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## Health without filters: the health and environmental impacts of cigarette filters

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**Abstract** *Tobacco-related diseases kill eight million people worldwide every year and are responsible for thousands of cases of cancer, cardiovascular disease and other illnesses in Brazil. Cigarette filters are believed by many to reduce the health risks of smoking. This article outlines the history of the technology of filters and discusses the impacts of these cigarette design features and their regulation. We conducted a literature review to assess the impacts of this technology. The results show that filters were initially developed for aesthetic purposes and later improved and marketed as a harm reduction technology. The most widely-used filters are those made of cellulose acetate with or without activated carbon. Despite smokers' beliefs and advertising claims, filters have no health benefits and filter tip ventilation can increase the health risks of smoking. Filters can also make cigarettes more appealing and cause significant environmental impacts. Cigarette filters have no health benefits and lull smokers into a false sense of security and should therefore be banned.*

**Key words** *The tobacco industry; Control and supervision of tobacco derived products*

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## Introduction

Tobacco-related diseases kill eight million people every year. In other words, the consumption of tobacco and its derivatives kills more people than AIDS, cocaine, heroin, alcohol, suicide and road traffic accidents put together<sup>1</sup>.

Every year in Brazil smoking is responsible for around 156,000 deaths, 1,103,421 medical procedures, 157,000 acute myocardial infarctions, 75,000 strokes and 63,000 cases of cancer<sup>2</sup>.

It is therefore natural that smokers seek ways of reducing tobacco impacts, and cigarette filters are believed by many to reduce the risks of inhaling cigarette smoke<sup>3-5</sup>. In addition, some cigarette manufacturers claim that filters are capable of reducing the emission of certain tobacco smoke toxins, without however linking this decrease to reduced health risks<sup>6</sup>. Some authors point out that the tobacco industry markets filters as a technology that makes cigarettes safer and less toxic. Filters are the main technology used by companies in so-called “light” or low-tar cigarettes<sup>7</sup>.

However, independent studies have shown that filters do not reduce the health risks of smoking (and in some cases may even increase the risks), but rather are used to boost cigarette consumption and attract new smokers and have a significant environmental impact<sup>8-12</sup>.

In light of the above, this article outlines the history of the technology of filters and discusses the impacts of these cigarette design features and their regulation.

## Methods

### Data sources

Between April and May 2019, we conducted a literature review using the PubMed database search engine as our main source. We included relevant articles cited in publications retrieved by the search. We also searched cigarette manufacturers’ websites, news websites and blogs.

Non-peer reviewed publications were also included because they can often provide information that is not available in peer-reviewed literature, such as how filters are used in marketing and the current technologies on the Brazilian market.

### Data selection, extraction and synthesis

We searched for publications and documents in English and Portuguese related to cigarette design and marketing, filter technology and new types of filter. The search focused on toxic emissions, perceptions and use, health and environmental impacts, and relevant legislation.

The search was performed using the snowball method with a combination of initial keywords (cigarette and filter), keywords related to filter design features (capsules, filter ventilation, additives, design), and terms relevant to the initial keywords (emissions, marketing, flavor, among others). The search was not restricted to a specific period or geographical region.

## Results

The final sample consisted of 93 articles (93 with the terms “cigarette filter”, 14 with the term “cigarette filter ventilation”, eight with the terms “cigarette filter capsules”, 14 with the terms “cigarette filter additives” and 18 with the term “cigarette filter design”) and 15 documents.

### History

Cigarette filters were introduced in 1860 to prevent pieces of tobacco from entering the smoker’s mouth and keep the lips moist, being mainly targeted at women<sup>13-15</sup>. In 1936, filters were called “beauty tips”, making it clear who the target audience was. They were originally made of cork and, even to this day, many filters simulate this material to preserve this appearance<sup>14</sup>.

By this time, a process for making filters from crepe paper had already been patented and, in 1935, a machine that produced filtered cigarettes was developed<sup>16</sup>, increasing the scale of production.

