Superior
Health Council

THE IMPACT OF CIGARETTE FILTERS ON PUBLIC HEALTH AND THE BELGIAN ENVIRONMENT

APRIL 2023
SHC № 9726

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Federal Public Service Health, Food Chain Safety and Environment

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Please cite this document as follows:
Superior Health Council. The impact of cigarette filters on public health and the Belgian environment. Brussels: SHC; 2023. Report 9726.

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Superior Health Council

ADVISORY REPORT OF THE SUPERIOR HEALTH COUNCIL no. 9726

The impact of cigarette filters on public health and the Belgian environment

In this scientific advisory report, which offers guidance to public health policy-makers, the Superior Health Council of Belgium provides a brief overview of the current research and consensus on the effects of cigarette filters on public health and their presence as waste in the environment. A ban on cigarette filters is advocated.

This version was validated by the Board on 5 April 2023[1]

I INTRODUCTION

On July 18th 2022, The Superior Health Council (SHC) received a request for advice from the Federal Minister of Climate, Environment, Sustainable Development and the Green Deal concerning the use of plastic filters in cigarettes. These filters are present in the vast majority of cigarettes used by Belgian smokers.

According to a recent report ("Tobacco poisoning our planet") of the World Health Organisation (WHO, 2022), ca. 4.5 trillion cigarette filters pollute the environment each year. As most filters are made of cellulose acetate, which is poorly biodegradable, these filters are an important source of microplastics threatening the environment. Besides, toxic compounds such as nicotine, metals and other contaminants present in cigarette smoke are also released into our ecosystems. Moreover, it is mentioned that cigarette filters have no proven health benefits for smokers. The WHO therefore encourages policy makers to treat these filters as single-use plastics, and to consider banning them to protect both public health and the environment.

In response to this position of the WHO, the Federal Minister of Climate, Environment, Sustainable Development and the Green Deal investigates the possibility of banning filters in Belgium by a Royal Decree. This Royal Decree may refer to the law restricting the single-use plastics. The legal basis of this is the Belgian Product Standards Act ("*Wet van 21 december 1998 betreffende de productnormen ter bevordering van duurzame productie- en consumptiepatronen en ter bescherming van het leefmilieu, de Volksgezondheid en de werknemers"*).

To obtain a scientific base for further actions, the following questions were asked to the Superior Health Council:

(1) Is there a benefit of cigarette filters for the health of smokers?
(2) Is there a possibility to ban cigarette filters?
(3) Are there plastic-free alternatives to cellulose acetate filters?

[1] The Council reserves the right to make minor typographical amendments to this document at any time. On the other hand, amendments that alter its content are automatically included in an erratum. In this case, a new version of the advisory report is issued.

In this report, the SHC will give a brief overview of the effects of cigarette filters on the health of smokers as well as the impact they cause on our environment.

The SHC is concerned about all aspects of the smoking epidemic in our society. A previous advisory report (SHC 9549) has already addressed the issue of the electronic cigarette (e-cigarette), which made a rise in recent years. However, the focus on the classic cigarette and prevention should not weaken as the objective remains to achieve a smoke-free society in the shortest possible timeframe.

II CONCLUSION AND RECOMMENDATION

Tobacco smoking is detrimental to health. Cigarette filters provide a **false sense of security** to remedy those unhealthy effects. Experiments suggest that filtered cigarettes are more sensory pleasing, resulting in an increase of the total number of cigarettes smoked. An altered combustion pattern increases the formation of carcinogenic tobacco-specific nitrosamines (TSNAs). The "filtered" smoke, including the TSNAs, is inhaled more deeply by smokers as a compensatory behaviour for the reduced amount of nicotine they inhale. These observations strongly suggest that the large increase in lung adenocarcinomas since the 1970s is (at least to a large extent) caused by **the increased use of filtered cigarettes** since the 1950s. While the incidence of **lung adenocarcinoma increased, squamous cell cancer decreased**. Also in Belgium, adenocarcinoma is now the dominant histological type of lung cancer. Based on studies in the US and Japan, the lag time to develop adenocarcinomas appears to be shorter.

Small pores in the outside of the filters dilute the smoke analysed by smoking machines (ISO tests), measuring much lower tar, nicotine and CO values than the smoker actually inhales. This was recently demonstrated by the Dutch RIVM for a large number of cigarettes that are also on the market in Belgium. This led to the Dutch designation "*sjoemelsigaret*" (= **fraudulent cigarette**).

It can be concluded from a public health perspective that **cigarette filters have no proven benefits in preventing adverse health effects of smoking**. Cigarette filters should be regarded primarily as a **marketing tool** of the tobacco industry, using misleading claims such as promoting "light" or "mild" cigarettes, in response to an increased public awareness of the harmful effects of smoking during the second half of the 20th century.

Cigarette filters also cause large environmental pressure. In Belgium, piecewise counts show that **cigarette butts** (including contaminated filters) are the **dominant type of litter**. Cigarette filters consist of cellulose acetate that **persists in the environment (soils, surface waters, seas, etc.)**. Ultimately, they give rise to the presence of **microplastics** after undergoing different physico-chemical fragmentation events. Limited data presented in the literature confirms the **high toxicity of contaminants** in cigarette butts (including the filter) **to aquatic organisms**. Scarce research on the effects on **terrestrial life** shows that (1) cigarette butts have inhibitory effects on the growth and germination of plants, (2) genotoxic damage in some songbirds increases if more cigarette butts are present in their nests, while (3) snails appear not very sensitive to cigarette butts.

The Superior Health Council sees no solution in advocating "green" **biodegradable filters**. Given that there are no significant health benefits for smokers, people might even be more prone to throw away cigarette filters in the environment because of the **misleading "green" image**. Although implementing biodegradable filters would decrease the microplastic problem, the contaminants adsorbed onto the biodegradable filter will make it less degradable. Aquatic and terrestrial animals will still be exposed to contaminated filters whose contaminants will be released into the soil and surface water even faster. This is also the case with cigarettes without filters, but besides solving the microplastic problem, unfiltered cigarettes are likely to become less attractive to smokers. "Leftovers" from non-filtered cigarettes will also end up in the environment, but it can be assumed that this represents only a fraction of the environmental impact of cigarette butts.

Altogether, both the health and environmental aspects provide sufficient arguments in favour of a **general ban on cigarette filters.** Currently, these should be **treated like Single Use Plastics.** The Superior Health Council notes that its views are shared by the World Health Organisation (WHO) and several recent scientific studies and research papers (e.g. Song et al., 2017; van Schalwyk et al., 2019; Oliveira da Silva et al., 2021; Evans-Reeves et al., 2021; Pulvers et al., 2021). Given the global impact of the filter issue and cross-border sales, the

Superior Health Council advocates implementing this ban at the national level and at the level of the European Union.

It should be noted that, after a filter ban, the ratio of squamous cell carcinomas to adenocarcinomas may change again in favor of squamous cell carcinomas (as it was vice versa with the introduction of the filter cigarette), although this is not certain given an **expected decrease in smoking because of this filter ban**. Smokers will be more reluctant to smoke non-filtered cigarettes because these are perceived as unhealthier and less pleasant. Although the **five-year survival** with the current treatment options is ca. 5 % higher in adenocarcinomas compared to squamous cell carcinomas, the constantly improving detection and treatment methods are evolving rapidly, making it difficult to make an accurate prediction.

The SHC believes that a ban on filter cigarettes is a preferable option, given the huge positive impact on the environment, because filters have no proven benefits in preventing adverse health effects and because of an expected reduction in the number of smokers. Furthermore, the SHC remains committed to thorough smoking prevention and cessation measures as a basis to protect public health.

III METHODOLOGY

After analysing the request, the Board of the Superior Health Council and the presidents of the Chemical Environmental Factors group identified the necessary fields of expertise. An *ad hoc* working group was set up which included experts in toxicology, oncology, cancer prevention, environmental health & risk assessment and chemistry. The experts of this working group provided a general and an *ad hoc* declaration of interests and the Committee on Deontology assessed the potential risk of conflicts of interest.

This advisory report is based on a review of the scientific literature published in both scientific journals and reports from national and international organisations competent in this field (peer-reviewed), as well as on the opinion of the experts.

The advisory report was endorsed by the working group and handed over and validated by the Board of the Superior Health Council.

<u>Keywords and MeSH *descriptor terms*</u>[2]

MeSH terms*	**Keywords**	***Sleutelwoorden***	***Mots clés***	***Schlüsselwörter***
Adenocarcinoma	Adenocarcinoma	*Adenocarcinoom*	*Adénocarcinome*	*Adenokarzinom*
Tobacco	Tobacco	*Tabak*	*Tabac*	*Tabak*
Behavior, addictive	Addiction	*Verslaving*	*Assuétude*	*Sucht*
Smoke	To smoke	*Roken*	*Fumer*	*Rauchen*
Nicotine	Nicotine	*Nicotine*	*Nicotine*	*Nikotin*
Cigarettes	Cigarette	*Sigaret*	*Cigarette*	*Zigarette*
/	Cigarette filter	*Sigarettenfilter*	*Filtre à cigarette*	*Zigarettenfilter*
/	Cellulose acetate	*Celluloseacetaat*	*Acétate de cellullose*	*Zelluloseacetat*

MeSH (Medical Subject Headings) is the NLM (National Library of Medicine) controlled vocabulary thesaurus used for indexing articles for PubMed http://www.ncbi.nlm.nih.gov/mesh.

<u>List of abbreviations used</u>

B[*a*]P	Benzo[*a*]pyrene
CO	Carbon monoxide
COex	Carbon monoxide in exhaled breath
COHb	Carboxyhemoglobin
DALY	Disability-adjusted life year
ETS	Environmental tobacco smoke
HCN	Hydrogen cyanide
IARC	International Agency for Research on Cancer
IHME	Institute for Health Metrics and Evaluation
ISO	International Organization for Standardization
MSS	Mainstream Smoke
NNAL	4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol
NNK	Nicotine-derived nitrosamine ketone
NNN	*N'*-nitrosonornicotine

[2] The Council wishes to clarify that the MeSH terms and keywords are used for referencing purposes as well as to provide an easy definition of the scope of the advisory report. For more information, see the section entitled "methodology".

OVAM	*Openbare Vlaamse Afvalstoffenmaatschappij*
PAH	Polycyclic Aromatic Hydrocarbon
RIVM	*Rijksinstituut voor Volksgezondheid en Milieu*
SCN	Thiocyanate
SHC	Superior Health Council
SSS	Side-stream smoke
TSNA	Tobacco-specific nitrosamines
VMM	*Vlaamse Milieumaatschappij*
WHO	World Health Organisation

IV ELABORATION AND ARGUMENTATION

1 General problem: smoking

Cigarette smoke is a complex and dynamic mixture of gases, (semi-)volatiles and liquid droplets with particles (0.1-1 µm diameter) that can penetrate deeply into the lungs (Thielen et al., 2008). There is wide consensus that cigarette smoke is hazardous to health for smokers themselves but also for people in their environment that are exposed to the cigarette smoke. Smoking is related to a diversity of cancers, but also to cardiovascular diseases, respiratory diseases, it worsens symptoms of asthma and respiratory infections, it may cause impotence in men and smoking during pregnancy is related to adverse birth outcomes and beyond (Centers for Disease Control and Prevention, 2022; National Institute on Drug Abuse, 2022; American Cancer Society, 2022).

Cigarette smoke contains more than 9,500 chemicals (Li & Hecht, 2022a) and has been found to be toxic, mutagenic and carcinogenic. The addictive properties of tobacco smoke are mainly attributed to nicotine, the principal tobacco alkaloid in smoke (Hukkanen et al., 2005). Up to date, a total of 83 different carcinogens (37 in unburned tobacco and 80 in tobacco smoke, with some overlaps) have been identified by IARC as having sufficient evidence for carcinogenicity in either laboratory animals or humans (Li & Hecht, 2022a). Eighteen compounds are classified as carcinogenic to humans (IARC group 1) (Table 1; Li & Hecht, 2022a). Polycyclic aromatic hydrocarbons (PAHs), Tobacco-Specific Nitrosamines (TSNAs), aromatic amines, aldehydes and certain volatile organics likely contribute significantly to the carcinogenic activity of tobacco smoke (Hecht, 2003).

