004, 2008, 2011 & 2014. The final category is with regard to a raise in the legal age to buy tobacco. Laws in that category were implemented in 2003 & 2014.

	Australia	The Netherlands
Nothing happened	1965-1973	1965-1980
Health warnings	1973, 1995, 2006, 2012	1982, 2002, 2016
Advertising bans	1976, 1990, 1993, 1998, 2011	1980, 1995, 1996, 2002, 2007, 2017
Location bans	1986, 1994, 1997, 2015	1990, 2004, 2008, 2011, 2014
Increase excise	1992, 2010, 2013-2020	
Age limit raise	1990	2003, 2014

Table 4: an overview of categorized laws of Australian and Dutch tobacco control

3.3 Statistical analysis

To measure the influence of a law, a statistical analysis in SPSS is to be made. As all data is already separated by gender and country, this is done for the statistical analysis as well. Data for this analysis is based on the variables 'smoking prevalence', 'lung cancer deaths as % of total deaths', 'mean years of education' and laws implemented by the Australian and Dutch government. The variables 'smoking prevalence', 'lung cancer deaths as % of total deaths' and 'mean years of education' are ratio variables. The laws implemented by the Australian and Dutch government have to be transferred into dummy variables in order to use them in SPPS.

To get a result that is more reliable, smoking prevalence and the mean years of education need to be transferred into values that measure the difference compared to the year before. Then, the dummy variables for the laws are made. This is done in 4 different ways:

1. A dummy variable is made that only represents the year in which a law was implemented. The year in which the law was implemented is coded '1', and all other years '0'. This means that 11 variables per country need to be made, 1 for every time period.
2. A dummy variable is made that represents the year in which a year was implemented, the year before implementation ánd the year after implementation. The year in which the law was implemented, the previous year and the following year are coded '1', and all other years '0'. This means that 11 variables per country need to be made, 1 for every time period.
3. A dummy variable is made that represents the whole time period. The years from which the law was implemented until a new law was implemented are coded '1', and all other years '0'. This means that 11 variables per country need to be made, 1 for every time period.
4. A dummy variable is made that represents every year in which a certain type of law, based on the categories in table 4, is implemented. The years in which a category encountered implementation are coded '1', and all other years '0'. This means that 6 variables per country need to be made, 1 for every time period

Method 1 is done to measure the direct effect of the implementation of laws on smoking prevalence. Method 2 is done to measure a 'shock effect', as the implementation of a law usually does not come out of the blue and might already have an effect a year before implementation or the year after. Method 3 is done to measure the effect of the implementation of laws on a longer time period. With this method, the effect can be measured in which a law or set of laws effects smoking prevalence until the implementation of a new law or set of laws. Method 4 is done to measure the effect of a category of laws, as laws that fall within a certain category are not implemented consecutively. Therefore, the separate law might not have an effect while the category as such can.

With the ratio and binary variables, a multiple linear regression can be performed. In this regression, 'smoking prevalence' is the dependent variable. Corresponding 'mean years of education' per country & gender and laws per country based on method 1, 2 or 3 are set as independent variables.

4. Results

4.1 The influence of laws

For Australia, the 18 laws were divided in 11 time periods. In figure 6, the borders for the 11 time periods are marked with green, vertical lines. From 1965 until 2019, smoking prevalence and lung cancer deaths as % of total deaths seem to follow the smoking epidemic model. Where Australia could be placed in stage 3 around 1970, it was on the edge of stage 4 in 2019 with a decreasing smoking prevalence for both genders and decreasing lung cancer deaths as % of total deaths for men. Only the increasing amount of lung cancer deaths as % of total deaths for women stops Australia from fully being placed in stage 4. The exact number of changes are placed in table 5.

