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Research

Burning truth: chemical formation and health hazards of tobacco smoking

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Abstract

Since the beginning of time, smoking for a number of years has been recognized to create serious health problems in people. Ironically, despite the fact that smoking is a harmful addiction that can be fatal, its prevalence is still not declining to a level that is desired. Smokers are growing unhappy as a result of their smoking habit.Tobacco smoking is the biggest preventable cause of mortality, resulting in about 6 million deaths annually worldwide. In 2007, smoking was the main cause of adult fatalities from non-communicable diseases, resulting in an average 10-year loss of life compared to non-smokers. There is currently a dearth of research reviewing the formation properties of nicotine, aldehydes, and phenols as well as the etiological dangers they pose. Therefore, understanding the chemical characteristics and the production of free radicals during tobacco burning is crucial to determining how smoking behavior and disease are related.

Keywords: Smoking, Cessation, Nicotine, Cigarette

INTRODUCTION

India's tobacco problem is extremely complex, with widespread use of a variety of smoking methods and smokeless tobacco products. Many of these products are manufactured in cottage and small-scale industries, with varying mixtures and manufacturing processes.

Every year, tobacco usage kills around six million individuals globally. The World Health Organization (WHO) estimates that 100 million premature deaths worldwide occurred as a result of tobacco use in the 20th century, and if present tobacco consumption trends continue, this number is predicted to increase to 1 billion in the 21st.

The health effects, advantages of quitting, chemical nature and behaviour, psychological, pharmacological, and social factors that contribute to the adoption and maintenance of the behaviour, and strategies to lessen the harm even in the face of ongoing tobacco or nicotine use are all covered in this paper.

In its many forms, tobacco is lethal. There is no question that exposure to tobacco smoke results in death, illness, and disability, according to scientific research. The International Agency for Research on Cancer (IARC) monograph states that there is enough proof that tobacco use causes cancer in humans, including cancer of the lung, oral cavity, naso-, oro-, and hypopharynx, nasal cavity and paranasal sinuses, larynx, esophagus, stomach,

pancreas, liver, kidney (body and pelvis), ureter, urinary bladder, uterine cervix, and bone marrow (myeloid leukemia). Although there is not enough proof to conclude that smoking cigarettes causes colorectal cancer, it is known to be linked to the disease.

Smoking is responsible for 80% of lung cancer fatalities in women and 90% in men. Active smoking has a well-established causal relationship with cardiovascular illness, chronic obstructive pulmonary disease, and poor reproductive consequences. Research on bidi smoking, which is the most prevalent type of tobacco use in India, shows that it is a carcinogenic chemical. Bidi smoking is strongly linked to malignancies in a number of locations, including the stomach, pharynx, larynx, esophagus, lung, and oral cavity (including subsites), according to case-control studies. Nearly every study demonstrates noteworthy patterns in the amount of bidis smoked and the length of time spent smoking them.

Useful and Harmful Chemicals of Tobacco

There are thousands of compounds in tobacco smoke, such as:

Nicotine, Carbon monoxide, and harmful substances like formaldehyde, arsenic, and benzene. Chemicals found in tobacco products of all kinds have the potential to be hazardous to your health. These substances can harm a developing fetus in a pregnant woman and have been connected to lung, heart, and cancer disorders. Nicotine can also be found in tobacco products. You could find it difficult to stop smoking and keep being exposed to these toxins since nicotine is addicting.

Tobacco Smoke

Cigarettes, cigars, and pipe tobacco are all created from dried tobacco leaves. Chemicals are routinely used to enhance flavor and improve the smoking experience. The smoke produced by these items is a complex mixture of chemicals resulting from the combustion of tobacco and additives.