Table 1. *Eighteen tobacco and tobacco smoke compounds classified as carcinogenic to humans (IARC Group 1) (Li & Hecht, 2022a).*

Class	Compound	IARC Volume, year
Volatile Organic Compounds	*1,3-butadiene*	100F, 2012
Volatile Organic Compounds	*benzene*	120, 2018
Polycyclic Org. Compounds	*benzo[a]pyrene B[a]P*	100F, 2012
Aromatic amines	*ortho-toluidine*	100F, 2012
Aromatic amines	*4-aminobiphenyl*	100F, 2012
Aromatic amines	*2-naphthylamine*	100F, 2012
TSNAs, *N*-Nitrosamines	*4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK)*	100E, 2012
TSNAs, Cyclic *N*-Nitrosamines	*N'-nitrosonornicotine (NNN)*	100E, 2012
Ethers	*ethylene oxide*	100F, 2012
Aldehydes	*formaldehyde*	100F, 2012
Halogenated compounds	*vinyl chloride*	100F, 2012
Halogenated compounds	*2,3,4,7,8-pentachlorodibenzofuran*	100F, 2012
Inorganic compounds	Arsenic	100C, 2012
Inorganic compounds	*Beryllium*	100C, 2012
Inorganic compounds	*Cadmium*	100C, 2012
Inorganic compounds	*Chromium (VI)*	100C, 2012
Inorganic compounds	*Nickel*	100C, 2012
Inorganic compounds	*Polonium-210*	100C, 2012

Despite common knowledge that tobacco use is harmful to health, Belgium still has 19.4 % smokers (*Gezondheidsenquête, 2018*). This 19.4 % can be divided into 15.4 % daily smokers and 4.0 % occasional smokers (*Gezondheidsenquête, 2018*). The smoking epidemic has a component of social inequality: the results of the Gezondheidsenquête showed that lower-educated people score worse than higher-educated people in all indicators. Moreover, men are more likely to smoke than women. An impression of smoking preferences is given by the "*Rookenquête*" (2021) which has been conducted by Ipsos among Belgian smokers. (Filtered) Cigarettes (65 %), subject of this report, were the most popular tobacco product, followed by hand-rolling tobacco (33 %). E-cigarettes, as an alternative to tobacco smoking, follow on the third place (13 %). Some smokers use multiple smoking products.The impact of the smoking epidemic on Belgian public health remains alarming. Smoking was an essential causal factor in ca. 13.6 % (14,834) Belgian deaths (Van Doorslaer, 2019). Tobacco use is also the most important behavioral risk contributing to Belgian DALYs (disability-adjusted life years) in 2019 (IHME, 2022). The IARC states that the proportion of lung cancer cases caused by cigarette smoking has reached 90 % in populations with prolonged cigarette use (IARC, 2004). About 90 % of lung cancers may therefore be entirely avoidable by avoiding smoking and reducing air pollution (Boyle & Maisonneuve, 1995; Cislaghi & Nimis, 1997).

This report discusses the specific effects of cigarette filters on smokers' health and the environment. With or without filter, the Superior Health Council sides strongly against smoking, given its destructive effects on society, public health care, health inequalities and the environment. From a scientific point of view, there can be no doubt: the only acceptable future is smoke-free. The first country to plan a smoke-free future stated by law is New Zealand. **In 2022, New Zealand passed the world's first tobacco law banning the sale of tobacco products to anyone born on or after 1 January 2009**. **It is recommended that Belgium follows up the impact of this decision in New Zealand with great interest.** In addition, smoking cessation should be further encouraged and facilitated among existing smokers of all ages. Among many other advantages, studies on the benefits of smoking cessation show that **early cessation can substantially lower lung cancer risks** (Figure 1; Peto et al., 2000; IARC, 2004).

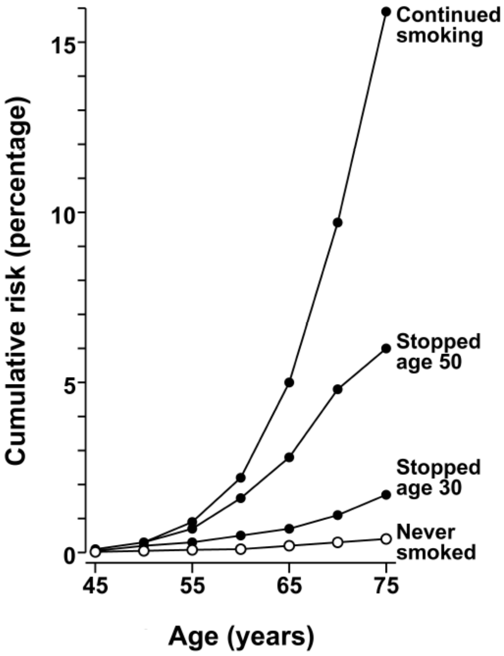


Figure 1. *Cumulative lung cancer risk (after Peto et al., 2000) by smoking status and age at quitting in men in the UK. (Source: IARC, 2004: Volume 83, fig. 2.1.1.6)*

2 Filter properties: composition, quality standards and tests

2.1 Composition of modern cigarettes

Modern-day cigarettes are **designed to increase the attractiveness to consumers** by reducing negative experiences and creating perceptions of higher taste and decreased risks, leading to more intense smoking behaviour (Talhout et al., 2019). Cigarette parts are made by a tobacco rod (with or without additives) and a filtration zone (Figure 2):

- The tobacco rod consists of a tobacco blend wrapped by permeable (wrapping) paper. Air is sucked in by the tip and through the paper, supplying oxygen to the tobacco combustion. The burned tobacco and paper become ashes. Brand logo ink is often present on the wrapping paper. In the past, additives were added to unburned tobacco to improve sensory attractiveness. Poppendieck et al. (2016) (USA) mention *glycerol, propylene glycol, menthol, vanillin, diammonium hydrogen phosphate, n-propyl-p-hydroxybenzoate* and complex additive mixtures such as *cocoa, licorice and mint oil*. These additives have been restricted in the European Union since 2020: Directive 2014/40/EU forbids that cigarettes and roll-your-own tobacco products have a characterising flavour that masks the taste and smell of the tobacco.
- The filtration zone is shorter and consists of a cellulose acetate filter and the tipping paper (traditionally in orange, cork colours). The filter contains small holes to enhance ventilation.

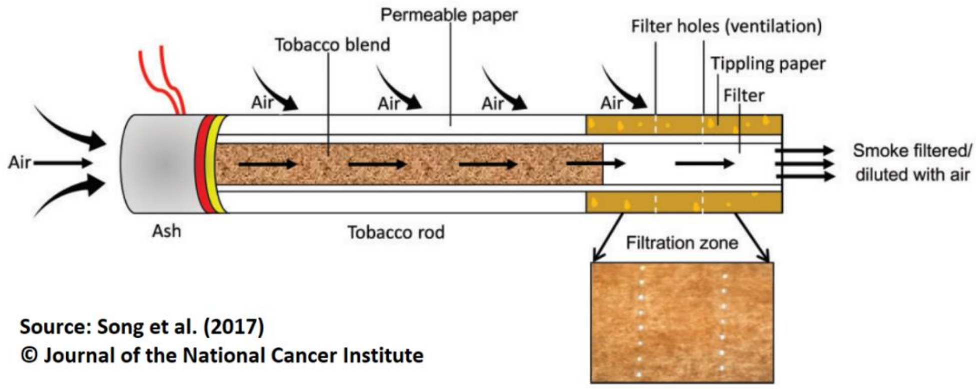


Figure 2. *Composition of the modern-day filtered cigarette. (Source: Song et al., 2017: fig. 2)*

2.2 Cigarette filters

Filters were originally introduced in 1860 to prevent pieces of tobacco from entering the mouth (Oliveira da Silva, 2021). However, the filtered cigarette only became more popular since the 1950s due to the claim of reduced tar yields. In that decade, more and more scientific evidence became available showing the link between lung cancers and tobacco use (Doll & Hill, 1956). Different types of filters have existed, made of cork, crepe paper and even asbestos. **The current filter is a white plug consisting of a bundle of 12 000 white fibres of cellulose acetate.** The fine-spun fibres retain particles in the smoke to reduce the delivery of tar and nicotine. These fibres also contain titanium dioxide (TiO_2). A plasticizer triacetin (glycerol triacetate) is generally applied to enhance the fibre processing (Pauly et al., 2002). According to Taschner (2000), target values for triacetin typically vary between 6-9 % of the total filter weight. Charcoal is sometimes included as its adsorption properties can reduce some of the gaseous components in smoke (Thielen et al., 2008). Cigarettes with filters were marketed as less harmful. They yield less tar and less nicotine (mg/cigarette) (Figure 3). Also, the carbon monoxide (CO) and hydrogen cyanide (CN) content seems lower, when cigarettes with and without filters are compared.

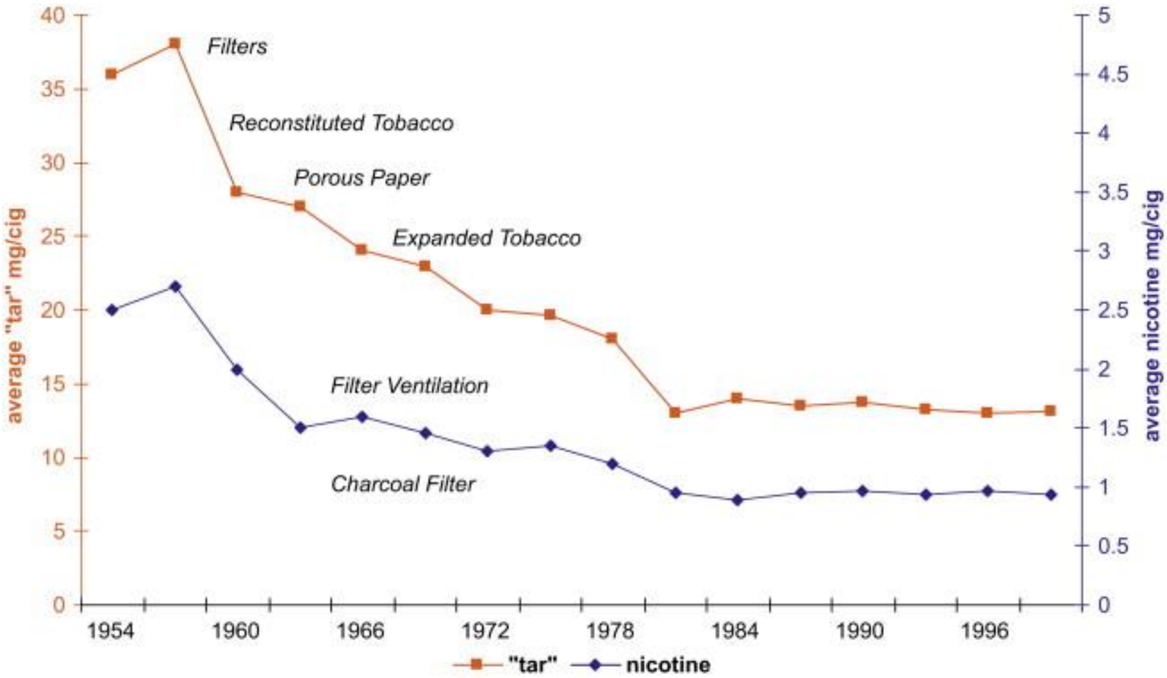


Figure 3. *The changing cigarette. US sales weighted average tar and nicotine yields and selected product innovations (Davis & Nielsen, 1999)*
(Source: Thielen et al., 2008, fig. 4)

During the early 1970s, **microscopic filter holes** were introduced in the filters through which additional air is inhaled when taken a puff (Evans-Reeves et al., 2021; Oliveira da Silva, 2021). These **ventilated cigarettes** were often labelled as "light" or "mild" cigarettes. Filter ventilation has some influence on the burning temperature during puffing and hence may influence the compounds that are formed. As the filter elevates the resistance in the cigarette, reducing the oxygen level to induce a high-temperature combustion, the tobacco is incompletely combusted. Besides, due to the perforations in the filter, the volume and velocity of the air moving through the shaft are decreased, leading to an increased amount of environmental tobacco smoke (ETS) and decreased combustion (Schulz et al., 2016). In general, **ventilation leads to changes in the combustion process and changes in the production of toxicants**. Song et al. (2017) mention the following reasons:

- *"As filter ventilation increases, the cigarette is burned down less rapidly on the smoking machine. There are more puffs per cigarette."*
- *"As the tobacco rod burns down less rapidly, there is more time for the coal to smolder and form more toxic constituents."*
- *"With increased ventilation in the range of most commercial cigarettes, there is decreased air flow through the burning coal tip and lower coal temperatures, resulting in more incomplete combustion and more toxic constituents."*
- *"More filter ventilation increases cigarette smoke mutagenicity as measured by the Salmonella Reverse Mutation Assay (Ames test)[3], which is a highly replicated and extensively used assay for the screening of mutagenic potential."*
- *"Increased filter ventilation increases particle size in the smoke due to increased water content, condensation, and coagulation as the smoke passes through the tobacco rod. This is due to the slower burn down of the cigarette and increased residence time of the smoke, allowing for the particles to absorb more water and constituent gases."*

[3] The Ames test (*Salmonella typhimurium* reverse mutation assay) is a biological assay to assess the mutagenic potential of chemical compounds, detecting mutations in a gene of a histidine-requiring strain that produce a histidine independent strain. A high, but not complete, correlation has been found between carcinogenicity in animals and mutagenicity in the Ames test (Föllmann et al., 2013).