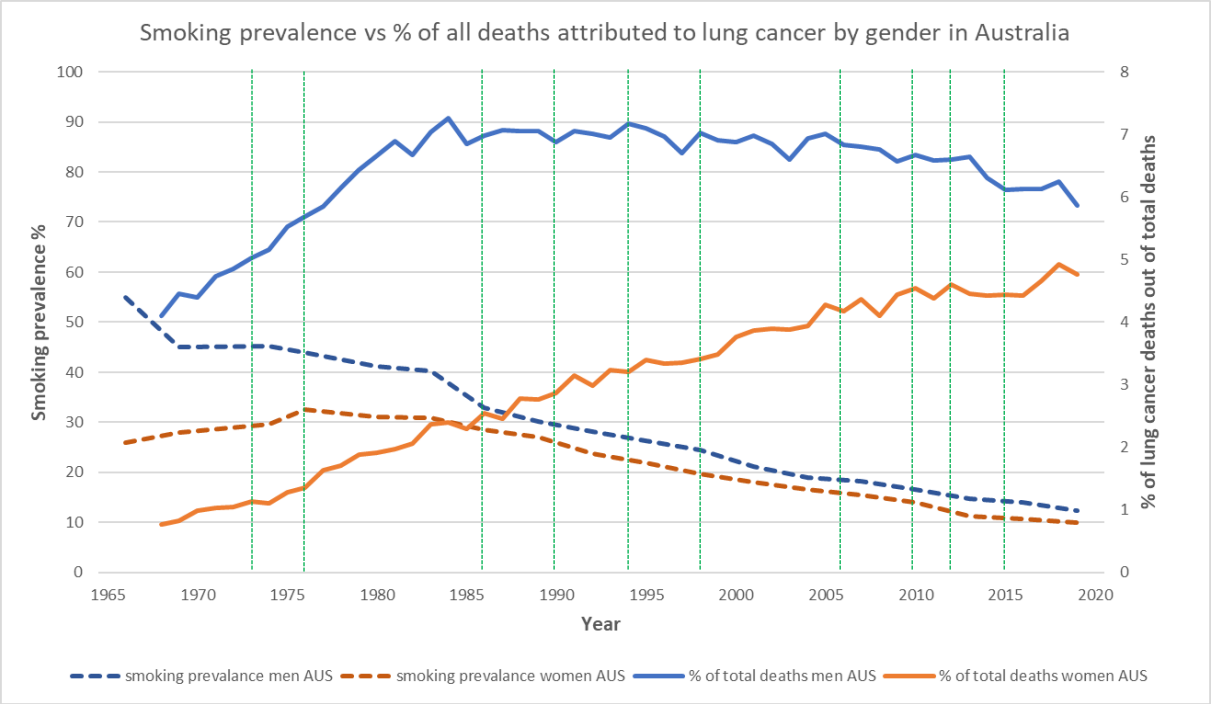

Figure 6: Smoking prevalence vs lung cancer deaths as % of total deaths by gender in Australia

Until 1973, when no laws were implemented, only smoking prevalence among men was decreasing. The amount of lung cancer deaths as % of total deaths for both men & women and smoking prevalence among women was increasing. This situation remains the same in time period 2. However, in time period 3, first changes are visible. Where the amount of lung cancer deaths as % of total deaths continues to increase for both men & women, smoking prevalence is now decreasing for both genders. In time period 4, the situation continues to get better as the amount of lung cancer as % of total deaths stabilizes for men. This situation remains unchanged until time period 9, as from 2010 the amount of lung cancer deaths as % of total deaths for men starts to decrease and it more or less stabilizes for women. From time period 10 onwards, smoking prevalence and the amount of male lung cancer deaths as % of total deaths continues to decrease whereas the amount of female lung cancer deaths as % of total deaths increases again.

	Male smoking prevalence	Female smoking prevalence	Male lung cancer deaths as % of total deaths	Female lung cancer deaths as % of total deaths
Time period 1	55% -> 45.3%	26% -> 29.6%	4.11% -> 5.03%	0.77% -> 1.14%
Time period 2	45.3 % -> 43.9%	29.6% -> 32.5%	5.03% -> 5.7%	1.14% -> 1.36%
Time period 3	43.9% -> 32.9%	32.5% -> 28.5%	5.7% -> 6.85%	1.36% -> 2.54%
Time period 4	32.9% -> 30.2%	28.5% -> 27%	6.85% -> 6.88%	2.54% -> 2.88%
Time period 5	30.2% -> 26.3%	27% -> 22%	6.88% -> 7.16%	2.88% -> 3.21%
Time period 6	26.3% -> 24.4%	22% -> 19.8%	7.16% -> 7.03%	3.21% -> 3.41%
Time period 7	24.4% -> 18.3%	19.8% -> 15.4%	7.03% -> 6.84%	3.34% -> 4.18%
Time period 8	18.3% -> 16.6%	15.4% -> 14.1%	6.84% -> 6.68%	4.18% -> 4.55%
Time period 9	16.6% -> 12.4%	14.1% -> 10%	6.68% -> 6.59%	4.55% -> 4.76%
Time period 10	14.7% -> 14%	11.3% -> 10.8%	6.59% -> 6.11%	4.6% -> 4.44%
Time period 11	14% -> 12.4%	10.8% -> 10%	6.11% -> 5.86%	4.44% -> 4.76%