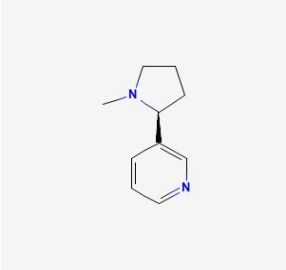
Carcinogens

Tobacco smoke contains thousands of compounds, including at least 70 recognized carcinogens. These cancer-causing substances are known as carcinogens1. Some of the carcinogens detected in tobacco smoke are:

- Aldehyde
- Arsenic
- Benzene
- Cadmium
- Hydrazine
- Formaldehyde
- Lead
- Nickel
- Polycyclic aromatic compound (PHAs)
- Radioactive elements,such as Uranium-235, Polonium-210 etc
- Tobacco – specific nitramines (TSNAs)
- Vinyl chloride

Cancer is known to be caused by certain chemicals. Some may also harm a developing fetus in a pregnant woman or cause lung or heart problems. The majority of the compounds originate from the actual burning of tobacco leaves. Tobacco smoke is classified as mainstream or sidestream for risk assessment purposes. Mainstream smoke is inhaled through the cigarette's column and filter tip. Nonsmokers can inhale sidestream smoke, which is exhaled from a burning cigarette between puffs. Although mainline and sidestream smoke have comparable chemical compositions, sidestream, or "passive," smoke contains a higher concentration of several elements.

Nicotine



[Structure of Nicotine(C10H14N2)]

Nicotine, the second most prevalent element of tobacco smoke, is responsible for tobacco's addictive characteristics and is a significant source of TSNAs. 3 Nicotine is found in both mainstream and sidestream smoke and is quickly absorbed by the alveoli of the lungs. Nicotine accumulates in the pulmonary veins as a bolus and circulates throughout the body. Nicotine dependency is thought to result from the subsequent release of dopamine through the stimulation of cholinergic receptors in the brain and the manipulation of hormones such as adrenaline and cortisol. The impact of polymorphisms in the dopamine transporter (SLC6A3) and dopamine D2 receptor (DRD2) genes on smoking initiation and nicotine dependency is still debated and under investigation.

The presence of natural acids and bases, the tobacco blend, tip ventilation, and the usage of additives are some of the variables that determine whether the nicotine in cigarette smoke is protonated or unprotonated. The design of cigarettes makes sure that there is just enough unprotonated nicotine in the smoke to quickly deliver nicotine to the body without being too harsh for the user to continue smoking.

Nicotine addiction is another acute, clinically harmful health effect of cigarette smoking. According to the 2012 Surgeon General's study, smoking cigarettes is causally linked to nicotine addiction, which starts in adolescence. Shortly after starting to smoke, nicotine addiction starts to develop. It is impossible to overstate the significance of nicotine addiction as an immediate negative health consequence. Through its role in encouraging prolonged smoking, nicotine addiction plays a key role in determining all of the negative health impacts of cigarette smoking. The underlying cause of the long-term, continuous exposure to the chemicals in tobacco smoke that fuel the negative health effects of cigarette smoking is the frequently chronic, long-lasting addiction to nicotine.

Radioactive material in Tobacco smoke

The tobacco leaves used to create cigarettes contain radioactive elements. They originate from the soil and fertilizer used to cultivate the tobacco leaves. The type of fertilizer used and the soil in which the plants were grown determine how much radioactive material is present in tobacco leaves.

The combinations of tobacco and tobacco smoke are quite complicated. They contain a variety of organic and chemical substances as well as naturally occurring radioactive elements, or radionuclides. This study reports the natural radionuclide activity concentrations of nine distinct cigarette samples that are sold in Slovenia: 234U, 238U, 228Th, 230Th, 232Th, 226Ra, 210Pb, and 210Po. For the first time, it has been established that thorium isotopes, in addition to 210Po, are transferred from cigarettes to the body and lungs of smokers.