In addition, tobacco blends with air-cured (burley) tobacco contain a higher nitrate content leading to an increased generation of nitrogen oxides, enhancing the formation of carcinogenic *N*-nitrosamines in the smoke, especially TSNAs (Hoffmann & Hoffmann, 1997).

Environmental Tobacco Smoke (ETS) consists of mainstream smoke (MSS; 15 %), exhaled by the smoker, and side-stream smoke (SSS; 85 %), emitted from the smoldering cigarette between puffs (Besaratinia & Pfeifer, 2008). Particulate matter is an integral part of ETS (Gerber et al., 2015). $PM_{2.5}$ is defined as a mixture of particles and droplets of 2.5 µm in diameter or smaller, suspended in the air (Lipmann, 2014). This particulate matter penetrates the smaller bronchi, bronchioles, and even the alveoli and therefore can exacerbate asthma (Balmes et al., 2014). Particulate matter (PM) has been shown to be an independent risk factor for **pulmonary and cardiovascular diseases** (Hsu et al., 2014). Schulz et al. (2016) compared the concentration of particulate matter in the ETS produced by reference cigarettes 3R4F, filtered tipped Roth-Händle cigarettes and non-filtered tipped Roth-Händle cigarettes. The filtered-tipped cigarettes produced significantly more $PM_{2.5}$ than the non-filtered cigarettes of the same brand, therefore suggesting that **filtered cigarettes may increase the risks associated with passive smoking**. Other studies comparing SSS from filtered and non-filtered cigarettes give conflicting results (Braun et al., 2019). The use of charcoal filters was suggested as an alternative in terms of SSS (Laugesen et al., 2005).

Before cigarettes are marketed, they need to fulfil minimal quality parameters. These parameters are mechanically based. In **smoking machine tests**, ventilated filters lead to **less tar and nicotine, but more mutagenic activity and more TSNAs per mg smoke condensate**. This has been shown by several studies performed by amongst others the tobacco industry itself (Song et al., 2017). Also, Harris (2004) found that many toxic compounds exhibited significantly greater yields per mg nicotine in the so-called “lower-tar” than “higher-tar” brands. Therefore, from the toxicological standpoint, incomplete compensation for nicotine does not necessarily translate into harm reduction.

Filter ventilation leads to dilution of smoke and less tar, reduced nicotine and CO yields if tested on smoking machines according to the International Organization for Standardization (ISO). Also small particles generated in the mainstream smoke are retained by the filters (McCusker et al., 1983; Cavallo et al., 2013). However, these ISO tests do not reflect the parameters applicable to contemporary smokers, and especially not those applicable to the smoking of so-called “low-yield” filtered cigarettes (a misleading term). Recently, the Dutch “*Rijksinstituut voor Volksgezondheid en Milieu*” (RIVM, 2020) studied the differences between the ISO standard method and the alternative WHO Intense Method (= Canadian Intense Method) measuring tar, nicotine and carbon monoxide during cigarette smoking (Table 2). **The WHO intense method simulates more intensive smoking behavior**: the test protocol uses a sampling machine that “inhales” deeper and more frequently, while the pores in the filter are kept closed. The latter is a **better representation of the reality**: smokers shut the filter pores when holding the cigarettes with their fingers or lips. For more than 100 different types and brands of cigarettes, the WHO Intense / ISO ratios were measured and calculated by the RIVM. On average, **the WHO Intense method measured 3 times higher values than the ISO method**. Results largely vary between different cigarettes and brands. The largest difference between both methods was found for the so called “light” cigarettes with strong filter ventilation. For example, the WHO Intense Method measurements were 26, 17 and 20 times higher for tar, nicotine and CO respectively in Marlboro Prime cigarettes. So, in reality, the **difference between "light" and "heavy" cigarettes is inexistent**, which perfectly **justifies the prohibition of terms like "light" and "mild”**. Similar findings were also reported by Pauwels et al. (2020). These authors even measured higher puffing intensities among human smokers compared to both the ISO method and the Canadian Intense method, due to variations in smoking behavior. **The large measured differences due to filter ventilation led to the term "*sjoemelsigaret*" (= fraudulent cigarette) in the Netherlands.**

Table 2. *Characteristics of the ISO method, the WHO Intense Method (= CI, Canadian Intense Method) and an indication of the smoking behavior of an average smoker (WHO, 2012; adapted from RIVM, 2020).*

Smoking regimen	Puff duration	Puff Volume	Puff frequency	Filter ventilation holes
ISO regimen (ISO 3308)	2 s	35 ml	1x / 60s	No modifications
Intense method (WHO, CI)	2 s	55 ml	1x / 30s	100% blocking of ventilation holes
Average smoker (*according* RIVM)	1.4 s	53 ml	1x / 33 s	50 % by fingers and lips

3 Impact of cigarette filters on public health

3.1 Human biomonitoring

An assessment of the health benefits (if any) of filtered cigarettes can only be done through epidemiological studies of 10–20 years duration following the introduction of the modified cigarettes. Interpretation of these studies is often hampered by simultaneous changes of other environmental and lifestyle risk factors such as air pollution and diet. Biomonitoring of smokers offers the opportunity of showing potential harm reduction in a much shorter time period and is proposed to be an element in evaluating new tobacco products. Biomarkers measure the smoking dose (the amount of smoke uptake per day or per cigarette). Biomonitoring data allows a precise understanding of an individual's uptake of specific smoke components.

When the number of cigarettes smoked is taken into account, **smoking-machine derived carbon monoxide (CO) and hydrogen cyanide (HCN) yields per cigarette do not predict the CO and SCN biomarker levels in humans** (Wald et al., 1977; Scherer, 2006). In general, the levels of ‘classical’ biomarkers of exposure to tobacco - carboxyhemoglobin (COHb) and its equivalent carbon monoxide in exhaled breath (COex) and urinary thiocyanate (SCN), a detoxification product of cyanide - were not related to the mechanically measured CO and CN yield.

There are other specific biomarkers for the exposure to tobacco smoke such as **cotinine (the main metabolite of nicotine)** in body fluids. However, for the same nicotine yield per cigarette measured by smoking machines according to ISO standards, the nicotine uptake shows a large variability in cotinine concentration between individuals (Jarvis et al., 2001: fig. 1). It was concluded that smokers can achieve whatever delivery of nicotine they desire, irrespective of nominal machine-smoked delivery, through taking larger and more frequent puffs and manoeuvres such as blocking ventilation holes. **Therefore, the current approach of characterizing tar and nicotine yields of cigarettes (e.g. ISO method) provides a simplistic guide to smokers’ exposure, misleading consumers and policy makers** (Jarvis et al., 2001).

The tobacco-specific nitrosamines NNK and NNN are converted in humans to urinary metabolites (such as NNN/NNAL-glucuronide). These compounds can be quantified by mass spectrometry as **biomarkers of exposure to these carcinogens**. They are also metabolized to diazonium ions and related electrophiles that react with DNA to form addition products (covalently bonded) that can be detected and quantified by mass spectrometry (Li & Hecht, 2022b). **These urinary metabolites and DNA addition** products can serve as **biomarkers of exposure and metabolic activation**, respectively. **Urinary and serum NNAL have been related to lung cancer risk, and urinary NNN has been related to oesophageal cancer risk** in prospective epidemiology studies (Yuan et al., 2011; Stepanov et al., 2014) leading us to the next point.

3.2 Carcinogenicity

Epidemiological studies have demonstrated that tobacco smoking increases the risks of many types of cancer in humans, including cancers of the lung, larynx, oesophagus, oral cavity and pharynx, bladder, liver, uterine cervix, kidney, stomach, colorectum, pancreas, and myeloid leukaemia (Islami et al., 2018). Multiple types of lung cancers occur (Fig. 4).

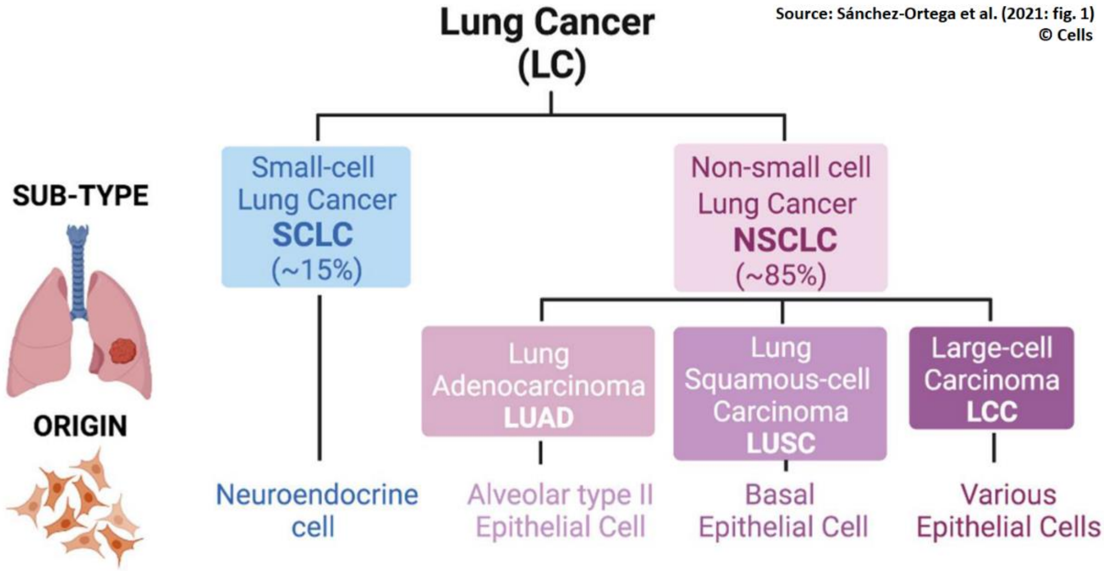


Figure 4. *Histological classification of lung cancer.*
(Source : Sánchez-Ortega et al., 2021: fig. 1)

When the incidence of lung cancer began to rapidly increase in the 1950s through the 1970s, **lung squamous cell carcinoma** was the most common subtype for men, but these decreased over the next 40 years with the decreasing smoking prevalence (Song et al., 2017). In the United States, the incidence of **lung adenocarcinomas in men exceeded squamous cell cancers from about 1990** and currently comprises about 60 % of non-small cell lung cancers (Figure 5). In 2014, the Surgeon General's Report on the Health Consequences of Smoking concluded: **"*The evidence is sufficient to conclude that the increased risk of adenocarcinoma of the lung in smokers results from changes in the design and composition of cigarettes since the 1950s*"**. This was suggested amongst others by a birth cohort effect in men when successive generations of smokers transitioned from the use of unfiltered cigarettes to filtered cigarettes. A less obvious effect is seen for women, as they generally started smoking later in the century and thus tended to smoke mostly filtered cigarettes (US Department of Health and Human Services, 2014; Song et al., 2017). **Placing filters on cigarettes, followed by using less tobacco in cigarettes of the same length, using reconstituted and expanded tobaccos, increasing cigarette paper porosity and placing ventilation holes in the filter to dilute the smoke were accompanied by an increased incidence of adenocarcinoma** (Song et al., 2017). The Surgeon General's Report added that "*The evidence is not sufficient to specify which design changes are responsible for the increased risk of adenocarcinoma, but there is* ***suggestive evidence that ventilated filters and increased levels of tobacco-specific nitrosamines have played a role***". This report was followed by a detailed review by Song et al. (2017). The analysis of these authors strongly suggested that filter ventilation contributed to the rise of lung adenocarcinomas. Song et al. (2017) concluded that **"*a single action for banning filter ventilation by the FDA (US Food and Drug Administration) is scientifically justified and within its mandate to improve public health*"**.