Table 5: changes in smoking prevalence and lung cancer deaths as % of total deaths in Australia

For The Netherlands, the 16 laws were divided in 11 time periods. In figure 7, the borders for the 11 time periods are marked with green, vertical lines. Similarly to Australia, smoking prevalence and lung cancer deaths as % of total deaths seem to follow the smoking epidemic model. Even though data on lung cancer deaths as % of total deaths was not available yet, a decreasing smoking prevalence shows signs of The Netherlands moving to stage 4. From the moment data on lung cancer deaths as % of total deaths is available, it is slowly decreasing for men whereas for women it has stabilized since 2010. The exact number of changes are presented in table 6. In 2019, The Netherlands was placed in stage 4.

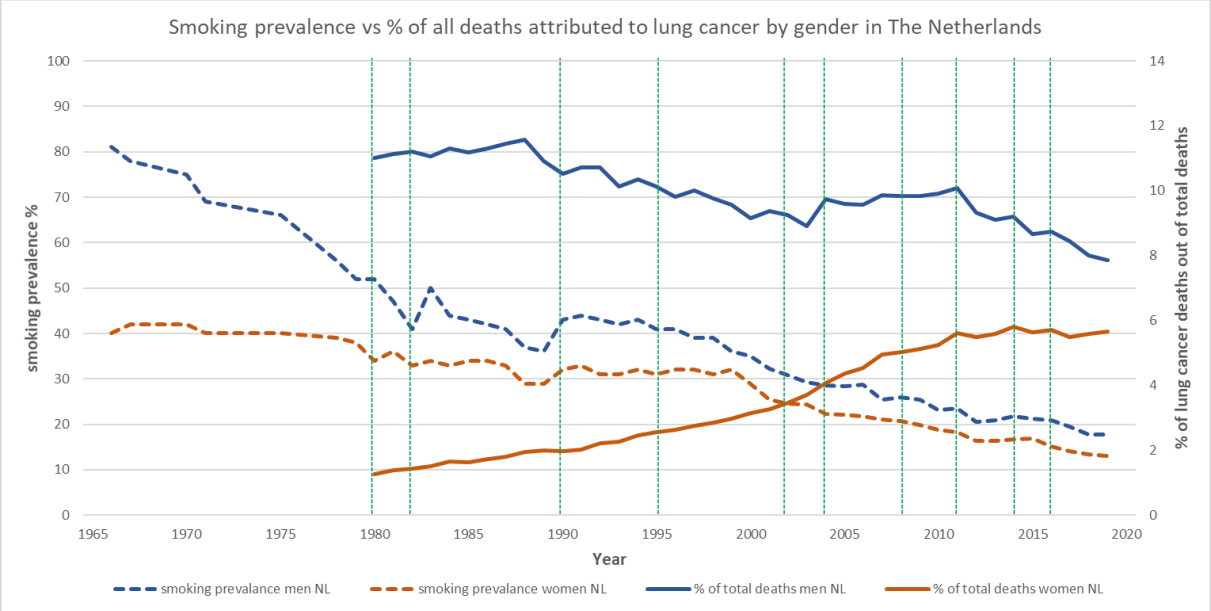

Figure 7: Smoking prevalence vs lung cancer deaths as % of total deaths by gender in The Netherlands

Until 1980, when no laws were implemented, smoking prevalence among men was decreasing whereas it remained more or less stable. In time period 2, smoking prevalence in general was decreasing until 2019 while lung cancer deaths as % of total deaths was increasing for women and remained stable for men. This situation remained unchanged in time period 3, after it changed in time period 4 with a decrease in lung cancer deaths as % of total deaths for men. This then was the situation until time period 6, where lung cancer deaths as % of total deaths increased. In time period 7 and 8, lung cancer deaths as % of total deaths then stabilized, only to decrease for the rest of time. Lung cancer deaths as % of total deaths for women stabilized from time period 9 onwards.