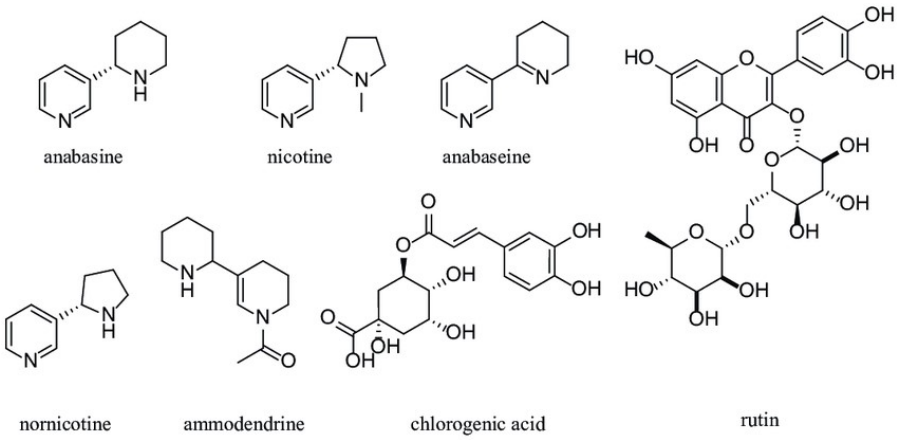
To find out how much 210Po and thorium isotope is transported from the tobacco to the smoker's lungs, cigarette smoke and exhaled air from smokers' lungs were collected from volunteer smokers (C-4 brand). Additionally, smoked filters and cigarette ash were gathered and examined. 210Pb and 210Po have the greatest activity concentrations among the identified isotopes. About 22% of 210Po (and most likely its precursor 210Pb), 0.6% of 228Th, 24% of 230Th, and 31% of 232Th are transmitted from the cigarette and maintained in the smoker's body throughout a single cigarette. Smokers are projected to receive 61 μSv/year from 210Po, 9 μSv/year from 210Pb, 6 μSv/year from 228Th, 47 μSv/year from 230Th, and 37 μSv/year from 232Th as their yearly effective dosage. These findings demonstrate how crucial thorium isotopes are in determining the yearly effective dose for smoking.

Cigarettes and cigars emit radioactive elements through smoke inhalation. Prolonged exposure to this radiation can harm your lungs and worsen the effects of other carcinogens. This may increase your chance of lung cancer.

Many of the listed components (such as methyl chloride, acetamide, and styrene) have not been thoroughly investigated in benchmark trials involving a range of commercially available brands. The variability of toxicants across brands and the possibility of toxicant reduction can be assessed once data has been obtained. As a result, it is advised that the list of dangerous smoke components be tracked across many brands and smoking habits. Many components already have approved methodologies accessible from organizations like Health Canada and the International Organization for Standardization (ISO). Such techniques must be created or adapted from other applications for other components. NNK, NNN, acetaldehyde, acrolein, benzene, benzo(a)pyrene, 1,3-butadiene, carbon monoxide, and formaldehyde will all be measured using harmonized and validated standards inside the FCTC framework.

Once the list of components has been further investigated and monitored, and the results have been reviewed, another component from the shortlist can be chosen for regulatory purposes. Other criteria that can be considered include the unpredictability of the toxicants across brands, the potential for the toxicant to be reduced, the requirement to include components from other chemical classes, and any attractiveness- or addictiveness-enhancing effects of components. Routine collection and analysis of specific smoke components will hasten progress in tobacco control.