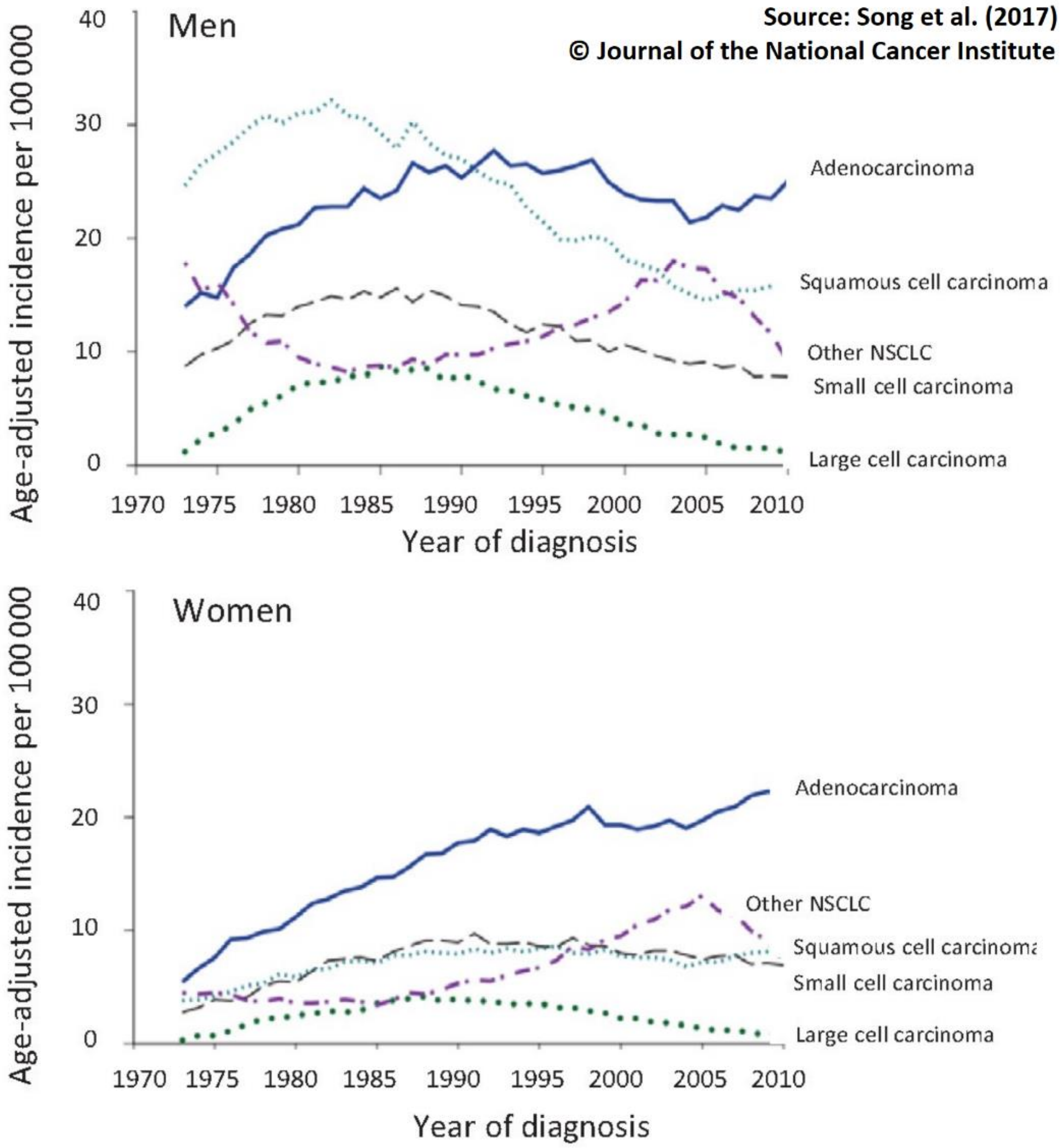
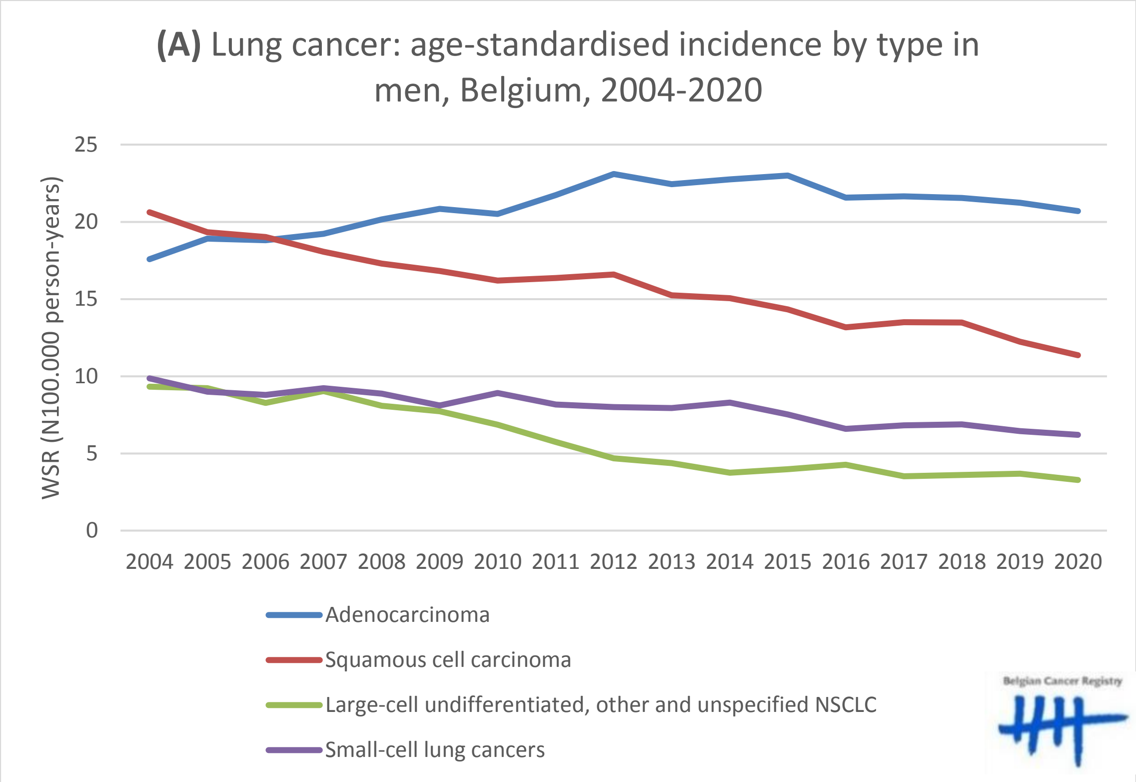


Figure 5. *Trends in age-standardized incidence rates in the US from 1973 to 2010 for lung cancer for men (A) and women (B), adapted from the 2014 Surgeon General's Report by Song et al. (2017). (Source: Song et al., 2017: fig. 1)*

Updated figures for Belgium (2004-2020) were provided for this report by the Belgian Cancer Registry (Figure 6). **For both sexes in Belgium, the observed trends in age-standardised incidence for the different lung cancer types are similar to the trends in the United States** reported by Song et al. (2017) (Figure 5). While in the US the number of lung adenocarcinomas in men exceeded the number of squamous cell carcinomas in the 1990s, we see this happening **in Belgium around 2005**. For Belgian women, between 2004 and 2020, the difference in the number of adenocarcinomas and squamous cell carcinomas was even more pronounced (Figure 6), presumably because of the same reasons as in the United States.



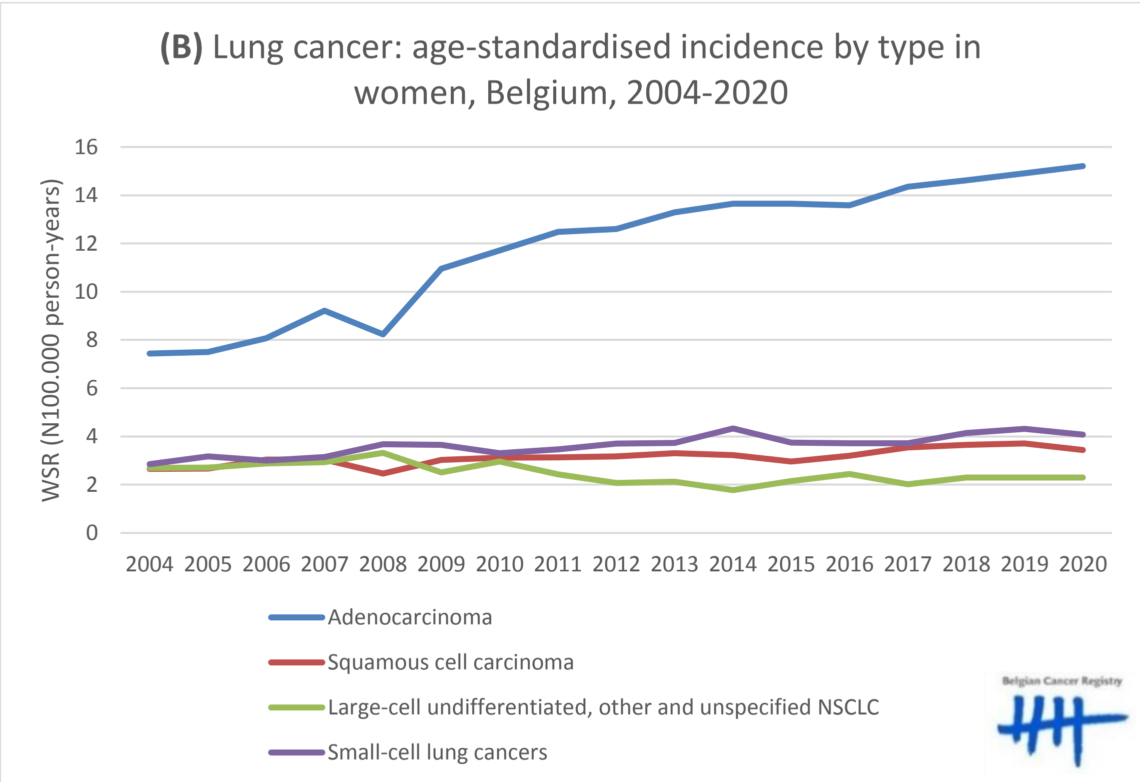


Figure 6. *Trends in age-standardized incidence rates (using the World Standard Population) in Belgium from 2004 to 2020 for lung cancer for men (A) and women (B). Updated data provided by Belgian Cancer Registry (Brussels, 2023).*

Similar findings to these of Song et al. (2017) were reported before by Ito et al. (2011). A multiple regression framework was used to examine the relationship between tobacco use and incidence of lung cancer by histological type. Both tobacco consumption data and population-based incidence data for the US (1973-2005) and Japan (1975-2003) were used. This study revealed that **filter cigarette consumption was positively associated with the incidence of adenocarcinomas**, with **time lags of 25 and 15 years** in Japan and the United States, respectively (Table 3). In contrast, **nonfilter cigarette consumption was positively associated with the incidence of squamous cell carcinomas, with time lags of 30 and 20 years** in Japan and the United States, respectively. In conclusion, the shift from nonfilter to filter cigarettes appears to have merely altered the most frequent type of lung cancer, from squamous cell carcinoma to adenocarcinoma. **Adenocarcinomas occurred earlier than squamous cell carcinomas (shorter lag time)** and their association with filter cigarette consumption appears stronger than between squamous cell carcinomas and nonfilter cigarette consumption (Ito et al., 2011). The general findings of these authors can be confirmed with Belgian incidence data (Table 4). **In 2020, the share (%) of adenocarcinoma cases of Belgian patients < 50 years was almost double that of squamous cell carcinoma cases in this age category.**

Table 3. *The relationship between cigarette consumption and lung cancer incidence by histologic type in Japan and the United States, calculated by Ito et al. (2011: table 3).*

Type of cigarette	SQ			AD		
	Lag time τ*	$\hat{\beta}_2^{SQ}$ ($\times 10^{-3}$)†	95% CI ($\times 10^{-3}$)	Lag time τ*	$\hat{\beta}_2^{AD}$ ($\times 10^{-3}$)†	95% CI ($\times 10^{-3}$)
Japan						
Nonfilter	30	0.464‡	(0.164, 0.764)	24	−1.099‡	(−1.767 to −0.431)
Filter	30	−0.340‡	(−0.518, −0.162)	25	1.946‡	(1.297–2.594)
United States						
Nonfilter	20	0.455‡	(0.319, 0.591)	17	0.353	(−0.020 to 0.757)
Filter	25	−0.268‡	(−0.383–0.152)	15	3.183‡	(1.955–4.411)

*τ is defined as the lag between lung cancer incidence and cigarette consumption; CI, confidence interval. †β_2 is the coefficient for cigarette consumption in the model of $Y(t^+) = \beta_0 + \beta_1 Y(t) + \beta_2 X(t^+ - \tau) + \varepsilon$ ‡Statistically significantly different from zero (two-sided $p < 0.05$, calculated using a *t*-test).

