www.envsciarch.com

ENVIRONMENTAL SCIENCE ARCHIVES
ISSN: 2583-5092
Volume V Issue 1, 2026

RESEARCH PAPER OPEN ACCESS

Butt Out: Addressing the Environmental and Public Health Impacts of Cigarette Butt Pollution

Meenakshi Thakur[1], Hiba Iqbal[2], Nisha Singh[1], Sushma Bhardwaj[3] and Jyotsna Singh[1]

[1]Department of Zoology, Daulat Ram College, University of Delhi, Delhi, India
[2]Department of Biosciences and Bioengineering, Indian Institute of Technology, Roorkee, Uttarakhand, India
[3]Department of Zoology, Acharya Narendra Dev College, University of Delhi, Delhi, India
*Correspondence for materials should be addressed to MT (email: meenakshithakur@dr.du.ac.in)

Received: 2025/11/29
Accepted: 2025/12/28
Published: 2026/01/01

Abstract

Cigarette butt pollution, the discarded remains of the smoked cigarette, is a global environmental concern with profound health and ecological ramifications. Cigarette butts—the small, fibrous ends left after smoking—are the most commonly littered item worldwide and pose serious environmental and public health risks due to their toxic, non-biodegradable nature. This study addresses the pressing need for coordinated efforts involving the public, manufacturers, lawmakers, and citizens to manage and mitigate the detrimental consequences of this pervasive pollutant. The research focuses on the younger generation's awareness of this issue. The survey encompassed 454 respondents, primarily individuals aged between 13-19 years (60%), with a substantial representation of females (64%) and this was done keeping in mind that the youths of today are the future of tomorrow, especially the females. It is said that if one female is educated then she will educate the whole family which further can bring a change in the society. Encouragingly, an overwhelming majority (97%) recognized cigarette butts as pollutants, irrespective of gender, highlighting substantial public awareness. Notably, respondents reported encountering cigarette debris in public places, often witnessing improper disposal, such as in drains, contributing to water pollution. While respondents exhibited reasonable awareness of the hazards linked to cigarette butts, including fires and harm to wildlife, only 42% were aware of their role in marine pollution, suggesting a knowledge gap. Notably, despite the awareness, improper disposal remains a concern, indicating societal insensitivity. This underscores the need for enhanced public education. The study concludes with recommendations, including awareness campaigns and biodegradable filters, to address cigarette butt pollution. Comprehensive interventions and legislation against careless disposal are essential. This research aims to stimulate further interdisciplinary exploration and draw policymakers' attention to reducing this potential pollutant's impact through sustainable methods.

Keywords: Cigarette; Cigarette butts (CBs); Cigarette butt pollution; Smoking; Environmental pollution; Environmental Education; Public Awareness

Introduction

Cigarette butts, the remains of cigarettes after smoking, are tiny and tend to be neglected but are a form of non-biodegradable litter (Araújo and Costa, 2019). Cigarette butts are often discarded on streets, find their way to drains, and eventually end up in water bodies. According to WHO, 'Cigarette butts account for 30–40% of all items collected in coastal and urban clean-ups' (WHO, 2017). Even if the residues of cigarettes seem small, they are generated in large amounts. It has been estimated that nearly 6 trillion cigarettes are smoked every year worldwide, and about 4.5 trillion cigarettes are littered in the environment, which makes cigarette butts the most common form of litter in the world (Araujo and Costa, 2019).

According to WHO, 'Tobacco waste contains over 7000 toxic chemicals that poison the environment, including human carcinogens' (WHO, 2017). Smoking cigarettes can be a root cause of several health problems such as cancer, heart attacks and strokes, lung diseases, etc. (WHO, 2017). People getting exposed to second-hand smoke (also called environmental tobacco smoke, involuntary smoking, and passive smoking) can directly affect a person's heart (with an estimated increased risk of 25-30% of developing heart disease) and blood vessels along with inflamed airways (Logue *et al.*, 2017). According to a scientific report published in the journal Environmental Science and Technology, 'a person smoking a pack of 20 cigarettes per day for 50 years is responsible for 1.4 million liters of water depletion.' (Dunning and Wilson, 2018). The tobacco industry can cause severe impacts on the environment, as nearly 600 million trees are chopped down each year along with the annual production of about 64 million metric tons of carbon dioxide globally (Tobacco Free Life, 2016a). The toxic chemicals from cigarettes pose a serious health threat to humans, wildlife, and aquatic organisms (Kurmus and Mohajerani, 2020). One of the studies showed how organic compounds (like nicotine and PAH) along with metalloids from cigarette butts leach into aquatic ecosystems, which are toxic to aquatic creatures (Akhbarizadeh *et al.*, 2021; Green *et al.*, 2014).

This study aims to bring attention to the severity of the pollution caused by littering cigarette butts and to understand its impact on humans and the environment. The research includes the components and toxicity of cigarette butts along with the potential impacts on humans, the environment, and the economy.

Study Background

Components of cigarette filters

Owing to the widespread nature and the magnitude of cigarette butts released into the environment, it is important to understand the composition of cigarette butts to evaluate their potential impacts on nature. A cigarette filter along with cigarette paper, capsules, and adhesives, is a part of the cigarette that was introduced in the early 1950s and specially designed to absorb vapours and accumulate particulate smoke components (In Wikipedia). Filters come with advantages like preventing tobacco from passing into the smoker's mouth along with a medium as a mouthpiece that will not crumble as the cigarette is smoked.

Cigarette filters look like white cotton but are made of plastic fibres of cellulose acetate, which makes them non-biodegradable, as it takes nearly 10 years to decompose (In Wikipedia). Cigarettes contain more than 4000 toxic chemicals such as polycyclic aromatic hydrocarbons, formaldehyde, etc. The cigarette butts contain pyrolysis and distillation products along with primary contaminants which eventually leach into the environment (Poppendieck *et al.*, 2016).

Toxicity of cigarette butts

Cigarette butts are one of the most abundant forms of waste in the world, with thousands of chemicals along with micro- and nanoparticles that have a critical consequential impact on the health of humans, wildlife, and aquatic organisms (Kurmus and Mohajerani, 2020; Moroz *et al.*, 2021). Cigarette butts are ubiquitous to terrestrial life which in due course make their way to freshwater and marine life, leaching various toxic chemicals that can remain for as long as 10 years (Kurmus and Mohajerani, 2020). The main toxic agents include polycyclic aromatic hydrocarbons, formaldehyde, argon, carbon monoxide, nitrogen oxides, benzene, hydrocarbons, etc. (Soleimani *et al.*, 2022).

