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A COMPREHENSIVE REVIEW ON TOXIC CHEMICAL COMPOSITION OF CIGARETTE SMOKE AND ITS IMPACT ON RESPIRATORY HEALTH

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ABSTRACT

Cigarette smoke is a complex mixture of over 7,000 chemical compounds, many of which are toxic, carcinogenic, and harmful to human health. This review provides a comprehensive analysis of the toxic chemical composition of cigarette smoke, including major constituents such as nicotine, carbon monoxide, tar, formaldehyde, benzene, and heavy metals. The paper explores how these substances interact with the respiratory system, leading to structural and functional impairments. Chronic exposure to cigarette smoke is strongly associated with respiratory diseases such as chronic obstructive pulmonary disease (COPD), asthma, bronchitis, and lung cancer. Mechanisms of damage include oxidative stress, inflammation, impaired mucociliary clearance, and cellular DNA damage. The review also highlights the impact of both active and passive smoking on respiratory health, emphasizing vulnerable populations such as children and the elderly. Understanding the chemical toxicity and its pathological consequences is essential for developing effective prevention strategies and public health policies aimed at reducing smoking-related morbidity and mortality. Cigarette smoke is a complex mixture of thousands of toxic and harmful chemicals that significantly affect respiratory health. This review examines the main toxic components of cigarette smoke, including nicotine, carbon monoxide, tar, and carcinogenic compounds, and their impact on the human respiratory system. Continuous exposure to these substances leads to oxidative stress, chronic inflammation, and structural damage to lung tissues. As a result, cigarette smoking is strongly associated with several respiratory diseases such as chronic obstructive pulmonary disease (COPD), chronic bronchitis, emphysema, asthma exacerbations, and lung cancer. Additionally, smoking increases the risk of respiratory infections like pneumonia and reduces overall lung function. Both active smoking and passive (secondhand) smoke exposure contribute to disease development, particularly in vulnerable populations such as children and the elderly. Understanding the link between toxic chemical exposure and respiratory diseases is essential for improving prevention strategies and reducing the global burden of smoking-related illnesses.

KEYWORDS: Cigarette smoke, toxic chemicals, respiratory health, nicotine, carbon monoxide, tar, carcinogens, oxidative stress, inflammation, COPD, lung cancer, passive smoking.[1]

INTRODUCATION

Cigarette smoking remains one of the leading causes of preventable disease and death worldwide, posing a major threat to public health. Cigarette smoke is a highly complex and dynamic mixture composed of more than 7,000 chemical compounds, of which hundreds are toxic and at least 70 are known carcinogens.[2] These chemicals exist in both particulate and gaseous phases and are generated through the incomplete combustion of tobacco.[3] The inhalation of this toxic mixture exposes the respiratory system to a wide range of harmful substances, making the lungs the primary target of smoking-related damage.The main toxic constituents of cigarette smoke include nicotine, carbon monoxide, tar, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), aldehydes such as formaldehyde and acrolein, and heavy metals including cadmium, lead, and arsenic.[4] Nicotine is the primary addictive component that sustains tobacco dependence, while carbon monoxide reduces oxygen-carrying capacity of blood, leading to tissue hypoxia. Tar contains numerous carcinogenic compounds that accumulate in the lungs, promoting cellular mutations and tumor development.[5] Additionally, reactive oxygen species (ROS) and free radicals present in cigarette smoke contribute significantly to oxidative stress and cellular injury.[6]

The respiratory system is particularly vulnerable due to its direct exposure to inhaled smoke. The airway epithelium, alveoli, and pulmonary defense mechanisms are adversely affected by repeated exposure to toxic chemicals. One of the key pathological mechanisms involved is oxidative stress, which results from an imbalance between free radicals and the body’s antioxidant defenses.[7] This leads to lipid peroxidation, protein damage, and DNA mutations. Furthermore, cigarette smoke induces chronic inflammation by activating immune cells and releasing pro-inflammatory cytokines, which contribute to tissue damage and remodeling of the airways.[8] Prolonged exposure to cigarette smoke is strongly associated with the development of several serious respiratory diseases. Chronic obstructive pulmonary disease (COPD), which includes chronic bronchitis and emphysema, is one of the most common outcomes and is characterized by persistent airflow limitation and progressive lung function decline.[9] Smoking is also the primary risk factor for lung cancer, a leading cause of cancer-related mortality globally. In addition, cigarette smoke exacerbates asthma, increases susceptibility to respiratory infections such as pneumonia, and impairs mucociliary clearance, reducing the lungs' ability to remove harmful particles and pathogens.[10]