Table 4. *The share of Belgian patients < 50 years by sex for both adenocarcinoma and squamous cell carcinoma in 2020. Data provided by Belgian Cancer Registry (Brussels, 2023).*

	Histology (lung cancer)	Cases < 50 years	Total cases	Share (%) <50 years
Men				
	Adenocarcinoma	**207**	**2387**	**8.7**
	Squamous cell carcinoma	**69**	**1405**	**4.9**
Women				
	Adenocarcinoma	**197**	**1766**	**11.1**
	Squamous cell carcinoma	**28**	**434**	**6.5**

In populations still smoking tobacco products without filters (e.g. *bidi* cigarettes in India), **squamous cell lung cancer** (and not lung adenocarcinoma) still seems to be the most frequent histological type of lung cancer. For example, a study in northern India showed that squamous cell lung cancer was the most common histology overall and among smokers (Singh et al., 2010)

Lung adenocarcinomas mainly arise in the more **distal branches of the lung**, from Type II pneumocytes primarily located in the alveolar space and probably also from Clara cells that are non-ciliated and located in the terminal bronchioles (Belinsky et al., 1992; Song et al., 2017). The introduction of filter cigarettes in the 1950s resulted in **deeper inhalation of smoke,** and thus **higher doses to the distal airways from which adenocarcinomas most commonly arise** (IARC, 2004). Also, Stellman et al. (1997) linked the **lack of protection against adenocarcinomas from filter cigarettes to (1) smokers' "compensating" with deeper and more frequent inhalation and (2) the higher concentrations of nitrosamines**. TSNAs play an important role in the induction of lung adenocarcinomas. Suggestive experimental animal studies indicate that the tobacco-specific nitrosamine NNK induces peripheral lung adenocarcinomas while PAHs are more likely to induce central squamous cell tumors, although not exclusively (Hoffmann et al., 1996; Song et al., 2017).

Kawase et al. (2011) analysed pulmonary squamous cell carcinoma and adenocarcinoma patient survival in the National Cancer Center Hospital East (Japan). In squamous cell carcinoma patients, there were more elderly male smokers and more patients with T2–4 tumors, moderately/poorly differentiated tumors, lymph node metastasis or vascular invasion than in adenocarcinoma patients. In all patients and in pN0 patients (no regional lymph node metastases), **patients with squamous cell carcinoma showed significantly poorer overall survival** than those with adenocarcinoma, but there were no statistically significant differences in the recurrence-free proportion between the two histologic types. There were statistically **significantly more lung cancer-specific deaths in patients with adenocarcinoma** than in patients with squamous cell carcinoma (P= 0.001). There were no differences in the development of recurrence between squamous cell carcinoma and adenocarcinoma of the lung, but considerable differences in overall survival were observed between the two histologic types. According to the stage grouping strategy of the TNM Classification for Lung and Pleural Tumors, these two histologic types need to be staged differently. **This survival difference, however, may reflect the difference in patient background rather than in biologic aggressiveness between the two histologic types** (Kawase et al., 2011).

A recent study in Turkey investigated the effects of clinical and pathological indicators at the time of the diagnosis on overall survival in patients diagnosed with non-small cell lung cancer (see Figure 4) (Önal et al., 2020). The **average life expectancy** was found to be **11.50 ± 1.40 months** in patients with **squamous cell carcinoma**, **12.60 ± 1.59 months** in patients with **adenocarcinoma**, and 8.70 ± 1.87 months in the other patients. The estimated 5-year relative survival rate for non-small cell lung cancer was 8 % (7 % for men and 18 % for women). In Belgium, the 5-year relative survival for both adenocarcinoma and squamous cell carcinoma is higher than in Turkey (Table 5), **with an average difference of 5 % between both histological cancer types in favour of adenocarcinoma survival rates.**

Table 5. *5-year relative survival of lung adenocarcinoma and squamous cell carcinoma. Data provided by Belgian Cancer Registry (Brussels, 2023).*

	Diagnoses in 2015-2020		
Male & female	N at risk	5y RS	95% CI
Adenocarcinoma (lung)	**23708**	**30.2%**	**[29.4%:30.9%]**
Squamous cell carcinoma (lung)	**11764**	**25.1%**	**[24.0%:26.1%]**
Male	N at risk	5y RS	95% CI
Adenocarcinoma (lung)	**14135**	**26.9%**	**[26.0%:27.9%]**
Squamous cell carcinoma (lung)	**9247**	**23.9%**	**[22.8%:25.1%]**
Female	N at risk	5y RS	95% CI
Adenocarcinoma (lung)	**9573**	**35.0%**	**[33.7%:36.2%]**
Squamous cell carcinoma (lung)	**2517**	**29.3%**	**[27.1%:31.5%]**

In Belgium, between 2004 and 2017, proportionally **more stage IV lung adenocarcinomas** were registered than lung squamous cell carcinomas (Figure 7). This was the case in both men and women (Belgian Cancer Registry, 2020).

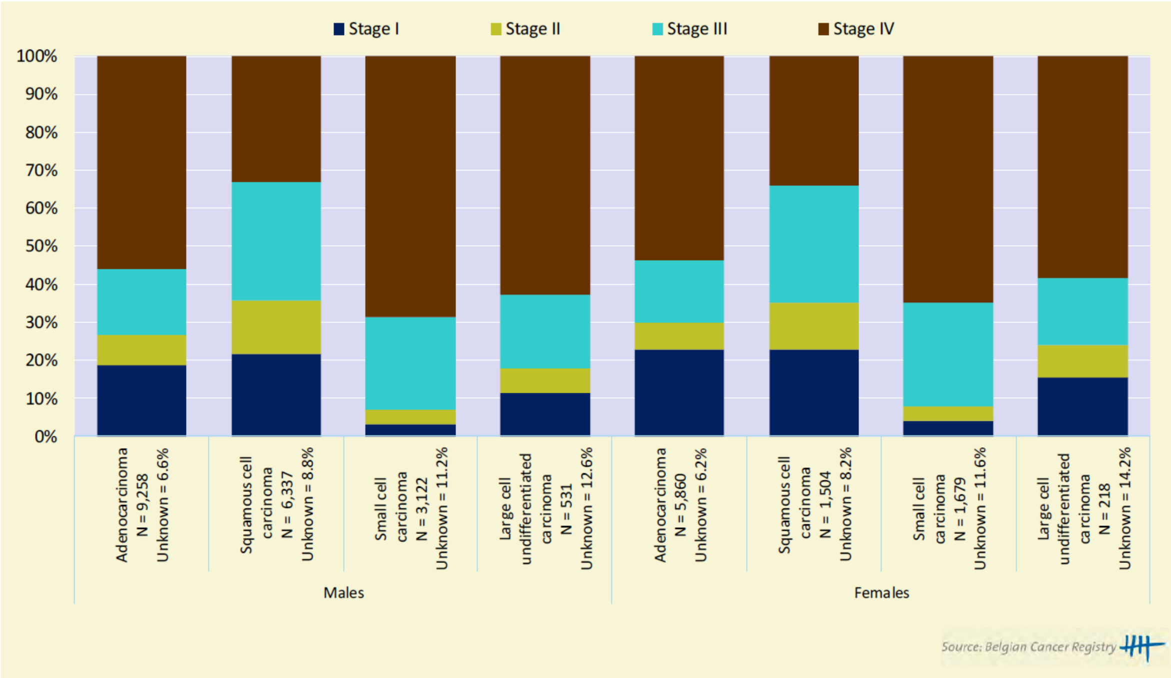


Figure 7. *Lung cancer: stage distribution by sex and histology, Belgium 2004-2017. Source: Belgian Cancer Registry (2020)*

3.3 Other (health) effects

Unlike the impact on the histology of lung cancers, no studies are available for **most other types of cancer** that investigate the effects of cigarettes with and without filters.

A Chinese case-control study among 319 male cases and 428 male controls was performed by Fu et al. (2012) to investigate the impact of filter and non-filter cigarettes on the development of **oral squamous cell cancer**. The adjusted odds ratios for oral cancer were 1.30 (95 % Confidence Interval: 1.15-1.48) for filter cigarette smokers, 2.06 (95 % Confidence Interval: 1.17-3.62) for non-filtered cigarette smokers and 1.73 (95 % Confidence Interval: 1.33-2.25) for mixed smokers. In this study, it was concluded that the possible "protective effect" of the cigarette filter was limited, restricted to smokers of small amount of smoking accumulation. For most smokers, however, **the difference was non-significant between filter and non-filter cigarettes**.

Also data on differences within **non-cancerous health effects** caused by cigarette filters are **scarce**. Filters are not mentioned in the Surgeon General's Report chapters treating respiratory diseases, cardiovascular diseases, reproductive outcomes and other specific outcomes (US Department of Health and Human Services, 2014). This does not necessarily mean that there are no effects, but rather indicates a lack of studies.

The possible impact of the cigarette filter on **coronary heart disease** was studied by Castelli et al. (1981). In this cohort study, smokers of filtered cigarettes did not experience benefits. Among smokers of filtered cigarettes, there was no occurrence of lower corona heart disease incidences compared to smokers of non-filtered cigarettes.

Macigo et al. (2001) studied the influence of cigarette filters on the risk of developing oral leukoplakia in a small Kenyan population (85 cases, 141 controls). There was **no statistically**

significant difference between the influence of filtered an non-filtered cigarettes on the risk of developing **oral leukoplakia**.

Tanik & Demirci (2022) performed a 4-years retrospective clinical study to evaluate the effect of filtered and non-filtered cigarette smoking on marginal bone loss in the subjects with dental implants. In total, 419 dental implants were placed in 188 subjects aged 23-76. It was shown that tobacco smoking had a significant negative effect on marginal bone loss. Moreover, there was **a significant increase in marginal bone loss** on the mesial and distal surfaces, especially in **unfiltered heavy tobacco smokers (>20 cigarettes/day)**.

Menezes et al. (1995) associated the smoking of different types of cigarettes with **chronic bronchitis**, based on interviews with 1053 subjects living in an urban area of Southern Brazil. These authors found that the number of daily cigarettes was strongly associated with the risk of chronic bronchitis (Odds ratio: 8.10, 95 % Confidence Interval: 4.46-14.71 for ≥ 20 daily cigarettes) compared to non-smokers. However, differences were observed between several cigarette types, with **the risk for filtered cigarettes still significantly increased compared to non-smokers** (Table 6).

Table 6. *Odds ratios for chronic bronchitis according to the type of cigarettes smoked. Values adjusted for gender, age, schooling, housing quality, indoor pollutions, occupational exposure to dust, passive smoking and report of respiratory illnesses (Menezes et al., 1995). The confidence intervals between filtered and non-filtered (plain) cigarettes are largely overlapping.*

Type	Odds Ratio	95% Confidence Interval
Non-smoking	1.00	1.00
Filtered cigarettes	2.19	1.19-4.03
Plain cigarettes	3.17	1.50-6.70
Hand-rolled paper cigarettes	4.11	2.92-7.73
Hand-rolled maize leaf cig.	5.43	2.65-11.13

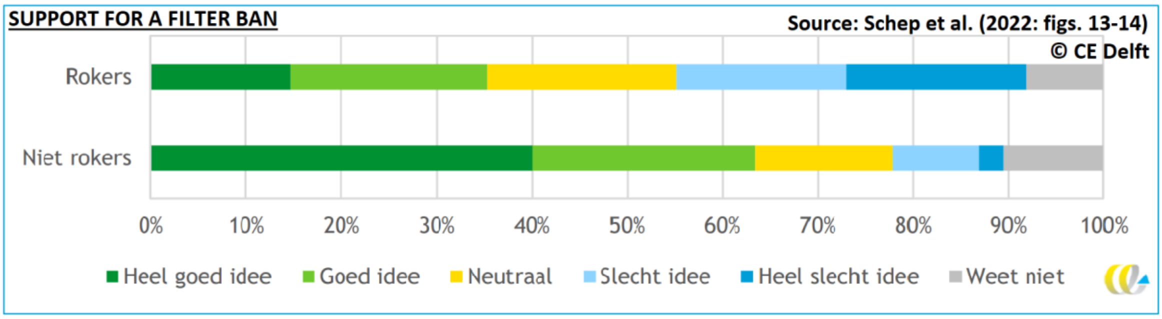
Pauly et al. (1995) warned that cigarette **filters may release fibers** that might be inhaled/ingested by smokers. These researchers observed cigarette filters fibers in lung tissue from lung cancer patients. This phenomenon and its consequences are much less studied in the literature, but should not be ignored.