Nicotine contamination

Cigarette butts contain nicotine which along with its metabolites, such as cotinine and trans-3'- hydroxyl cotinine make their passage to wastewater streams as they are littered (Benotti and Brownawell, 2007). Other means of transit to the environment are through cigarette production cigarette combustion and cigarette butt disposal. Nicotine has been found to increase oxidative damage, nicotine-mediated inhibition of nuclear factor erythroid, and elevated cortisol that may promote central obesity, PCOS, endothelial dysfunction, vascular inflammation, and many more (Rehman *et al.*, 2021).

Tobacco- specific nitrosamines (TSNA)

TSNA, one of the constituents of the complex mixture of chemicals present in cigarette smoke has been found to cause cancers of the lung, pancreas, oesophagus, and oral cavity. TSNA has a direct impact on people who use tobacco products along with people who are exposed to second-hand smoke (Konstantinou *et al.*, 2018).

Polycyclic aromatic hydrocarbons (PAHs)

Cigarette butts with partial or incomplete tobacco burning may contain high levels of polycyclic aromatic hydrocarbons (PAHs) (Dobaradaran *et al.*, 2020). The three most abundant PAHs in tobacco smoke tar are the low molecular weight two-ring naphthalene, and the three-ring PAHs fluorene and phenanthrene. The PAHs are carcinogenic to humans and can remain in the environment for decades if present in higher or accumulated concentrations (Gong *et al.*, 2020).

Carbon monoxide

Cigarette smoking directly exposes the smoker to carbon monoxide which can increase the preoperative carbon monoxide levels. The estimated preoperative carbon monoxide level in the exhaled breath level may serve as an indicator of the potential risk of perioperative respiratory complications (Ozgunay *et al*., 2018).

Impacts on the environment

Cigarette litter is a notable concern to the environment as it contains chemicals such as arsenic (used to kill rats), lead, and heavy metals which seep into soil and water sources making their way into the food chain and thereby pressing the ecotoxicological challenges. Toxic exposure to such chemicals poses a serious threat to aquatic and terrestrial animals (Truth initiative, 2017; Qamar *et al*., 2020).

Microorganisms

Microorganisms include prokaryotes (bacteria), eukaryotes (fungi and protozoans), symbioses, and viruses. Littered cigarette butts can leach a significant amount of chemicals into the soil which affects the bacterial communities (Koroleva *et al*., 2021). The leachate constrains nicotine into the environment which can impair aquatic primary producers and hence predators at relevant concentrations (Oropesa *et al*., 2017). Therefore, population dynamics and food web interactions are largely affected once nicotine enters aquatic systems.

One of the studies demonstrated the impact of CBs on the diversity of microbial communities in the environment where marine sediments were treated with smoked CBs for 96h. The result showed the microbial communities were altered with a decrease in two taxonomic families, Cyanobacteria (involved in primary production through photosynthesis) and Bacteroidetes (involved in organic matter biodegradation) (Quemeneur *et al*., 2020).

Aquatic organisms

Cigarette butts litter and often wash off to aquatic bodies. CBs float for a long time before sinking (Dobaradaran *et al*., 2021). CBs, along with their toxic chemicals (mainly nicotine and ethyl phenol, which are toxic to marine life), along with metalloids might be ingested by diverse aquatic organisms which can have immunotoxic, morphotoxic, and mutagenic (Montalvão *et al*., 2019). Fishes, turtles, and seabirds frequently consume cigarette butts by mistaking them for food.

It has been found at concentrations of one cigarette butt per liter of water, the toxins are lethal to small fish and to planktonic organisms such as water fleas at one-eighth of this concentration. Several bioassays were tested and they concluded that marine assays were more affected by leachates than freshwater ones (Olivia *et al*., 2021).

Plants

Leachate of CBs contains nicotine which is one of the reasons for the elevated nicotine levels in plant commodities. Detection of elevated nicotine levels in plant tissues that are not known for endogenous nicotine synthesis, and where nicotine-containing insecticides had not been applied (Selmar *et al*, 2015; Weidner *et al*., 2005). High levels of nicotine cause human health risks which are a concern to the market causing economic losses for farmers and distributors (Semar *et al*., 2018).

Many studies have been conducted to demonstrate the impact of CBs and their associated smoke on the soil and plant processes. Montalvão et al. noted that the leachate of smoked CBs at environmental concentrations (1.9 µg/L of nicotine) had cytotoxic, genotoxic, and mutagenic effects on onion (Allium cepa) roots (Montalvão *et al*., 2018). Another study showed that discarded CBs reduced the germination success and shoot length after 21 days of both perennial ryegrass (Lolium perenne) and white clover (Trifolium repens) (Green *et al*., 2019). The studies prove the potential of CB litter in reducing the net primary productivity of terrestrial plants.

Animals

The leachate of CBs contains various toxic compounds including nicotine, PAHs, metals, and volatile organic compounds which are known to be toxic to many aquatic organisms mainly zooplankton, frogs, snails, and fishes (Venugopal *et al*., 2021). The bioaccumulation of nicotine starting with plants and later on passing to animals have a great impact on the environment. The CB pollutants have a potential chronic impact on the growth and behaviour of both aquatic and terrestrial animals. The non-biodegradable plastic CBs made of cellulose acetate are frequently consumed by animals which may lead to vomiting and neurological toxicity (Novotny *et al*., 2011). Cigarettes contain tobacco and it is known to be lethal to various mammals.

Humans

As noted earlier, the CB and its associated smoke contain thousands of chemicals that pose severe health issues to humans. Likewise, exposure to second-hand smoke also has critical impacts. The main components of the environment like water, soil, dust, and plants have been contaminated with tobacco, and water is a significant route to expose tobacco to humans. The bioaccumulation of nicotine in plants and animals presents a possible source for

human exposure to nicotine in addition to metals, PAHs, and plastic nanoparticles. Recent studies suggest that tobacco waste pollution is toxic to humans using mice and human cell-based assays.

Waste management system

Cigarette butts are abundant and widespread non-biodegradable waste in our environment. It is mainly composed of a cellulose acetate-based polymeric structure which makes CB take years to biodegrade and leach its toxic chemicals and heavy metals. Therefore, it is very important to find an appropriate method to recycle useful resources from waste. Researchers have developed a novel encapsulation technique for CBs where they incorporated bitumen and wax-encapsulated cigarette butts in dense-graded asphalt preparation to recycle the CBs as a construction material (Rahman & Mohajerani, 2021). CBs consist of nicotine and harmine which have been used for the fabrication of N-doped carbon aerogel (NDC) via hydrothermal and carbonization processes (Alhokbany *et al*., 2020). Cigarette-derived functional carbon (CDFC) materials have been prepared by pyrolysis of CBs which applications in supercapacitors and water contaminant removal (Li *et al.*, 2020). CBs are recycled into fired clay bricks and asphalt production without any pre-processing.