Importantly, the harmful effects of cigarette smoke are not limited to active smokers. Passive or secondhand smoke exposure also contains many of the same toxic chemicals and poses significant health risks, particularly to children, pregnant women, and the elderly. Environmental tobacco smoke has been linked to increased incidence of asthma, respiratory infections, and reduced lung development in children.[11]

In recent years, growing awareness of the toxic chemical composition of cigarette smoke and its impact on respiratory health has led to stronger tobacco control policies and public health interventions. However, smoking continues to be prevalent in many parts of the world, emphasizing the need for continued research, education, and preventive strategies.

Understanding the relationship between toxic chemical exposure and respiratory disease is essential for developing effective treatments and reducing the global burden of smoking-related illnesses.[12]

Chemical Components of Cigarette Smoke and Their Impact on Human Health

1. Nicotine

Nicotine is the primary addictive chemical present in cigarette smoke that directly affects the brain and nervous system. It stimulates the release of dopamine, creating a feeling of pleasure and dependence. Nicotine increases heart rate and blood pressure, putting extra strain on the cardiovascular system. Although it is not the main cause of cancer, it plays a crucial role in maintaining smoking addiction, which leads to prolonged exposure to other harmful chemicals.[13]

2. Carbon Monoxide

Carbon monoxide is a poisonous gas produced during the burning of tobacco. It binds strongly with hemoglobin in the blood, reducing the blood's ability to carry oxygen to vital organs. This results in tissue hypoxia, which can damage the heart and brain. Long-term exposure increases the risk of cardiovascular diseases, including heart attacks.

3. Tar

Tar is a sticky, dark substance that accumulates in the lungs when cigarette smoke is inhaled. It damages the cilia, which are responsible for cleaning the airways of dust and pathogens. As a result, mucus builds up, leading to coughing and infections. Tar contains many carcinogenic substances that significantly increase the risk of lung cancer and chronic respiratory diseases like bronchitis and emphysema.[14]

4. Formaldehyde

Formaldehyde is a highly toxic chemical commonly used as a preservative. In cigarette smoke, it irritates the respiratory tract, causing symptoms such as coughing, throat irritation, and breathing difficulties. Prolonged exposure damages lung tissues and increases the likelihood of developing cancers, especially of the respiratory system.[15]

5. Benzene

Benzene is a well-known carcinogen found in cigarette smoke that affects the blood and bone marrow. It interferes with the production of blood cells, leading to conditions such as anemia and leukemia. Benzene also weakens the immune system, making the body more vulnerable to infections and diseases.[16]

6. Ammonia

Ammonia is added to cigarettes to enhance nicotine absorption, increasing its addictive effects. It irritates the eyes, nose, and throat and damages the lining of the respiratory tract. Continuous exposure leads to breathing discomfort and contributes to long-term respiratory problems.[17]

7. Hydrogen Cyanide

Hydrogen cyanide is a highly toxic compound that interferes with the body's ability to use oxygen at the cellular level. It damages lung tissues and paralyzes the cilia, reducing the lungs' ability to clear harmful substances. This leads to an increased risk of respiratory infections and chronic lung diseases.

8. Acrolein

Acrolein is a strong irritant that severely affects the lungs and airways. It causes inflammation and damages the cells lining the respiratory tract. This results in reduced lung function and contributes to diseases such as chronic obstructive pulmonary disease (COPD).[18]

9. Cadmium

Cadmium is a toxic heavy metal present in cigarette smoke that accumulates in the body over time. It primarily affects the lungs and kidneys, causing organ damage. Cadmium is also associated with weakened bones and has been linked to the development of cancers.[19]