3.4 Smoking behaviour

Already in 1989, it was suggested that **compensation behaviour** (increasing the number of cigarettes per day) to meet nicotine demands after switching to filtered cigarettes is an important risk factor for lung cancer that needs to be taken into account in epidemiologic studies (Augustine et al., 1989). As the largest particles are retained, **filters reduced the irritation, resulting in lower perceived risks** (Kozlowski & O’Connor, 2002; Oliveira da Silva et al., 2021).

Recently, a behavioural experiment was carried out by Pulvers et al. (2021) to inform a ban on sales of cigarette filters. A cross-over randomised trial involved 43 volunteers who smoke filtered cigarettes. Participants were provided 2 weeks’ supply of filtered cigarettes, 2 weeks of the same brand of unfiltered cigarettes and randomly assigned to starting positions. The overall sensory effects of filtered cigarettes were found to be better tasting, more satisfying, more enjoyable, less aversive, les harsh, less potent and less negatively reinforcing than unfiltered cigarettes. **Filtered cigarettes were smoked at a significantly higher rate ($p \leq 0.05$) than unfiltered cigarettes**. Although cotinine (main metabolite of nicotine), dependence and intention to quit were similar for smoking unfiltered and filtered cigarettes, **results suggested that banning the sale of filtered cigarettes might make smoking less attractive overall to smokers** (Pulvers et al., 2021).

The Dutch Ministry of Infrastructure and Water Management ordered a study from CE Delft to quantify the size of the filter problem in Dutch litter and to investigate possible policy measures. In December 2022, a report was published by CE Delft (Schep et al., 2022). A consumer survey was executed to estimate smokers' response to a possible ban on single use cigarette filters. The public support for a filter ban appears to be markedly higher among non-smokers (63 %) compared to smokers (35 %). It was found that 28 % of smokers would comply with the filter ban, while 18 % would be discouraged. Only 16 % would not comply with the ban. Responses to a ban will be diverse. **Some respondents (12 %) indicated that a filter ban would be a reason to quit smoking, or to smoke less**. Others will switch to other smoking products (6 %), unfiltered cigarettes (16 %) or self-made cigarettes with reusable filters (18 %). Other smokers want to buy filtered cigarettes abroad (18 %) or on the illegal market (8 %). The latter findings indicate that for maximum effectiveness, a filter ban is best implemented at a supranational level (e.g. European Union).



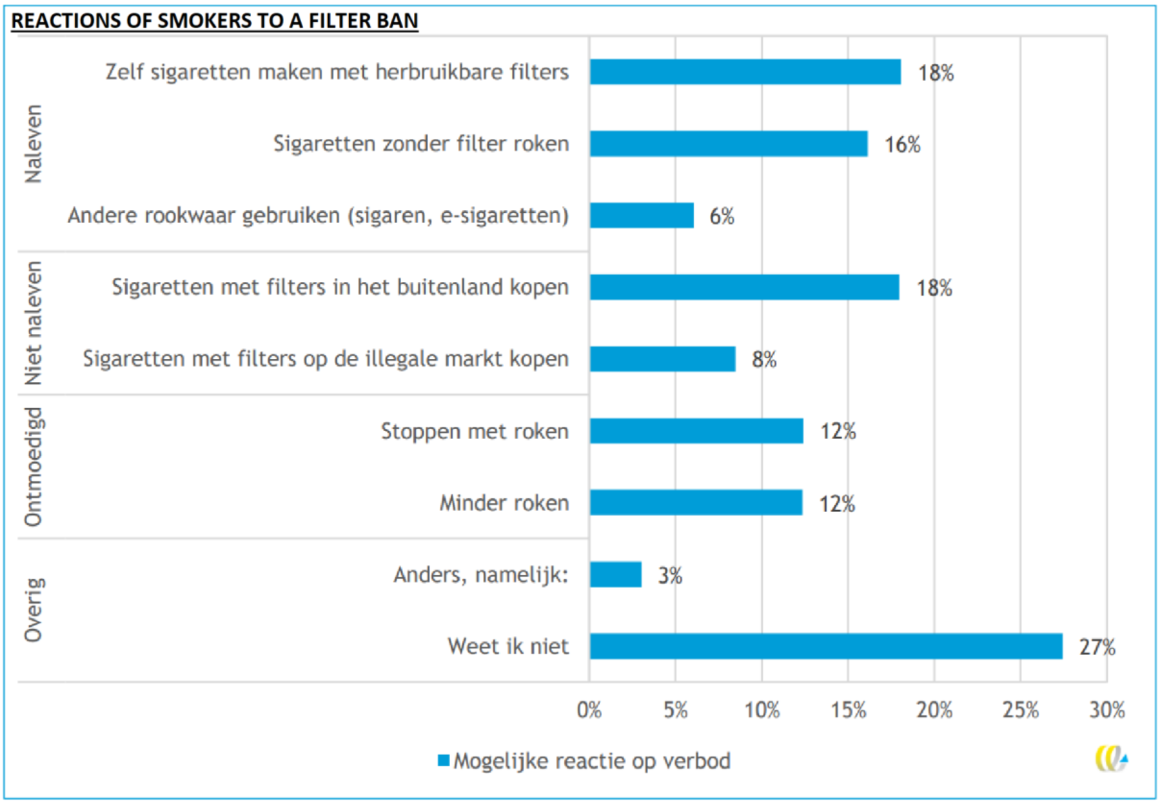


Figure 8. *Results of a consumer survey executed by CE Delft, to investigate the public support for a filter ban and the reactions of smokers to a filter ban (1.051 respondents, including 527 smokers of whom 348 use filtered cigarettes). Source: Schep et al. (2022: figs. 13-14).*

3.5 Conclusion

The cellulose acetate cigarette filter has no proven benefits in preventing adverse health effects of smoking. It is very likely that the rise of lung adenocarcinomas since 1970 can be explained, at least to a large extent, by the increased use of cigarette filters in the decades before. Adenocarcinomas tend to occur earlier than squamous cell carcinomas (shorter lag time). In Belgium, their average 5-year relative survival rate was 30.2 % and 25.1 % respectively between 2015-2020. Pores in the filter result in lower ISO-standardised measurements of tar, nicotine and CO in the smoke than the smoker actually inhales, because many filter pores are in reality blocked by the smoker's fingers. An altered combustion pattern increases the formation of tobacco-specific nitrosamines (TSNAs). Moreover, due to the better sensory effects, smokers are likely to smoke a greater number of filtered cigarettes per day compared to unfiltered cigarettes. There are also indications for deeper inhalation as compensation behaviour. The cellulose acetate cigarette filter has been misleading in terms of its implied protection of smokers' health, while becoming an important marketing tool for the tobacco industry since the 1950s. The latter created misconceptions about the composition and health effects of the cellulose acetate filter, creating a false sense of security among smokers.

4 Impact of cigarette filters on the environment

On a global scale, the production of cigarettes puts enormous pressure on the environment, biodiversity and natural resources. Land, water and agrochemicals are needed to grow tobacco. Tobacco cultivation competes with crop farming for human food security. Every year, nearly six trillion cigarettes are produced, and ca. 5.8 trillion cigarettes are smoked (Zafeiridou et al., 2018). It is estimated that about 4.5 trillion discarded cigarette butts (> 75 %) annually pollute the environment (Torkashvand & Farzadkia, 2019; WHO, 2022). Cigarettes are the most common littered items on Earth. A cigarette butt is what remains of the cigarette after smoking, including the cellulose acetate filter polluted with toxic contaminants.

The industry promoted for many years the idea that only the consumer is responsible for the litter problem. From the 1970s on, the tobacco industry started to be concerned about the cigarette butt litter issue. They introduced litter programs with only 3 goals: (1) to prevent cigarette litter from impacting the social acceptability of smoking; (2) to remove cigarette litter as an issue leading to bans or restrictions of sales of cigarettes; and (3) to ensure that the tobacco industry was not held practically or financially responsible for cigarette litter (Smith & McDaniel, 2010).

4.1 Degradation rate of cigarette butts

Cigarette butts are mainly degraded due to microbial degradation, photo-oxidation, mechanical and chemical abrasion (Poppendieck et al., 2016).

However, as cigarette filters consist almost entirely of **cellulose acetate**, degradation is very slow. Cellulose acetate is obtained by acetylation reactions between non-edible cellulose and acetic acid. Even the fact that cellulose acetate is biosourced (Glasser et al., 1994), the final thermomechanical properties as well as their biodegradation ability are mostly depending on the final acetylation degree with some additional contributions from various intrinsic factors (e.g. degree of crystallinity, molecular weight). The biodegradation ability and the biodegradation rate of cellulose acetate are reduced with the increasing degree of acetylation or even suppressed after a degree of substitution above 2.5 (Samios et al., 1997; Yadav & Hakkarainen, 2022). This is in contrast to fully biodegradable cellulose.

External **environmental factors**, such as temperature, UV exposure, pH, presence and concentration of microorganisms, and salinity, can further influence positively or negatively the subsequent degradation rate of cellulose acetate.

Also, **biological factors** such as microbial nitrogen (N) starvation might contribute to the very slow decay of cigarette butts. As cigarette butts have C/N ratio of ~200, microbial activity may be limited, according to a study of Bonanomi et al. (2020). These authors set up a 5-years experiment without soil, in park grassland and a sand dune. Chemical, physical and ecotoxicological changes in the cigarette butts were assessed. The following conclusions were drawn:

- Contaminated cigarette butts remain toxic immediately after smoking but inhibitory effects rapidly decrease during decomposition. A second toxicity peak emerged (for *Raphidocelis subcapitata*[4]) at intermediate-to-late-stage (2-5 years), clearly showing a long-term hazard for the environment. The first 2 years, cigarette butt degradation is very slow. Thereafter, cigarette butts take different trajectories in relation to the presence of exogenous N sources and the local microbiome. In urban environments without soil, decomposition of butts is mainly limited by microbial N starvation.

[4] *Raphidocelis subcapitata* is probably the most commonly used microalga in ecotoxicity testing.

- In sand dunes with some fungi species of the Basidiomycota group, cellulose acetate can be degraded irrespective of cellulose de-acetylation, but these are not representative of common conditions in nature.

Irrespective of the natural compartments, it is very critical that the cigarette filters, particularly cellulosic derivatives, must be completely converted to CO_2 by the microbial metabolism.

Biodegradability is uniquely accepted when accompanied by complete microbial bio-assimilation, which is necessary to eliminate harmful impacts associated with **microplastics and (nano)plastics** derived from partial degradation of plastics (Mohanty et al., 2022). A general accepted definition was established about the microplastics and is ascribed to plastic particles with a size below 5 mm and a poor water solubility. Cigarette filters are considered as a source of microplastics due to their poor degradation ability (Belzagui et al., 2021). Plastic pollution is becoming more and more problematic as these plastic debris are largely found in various natural compartments (soil, water, etc.) and may persist over a long period of time (e.g., more than 100 years).

It is well-accepted that the final destination of these plastic wastes remains seas and oceans, impacting the marine flora and fauna negatively. As a consequence, these microplastics can enter into the food chain from different organisms present in these compartments (e.g., zooplankton, oyster larvae), leading to the contamination of seafood for humans.

The consequences of microparticle uptake by the organisms and humans are not well known yet, but some possible effects on human beings such as metabolism disturbances, neurotoxicity, and increases in the chances of cancer could be reported in the next years (Galloway & Lewis, 2016).