However, the filtered cigarette only became popular in the 1960s in response to scientific evidence showing the damage caused by smoking. Tobacco company advertising contained claims that filtered cigarettes were safer, even using doctors in their ad campaigns. Various types of cigarette filters were developed at this time, capitalizing on public concern about the harmful effects of tobacco, with some filters containing asbestos. By 1980, filtered cigarettes accounted for more than 90% of cigarette sales<sup>8,13</sup>.

In response to public health concerns, the tobacco industry prioritized successful market-

ing campaigns focused on filtered cigarettes. For example, at the beginning of the 1920s, Marlboro was a women's cigarette and was taken off the market during World War II. In the middle of the 1950s, the brand was reintroduced as a men's cigarette with a filter, symbolized by the famous Marlboro man and later becoming one of the world's best-selling brands<sup>17</sup>.

At the beginning of the 1970s, the tobacco industry introduced filter tips with perforations designed to dilute mainstream tobacco smoke. On the basis of machine smoking conditions, perforated cigarettes showed lower nicotine, tar and carbon monoxide yields<sup>8,18,19</sup>. However, machine-based measures of chemicals from cigarettes with ventilation holes do not accurately reflect actual smoking because smokers block the holes with their fingers and lips, being used by the industry to support spurious health claims in "light" or "mild" cigarette advertising<sup>8,20-23</sup>.

These days, filters come in a range of colors and have various design features, including additives, adjustable filters and flavor capsules<sup>4,8,24</sup>.

### Type of filters and associated technologies

Various materials have been used or suggested for use as cigarette filters besides cork and crepe paper, including natural and synthetic foams and sponges, resins, special papers, cotton, silk, flax, corn silk and other natural fibers, synthetic fibers, absorbent granules and powders, aluminum oxides and salicylate, and fine-cut tobacco<sup>8</sup>.

The materials that most grabbed our attention were commercially produced filters with asbestos, due to its high toxicity<sup>25</sup>, and a patent for a cheese-filter with or without activated carbon, which appears not to have been commercially produced<sup>26</sup>.

The most widely-used filters these days are those made of cellulose acetate treated with triacetin or combined with activated carbon<sup>6,8</sup>.

The efficiency of filters made of cellulose acetate fiber in reducing particulate matter is influenced by a range of factors, including size, circumference, number of fiber filaments, and use of additives in the fibers. Cellulose acetate filters with active carbon are designed to selectively remove tobacco smoke toxins<sup>8,27</sup>.

The articles and documents reveal that the tobacco industry uses cigarette filters to produce "elastic" cigarettes, which deliver higher toxin yields for smokers than would be expected from standard machine smoked tests. The underestimation of actual smoke exposure gives the im-

pression that "light" cigarettes emit less toxins than conventional cigarettes<sup>28-31</sup>.

### Filters and smokers' health

Smokers believe that the risks of smoking are lower with filtered cigarettes<sup>9,15,32</sup>, despite evidence to the contrary (especially in relation to cigarettes with filter tip ventilation)<sup>19,33</sup>.

Filters and perforated filter tips led to the emergence of the so-called low-tar or "light" and "ultra-light" cigarettes<sup>19</sup>. The health claims in advertising and health professionals' beliefs that filtered cigarettes were "healthier" than unfiltered cigarettes, meant that that the former have come to be preferred by smokers, especially those concerned about their health<sup>34-37</sup>. These technologies also reduce the irritation caused by cigarette smoke, resulting in lower perceived risk<sup>19,28</sup>.

Studies show that the use of filters and perforations increases health impacts as smokers change their puffing patterns to increase the volume of smoke to obtain adequate levels of nicotine. This increase in puff volume leads to higher toxin intake, resulting in a greater impact on smokers' health<sup>28-31</sup>. This phenomenon is known as compensatory smoking or compensation<sup>28</sup>.

Other studies also showed that when filter vents were blocked, measured tar yields increased by more than 10-fold in comparison to unblocked cigarettes of the same brand, revealing that low-tar or "light" cigarettes do not differ from conventional cigarettes<sup>18,31</sup>.