However, methods like absorbent material production, vector control, and use as a biofilm carrier in wastewater treatment need various processing methods (Torkashvand and Farzadkia, 2019). The current waste management system faces challenges and has inferior performance therefore basic strategies like reducing the littering rate and recycling are best for the management of this toxic abundant waste (Ghasemi *et al.*, 2022).

Cigarette butt as potential pollutant

Cigarette smoking is not just injurious to health but also has a greater overall environmental impact. Cigarettes are made from tobacco and the tobacco industry contributes significantly to global warming along with massive exploitation of human lives, trees, and natural resources (WHO, 2022). Smoke from these tobacco products contains fine particles in their additives and paper, containing over 7000 chemicals which after combustion release carcinogens. Thus, inhaling cigarette smoke through passive smoking has similar effects as active smoking in the form of increased genomic mutations, tumour-inducing inflammations, and epigenetic abnormalities (Kwit, 2022; Zhou, G., 2019). Besides being a major contributor to air pollution, cigarettes have now also become one of the most abundant sources of marine pollution. Their residues in the form of cigarette butts are often thrown about or tossed onto the streets, beaches, etc, from where they sweep into the drains and other water bodies.

These residual cigarette butts, being lightweight, are easily carried away by rain and get embedded in the water cycle, yielding their harmful effects on our marine ecosystem. Several studies have shown the potential of cigarette butts to pollute water as a more harmful source of pollution than plastic bags, imparting their toxicity to aquatic life (Tobacco Free Life, 2016b; Kwit, 2020). Cigarette butts pose a great threat to our environment, being the most littered item on the planet, leading to catastrophic consequences due to their toxicity and retention which most people are unaware of.

Methodology

The study was a cross-sectional survey primarily among the Indian population which was conducted online. The survey adopted a non-experimental research design to investigate the observations and awareness of the population about cigarette butts as a potential environmental pollutant. The survey collected the responses primarily from undergraduate students and included the responses of individuals who live in an urban set-up and were either smokers or lives around people who smoke. The response was collected for a period of 16 months from July 2022 to July 2024. The objective of the study was described in the questionnaire for the participants. Permission of the participants was taken in for using the data for research purposes and a declaration of confidentiality and anonymity was made.

For the effectiveness of the study, inclusion criteria were set as individuals with age 13 years and above, with no education level bounding. Both smokers and non-smokers were included in the study considering the impact to be similar to both. The responses were recorded, and frequencies were consolidated from the response sheet. The demographic details were segregated from the obtained data. The data was segregated to compare the responses of male and female respondents.

The questionnaire was peer-reviewed and was cross-evaluated by experts following the face and content validity techniques (Tanner, 2018). The initial draft of the questionnaire was distributed among the peer group and was assessed for meaningfulness and fulfilment of the desired objective. The suggestions and errors were rectified based on the suggestions by the peer review. The final questionnaire was evaluated by experts in public health research. The final questionnaire for the survey was shared via WhatsApp, Gmail, Facebook, and other message-sharing platforms. Statistical analysis was done by chi-square analysis to understand the difference between the opinions of the male and female respondents at a significance level of 0.05 (5%) with 1 degree of freedom.

Results

A total of 454 responses were recorded during the survey, where 364 (80%) respondents were females, and 90 (20%) respondents were males. Of a total of 273 (60%) respondents in the age group of 13-19 years, 234 (64%) were females and 39 (43%) were males. 166 (37%) respondents were in the age group of 20-39 years, and the rest fell in the age group between 40 and above. The mean age of the respondents was 23 years, while 13-19 years was the modal group. The age distribution of the study group is given in Table 1 and Figure 1, along with the variation in the responses from males and females. About 90% (408) of the study group consisted of students, 6% (29) of respondents were employed, and the remaining 4% (17) were unemployed youth (Fig. 2).

Age group	Females	Males	Total
13 - 19 years	234	39	273
20 - 39 years	119	47	166
40 - 49 years	8	4	12
60+ years	3	0	03
Total	**364**	**90**	**454**

Table 1. Age distribution of male and female respondents in number and percentage

It was notable that most respondents were non-smokers, yet they often encountered smokers in their surroundings. Given the equal significance of awareness regarding smoking's health and environmental impacts for both smokers and non-smokers, our study included both groups in the analysis (Fig. 3). Awareness about different parameters such as the composition, degradability, and hazards of cigarette and its butt in the environment were studied with the help of a questionnaire circulated among the study group.

Cigarettes as litter

A significant portion of respondents, 97%, recognized cigarettes as litter and pollution-causing agents. This awareness was consistent across genders, with 98% of females and 94% of males acknowledging it (refer to Figure 4). Statistical analysis through a chi-square test indicated no significant association between gender and the perception of cigarette butts as litter [$\chi^2 = 1.584$ at $\alpha = 0.05$ (1 df) = 3.841]. Additionally, 78% of all respondents were aware that cigarette filters are made of plastic, causing toxic plastic pollution (Fig. 5). No significant gender-based differences were observed [$\chi^2 = 1.584$]. Moreover, 87% of females and 89% of males were aware that cigarettes (including filters) are non-biodegradable, while the remaining respondents believed them to be biodegradable [$\chi^2 = 0.1894$] (Fig 6).

Hazards of cigarette butt

81% of females and 76% of males were cognizant of the fact that cigarette butts can cause cigarette-induced fires which claim hundreds of lives, forest fires killing off wildlife and vegetation. No significant difference in the awareness of males and females was observed [$\chi^2 = 0.0714$] (Fig. 7). However, only 42% of respondents were aware of the fact cigarette butts are the single greatest source of ocean trash, whereas the rest of the respondents could not correlate cigarette butt with ocean pollution (Fig. 8).