4.2 Pressures on the environment

Cigarette butts are one of the fractions included in the study of the composition of litter in Flanders. The composition of litter in Flanders during the period 2019-2021 was determined using a large-scale count of 29 precisely defined fractions of litter at more than 6 500 locations within Flemish public space in Flanders (OVAM, 2022a). The composition is calculated using three parameters, each of which has its relevance to the litter problem: number of pieces, weight and volume. **Cigarette butts**, together with chewing gum, are most often found as litter. By number of pieces, cigarette butts are the most problematic (**41 % of litter**). The proportion of butts by weight and volume is more limited, 2.5 % and 1.1 % respectively of the total amount of the litter in public spaces. In 2021, 18 171 tonnes of litter was cleaned up in Flanders (OVAM, 2022b). Combining the figures from both studies gives an estimate of the amount of cigarette butts in litter. However, this is a rough estimate, as both studies were carried out using a different methodology. Moreover, cleaning up this small litter is very difficult. More than 60 % of it remains in the environment, even after an intensive clean-up or sweeping round (Mooimakers, 2022).

The **influence of cigarette filters on the wastewater** treatment sector is largely **unknown**. Neither Aquafin nor VMM possess information about any adverse effects on the microbial activity of the activated sludge process. Harmful chemicals from cigarette filters are considered marginal because of the large water volumes and the presence of other (micro)pollutants in domestic wastewater. The impact of butts on the wastewater treatment process is therefore considered negligible. Upon entry in the wastewater treatment plant, cigarette butts will be removed by the fine screens (6 mm) and processed along with the solid waste of the plant.

However, since cigarette butts enter the sewer systems through street inlets (storm drains), and a considerable portion of the sewer systems are separated, a considerable fraction of discarded cigarette butts will enter storm sewers and **directly be discharged to surface**

waters without treatment. Separate sewer systems are gaining presence as standard practice, so this route of discharge is becoming more prevalent. Additionally, in combined sewer systems, rain events may cause cigarette butts to enter surface waters because of sewer overflow.

4.3 Ecotoxicity of cigarette butts and filters on aquatic and terrestrial organisms

Cigarette butts are a common form of litter in the environment, mainly in terrestrial and aquatic compartments. In this respect, potentially toxic compounds may leach out from these butts and pose a risk to both aquatic and terrestrial organisms. However, with respect of the effects of the filters on the environment, few information is available. Although the terrestrial compartment (soil, sand, etc.) gets usually impacted by the first stage of littering in the environment, most of the **studies have mainly been conducted on the effects of cigarette butts on aquatic organisms.** Much less information is available on the effect of butts on terrestrial species. In most cases, effects are studied of the whole cigarette butts, i.e. the filter including a piece of tobacco and paper. Few studies, however, could be found on the effect of the filters only (without tobacco remnants).

Concerning the <u>terrestrial effects,</u> little information is available. Studies have been mainly conducted on terrestrial plants and on snails. In a study of Green et al. (2019) the grass species *Lolium perenne* and white clover *Trifolium repens* were exposed in a mesocosm experiment to smoked and unsmoked cigarette butts. All remnants of tobacco were removed from both types of cigarette butts. A density of 61 cigarette butts/m^2 was used, corresponding to the densities they found in parks in Cambridge (UK). The germination success and the initial **growth of both plant species was reduced** by both types of butts. The germination of the white clover was more strongly reduced by the smoked cigarette filters.

Gill et al. (2018) studied the effect of cigarette butts on terrestrial invertebrates. The flamed tigersnail *Anguispira alternata* was exposed to smoked cigarette butts containing tobacco remnants. Extracts of cigarette butts (45 mL) were added to 150 g artificial soils whereafter two snails were exposed per treatment. The maximal used concentration was the extract of 4 cigarette butts/L. As endpoints snail mortality and growth was assessed as well as the feeding rate (on lettuce). No effects were observed in comparison with the reference situation. In addition, a choice experiment was performed in which snails were exposed to intact cigarette butts (0, 1, 2 and 4 butts) placed in one compartment and avoidance was tested. During the first two weeks the snails significantly avoided the cigarette butts but avoidance decreased with time and after 16 days no significant differences were observed anymore compared to the control. This suggests, but it has to be tested, that toxicity decreases with aging. In a master thesis at the University of Antwerp (Kargar, 2022) the land snail *Cornu aspersum* was exposed to print paper soaked in leachates of cigarette butts. As endpoints mortality and feeding rate were assessed. However, even at the highest concentration (50 cigarette butts/l) no mortality, nor a difference in feeding rate was observed. From these studies it seemed that cigarette butts are **not very toxic to terrestrial invertebrates**. However more species must be tested and different ways of exposure have to be investigated.

Some birds use cigarette butts as building material to construct their nests. Suárez-Rodríguez et al. (2013) mentioned that some birds in urban environments use cigarette butts (with nicotine) in their nests to repel nest-dwelling ectoparasites. However, besides its beneficial antiparasitic effects, genotoxic effects have also been observed in the red-blood cells of songbirds (Suárez-Rodríguez et al., 2017). **Genotoxic damage** increased if more cigarette butts were present in the nests.

Concerning the <u>aquatic effects,</u> again little information is available, but studies have been conducted on (among others) bacteria, flatworms, crustaceans and fish. In most cases extracts were made of smoked or unsmoked cigarette buts and effects are mainly expressed as cigarette butts per litre.

From a review study (Dobaradaran et al., 2021) it was clear that leachates of cigarette butts can be **very toxic** to different **aquatic species**. It was also shown that smoked filtered cigarette butts with remnants of tobacco present are more toxic than unsmoked cigarette butts. The most sensitive species tested so far appear to be crustaceans with 48h-LC_{50} (lethal concentrations with 50 % mortality after 48h of exposure) values for the water flea *Ceriodaphnia dubia*[5] of 0.03 to 0.08 cigarette butts per litre (Micevska et al. 2006). Fish appear to be less sensitive with, depending on the tested species LC_{50}-values of 0.84 to 5.1 CB/l (Slaughter et al. 2011). As expected, the toxicity increased with exposure duration. In the study of Slaughter et al. (2011), the toxicity for two fish species was compared between smoked filters without tobacco, smoked filters with tobacco and unsmoked filters without tobacco. The least toxic were the unsmoked filters. Smoked filters without tobacco were for one species less toxic than the smoked filters with tobacco, but for the other species no significant difference was found. Chronic effects on aquatic organisms, looking to long-term effects of sub-lethal concentrations are not well studied.

In two master theses at the University of Antwerp the toxicity of cigarette butts was investigated on two aquatic species i.e. the amphipod *Gammarus pulex* (Van Roy 2021) and the pond snail *Lymnea stagnalis* (Steurbaut, 2022). In the study of Van Roy (2021) *G. pulex* was exposed to leachates of cigarette butts that were collected from smoking areas. The age of the butts was not more than 24hs. In all cases the butts still contained remnants of tobacco. The 96h-LC_{50} for *G. pulex* ranged from 0.032 to 0.059 cigarette butts/l. As sublethal effect the feeding rate was assessed and significant effects on feeding rate were observed at average concentrations of 0.02 cigarette butts/l.

Concerning the pond snails a different approach was followed (Steurbaut 2022). Cigarette butts were collected in the same way but in this thesis a distinction was made between the toxicity of the whole butt and the toxicity of only the tobacco collected from the butts. The 96h-LC_{50} of the whole butt was 0.48 cigarette butts/l and of the tobacco it was 0.27 cigarette butts/l. Differences were, however, not significant.

4.4 Conclusion

Based on global estimates, 4.5 trillion cigarette butts end up in the environment each year. This is also a large problem in Belgium: piecewise counts by OVAM showed that cigarette butts account for 41 % of Flemish litter. Due to acetylation, cellulose acetate can only be degraded very slowly by microbial activity. In addition, cigarette filters are a source of microplastics. The limited data presented in literature show that cigarette butts are very toxic to aquatic organisms. Concerning terrestrial organisms, negative effects are observed on germination and growth of plants at cigarette butt densities found in the environment. Concerning terrestrial invertebrates, almost no information is available, but it seems that snails are not very sensitive to cigarette butts. The density of cigarette butts in songbird nests has been linked to increasing genotoxicity in their red-blood cells. Based on current knowledge, it can be concluded that cigarette filters have a considerable environmental impact.

[5] *Ceriodaphnia dubia* is a species of water flea, often used in toxicity testing of (waste)water.

5. Any more environmentally-friendly filters?

In order to address pollutions related to the littering of cigarette butts in the environment, further efforts have been made to propose more environmentally-friendly solutions, mainly by implementing e-cigarettes and biodegradable filters.

Regarding e-cigarettes, even it could be envisioned as an acceptable environmentally-friendly solution by reducing the amount of wastes about cigarette butts, the end-life scenario of e-cigarettes remains unascertained. Beside the possible (un)intentional disposal of e-cigarettes in the environment, their recycling pathways are complex as they are constituted of different elements to be valorized (batteries, plastic, etc.) and cannot enter the classical pathways existing in Belgium about waste management (e.g., blue bags).

In the case of biodegradable filters, some suggest that biodegradable filters could be a step towards a solution, when not opting for a ban. However, Evans Reeves et al. (2021) formally refute this option:

"Now tobacco companies are exploring the possibility of biodegradable filters. However, this should be regarded with caution. First, biodegradable filters would still leach harmful chemicals into the environment if discarded improperly and second, it is likely that the tobacco industry will use biodegradable filters as both a Corporate Social Responsibility and a marketing opportunity. Given that we know that tobacco companies are already marketing their filter innovations to retailers in a way that connotates health benefits, biodegradable filters are likely to be no exception".

Moreover, Green et al. (2022) conclude that biodegradable filters pose a similar threat to the environment as conventional butts do, after reviewing the available data on degradation dates and ecotoxicology.

The Superior Health Council fully endorses the assessments of Evans-Reeves et al. (2021) and Green et al. (2022). Irrespective of the presence of a filter, cigarettes are unhealthy for the population. The biodegradable or "green" nature of filters may lead to a false positive "health" perception among smokers. This leads to even less sensitization of the need to keep cigarette butts out of the environment and disposed of in a waste bin. Biodegradable filters also do not address the leakage of contaminants into soil and water compartments. A ban on cigarette filters therefore seems a more appropriate choice than the search for a biodegradable filter. It can be assumed that "leftovers" from non-filtered cigarettes will represent only a fraction of the environmental impact of cigarette butts.

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VI COMPOSITION OF THE WORKING GROUP

The composition of the Committee and that of the Board as well as the list of experts appointed by Royal Decree are available on the following website: About us.

All experts joined the working group ***in a private capacity***. Their general declarations of interests as well as those of the members of the Committee and the Board can be viewed on the SHC website (site: conflicts of interest).

The following experts were involved in drawing up and approved this advisory report. The working group was chaired by **Greet SCHOETERS** and **Pieter SPANOGHE**; the scientific secretary was Stijn EVERAERT.

BARTSCH Pierre (†)	Pneumology	ULiège
BERVOETS Lieven	Ecotoxicology	UAntwerpen
FRAEYMAN Norbert	Pharmacology	UGent
GODDING Véronique	Pediatric pneumology, tobaccology	CHU UCL Mont-Godinne
HAERDEN Yves	Toxicology	ex-Antigifcentrum
JANSSENS Annelies	Thorax oncology, pneumology	UAntwerpen
LARDON Filip	Oncology, Medical physiology	UAntwerpen
MEERBURG Francis	Biology, Environmental engineering	Aquafin
RAQUEZ Jean-Marie	Polymer chemistry	UMons
SCHOETERS Greet	Environmental health & toxicology	UAntwerpen
SPANOGHE Pieter	Phytopharmacy, residue analysis	UGent
VAN LAREBEKE Nicolas	Toxicology & Cancerology	UGent

The following experts were heard but did not take part in the approval of the advisory report:

DE BAERE Piet	Waste and materials management	OVAM
HOLSBEEK Ludo	Environmental Risk Assessment	Departement Omgeving

The following associations and/or experts peer reviewed and endorse the advisory report:

- **Koninklijke Academie voor Geneeskunde van België:**
  ALLEGAERT Karel, DECLERCK Dominique, HERREGODS Marie-Christine, NEMERY Ben, POLITIS Constantinus, SCHÖFFSKI Patrick, VAN RAEMDONCK Dirk (Appendix 2)
- **Belgian Society of Medical Oncology:**
  DE AZAMBUJA Evandro, BROUWERS Barabara, LYBAERT Willem, VAN MARCKE Cédric, FONTAINE Christel, NAERT Eline, VAN RYCKEGHEM Florence, GENNIGENS Christine, PUNIE Kevin, VERBIEST Annelies (Appendix 3)
- **Belgian Respiratory Society; Vlaamse Vereniging voor Respiratoire Gezondheidszorg en Turberculosebestrijding; Fonds des Affections Repiratoires:** Peer reviews by NACKAERTS Kristiaan, LAHOUSSE Lies
- **Vlaams Instituut Gezond Leven:** Peer review by Stefaan HENDRICKX
- **Domus Medica:** Peer review by AVONTS Dirk
- In personal capacity:
  VAN GESTEL Dirk & VAN MEERBEECK Jan (College of Oncology)
  and **CASIMIR Georges** (Hôpital Universitaire des enfants Reine Fabiola)

The following association was heard:

- **Alliantie voor een Rookvrije Samenleving**
  Represented by VAN KALMTHOUT Danielle & BIZEL Pierre

VII APPENDIXES

Appendix 1: Recommendations of SHC report 9549

"De HGR wil erop wijzen dat op de achtergrond van het debat over de e-sigaret het ontmoedigen van roken zeer sterk dient mee te spelen en dat voor de beleidsverantwoordelijken het absolute risico van tabak roken moet primeren op het relatief beperktere risico van de e-sigaret. Ons land blijft kampen met te veel mensen die roken en met te traag dalende tabaksprevalentiecijfers. Hoe de volgende jaren het ontmoedigen van roken verder te voorkomen?