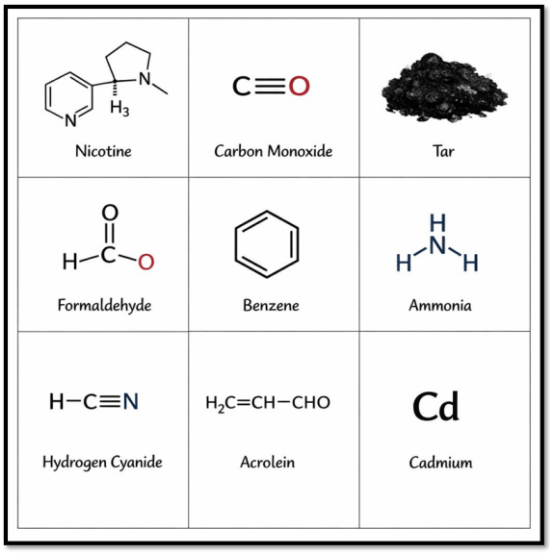

Fig: Harmful chemical Substance for Lungs.

Diseases Caused by Cigarette Smoke

1. Chronic Obstructive Pulmonary Disease (COPD)

COPD is one of the most common diseases caused by cigarette smoking. It includes chronic bronchitis and emphysema. Harmful chemicals such as tar, acrolein, nitrogen oxides, and formaldehyde continuously irritate the airways and lung tissues. These toxic substances cause chronic inflammation, narrowing of bronchi, mucus accumulation, and destruction of alveoli. Over time, breathing becomes difficult, oxygen exchange decreases, and the patient experiences cough, wheezing, and shortness of breath.[20]

2. Chronic Bronchitis

Chronic bronchitis occurs when cigarette smoke repeatedly irritates the bronchial tubes. Chemicals like tar, sulfur dioxide, and ammonia inflame the bronchial lining and stimulate excessive mucus production. The cilia that normally remove mucus become damaged, causing mucus retention and persistent cough. Long-term smoking leads to narrowed airways and breathing discomfort.

3. Emphysema

Emphysema is caused by the destruction of alveoli, the tiny air sacs responsible for gas exchange. Toxic compounds such as cadmium, tar, and free radicals damage alveolar walls and reduce lung elasticity. As the alveoli collapse or merge, the lungs lose their ability to exchange oxygen efficiently. This results in severe breathlessness, fatigue, and reduced physical activity.[21]

4. Lung Cancer

Lung cancer is strongly associated with cigarette smoking. Smoke contains carcinogens such as benzene, arsenic, chromium, cadmium, nitrosamines, and polonium-210. These chemicals damage DNA in lung cells, causing mutations

and uncontrolled cell growth. Repeated exposure increases the chance of tumor formation, especially after long-term smoking.

5. Asthma Exacerbation

Smoking may worsen asthma or trigger asthma attacks. Chemicals such as formaldehyde, acrolein, and particulate matter irritate sensitive airways and cause bronchospasm. The airways become inflamed, swollen, and narrow, leading to wheezing, chest tightness, coughing, and breathing difficulty.

6. Pneumonia and Respiratory Infections

Smokers are more prone to lung infections such as pneumonia. Nicotine, tar, and carbon monoxide weaken the immune defenses of the respiratory tract. Cigarette smoke damages cilia, which normally remove bacteria and dust. As a result, microbes remain trapped in the lungs and infections develop more easily.[22]

7. Tuberculosis (TB)

Smoking increases the risk of tuberculosis and worsens its severity. Nicotine and tar suppress immune cells that help fight Mycobacterium tuberculosis. Damaged lungs become more vulnerable to infection, and smokers have a higher chance of activating latent TB.

8. Interstitial Lung Disease / Pulmonary Fibrosis

Long-term exposure to smoke chemicals such as cadmium, nickel, and oxidants may cause chronic inflammation and scarring of lung tissues. This fibrosis thickens lung walls and reduces lung flexibility. Patients experience dry cough, fatigue, and difficulty breathing.

9. Reduced Lung Function

Smoking gradually reduces overall lung function. Carbon monoxide decreases oxygen transport by binding to hemoglobin, while tar blocks air passages and nicotine constricts blood vessels. This reduces oxygen supply and makes physical activity more difficult.[23]

10. Respiratory Failure

In severe chronic smokers, progressive lung damage may lead to respiratory failure. The lungs become unable to maintain normal oxygen and carbon dioxide levels. This condition is life-threatening and often develops from advanced COPD, emphysema, or lung cancer.

Fig: Harm caused by smoking.