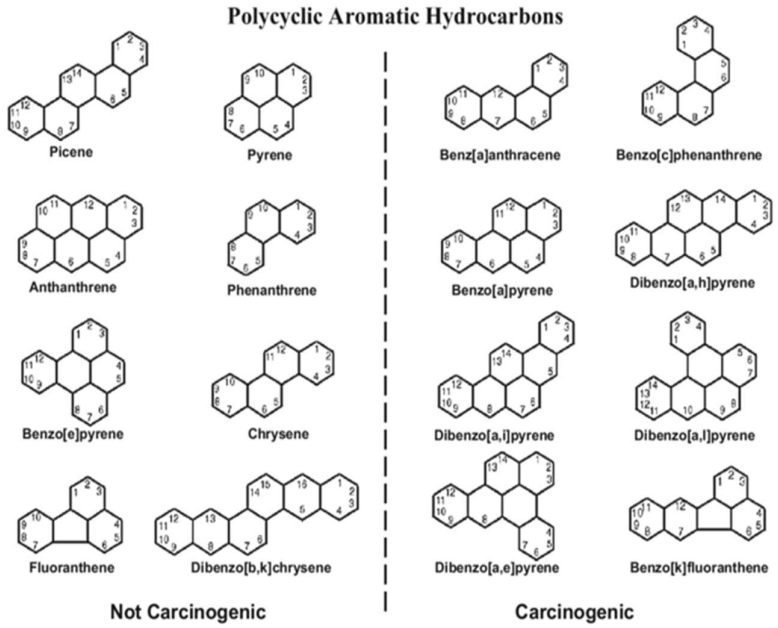
Tobacco Alkaloids



High alkaloid-content plants, like tobacco, frequently have a built-in pharmacologic defense against insects, vertebrates, and microbes. For instance, nicotine has long been produced from tobacco for use as a commercial insecticide despite being harmful to many insects. Anatabine, anabasine, nornicotine, N-methylanabasine, anabaseine, nicotine, nicotine N′-oxide, myosmine, β-nicotyrine, cotinine, and 2,3′-bipyridyl are among the alkaloids found in tobacco leaves. Nicotine contents in commercial tobacco products vary from 6 to 18 mg/g (0.6 to 1.8 percent by weight). The combined concentrations of nor-nicotine, anatabine, and anabasine make up around 5% of the nicotine concentration. Numerous minor tobacco alkaloids have one or more pharmacological effects on humans. In a number of animal experiments, Clark and associates (1965) found that some of these alkaloids had physiological effects.

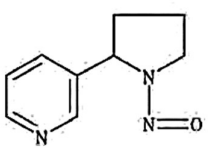
Polycyclic aromatic compound (PHAs)

PAHs are chemical compounds containing two or more condensed aromatic and cyclic rings of carbon and hydrogen atoms. Recent investigations have found at least 539 PAHs in tobacco smoke. The United States Environmental Protection Agency (EPA) has selected sixteen priority environmental PAHs based on evidence that they cause or may cause cancer. acenaphthylene, acenaphthene, anthracene, benz[a] anthracene, benzo[a]pyrene (B[a]P), benzo[b]fluoranthene (B[b]F), benzo[k]fluoranthene (B[k]F), benzo[g,h,i] perylene, chrysene, dibenz[a,h]anthracene, fluoranthene, fluorene, indeno[1,2,3-cd]pyrene, naphthalene, phenanthrene and pyrine.

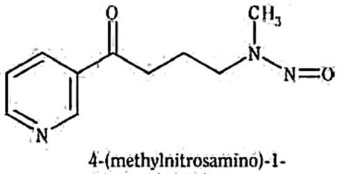


The 16 PAHs were found in tobacco smoke particle matter. They have molecular weights ranging from 128 to 278 and two to six fused rings. The distribution of PAHs in the gas and particle phases of tobacco smoke changes with the boiling point, and they range from extremely volatile to comparatively nonvolatile. However, only an estimated 1% of the total PAHs present in tobacco smoke were detected in the gas phase. Mainstream smoke has a different PAH composition than sidestream smoke, and its lipophilic properties range from moderate to high.

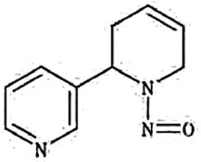
N-nitrosamines



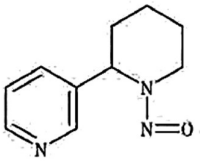
N'-nitrosonornicotine



4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone



N'-nitrosoanatabine



N'-nitrosoanabasine

A class of chemical compounds known as N-nitrosamines has an amine nitrogen joined to a nitroso group. Tobacco and tobacco smoke contain both volatile and nonvolatile nitrosamines, including TSNAs. N-nitrosodimethylamine, N-nitrosoethylmethylamine, N-nitrosodiethylamine, N-nitro-sopyrrolidine, and N-nitrosomorpholine are examples of volatile nitrosamines. The following are examples of nonvolatile nitrosamines: 3-(N-nitroso-N-methylamino)propionic acid, N-nitrosoproline, N-nitrosopipecolic acid, N-nitroso-sarcosine, and 4-(N-nitroso-N-methyl-amino)butyric acid. Numerous studies have been conducted on tobacco and tobacco smoke's nonvolatile TSNAs (Figure 3.4). These consist of 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), N′-nitrosoanatabine (NATB), N′-nitrosoanabasine (NAB), and N′-nitrosonornicotine (NNN). Smokers are exposed to higher levels of TSNAs than other nitrosamines, and tobacco products have higher levels of nitrosamines than other consumer goods like beer and cooked bacon.