Disposal of cigarette residues

73.6% of respondents reported that they have seen cigarette butt residues near transportation sites such as bus stands and railway stations, near general stores, tourist places, public places like banks, and even schools and colleges (Fig. 9). To gain insights into the motivations behind these disposal practices, we asked respondents about their perceptions. 59% of respondents observed that people mostly discard them on streets randomly, 42% of people have reported having observed dropping the butts while they are still burning, while 23.3% of individuals have reported seeing people disposing of the cigarette butts in the public drainage (Fig. 10). No significant difference was found in the disposal methods reported by male and female respondents [$\chi^2 = 1.092$ (3 df)]. The possible reasons for careless disposal of cigarette residue by smokers were attributed to the common belief of smokers that one cigarette butt won't cause any harm to the environment (26.2%) or that cigarette filters are made of biodegradable cotton (3.1%). Some respondents also believed that people do not see cigarette butts as litter (11.1%). However, about 55.1% of respondents considered all the above reasons to be the potential cause for the irresponsible behaviour of smokers. Many respondents believed that people do not care about the environment, or they do not consider it their responsibility to worry about environmental pollution (Fig. 11).

Suggestions to control cigarette-butt littering

When asked for their suggestion on talking about the problem of cigarette butt disposal, 72% of respondents suggested that there is a need to create awareness among smokers about the hazards of irresponsible disposal of the butts while 34.6% of respondents suggested that public health programs should run an anti-littering campaign (Fig. 12). 47% of respondents suggested the use of biodegradable filters in cigarettes. Some respondents (63%)

suggested that there should be a ban on the manufacturing of plastic cigarette butts, while others suggested the introduction of an anti-litter law (37%).

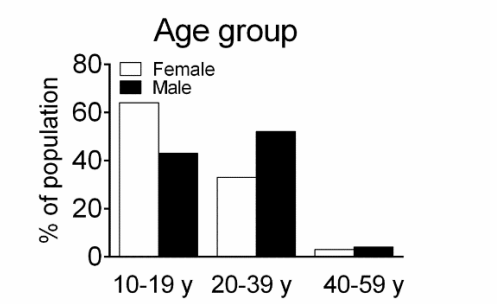

Fig 1: Percentage of male and female respondents

Fig 1 shows the percentage distribution of males and females of different age groups, i.e., 10-19 years, 20-39 years, and 40-59 years. The white bars represent female participants, and the black bars represent male participants.

Fig 2: Occupational status of respondents.

Fig 2 shows the occupation of participants. The white bar represents the student, the dotted bar represents the employed participants, and the black bar represents the unemployed participants.

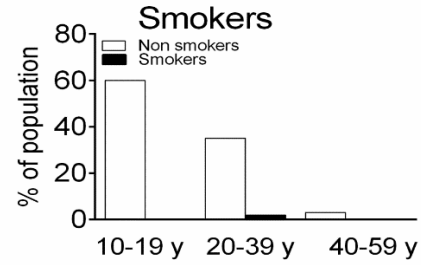

Fig 3: Smoking habits of respondents.

Fig 3 represents the percentage of smokers and non-smoker students across different age groups. The white bar represents non-smokers, and the black bar represents smokers.

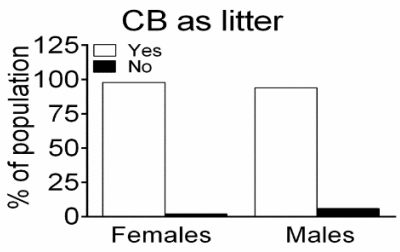

Fig 4: Male and female respondents were aware that cigarette butts are potential pollutant.

Fig 4 represents the percentage of female and male respondents' awareness about the fact that cigarette butts are a source of potential pollutants. The white bar represents participants who were aware, and the black bar represents participants who were not aware.

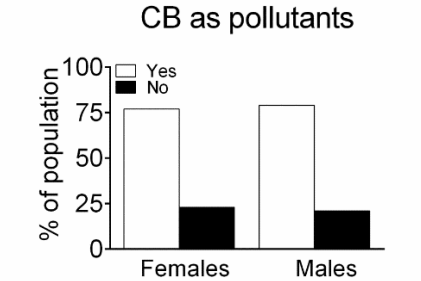

Fig 5: Male and female respondents knows that plastic filled in cigarette filters are toxic

Fig 5 shows the percentage of female and male respondents who are aware that cigarette butts' filters are made of plastic, which causes plastic pollution. The white bar represents participants who were aware, and the black bar represents participants who were not aware.

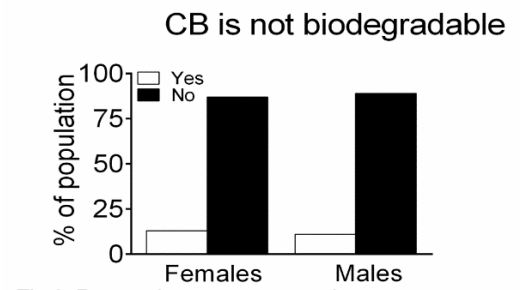

Fig 6: Respondents were aware that some part of cigarette butts are not biodegradable

Fig 6 shows the percentage of female and male respondents who are aware that cigarette butts are not biodegradable. The white bar represents participants who were aware, and the black bar represents participants who were not

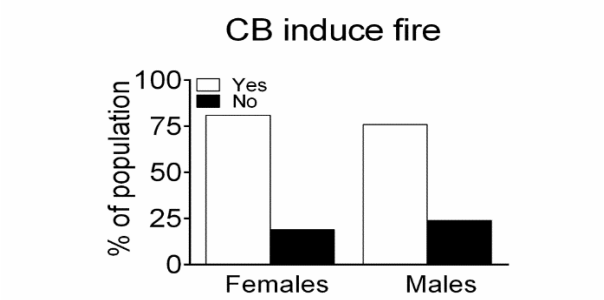

Fig 7: Respondents were aware of the hazardous impact of cigarette butts causing harm to forest and wildlife.

Fig 7 represents the percentage of female and male respondents' awareness about the fact that cigarette butts are hazardous for forests and wildlife and vegetation, as they can cause fire in the forest. The white bar represents participants who were aware, and the black bar represents participants who were not aware.

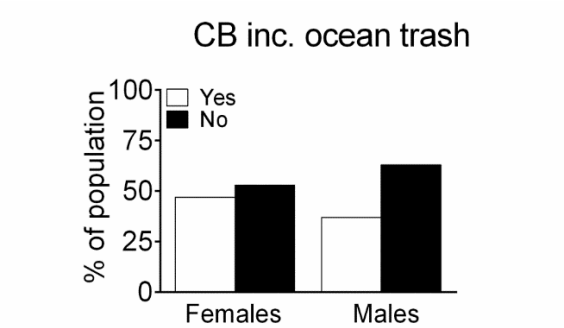

Fig 8: Respondents were unaware that cigarette butts are signficant source of ocean and water body pollutions.