Detailed Steps to Avoid Lung Damage

1. Quit Smoking Completely

The most important step to prevent lung damage is to stop smoking cigarettes, bidis, cigars, and other tobacco products. Cigarette smoke contains thousands of toxic chemicals such as tar, nicotine, carbon monoxide, formaldehyde, and benzene that continuously injure lung tissues. Quitting smoking reduces airway inflammation, improves oxygen supply, and allows the lungs to begin natural repair. Within weeks of quitting, breathing often improves and coughing may decrease.

2. Avoid Secondhand Smoke

Even if a person does not smoke, inhaling smoke from others can also harm the lungs. Secondhand smoke contains many of the same dangerous chemicals found in directly inhaled smoke. Regular exposure can cause irritation of the airways, asthma attacks, bronchitis, and increased risk of lung disease. Staying away from smoking areas and maintaining smoke-free homes is highly beneficial.[24]

3. Use Cigarette Filters / Smoke Filters

If a smoker is unable to quit immediately, the use of cigarette filters or advanced smoke filtration devices may help reduce the intake of tar, particulate matter, and some toxic chemicals. These filters are designed to trap harmful substances before they reach the lungs. Although filters do not make smoking safe and quitting remains the best option, they may lower exposure to certain toxic compounds and can be considered a harm-reduction step during smoking cessation efforts.

4. Use Protective Masks in Polluted Areas

Air pollution, dust, and industrial fumes can significantly damage the respiratory system. Wearing a quality protective mask in traffic-heavy areas, construction sites, factories, or dusty environments helps reduce inhalation of fine particles and toxic gases. This is especially important for people with asthma, smokers, or those with weak lungs.[25]

5. Maintain Indoor Air Quality

Indoor air pollution can also harm the lungs. Smoke from cooking fuels, incense sticks, candles, mold, dust, and poor ventilation can irritate the airways. Keeping windows open for ventilation, cleaning dust regularly, avoiding indoor smoking, and using air purifiers can improve indoor air quality and reduce respiratory irritation.

6. Exercise Regularly

Physical activity strengthens the lungs and improves breathing efficiency. Activities such as walking, jogging, cycling, swimming, and yoga increase lung capacity and oxygen circulation. Exercise also helps remove mucus from the airways and improves overall respiratory endurance. Regular activity can lower the risk of chronic lung disease.

7. Eat Antioxidant-Rich Foods

Healthy foods help protect lung cells from oxidative stress caused by pollution and cigarette smoke. Fruits and vegetables rich in vitamins C and E, beta-carotene, flavonoids, and minerals support lung repair and immunity. Foods such as oranges, berries, spinach, carrots, tomatoes, turmeric, garlic, and green tea are beneficial for respiratory health.

8. Stay Hydrated

Drinking enough water keeps the mucus in the respiratory tract thin and easier to remove. Thick mucus can block airways and trap bacteria or pollutants. Proper hydration helps maintain smoother breathing and supports normal lung function.

9. Prevent Respiratory Infections

Infections such as influenza, pneumonia, bronchitis, and tuberculosis can severely damage the recommended vaccinations can lower the risk of respiratory infections. Strong immunity helps the lungs remain healthy.lungs. Hand washing, avoiding contact with infected people, maintaining hygiene, and receiving.

10. Regular Health Checkups

People who smoke or have breathing symptoms should undergo regular medical examinations. Lung function tests, chest X-rays, and clinical assessments can help detect diseases such as COPD, bronchitis, asthma, or lung cancer at an early stage. Early diagnosis allows faster treatment and better outcomes.[26]

Filters Used in the Market to Reduce Harm of Smoking

Various cigarette filters are available in the market that claim to reduce the intake of harmful substances such as tar, nicotine, smoke particles, and toxic gases. These filters do not make smoking safe, but they may help lower exposure to some harmful chemicals. The most common filters used in the market are activated carbon filters, reusable cigarette holders, disposable tar-blocking filters, and multi-stage filtration devices.

1. Activated Carbon Filters

Activated carbon filters are among the most effective commercially available smoking filters. These filters contain porous activated charcoal, which helps adsorb toxic gases, volatile organic compounds, and some odor-causing chemicals from cigarette smoke. They may reduce compounds such as benzene, formaldehyde, and acrolein. These filters are commonly used in premium cigarette holders and reusable filter systems.