Health Impact of Smoking and the Advantages of Quitting

About 6 million individuals globally and 96,000 in the UK are thought to die young each year as a result of tobacco use. A "premature death from smoking" occurs when a person who would have died later from another cause passes away from a smoking-related illness. Ten years of life are wasted on average as a result of these untimely deaths. People who have quit smoking but whose health has already been negatively impacted by smoking account for a large number of these deaths. Additionally, smokers who continue to smoke lose an average of 10 years off their life expectancy when compared to those who never smoke, and they begin to experience the onset of old age-related illnesses about 10 years before non-smokers do.

Impact of smoking on Health

Table 1: Main Cause of death from Tobacco Smoking and Advantages of quitting

Cause of death from smoking	Advantages of quitting smoking
Coronary heart disease and stroke	Preventable if cessation occurs in early adulthood; at least partially reversible thereafter
Cancers of the lung and upper airways	Preventable if cessation occurs in early adulthood; further increase in risk prevented thereafter
Chronic obstructive pulmonary disease	Preventable if cessation occurs in early adulthood; further decline in lung function slowed thereafter

Cause of death from smoking	Advantages of quitting smoking
Miscarriage and underdevelopment of foetus	Preventable if cessation occurs early in pregnancy; risk is mitigated by stopping at any time in pregnancy

Diseases are positively correlated, but the relationship is non-linear in the case of cardiovascular disease, meaning that low cigarette consumption carries a higher risk than one might anticipate from a straightforward linear relationship. Cancers (mostly lung cancer), respiratory conditions (primarily chronic obstructive pulmonary disease, or COPD), and cardiovascular conditions (primarily coronary heart disease) account for the majority of smoking-related deaths. Smoking increases the risk of stroke, osteoporosis, back pain, blindness, deafness, and peripheral vascular disease, which can result in amputation. Smokers typically have greater degrees of discomfort and disability than non-smokers beyond the age of 40.

Both men and women who smoke have lower fertility. Pregnancy-related smoking impairs fetal development, raises the chance of miscarriage, neonatal mortality, and respiratory illnesses in the fetus, and is likely to contribute to mental health issues in the child.

Average daily cigarette consumption and the risk of smoking-related Carbon monoxide (CO) is another gas found in tobacco smoke. CO is a strong poison that causes hemoglobin molecules to lose their oxygen. But immediately, the body makes more red blood cells to make up for the lack of CO in tobacco smoke, which is too little to cause hypoxia. Tobacco smoke contains nicotine, which may contribute slightly to the rise in cardiovascular disease but little to no increase in the risk of cancer or respiratory illnesses. Nearly 90% of the harm is caused by the other ingredients in cigarette smoke. Studies with other species have suggested that nicotine harms the adolescent brain, but there is no proof that people who smoked as adolescents and then quit do not have clinically significant impairments in their ability to think or feel.

Both adults and children are at serious risk from second hand smoking exposure. As a result, non smokers who are around smoke are more likely to get heart disease, cancer, and respiratory conditions.

One of the main causes of cancer and cancer-related deaths is tobacco usage. Because tobacco products and second hand smoke include numerous chemicals that damage DNA, people who use tobacco products or are frequently around environmental tobacco smoke, also known as second hand smoke, are more likely to develop cancer. Numerous cancers are brought on by tobacco use, including acute myeloid leukemia and cancers of the lung, larynx (voice box), mouth, esophagus, throat, bladder, kidney, liver, stomach, pancreas, colon, and rectum, as well as the cervix. Individuals who use smokeless tobacco, such as snuff or chewing tobacco, are more likely to develop pancreatic, esophageal, and oral malignancies. Tobacco use has no safe threshold. People who use tobacco products of any kind are strongly encouraged to stop. Regardless of age, quitting smoking significantly increases life expectancy as compared to continuing to smoke. Additionally, the risk of death is decreased when smoking cessation occurs at the time of a cancer diagnosis.