	Male smoking prevalence	Female smoking prevalence	Male lung cancer deaths as % of total deaths	Female lung cancer deaths as % of total deaths
Time period 1	81% -> 52%	40% -> 34%	No data available	No data available
Time period 2	52% -> 41%	34% -> 33%	11.01% -> 11.21%	1.28% -> 1.43%
Time period 3	41% -> 43%	33% -> 32%	11.21% -> 10.52%	1.43% -> 1.98%
Time period 4	43% -> 41%	32% -> 31%	10.52% -> 10.14%	1.98% -> 2.57%
Time period 5	41% -> 30.9%	31% -> 24.5%	10.14% -> 9.26%	2.57% -> 3.45%
Time period 6	30.9% -> 28.6%	24.5% -> 22.3%	9.26% -> 9.75%	3.45% -> 4.07%
Time period 7	28.6% -> 25.9%	22.3% -> 20.8%	9.75% -> 9.84%	4.07% -> 5.03%
Time period 8	25.9% -> 23.5%	20.8% -> 18.3%	9.84% -> 10.09%	5.03% -> 5.62%
Time period 9	23.5% -> 21.7%	18.3% -> 16.7%	10.09% -> 9.21%	5.62% -> 5.79%
Time period 10	21.7% -> 20.9%	16.7% -> 15.2%	9.21% -> 8.73%	5.79% -> 5.71%
Time period 11	20.9% -> 17.7%	15.2% -> 13.1%	8.73% -> 7.85%	5.71 -> 5.67%

Table 6: changes in smoking prevalence and lung cancer deaths as % of total deaths in The Netherlands

4.2 Regression analysis

There is a great variety in the way smoking prevalence changes after implementing nation-wide laws among Australian & Dutch men and women (table 7). Based on the multiple linear regression, men in Australia are not sensitive for the implementation of laws. Regression based on any method did not lead to significant results for any law. The only variable that significantly influenced smoking prevalence was the mean years spent on education. All different types of regression methods lead to different outcomes, with regression coefficients varying from -23.866 to -13.584. This means, depending on the type of method, that smoking prevalence decreases with 13.6% to 23.9% per year men from Australia spend on education.

Based on the multiple linear regression, women in Australia are most sensitive for the implementation of laws. Regression based on method 2, in which the 'shock effect' is taken into account, shows that the law(s) that start time period 2, 3 & 5 significantly influence smoking prevalence. Where the start of time period 2 & 3 have a positive effect of respectively 0.952 & 0.505, the start of time period 5 has a negative effect of -0.786. Regression based on method 3, in which the whole time period is taken into account, also shows a significant effect. Similar to method 2, time period 2 & 5 follow the same pattern of influence, but now time periods 1 & 9 have a significant influence instead of time period 3. Time period 1 has a positive effect of 0.716 while time period 9 has a negative effect of -0.523 on smoking prevalence. As expected, with method 4 it is shown that if no laws are applied smoking prevalence increases, in this case with 0.7% per year.

Based on the multiple linear regression, men in The Netherlands are least sensitive for the implementation of laws. Regression based on method 1, where the year of implementation was taken into account, only shows a significant result of 10.701 for time period 3. Regression based on method 3 also shows a significant positive, but lower effect (2.484) of time period 3. However, regression based on method 2 only shows a significant effect of 3.999 for time period 4. Out of all categories, only years in which laws related to health warnings were implemented showed a significant effect of 3.526 on smoking prevalence.

Based on the multiple linear regression, women in The Netherlands are least sensitive for the implementation of laws. Regression based on any method showed no significant results.