Fig 8 shows the percentage of female and male respondents who are aware that cigarette butts are the single greatest source of ocean trash and waterbody pollution, posing a significant threat to marine life. The white bar represents participants who were aware, and the black bar represents participants who were not aware.

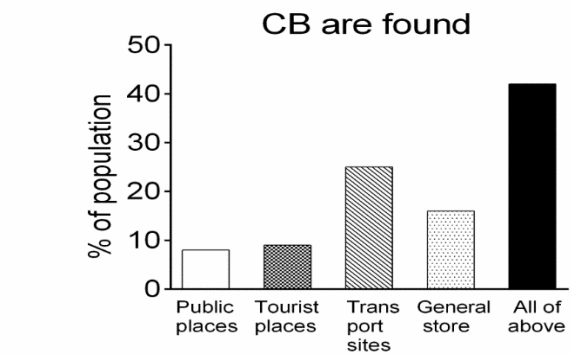

Fig 9: Observation by respondents where cigarette butts are found in different public places.

Fig 9: The different bars represent the places where cigarette butts are commonly found according to the respondents. The white bar represents public places such as school; the grey bar represents tourist places; the vertical striped bar represents transportation sites (bus, railway station); the horizontal stripes represent general stores; and the black bar represents all the above.

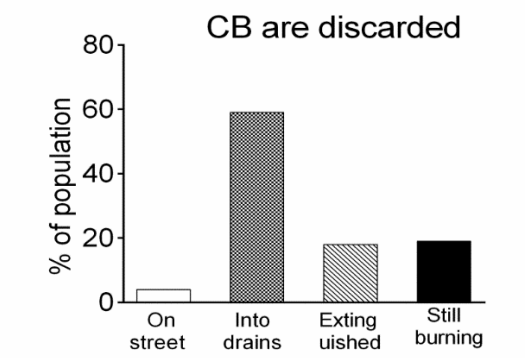

Fig 10 : Observation by respondents of where cigarette butt are disposed off.

Fig 10: The different bars represent the places of disposal of cigarette butts. The white bar represents the streets, the grey bar represents drains, the vertical striped bar represents extinguished, and the black bar represents still burning.

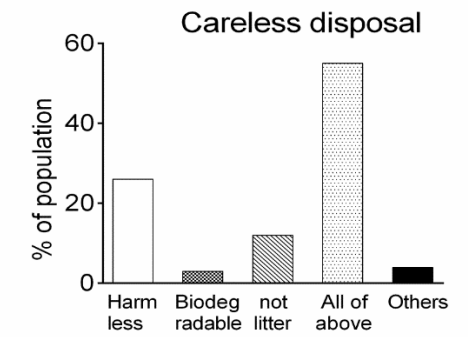

Fig 11: Reasons for careless disposal of cigarette butts.

Fig 11: The different bars represent the reasons for the careless disposal of cigarette butts. The white bar represents those who think cigarette butts are harmless; the grey bar represents those who think butts are made of biodegradable cotton; the vertical striped bar represents those who don't think cigarette filters are litter; and the horizontal stripes above represent others.

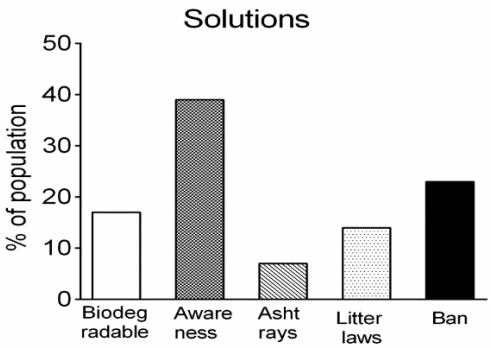

Fig 12: Suggestions to tackle cigarette butts littering.

Fig 12 shows the solutions respondents suggested for addressing the problem of cigarette butts. The white bar represents the population who suggested cigarettes should be made from biodegradable material, the population represented by the grey bar suggested awareness campaigns, the vertical striped bar suggests free distribution of ashtrays, the horizontal stripes suggest the implementation of strict laws against litter, and the black bar represents a ban on plastic cigarette butts.

Discussion

Cigarette butt pollution is a pervasive environmental concern with significant health and ecological implications. There is an urgent need for attention from all the public sectors, including the users, manufacturers, lawmakers, and the public, to manage and prevent the consequences caused by this pollutant. Significant damage is caused to the biota by the ingestion of leachate from cigarette butts due to soil and water pollution (Araujo & Costa, 2019).

The present survey is a pilot study to understand the awareness about this potential pollutant mainly in the young generation. The majority of respondents (60%) fell into the 13-19 years age group, with a significant proportion of females in this category (64%). The difference in the male-female response ratio in the study can be attributed to the fact that the primary study group was students from various colleges of the University of Delhi, many of which were women-only colleges. The study reveals that both males and females are equally aware and have similar observations on cigarette residue and issues related to it.

A key aspect of the study was to gauge respondents' awareness of cigarette butt pollution. Encouragingly, a vast majority of respondents (97%) recognized that cigarette butts are a form of litter and a source of pollution. This awareness is consistent across genders, with 98% of females and 94% of males acknowledging the issue. This finding suggests a high level of public awareness regarding the environmental impact of discarded cigarette butts. Public places such as bus stands, railway stations, banks, educational institutes, and tourist places are reported to be the common places where cigarette debris is commonly found. It was also a general observation that many people throw butts in the drain, which causes water pollution. Many studies have revealed that leachate from the CBs is a major source of urban and ocean pollution (Araújo & Costa, 2019; Green *et al*., 2014; Dobaradaran *et al*., 2020). Cigarette butts contain a high amount of polycyclic aromatic hydrocarbons (PAHs) due to incomplete combustion of tobacco. Various studies show that the leached concentration of PAHs in water bodies has exceeded the permissive limits, causing a potential health risk to human beings and aquatic organisms (Dobaradaran *et al*., 2020). The potentially toxic elements dissolve in the water bodies and integrate with the aquatic and terrestrial food web and pose a severe threat to human health (Akhbarizadeh *et al*., 2021).