• toepassing van artikel 5.3. van de FCTC: de tabaksindustrie op geen enkele manier toelaten bij de ontwikkeling en implementatie van het beleid rond volksgezondheid en tabaksregelgeving,
• hogere accijnzen die inzetten op het ontmoedigen van tabaksgebruik,
• een drastische vermindering van de vele tabaksverkooppunten in ons land en een verbod van de verkoop via automaten,
• een uitstalverbod in de verkooppunten,
• herhaalde campagnes op maat van de overblijvende rokers die hen oproepen om méér stoppogingen te doen met behulp van alle effectieve rookstopmiddelen die er zijn,
• nicotinevervangers (NRT - erkende rookstopmedicijnen) terugbetalen en gratis maken voor de meest kwetsbare groepen rokers,
• uitbreiding van de professionele rookstophulp aan rokers en in het bijzonder aan kwetsbare groepen (bv met lagere scholingsgraad of met psychische problemen),
• jaarlijkse monitoring van het gebruik: zowel van klassieke tabaksproducten als van nieuwe tabaksvrije nicotineproducten."

Appendix 2: Letter from the Koninklijke Academie voor Geneeskunde van België (March 4th, 2023)

KONINKLIJKE ACADEMIE
VOOR GENEESKUNDE VAN BELGIË

Paleis der Academiën
HERTOGSSTRAAT 1 – 1000 BRUSSEL
Tel. 0492/15 44 29
E-mail: academiegeneeskunde@vlaanderen.be
Website: www.academiegeneeskunde.be

PEER REVIEW

ADVIES HOGE GEZONDHEIDSRAAD
OVER DE EFFECTEN VAN SIGARETTENFILTERS OP DE VOLKSGEZONDHEID
EN HET MILIEU IN BELGIE (nr. 9726)

Opmerkingen en suggesties:

- Het opzoekingswerk is grondig gebeurd en het verslag is logisch opgebouwd en vlot leesbaar. De vraag stelt zich echter hoe de boodschap, die duidelijk is voor wetenschappers, zal overkomen bij politici, de tabaksindustrie en het brede publiek.

- Na een grondige lezing van dit document van de HGR, vond ik dit een goed geschreven en stevig onderbouwd advies. Ik heb geen bijzondere opmerkingen te formuleren en kan me persoonlijk akkoord verklaren met de conclusies van dit advisory report.

- Ik begrijp de complexiteit van deze vraagstelling, omdat het de facto natuurlijk beter is om in te zetten op reductie en eliminatie van rookgedrag. Daar zijn we het snel over eens. Andere landen en gemeenschappen (Nieuw Zeeland) zijn daar veel helderder en rechtlijniger in.
  De vraagstelling nu is echter geïnduceerd door een "klimaat"reflectie over single use plastics, dus indirect, en m.i. eerder "creatief" met de vraag of een ban op filters geassocieerd zou zijn met "health risks". Ik vermoed dat dit binnen het publieke domein veel disparate opinies zal induceren. Het gebruik van het milieu argument is hierbij een out of the box benadering, maar bannen van filters zou m.i. best gepaard gaan met verder stimuleren en beschikbaar stellen van afkickprogramma's en positieve maatregelen. Ik vermoed dat we het ook over dit aspect snel eens zouden kunnen zijn.
  In de conclusies focust men op het "vals gevoel van veiligheid" met hoofdzakelijk nadruk op preventie van kanker (shift squameus naar adenocarcinoom), de onbetrouwbaarheid of misschien eerder de irrelevantie van de gebruikte lab testen versus het de facto gebruik, en de afwezigheid van relatieve gezondheidswinst van filtered versus unfiltered cigarette (behalve een beperkt effect op chronische bronchitis). Als kinderarts vond ik het stukje over "second hand/passive" smoking, met eerder een hoger risico bij filter ook relevant, en dat mag zelfs nog wat meer naar voor gebracht worden.
  In het kader van de afwezigheid van relatieve gezondheidswinst, en omdat ik ook docent farmacologie ben voor de studenten tandheelkunde, leek mij een search naar

tandheelkundige impact of filtered versus unfiltered cigarettes zinvol, en daar is wel een beperkt signaal voor verschillen in o.a. marginal bone loss na dentale implantaten (Tanik et al, PMID 36261406). Oral leukoplakia lijkt dat weer niet verschillend te zijn tussen filtered and unfiltered setting (Macigo et al, PMID 11355433). Volgens mij is dit even relevant als het beperkt effect op chronische bronchitis, dus niet voldoende relevantie t.o.v. passief roken en de milieu impact. Rapporten over verschillen in cardiovasculaire outcome tussen filtered en unfiltered cigarettes kon ik niet direct vinden.
Volgende bijkomende bronnen kunnen misschien ook zinvol zijn voor de adviestekst:
- Korte editorial in de BMJ: https://www.bmj.com/content/367/bmj.l5890
- Het wetenschappelijke onderzoeksbureau STOP geleid vanuit Bath University, heeft goede begrijpelijke info over dit soort zaken zoals: https://exposetobacco.org/campaigns/cigarettes-are-single-use-plastics/

In conclusie, akkoord met deze wetenschappelijke analyse.

- Ik kan de redenering rond de gezondheidswinst in de samenleving door het afschaffen van deze filters goed begrijpen. Afschaffen van de sigarettenfilters zal:
  - het weggooien van deze peuken in de natuur elimineren met een gunstig effect op het klimaat voor planten, dieren en mens (deze filters worden beschouwd als single-use plastics verzadigd met toxische stoffen)
  - het roken van sigaretten minder aantrekkelijk maken (viezer voor de gebruiker) met een verhoopt gunstig effect door een verminderd rookgedrag in de bevolking

  Een mogelijk negatief effect van het verbod op gebruik van filters bij onverminderd rookgedrag, is inderdaad een mogelijks nieuwe shift van adeno- naar spinocellulaire carcinomen en een toename van kankers in bovenste luchtwegen (mond, farynx, sinus, trachea).
  Uiteraard blijven de andere maatregelen voor rookstop even belangrijk om op in te zetten zoals die aan bod komen in het plan van Minister Vandenbroucke:
  - mediacampagnes
  - counseling met tabakologen
  - vervangmiddelen voor verslavende nicotine
  - rookverbod op openbare plaatsen
  - taxatie van tabak
  - vroegtijdige kankerscreening

- Wat betreft specifieke aspecten op vlak van mondgezondheid, lijken orale carcinomen de enige mogelijk echt relevante. Ik kon geen recente studies of systematic reviews met betrekking tot dit aspect vinden. Wel de volgende paper (weliswaar case-control studie) waar geconcludeerd wordt dat filters geen verschil maken: https://pubmed.ncbi.nlm.nih.gov/22779984/

Het ontwerp van advies werd gereviewd door de volgende leden van de Koninklijke Academie voor Geneeskunde van België:
Karel Allegaert (kindergeneeskunde, neonatologie), Dominique Declerck (tandheelkunde, mondgezondheid), Marie-Christine Herregods (cardiologie), Ben Nemery (pneumologie, toxicologie, milieugeneeskunde), Constantinus Politis (stomatologie), Patrick Schöffski (oncologie) en Dirk Van Raemdonck (thoraxheelkunde, pneumologie)

Appendix 3: Letter from the Belgian Society of Medical Oncology (March 4th, 2023)

Belgian Society of Medical Oncology

Belgische Vereniging voor Medische Oncologie v.z.w.
Société Belge d'Oncologie Médicale a.s.b.l.

To: Superior Health Council
Ing. Stijn Everaert

BSMO review and endorsement of Advisory Report of the superior health council.

March 4th 2023

Dear Mr. Everaert,

Dear members of the Superior Health Council,

First, we want to express our gratitude for receiving the opportunity to peer-review and provide support for this advisory report. At a high level, our society supports the initiative and endorses the advice. As such, we would be happy to be included in the list of peer reviewers.

The beneficial environmental impact of the proposed ban is the main driver of this support. From an oncological point-of-view, it remains uncertain if and to what extent the advice would effectively result in decreased smoking-induced morbidity. In our view, the report might include focus on the importance of smoking prevention and smoking cessation support measures. Increased prevention, availability of tabacologists and improved collaboration with primary care physicians and medical specialists should optimally be part of any intervention with the goal to minimize impact of smoking on health and environment.

As medical oncologists, we think the proposed measures might not go far enough. We strongly favor the example of New Zealand, where a stepwise approach was implemented in making smoking less affordable and accessible, implementing a legislation with an annually rising legal smoking age ban. We hope that the advice text can also recommend interaction between Belgium and New Zealand on this topic, which could hopefully pave the way towards a smoking-free future.

We want to thank you again for reaching out to our society on this matter.

With kind regards
On behalf of the Belgian Society of Medical Oncology and its board members

BSMO President
Prof. Dr. Evandro de Azambuja

Dr. Barbara Brouwers	Dr. Christel Fontaine	Prof. Christine Gennigens
Dr. Willem Lybaert	Dr. Eline Naert	Dr. Kevin Punie
Dr. Cédric Van Marcke	Dr. Florence van Ryckegem	Dr. Annelies Verbiest

About the Superior Health Council (SHC)

The Superior Health Council is a federal advisory body. Its secretariat is provided by the Federal Public Service Health, Food Chain Safety and Environment. It was founded in 1849 and provides scientific advisory reports on public health issues to the Ministers of Public Health and the Environment, their administration, and a few agencies. These advisory reports are drawn up on request or on the SHC's own initiative. The SHC aims at giving guidance to political decision-makers on public health matters. It does this on the basis of the most recent scientific knowledge.

Apart from its 25-member internal secretariat, the Council draws upon a vast network of over 500 experts (university professors, staff members of scientific institutions, stakeholders in the field, etc.), 300 of whom are appointed experts of the Council by Royal Decree. These experts meet in multidisciplinary working groups in order to write the advisory reports.

As an official body, the Superior Health Council takes the view that it is of key importance to guarantee that the scientific advisory reports it issues are neutral and impartial. In order to do so, it has provided itself with a structure, rules and procedures with which these requirements can be met efficiently at each stage of the coming into being of the advisory reports. The key stages in the latter process are: 1) the preliminary analysis of the request, 2) the appointing of the experts within the working groups, 3) the implementation of the procedures for managing potential conflicts of interest (based on the declaration of interest, the analysis of possible conflicts of interest, and a Committee on Professional Conduct) as well as the final endorsement of the advisory reports by the Board (ultimate decision-making body of the SHC, which consists of 30 members from the pool of appointed experts). This coherent set of procedures aims at allowing the SHC to issue advisory reports that are based on the highest level of scientific expertise available whilst maintaining all possible impartiality.

Once they have been endorsed by the Board, the advisory reports are sent to those who requested them as well as to the Minister of Public Health and are subsequently published on the SHC website (www.shc-belgium.be). Some of them are also communicated to the press and to specific target groups (healthcare professionals, universities, politicians, consumer organisations, etc.).

In order to receive notification about the activities and publications of the SHC, please contact: info.hgr-css@health.fgov.be.

www.shc-belgium.be

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