Study population	Method with significant results	Significant time period or category	Model fit (R^2 =…)	Individual level of significance (p=…)	Value of regression coefficient	Standard error of regression coefficient
Australian men	Method 1	Mean years of education	0.237	0.005	-14.038	4.679
	Method 2	Mean years of education	0.295	0.002	-13.584	4.121
	Method 3	Mean years of education	0.319	0.001	-23.866	6.865
	Method 4	Mean years of education	0.246	0.004	-17.588	5.873
Australian women	Method 1	No significant results	x	x	x	x
	Method 2	Time period 2 Time period 3 Time period 5	0.642	0.000 0.035 0.002	0.952 0.505 -0.786	0.231 0.231 0.232
	Method 3	Time period 1 Time period 2 Time period 5 Time period 9	0.827	0.000 0.000 0.008 0.014	0.716 1.458 -0.436 -0.523	0.173 0.173 0.155 0.203
	Method 4	Nothing happens	0.353	0.026	0.659	0.285
Dutch men	Method 1	Time period 3	0.430	0.000	10.701	2.231
	Method 2	Time period 4	0.223	0.013	3.999	1.539
	Method 3	Time period 3	0.221	0.037	2.484	1.150
	Method 4	Health warnings	0.162	0.025	3.526	1.523
Dutch women	Method 1	No significant results	x	x	x	x
	Method 2	No significant results	x	x	x	x
	Method 3	No significant results	x	x	x	x
	Method 4	No significant results	x	x	x	x

Table 7: The influence of implementing laws on smoking prevalence in Australia and The Netherlands

Contrary to implementing laws, the bigger influence is the mean years of education a person attends. Where a linear regression is used on raw data, it becomes clear that an increase of mean years spent on education has a negative effect on smoking prevalence for both countries, no matter the gender. As presented in table 8, spending one more year in the educational system decreased smoking prevalence among women with 5-7%. Among men, the influence is even bigger as smoking prevalence among Australian men decreases with 11.6% per additional year in school and Dutch men saw a decrease of 23.0%.

Dependent variable	Independent variable	Value of regression coefficient	Individual level of significance (p=…)
Smoking prevalence for Australian men	Mean years of education for Australian men	-11.633	0.000
Smoking prevalence for Australian women	Mean years of education for Australian women	-5.135	0.000
Smoking prevalence for Dutch men	Mean years of education for Dutch men	-22.998	0.000
Smoking prevalence for Dutch women	Mean years of education for Dutch women	-7.078	0.000

Table 8: The influence of the mean years of education on smoking prevalence in Australia and The Netherlands

5. Discussion

Australia and The Netherlands have implemented laws from respectively 1973 and 1980 onwards for their tobacco control policy. In line with the smoking epidemic model, Australia and The Netherlands follow the pattern of smoking prevalence and lung cancer deaths as % of total deaths with both of them as good as positioned in stage 4 by the end of 2019.

The influence of the level of education was measured by linear regression. Increasing the years of education a person attends has a negative effect on smoking prevalence. This effect was much bigger for men than for women, even though it should be taken into consideration that smoking prevalence among was twice as big in 1965 and narrowed down to an almost equal level in 2019.

Contrary to the influence of the level of education, the influence of certain laws were not always significantly measurable. This could be due to the quality of the data, the way laws were implemented or other factors that influenced smoking prevalence. What can be said is that women in Australia were most sensitive for the implementation of laws, as smoking prevalence among Australian women significantly decreased by the implementation of laws in the early stages of Australian tobacco control policy. Australian men are more sensitive for an increase in mean years of education, while Dutch men were sensitive for the implementation of laws in the early stages of tobacco control policy and health warnings on tobacco products as a whole. Dutch women were not sensitive at all to the implementation of any law.

5.1 This thesis in a broader perspective

It was strongly found that longer persons are in education, the lower smoking prevalence becomes. This is in line with work by Zhang et al. (2011), who already found that higher education were less likely to smoke and more likely to quit. However, it is not clear what the effect of implementing laws is on smoking prevalence. In Australia, implementing laws was only of significance for women, while in The Netherlands it only had a significant effect on men. And even then, they did not respond to the same type of laws. This could have been expected, as Goel & Zhang (2013) found in Japan that the effect of tobacco control policy is not equal for men and women. For example, a price increase in cigarettes affected men more than women.