Respondents demonstrated a reasonable level of awareness regarding the hazards associated with cigarette butts. Most respondents (around 80%) acknowledged the potential risks, such as fires, wildlife and vegetation damage, caused by improper disposal of cigarette butts. It is noteworthy that only 42% of respondents were aware of the significant role cigarette butts play in ocean pollution. This indicates a possible lack of public awareness regarding this aspect. Furthermore, a significant portion of respondents (78%) correctly identified cigarette filters as being made of plastic, which contributes to toxic plastic pollution. Interestingly, despite their awareness, the study revealed that people do not properly discard cigarette waste. This indicates the insensitivity of people towards their surroundings and environmental health. Moreover, people who smoke, and discard cigarette butts carelessly, believe that a single butt would not be significant in causing any kind of pollution and some do not even consider it as litter (Fig. 11). This finding suggests a potential gap in public education on this specific aspect of cigarette butt pollution. Studies show that cigarette butts take a long time to decompose. Only 38% of CBs decompose in a period of 2 years (Bonanomi *et al*., 2015). The cellulose acetate filters present in the CBs sometimes take up to 10 years to decompose (Akhbarizadeh *et al*., 2021). This results in the leaching of heavy metals and toxic chemicals into the environment. The careless behavior of people in the disposal of CBs can add to this toxic load.

The study concludes with respondents' suggestions for addressing cigarette butt pollution. A majority (72%) advocated for awareness campaigns targeting smokers to educate them about the hazards of irresponsible butt disposal. This aligns with the need to bridge the gap in understanding and behavior among smokers. It was also suggested that the use of biodegradable and non-plastic filters could be an effective solution to reduce the pollution caused by CB disposal. There is a need for interventions at various levels, including public health bodies, environmental agencies, and policymakers, to tackle the issue of littering and pollution caused by CBs. Suggestions for awareness programs and anti-littering movements were prominent in the study. It is important to have proper laws against the careless disposal of CBs.

Case studies from the different parts of the world

Over the past few decades, cigarette pollution has emerged as a significant environmental issue in many parts of the world. Countries have been striving to educate themselves about the impact of cigarette butt pollution and to raise awareness among the public. Various nations have introduced policies to address this issue, but many people remain unaware of the problem.

United States

The most frequently littered item on U.S. beaches and waterways is cigarette butts, which can be attributed to the 190.2 billion cigarette sales by the largest U.S. cigarette companies in 2021 alone. According to the Bureau of Investigative Journalism, it has been estimated that at least five disposable e-cigarettes are discarded every second in the United States, totalling 150 million devices annually. Collectively, these devices contain enough lithium to power approximately 6,000 Teslas. The problem is not limited to cigarette butts but also extends to the vast amount of electronic waste generated by e-cigarettes in the U.S., which amounted to 6.92 kilotons in 2019. With ever-growing sales of e-cigarettes, reaching up to 321.4 million units in 2022, the need for safe and environmentally friendly disposal methods for e-cigarette waste is essential. It has been reported that approximately one in five U.S. adults (50.6 million) used tobacco products in 2019, while in 2022, around 2.5 million middle school and high school students were reported to use e-cigarettes by the U.S. FDA (Truth Initiative, 2023; Cornelius *et al*., 2019).

Asia

The harmful impact of cigarette smoking on public health is widely recognized, but the littering issues associated with cigarette butts still do not receive proper attention. Various phases of tobacco production, including littering, planting, processing, and consumption, cause significant damage to natural surroundings and habitats (Araújo & Costa, 2019). Evidence has shown that a single smoked cigarette butt can produce enough pollutants to contaminate nearly 1000 liters of water, demonstrating the severe harm cigarette butts cause to the environment, especially the marine ecosystem (Lee and Lee, 2015). These small, often neglected items contain deadly plastics.
The awareness of cigarette butts as a potential environmental hazard is lacking among the general public. While cigarette butts may break down into smaller parts under specific environmental conditions due to ultraviolet light from the sun, the source material never completely disappears and remains in the ecosystem (Novotny *et al.*, 2009; Root, 2019). The decomposition of cigarette butts takes many months. They pose a significant threat to biological organisms living in both terrestrial and aquatic ecosystems. Smoked cigarette butts are harmful to sea creatures, snails, mussels, insects, fish, plants, and can even interfere with bird behavior, according to some scientific reports (Bonanomi *et al.*, 2020).

In Bangladesh, marine life is endangered due to the lack of concern and instability in policies regarding cigarette butt litter. The increase in global pollution effects, including climate change and global warming, is also a crucial impact that needs consideration (Booth *et al.*, 2015). Cigarette butts have been discovered in the stomachs of marine fauna (fish, birds, whales) that inadvertently consume them, which can be seriously injurious to aquatic organisms (WHO, 2015).

In India, there is also a lack of awareness about the potential hazards of cigarette butts among the general public. However, the government of India has initiated various programs to educate the public about the proper disposal of cigarette butts to protect the marine ecosystem.

Europe

According to the World Health Organization (WHO), cigarette butts are the second most frequently found litter on European beaches. In 2022, WHO called on governments worldwide to consider cigarette filters as single-use plastics and ban them, as they damage the environment and have no proven health benefits (Min, 2023).
Several European nations, including the Netherlands, are considering a ban on cigarette filters. Dutch junior infrastructure minister Vivianne Heijnen informed lawmakers that "a complete ban on single-use cigarette filters seems to be the most effective solution to mitigate the harmful environmental impact of this litter." However, Heijnen pointed out that a national ban would violate the European free trade agreement, suggesting that Europe-wide regulation would be more appropriate. She proposed that this regulation could be incorporated into the 2026 revision of the European guideline on single-use plastics.

The Superior Health Council in Belgium suggested a Europe-wide ban on cigarette filters in April 2023 (Min, 2023). In a report, it argued that filters offer smokers a more "pleasant mouthfeel" and give them a "false sense of security." Health campaigners in Denmark also agreed and have joined the calls for a ban. In April 2023, climate activists in Portugal collected 650,000 cigarette butts to raise awareness about this often-overlooked form of pollution (Euronews, 2023).

Conclusion

Everywhere in the world, pollution has a profound emotional and economic impact. Cigarette butt pollution is pervasive, harmful to the environment, and expensive for society and the economy. The study reports the awareness of the younger generation, with the majority of respondents identifying cigarette butts as an environmental pollutant. The respondents recognized cigarette butts as a persistent and hazardous pollutant contributing to water pollution, fire-related threats to wildlife, and pollution of marine ecosystems. However, there is a significant gap in existing practices for proper waste management, which the study aims to address. Our findings highlight the significance of cigarette butt pollution mitigation strategies, smokers' focused education, and the adoption of sustainable alternatives, all of which will eventually contribute to a healthier and cleaner environment. We believe that by publishing our study, Indian academics from different fields will be inspired to carry out more structural research in this area. Furthermore, we think that the current study will alert policymakers to the problem and encourage them to create legislation to address the public's lack of knowledge about this issue. Using suitable, sustainable, and efficient techniques will aid in lessening the impact of this possible contaminant.