Advantages of quitting smoking

- After about age 35, quitting smoking restores 2–3 months of healthy life expectancy for each year of abstinence, or 4–6 hours for each day.
- The effects of quitting smoking vary depending on the type of smoking-related illness. Within a year of quitting smoking, the excess risk of heart attack brought on by smoking decreases by 50%. Quitting smoking lowers the frequency of "exacerbations," or sudden episodes of breathing difficulties that cause death or hospitalization in people with COPD, but it does not reverse the rate of reduction in lung function, which returns to the usual age-related decline.
- Giving up smoking "freezes" the risk of smoking-related malignancies at the level at which quitting occurs, but it does not completely reduce it.
- Compared to smokers who continue, people who quit exhibit lower levels of stress and mood disorders. Compared to those who continue, they also report higher levels of happiness and life satisfaction.
- This implies that smoking may have a negative impact on mental health, but the available

Some health advantages start to show nearly right away. Eliminating tobacco use every week, month, and year enhances your health even more.

- Your heart rate and blood pressure return to normal after 20 minutes of stopping.
- Your blood carbon monoxide level returns to normal after 12 hours of stopping.
- Within two weeks to three months of stopping, your lung function improves and your circulation gets better.
- Shortness of breath and coughing lessen 1 to 9 months after stopping, Your airways and lungs are better equipped to manage mucus, keep your lungs clean, and lower your risk of infection.
- Your risk of coronary heart disease is halved after a year of quitting compared to those who continue to use tobacco. Your risk of having a heart attack drastically decreases.

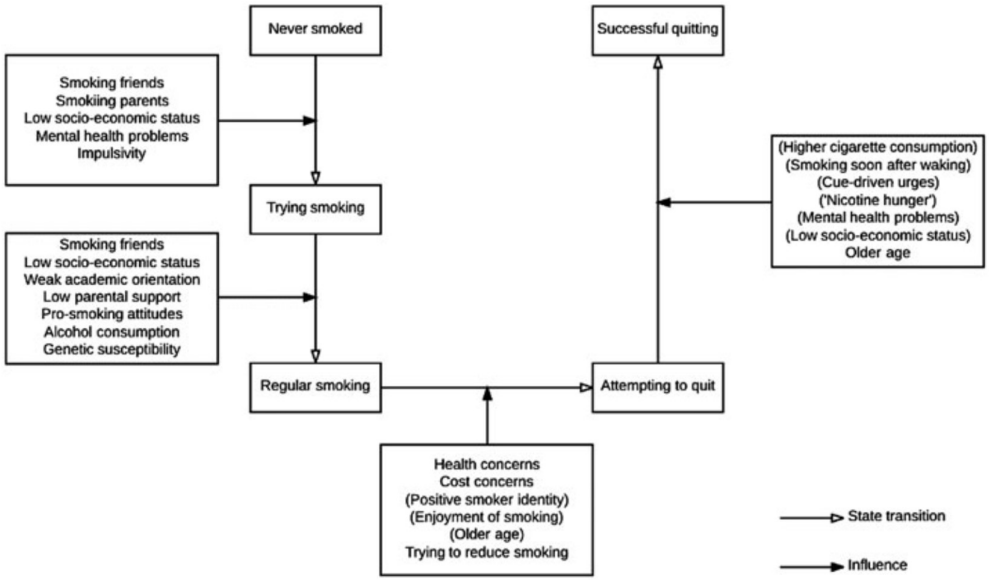
- You cut your risk of bladder, esophageal, throat, and oral cancers in half within five years of stopping. The risk of cervical cancer is lower than that of non smokers. After two to five years, your risk of stroke can drop to that of a non smoker.
- Your chance of dying from lung cancer within 10 years of stopping is around half that of someone who continues to smoke.
- You have the same risk of coronary heart disease as a non-smoker within 15 years of stopping.