2. Reusable Cigarette Holder Filters

Reusable cigarette holders are designed to hold the cigarette and pass smoke through an internal filter chamber. These devices usually contain cotton, microfiber, ceramic beads, or activated carbon layers. They are washable or replaceable and are more economical for long-term users. Popular products in the market include SmokeSafer and Cigibud reusable filters.

3. Disposable Tar Filters

Disposable cigarette filters are small attachments fitted to the cigarette tip. They trap visible tar and smoke particles as the smoker inhales. Many users notice brown residue collecting inside the filter after use, indicating captured tar. These filters are easy to use but need frequent replacement. Tarblock and similar products are examples.[27]

4. Multi-Stage Filters

Multi-stage filters combine different filtration materials such as cotton fiber, cellulose acetate, activated carbon, and mesh layers. These filters are designed to trap particulate matter, absorb gases, and cool the smoke before inhalation.

They may provide better filtration than single-material filters.

5. Nano or Advanced Filters

Some newer products use nanofibers, ceramic filters, or advanced adsorbent materials. These are marketed as modern harm-reduction devices. Certain filters claim to reduce nicotine and fine particulate matter more effectively than conventional filters, though scientific evidence varies.[28]

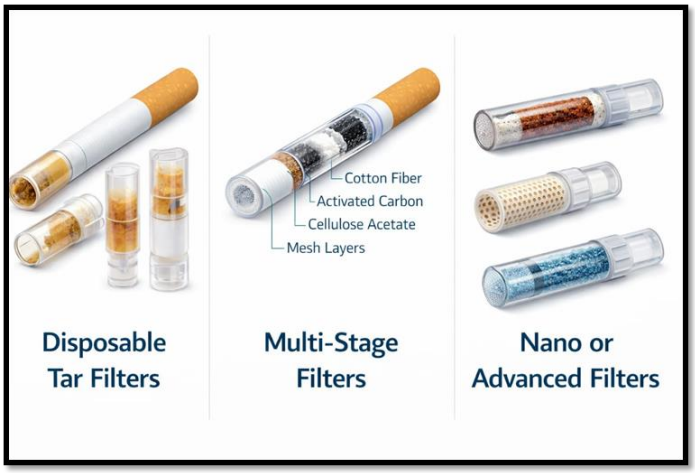

Fig: Filters use for reduction of harm of smoking.

RESULT

The present review demonstrates that cigarette smoke is a highly toxic aerosol containing thousands of harmful chemicals, including nicotine, carbon monoxide, tar, formaldehyde, benzene, acrolein, cadmium, hydrogen cyanide, and several carcinogenic compounds. Continuous exposure to these substances causes severe structural and functional damage to the respiratory system. The toxic components of smoke promote oxidative stress, chronic inflammation, mucociliary dysfunction, DNA mutation, and destruction of alveolar tissues, which collectively impair normal lung physiology.[29]

Analysis of available literature confirms a strong association between cigarette smoking and major respiratory diseases such as chronic obstructive pulmonary disease (COPD), chronic bronchitis, emphysema, lung cancer, asthma exacerbation, pneumonia, tuberculosis, pulmonary fibrosis, and progressive decline in lung function. Both active smoking and passive smoke exposure significantly increase morbidity and mortality, particularly among children, elderly individuals, and immunocompromised populations.

The review also indicates that cigarette filters available in the market, including activated carbon filters, reusable holders, disposable tar filters, and multi-stage filters, may reduce exposure to tar, smoke particles, and some toxic gases. However, these filters do not eliminate the harmful effects of smoking and cannot fully prevent smoking-related diseases.[30]

Overall, the findings emphasize that cigarette smoke remains a major preventable cause of respiratory illness worldwide. Complete smoking cessation is the most effective strategy to reduce lung damage and improve health outcomes. Public awareness, strict tobacco control measures, early screening, and preventive interventions are essential to decrease the global burden of smoking-related respiratory disorders.[31]