References

Akhbarizadeh R, Dobaradaran S, Nabipour I and Khorsand I (2021) Leaching of toxic chemicals from cigarette butts into aquatic ecosystems. Environmental Research 196:110904. DOI: 10.1016/j.envres.2021.110904.

Alhokbany N, Al-Mubaddel F, Alharthi F and Al-Mubaddel A (2020) Fabrication of N-doped carbon aerogel from cigarette butts. Journal of Environmental Chemical Engineering 8(6):104567. DOI: 10.1016/j.jece.2020.104567.

Araújo MCB and Costa MF (2019) A critical review of cigarette butt pollution. Marine Pollution Bulletin 146:125–133. DOI: 10.1016/j.marpolbul.2019.05.045.

Bekele TT and Ashall J (2019) Developmental toxicity of cigarette butt leachate in mice. Toxicology Reports 6:123–130. DOI: 10.1016/j.toxrep.2019.01.012.

Benotti MJ and Brownawell BJ (2007) Microbial degradation of nicotine in wastewater. Environmental Science & Technology 41(9):3326–3332. DOI: 10.1021/es062590c.

Booth DJ, Gribben P and Parkinson K (2015) Impact of cigarette butt leachate on tidepool snails. Marine Pollution Bulletin 95:362–364. DOI: 10.1016/j.marpolbul.2015.04.004.

Bonanomi G, Incerti G, Cesarano G, Gaglione SA and Lanzotti V (2015) Cigarette butt decomposition and associated chemical changes assessed by 13C CPMAS NMR. PLoS ONE 10(1):e0117393. DOI: 10.1371/journal.pone.0117393.

Bonanomi G, Maisto G, Di Marco A, et al. (2020) The fate of cigarette butts in different environments: Decay rate, chemical changes, and ecotoxicity revealed by a 5-year decomposition experiment. Environmental Pollution 261:114108. DOI: 10.1016/j.envpol.2020.114108.

Cornelius ME, Wang TW, Jamal A, Loretan CG and Neff LJ (2019) Tobacco product use among adults—United States. MMWR Morbidity and Mortality Weekly Report 68(46):1013–1019. DOI: 10.15585/mmwr.mm6846e1.

Dunning H and Wilson J (2018) Cigarettes have a significant impact on the environment, not just health. Imperial College London News, 31 October 2018.

Dobaradaran S, Schmidt TC, Parodi NL, et al. (2020) Polycyclic aromatic hydrocarbons (PAHs) leach from cigarette butts into water. Environmental Pollution 259:113916. DOI: 10.1016/j.envpol.2020.113916.

Dobaradaran S, Soleimani F, Akhbarizadeh R, et al. (2021) Environmental fate of cigarette butts and their toxicity in aquatic organisms: A comprehensive systematic review. Environmental Research 195:110881. DOI: 10.1016/j.envres.2021.110881.

Euronews with AFP (2023) Climate activists pile up 650,000 cigarette butts in Portugal. Euronews, 24 April 2023.

Green A, Putschew A and Nehls T (2014) Littered cigarette butts as a source of nicotine in urban waters. Journal of Hydrology 519:3466–3474. DOI: 10.1016/j.jhydrol.2014.05.046.

Green DS, Boots B, Carvalho JDS and Starkey T (2019) Cigarette butts have adverse effects on initial growth of perennial ryegrass (Lolium perenne L.) and white clover (Trifolium repens L.). Ecotoxicology and Environmental Safety 182:109418. DOI: 10.1016/j.ecoenv.2019.109418.

Gong M, Daniels N and Poppendieck D (2020) Measurement of chemical emission rates from cigarette butts into air. Indoor Air 30:711–724. DOI: 10.1111/ina.12648.

Ghasemi A, Mofrad MMG, Parseh I, et al. (2022) Cigarette butts as a super challenge in solid waste management: A review of current knowledge. Environmental Science and Pollution Research 29:61984–62007. DOI: 10.1007/s11356-022-20893-9.

Konstantinou E, Fotopoulou F, Drosos A, et al. (2018) Tobacco-specific nitrosamines: A literature review. Food and Chemical Toxicology 118:198–203. DOI: 10.1016/j.fct.2018.05.008.

Kurmus H and Mohajerani A (2020) The toxicity and valorization options of cigarette butts. Waste Management 104:104–118. DOI: 10.1016/j.wasman.2020.01.011.

Kwit (2020) Cigarette butts: The main source of sea and ocean pollution.

Kwit (2022) Smoking and air pollution: What are the risks?

Koroleva E, Mqulwa A, Norris-Jones S, et al. (2021) Impact of cigarette butts on bacterial community structure in soil. Environmental Science and Pollution Research 28:28029–28040. DOI: 10.1007/s11356-021-13152-4.

Lee W and Lee CC (2015) Developmental toxicity of cigarette butts—An underdeveloped issue. Ecotoxicology and Environmental Safety 113:362–368. DOI: 10.1016/j.ecoenv.2014.12.018.

Logue JM, Sleiman M, Montesinos VN, et al. (2017) Emissions from electronic cigarettes: Assessing vapers' intake of toxic compounds, secondhand exposures, and the associated health impacts. Environmental Science & Technology 51(16):9271–9279. DOI: 10.1021/acs.est.7b00710.

Li L, Jia C, Zhu X and Zhang S (2020) Utilization of cigarette butt waste as a functional carbon precursor for supercapacitors and adsorbents. Journal of Cleaner Production 256:120326. DOI: 10.1016/j.jclepro.2020.120326.

Montalvão MF, Sampaio LLG, Gomes HHF and Malafaia G (2018) An insight into the cytotoxicity, genotoxicity, and mutagenicity of smoked cigarette butt leachate by using Allium cepa as a test system. Environmental Science and Pollution Research 26:2013–2021. DOI: 10.1007/s11356-018-3731-2.

Montalvão MF, Chagas TQ, Alvarez TGDS, et al. (2019) How leachates from wasted cigarette butts influence aquatic life? A case study on the freshwater mussel Anodontites trapesialis. Science of the Total Environment 689:381–389. DOI: 10.1016/j.scitotenv.2019.06.385.

Moroz I, Scapolio L, Cesarino I, Leao A and Bonanomi G (2021) Toxicity of cigarette butts and possible recycling solutions: A literature review. Environmental Science and Pollution Research 28:10450–10473. DOI: 10.1007/s11356-020-11856-z.