Social, physiological, and psychological aspects of smoking and quitting

States and variables that affect the change between these can be used to represent the natural history of smoking. The variables specified in the diagram are provided descriptively without making an effort to explain how they might be related. Figure 1 illustrates transitions that have been studied

Smoking initiation

In western societies, having parents who smoke, friends who smoke, low social status, impulsivity, and a propensity for mental health issues are all significant predictors of beginning.



Factors linked to changes in the natural history of smoking (negative connections are indicated by parenthesis.

The pattern of smoking varies greatly, sometimes occurring quickly and other times taking years. In western countries, smoking initiation has a "heritability" of between 30 and 50 percent, which is the percentage of variance in a feature that can be attributed to genetic rather than environmental variable. This indicates that about half of the variation in an individual's propensity to start smoking can be explained by variations in their genetic composition. This does not negate the importance of environmental influences, as seen by the sharp drop in smoking initiation that has occurred in many western nations since the 1970s.

In western civilizations, cigarette addiction (as opposed to smoking) has a 70–80% heritability rate. Here, "cigarette addiction" refers to the degree to which a person feels compelled to smoke. The quantity of cigarettes smoked daily and the amount of time between waking up and smoking the first cigarette of the day are typically used as indicators. The self-reported intensity of cravings to smoke can also be used as an indicator. Cigarette addiction is more heritable than smoking and smoking start, as measured by the failure of cessation attempts. This implies that genetic variations have a greater impact on quitting smoking than on initiating smoking.

Smokeless Tobacco Products

In recent years, the market for smokeless tobacco products has seen significant diversification. A variety of innovative products, including snus and dissolvable tobacco products, have been introduced in addition to the conventional smokeless tobacco products of chewing tobacco and snuff. After reviewing the data, the Surgeon General's study from 1986 came to the conclusion that smokeless tobacco was a contributing factor to oral cancer. Additionally, using smokeless tobacco can result in nicotine addiction, gingival recession, and oral leukoplakia.

According to a 2007 International Agency for Research on Cancer (IARC) publication, smokeless tobacco is a Group 1 carcinogen, which means it can cause cancer in humans.

"Smokeless tobacco causes cancers of the oral cavity and pancreas," the IARC concluded after reviewing the evidence. Additionally, smokeless tobacco may raise the risk of esophageal cancer. The research pertaining to traditional smokeless tobacco products was the main focus of these earlier studies of the evidence regarding the health implications of smokeless tobacco usage, and the more recent products were not considered. According to a more recent analysis of the epidemiologic data supporting Swedish-type snus, a wet snuff, using snus might not be as bad as smoking cigarettes.

RESULTS

Nicotine's rapid, inexpensive, and palatable delivery of both positive and negative reinforcements is what largely sustains smoking behavior; the negative health effects are typically too uncertain and far off in the future to cause enough immediate anxiety to stop the behavior. Smokers may attempt to quit more frequently if immediate concerns about smoking are raised by tax rises, social marketing, and quick guidance from medical professionals. The likelihood that those quit attempts will be successful can be increased by offering behavioral and medication help. Reducing the prevalence of tobacco use and smoking-related deaths and illnesses can be achieved by the implementation of national programs that include these elements.

CONCLUSION

Significant health hazards associated with tobacco usage include cancer, heart disease, premature death and respiratory issues. Giving up tobacco use can lower the risk of tobacco-related health issues and significantly improve health outcomes. Giving up tobacco use can lower the risk of tobacco-related health issues and significantly improve health outcomes. It boosts vitality, improves quality of life, and advances general wellbeing. Education and awareness are essential, as are attempts to reduce tobacco use. Tobacco cessation efforts require collaboration between communities and governments. Although quitting tobacco is difficult, it is doable with counseling, support, and nicotine replacement treatment. Living without tobacco improves one's health and happiness. Put your health and wellbeing first by abstaining from any tobacco use, taking precautions for both you and other people, and making wise decisions. Choose life and refuse tobacco. Give up smoking now so you can breathe easier tomorrow. Make constructive changes for a better future and live a happy, healthy life. Give up smoking and live.

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