DISCUSSION

The present review shows that cigarette smoke is a highly toxic mixture containing more than 7,000 chemicals, many of which are harmful, carcinogenic, and damaging to the respiratory system. Major toxic substances such as nicotine, tar, carbon monoxide, benzene, formaldehyde, acrolein, and heavy metals contribute significantly to lung injury and disease development.One of the major mechanisms of damage is oxidative stress, where free radicals in cigarette smoke injure lung cells, proteins, and DNA. This leads to chronic inflammation, tissue destruction, and reduced lung function.[32] Continuous exposure also damages cilia and impairs mucociliary clearance, increasing the risk of infections such as pneumonia and tuberculosis.The review confirms a strong relationship between smoking and respiratory diseases including COPD, chronic bronchitis, emphysema, asthma exacerbation, pulmonary fibrosis, and lung cancer. Long-term smokers often experience progressive breathing difficulty and irreversible structural damage to lung tissues.Passive smoking also poses serious health risks, especially to children, elderly individuals, and people with pre-existing respiratory conditions. Exposure to secondhand smoke may cause asthma attacks, reduced lung growth, and recurrent infections.[33]

Although cigarette filters such as activated carbon and multi-stage filters may reduce some tar and toxic particles, they do not eliminate the harmful effects of smoking. Therefore, they should only be considered temporary harm-reduction tools.[34]

Overall, complete smoking cessation remains the most effective strategy to prevent respiratory damage. Public awareness, tobacco control policies, and early health screening are essential to reduce the burden of smoking-related diseases worldwide.[35]

CONCLUSION

In conclusion, cigarette smoke contains a complex mixture of toxic and carcinogenic chemicals that have severe adverse effects on respiratory health. Continuous exposure to harmful substances such as nicotine, tar, carbon monoxide, formaldehyde, benzene, and heavy metals leads to oxidative stress, chronic inflammation, tissue damage,

and impaired lung function.[36] These pathological effects significantly increase the risk of respiratory diseases including COPD, chronic bronchitis, emphysema, asthma, lung cancer, and respiratory infections.[37]

Both active and passive smoking contribute to substantial morbidity and mortality worldwide, making tobacco smoke a major public health concern. Although certain filtration methods may reduce partial exposure to some toxic compounds, they do not eliminate the health risks associated with smoking.[38]

Therefore, prevention through smoking cessation, public education, strict tobacco control measures, and early diagnosis of respiratory diseases remains essential.[39] Reducing tobacco exposure is the most effective strategy to improve respiratory health and decrease the global burden of smoking-related illnesses.[40]

REFERENCES

1. U.S. Department of Health and Human Services. The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General**.** Atlanta (GA): Centers for Disease Control and Prevention, 2014.
2. World Health Organization. WHO Report on the Global Tobacco Epidemic 2023**:** Protect People from Tobacco Smoke. Geneva: WHO, 2023.
3. U.S. Department of Health and Human Services. How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease**.** Atlanta (GA): CDC, 2010.
4. Hecht SS. Tobacco smoke carcinogens and lung cancer. J Natl Cancer Inst, 1999; 91(14): 1194–1210.
5. Rodgman A, Perfetti TA. The Chemical Components of Tobacco and Tobacco Smoke. 2nd ed. Boca Raton: CRC Press, 2013.
6. Hoffmann D, Hoffmann I, El-Bayoumy K. The less harmful cigarette: a controversial issue**.** Tob Control, 2001; 10(1): 82–89.
7. Pryor WA, Stone K. Oxidants in cigarette smoke: radicals, hydrogen peroxide, peroxynitrate, and peroxynitrite. Ann N Y Acad Sci, 1993; 686: 12–27.
8. Valavanidis A, Vlachogianni T, Fiotakis K. Tobacco smoke: involvement of reactive oxygen species and stable free radicals in mechanisms of oxidative damage. Int J Environ Res Public Health, 2009; 6(2): 445–462.
9. Church DF, Pryor WA. Free-radical chemistry of cigarette smoke and its toxicological implications. Environ Health Perspect, 1985; 64: 111–126.
10. Rahman I, MacNee W. Oxidative stress and regulation of glutathione in lung inflammation. Eur Respir J., 2000; 16(3): 534–554.
11. Barnes PJ. Chronic obstructive pulmonary disease: effects beyond the lungs**.** PLoS Med., 2010; 7(3): e1000220.
12. GOLD. Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease. Global Initiative for Chronic Obstructive Lung Disease, 2024.
13. Hogg JC, Timens W. The pathology of chronic obstructive pulmonary disease. Annu Rev Pathol, 2009; 4: 435–459.
14. MacNee W. Pathogenesis of chronic obstructive pulmonary disease. Proc Am Thorac Soc. 2005; 2(4): 258–266.
15. Tuder RM, Petrache I. Pathogenesis of chronic obstructive pulmonary disease. J Clin Invest, 2012; 122(8): 2749–2755.
16. Centers for Disease Control and Prevention. Smoking and Respiratory Diseases. Atlanta: CDC, 2022.