Studies reported that filtered cigarettes are not less harmful than unfiltered cigarettes<sup>9,38</sup>. Another study also suggests that cigarettes with filter ventilation may lead to an increased rate of lung adenocarcinoma when compared with cigarettes without ventilation<sup>19</sup>. Moreover, a preliminary study published in 2018 suggests that removing filter ventilation reduces cigarette abuse liability<sup>39</sup>.

### Filters and cigarette attractiveness

Filter ventilation also reduces the irritation caused by cigarette smoke, making the product more palatable and appealing, and giving smokers the impression that filtered cigarettes are less toxic<sup>28,31</sup>.

Some filters also contain flavor capsules that allow users to choose characterizing or non-characterizing flavors. According to the literature, these capsules can potentially increase the attractiveness of cigarettes and reduce perceived risk<sup>10,40</sup>.

Brands in Brazil containing capsules inside the filters have different design features, including flavor-changing filters (allowing the smoker to regulate flavor intensity) and two capsules that can be pressed to release individual flavors, theoretically giving the smoker a choice of four flavors (non-flavored, flavor 1 or 2, and a mixture of the two).

### Environmental impacts

Improperly discarded cigarette filters (or butts) are the most ubiquitous form of litter worldwide and most common pollutant found in the earth's oceans<sup>12</sup>. An estimated 4.5 trillion cigarette butts are thrown away every year worldwide<sup>41</sup>, representing approximately 845,000 tons of waste<sup>42</sup>.

Data from the UNEP's International Coastal Cleanup program<sup>43</sup> for the period 1989 to 2007 show that cigarette filters were the most common marine litter item, accounting for 24,6% of the total number of debris items<sup>43</sup>, followed by paper and plastic bags (9,4%), clearly illustrating the environmental impact of cigarette butts<sup>43</sup>.

The cigarette butt litter issue raised concerns among the tobacco industry, which understood that, just as evidence on the harmful effects of passive smoking had prompted smoke-free laws, cigarette waste could potentially lead to more restrictive environmental legislation<sup>44</sup>.

Tobacco industry internal documents show that companies monitored and developed strategies for addressing this issue because of its effects on the social acceptability of smoking and potential alliances between tobacco control advocates and environmentalists<sup>44</sup>.

It is also important to highlight that cigarette butts are not classified as toxic waste, despite the various toxins contained in tobacco smoke, such as nicotine, tobacco-specific nitrosamines, phenol and formaldehyde<sup>45</sup>, meaning that cigarette litter is not properly treated even when disposed of "correctly".

Some studies revealed that filters are toxic to aquatic organisms<sup>41,44</sup> as they release arsenic, nic-

otine, cadmium, lead and other chemical components to the environment.

In addition to these factors, cigarette butts are photodegradable, but are not biodegradable, meaning that they are broken down into small pieces that remain in the environment, essentially becoming diluted in water or soil<sup>42</sup>. The non-biodegradability of filters also increases landfill demands, increasing waste management costs and blighting public places<sup>42</sup>.

### Regulation of cigarette filters in Brazil and around the world

As far as we are aware, as yet, no place has prohibited the use of cigarette filters. Three attempts to ban filters in California based on their negative health and environmental impacts have failed<sup>46</sup>. However, Germany has banned cigarettes containing menthol capsules<sup>47</sup>.

The European Union also introduced legislation on single-use plastic products that provides that the packaging of tobacco products with filters should state that they contain single-use plastic and outline responsibility provisions and proper means of disposal and recycling<sup>48</sup>.

No legislation banning the perforation of filters was identified; however, various authors claim that filter vents are a misleading and dangerous design feature that can actually increase health risks, and should therefore be banned<sup>18,15,20-23,28,49</sup>.

### Final considerations

Considering that cigarette filters have no health benefits<sup>15,19,50,51</sup>, are used by the tobacco industry to attract new smokers, prompt an increase in puff volume, lull smokers into a false sense of security, and have a significant environmental impact<sup>10,12,15,28,41,52-55</sup>, there is no justification from a health and environmental point of view for the continued use of these items and they should therefore be banned.

## Collaborators

ALO Silva, SS Piras, SA Bialous and JC Moreira contributed to study conception, data analysis and writing this article.

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