Min R (2023) Butt, why? The EU countries are weighing a ban on cigarette filters to deter smoking and cut pollution. Euronews Health, 2 May 2023.

Novotny TE, Lum K, Smith E, Wang V and Barnes R (2009) Cigarette butts and the case for an environmental policy on hazardous cigarette waste. International Journal of Environmental Research and Public Health 6(5):1691–1701. DOI: 10.3390/ijerph6051691.

Novotny TE, Hardin SN, Hovda LR, et al. (2011) Tobacco and cigarette butt consumption in humans and animals. Tobacco Control 20(Suppl 1):i17–i20. DOI: 10.1136/tc.2010.040303.

Oropesa AL, Floro AM and Palma P (2017) Toxic potential of the emerging contaminant nicotine to the aquatic ecosystem. Environmental Science and Pollution Research 24:16605–16616. DOI: 10.1007/s11356-017-9084-4.

Ozgunay SE, Karasu D, Dülger S, et al. (2018) Relationship between cigarette smoking and the carbon monoxide concentration in the exhaled breath with perioperative respiratory complications. Brazilian Journal of Anesthesiology 68:462–471. DOI: 10.1016/j.bjane.2018.02.003.

Olivia M, Marchi LD, Cuccaro A and Pretti C (2021) Bioassay-based ecotoxicological investigation on marine and freshwater impact of cigarette butt littering. Environmental Pollution 288:117787. DOI: 10.1016/j.envpol.2021.117787.

Poppendieck D, Khurshid S and Emmerich S (2016) Measuring airborne emissions from cigarette butts: Literature review and experimental plan. Final report to U.S. Food and Drug Administration.

Qamar W, Abdelgalil AA, Aljarboa S, Alhuzani M and Altamimi MA (2020) Cigarette waste: Assessment of hazard to the environment and health in Riyadh city. Saudi Journal of Biological Sciences 27:1380–1383. DOI: 10.1016/j.sjbs.2019.12.002.

Quemeneur M, Chifflet S, Akrout F, Bellaaj-Zouari A and Belhassen M (2020) Impact of cigarette butts on microbial diversity and dissolved trace metals in coastal marine sediment. Estuarine, Coastal and Shelf Science 240:106785. DOI: 10.1016/j.ecss.2020.106785.

Rehman MT and Mohajerani A (2021) Thermal conductivity and environmental aspects of cigarette butt-modified asphalt. Case Studies in Construction Materials 15:e00569. DOI: 10.1016/j.cscm.2021.00569.

Rehman K, Haider K and Akash MSH (2021) Cigarette smoking and nicotine exposure contribute to aberrant insulin signalling and cardiometabolic disorders. European Journal of Pharmacology 909:174410. DOI: 10.1016/j.ejphar.2021.174410.

Selmar D, Engelhardt UH, Hansel S, et al. (2015) Nicotine uptake by peppermint plants as a possible source of nicotine in plant-derived products. Agronomy for Sustainable Development 35:1185–1190. DOI: 10.1007/s13593-015-0298-7.

Semar D, Radwan A, Abdalla N, et al. (2018) Uptake of nicotine from discarded cigarette butts: A so far unconsidered path of contamination of plant-derived commodities. Environmental Pollution 238:972–976. DOI: 10.1016/j.envpol.2018.01.113.

Soleimani F, Dobaradaran S, De-la-Torre G, Schmidt T and Saeedi R (2022) Content of toxic components of cigarettes, cigarette smoke vs cigarette butts: A comprehensive systematic review. Science of the Total Environment 813:152667. DOI: 10.1016/j.scitotenv.2021.152667.

Tobacco Free Life (2016a) Smoking environmental risks.

Tobacco Free Life (2016b) Smoking's impact on the ocean—How cigarette butt litter pollutes our waters.

Truth Initiative (2017) Five ways cigarette litter impacts the environment.

Truth Initiative (2023) Tobacco and the environment.

Tanner K (2018) Survey designs. In: Williamson K and Johanson G (eds) Research methods. 2nd ed. Chandos Publishing, Cambridge, pp.159–192. DOI: 10.1016/B978-0-08-102220-7.00006-6.

Torkashvand J and Farzadkia M (2019) A systematic review on cigarette butt management as a hazardous waste and prevalent litter: Control and recycling. Environmental Science and Pollution Research 26:11618–11630. DOI: 10.1007/s11356-019-04250-x.

Venugopal PD, Hanna SK, Ganliano GG and Chang HW (2021) No butts on the beach: Aquatic toxicity of cigarette butt leachate chemicals. Tobacco Regulatory Science 7(1):17–30. DOI: 10.18001/TRS.7.1.2.

Weidner M, Martins R, Muller A, Simon J and Schmitz H (2005) Uptake, transport, and accumulation of nicotine by the golden pothos (Epipremnum aureum): The central role of root pressure. Journal of Plant Physiology 162:139–150. DOI: 10.1016/j.jplph.2004.07.012.

World Health Organization (2015) Tobacco control in Bangladesh.

World Health Organization (2017) World No Tobacco Day 2017: Beating tobacco for health, prosperity, the environment, and national development.

World Health Organization (2022) WHO raises alarm on tobacco industry environmental impact.

Zhou G (2019) Tobacco, air pollution, environmental carcinogenesis, and thoughts on conquering strategies of lung cancer. Cancer Biology & Medicine 16(4):700–713. DOI: 10.20892/j.issn.2095-3941.2019.0180.

Author Contributions

MT: Conceptualization, methodology, supervision, manuscript drafting ,final approval; **HI:** Data nalysis, statistical validation, manuscript editing; **NS:** Literature review, figure preparation, data collection, manuscript drafting; **SB:** Data curation, visualization; **JS**: Review and editing, reference formatting. All authors have read and approved the final manuscript.

Acknowledgements

Not applicable.

Funding

Not applicable.

Availability of data and materials

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Competing interest

The authors declare no competing interests.

Ethics approval

Ethical approval was obtained for conducting the survey. Informed consent was collected from all participants, and confidentiality and anonymity were maintained throughout the study.

The preprint version is available at https://www.researchsquare.com/article/rs-3745229/v1

Citation: Thakur M, Iqbal H, Singh N, Bhardwaj S and Singh J (2026) Butt Out: Addressing the Environmental and Public Health Impacts of Cigarette Butt Pollution. Environmental Science Archives 5(1): 18-30.