Also, similar to Australia, India is divided into states and districts with their own decision power. In India, this led to less effectiveness of implementing laws (Kaur & Jain, 2011). It becomes then clear that a nation-wide reduction of smoking prevalence depends on nation-wide policy.

Furthermore, it is point of discussion to what extent laws in developed countries help decrease smoking prevalence on the long term. As Warner & Mendez (2010) found, tobacco control policy needs further innovations as MPOWER-based laws can only reduce smoking prevalence to a certain level.

5.2 Reflection on the research outcomes

As mentioned before, the influence of education was as expected. This may be explained by the way the data was treated. Where it was treated as a trend, a pattern becomes clear. This is in contrary to the effect of laws, that experienced more changes so that it was harder to find the effect.

And, even though much data comes from leading national statistic institutes, the data is still from different databases, so there may well be a difference in sample size & quality of given answers. To be able to make a distinction between men and women, it was needed to use the different databases, but it would have been better if one database had all data necessary for this thesis.

Also, there is a problem in the way laws are implemented. In The Netherlands, when a law is implemented, it is in place nation-wide. However, Australia is divided into 6 states who have their own power to implement laws. As a result, it has happened that in one state a certain law was implemented before it was implemented nation-wide. As this has happened on multiple occasions, this has a negative influence on the reliability of the data that only takes into account the year in which a certain law was implemented nation-wide. To deal with this problem, it was looked for in which year the law was firstly implemented in a state. That year was then taken a starting point of the law. Also, the time lag between states was not big enough that it spread out over more than 2 time periods. Even so, they

were often implemented in the same time period, so method 1 suffered most from this limitation, but methods 2,3 & 4 remained barely influenced.

Then, it was difficult to measure the effect of a specific law as some laws were implemented in the same year of right after each other. This was more and more the case when time passed. This might also explain why the laws that significantly influenced smoking prevalence were mostly found when the time span was bigger. In addition to this, a law might have been very effective, but only later in time. This would be measurable if no other laws were implemented, but impossible in this case as the study has to include all laws that were implemented.

Finally, it was chosen to only include the effect of education next to the implementation of laws, but there are more factors that influence smoking prevalence. Sociocultural (Bobo & Husten, 2000) and socioeconomic (Higgins & Chilcoat, 2009) are also factors that need consideration. For example, passive peer pressure has a huge impact on adolescent and young adult smoking behaviour (Harakeh & Vollebergh, 2012). Also, men and women in lower socioeconomic groups are influenced more by a change in price than higher socioeconomic groups (Townsend et al., 1994). Including income was considered for inclusion, but data was only available from 1995 onwards and therefore not useful.

6. Conclusion

6.1 Conclusion

This thesis focussed on the tobacco control policy by the Australian and Dutch government. To answer the main research question, it can be concluded that the implementation of laws helped Australia and The Netherlands in their tobacco control policy. Where this research only focusses on Australia and The Netherlands on a macro level, and the results of these two countries cannot be generalized for every country in the world, it is remarkable that smoking prevalence is in steady decrease and lung cancer deaths have found a turning point as well since both countries implemented an active tobacco control policy. Therefore, it is very promising that, like Australia and The Netherlands, an active tobacco control policy can lead to a smaller smoking population and less lung cancer deaths in the long term. However, an increase of mean years spent in education is of a bigger influence and an even more interesting way to bring down smoking prevalence. So, it could be a serious option for countries to invest more in education as extension to MPOWER.

6.2 Further research

For countries who enter stage 4 of the smoking epidemic model, similarly to Australia and The Netherlands, the effect of laws appear to run to their end. Apparently, certain groups are very persistent to smoking and not eager to quit quickly. In line with other research, it would therefore be of interest for governments to look at even stricter laws to ban smoking for good.

Where macro level data was useful to measure the effect of education, the effect of implementing laws was not measured strongly. Therefore, it is recommended that further research focusses more on a micro level. In-depth interviews among smokers and quitters can give a better explanation what made decide to change their smoking behaviour. It can also be useful to know from non-smokers what keeps them from smoking. This information can be used to know what laws are of effect and which are not.

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