17. International Agency for Research on Cancer (IARC). Tobacco Smoke and Involuntary Smoking. IARC Monographs Vol. 83. Lyon: IARC; 2004.
18. Alberg AJ, Brock MV, Ford JG, Samet JM, Spivack SD. Epidemiology of lung cancer. Chest, 2013; 143(5 Suppl): e1S–e29S.
19. Hecht SS. Lung carcinogenesis by tobacco smoke. Int J Cancer, 2012; 131(12): 2724–2732.
20. Lee PN, Forey BA, Coombs KJ. Systematic review with meta-analysis of the epidemiological evidence relating smoking to COPD. BMC Pulm Med, 2012; 12: 16.
21. Eisner MD, Balmes J, Katz PP, et al. Lifetime environmental tobacco smoke exposure and risk of chronic obstructive pulmonary disease**.** Environ Health, 2005; 4: 7.
22. US EPA. Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders. Washington DC: Environmental Protection Agency, 1992.
23. Burke H, Leonardi-Bee J, Hashim A, et al. Prenatal and passive smoke exposure and incidence of asthma and wheeze. Pediatrics, 2012; 129(4): 735–744.
24. Jones LL, Hashim A, McKeever T, Cook DG, Britton J, Leonardi-Bee J. Parental smoking and risk of respiratory infection in children. Thorax, 2011; 66(10): 847–855.
25. Arcavi L, Benowitz NL. Cigarette smoking and infection. Arch Intern Med, 2004; 164(20): 2206–2216.
26. Bates MN, Khalakdina A, Pai M, et al. Risk of tuberculosis from tobacco smoking: meta-analysis. Arch Intern Med. 2007;167(4):335–342.
27. Sopori M. Effects of cigarette smoke on the immune system. Nat Rev Immunol, 2002; 2(5): 372–377.
28. Repace J. Exposure to secondhand smoke. Tob Control, 2004; 13(Suppl 1): i10–i19.
29. Pauly JL, Mepani AB, Lesses JD, et al. Cigarette filter fibers and respiratory health risks. Cancer Epidemiol Biomarkers Prev, 2002; 11(12): 1512–1517.
30. Strzelak A, Ratajczak A, Adamiec A, Feleszko W. Tobacco smoke induces and alters immune responses in the lung. Adv Exp Med Biol, 2015; 849: 1–13.
31. Doll R, Peto R, Boreham J, Sutherland I. Mortality in relation to smoking: 50 years' observations on male British doctors. BMJ, 2004; 328: 1519.
32. Jha P, Ramasundarahettige C, Landsman V, et al. 21st-century hazards of smoking and benefits of cessation in the United States. N Engl J Med, 2013; 368(4): 341–350.
33. Ezzati M, Lopez AD. Estimates of global mortality attributable to smoking in 2000. **Lancet**, 2003; 362(9387): 847–852.
34. Prochaska JJ, Benowitz NL. Current advances in research in treatment and recovery: nicotine addiction. Sci Adv, 2019; 5(10): eaay9763.
35. Benowitz NL. Nicotine addiction. N Engl J Med, 2010; 362(24): 2295–2303.
36. West R. Tobacco smoking: health impact, prevalence, correlates and interventions. Psychol Health, 2017; 32(8): 1018–1036.
37. Messner B, Bernhard D. Smoking and cardiovascular disease: mechanisms of endothelial dysfunction and early atherogenesis**.** Arterioscler Thromb Vasc Biol, 2014; 34(3): 509–515.
38. Ambrose JA, Barua RS. The pathophysiology of cigarette smoking and cardiovascular disease. J Am Coll Cardiol, 2004; 43(10): 1731–1737.

39. Huxley RR, Woodward M. Cigarette smoking as a risk factor for coronary heart disease in women compared with men. Lancet, 2011; 378(9799): 1297–1305.
40. Thun MJ, Carter BD, Feskanich D, et al. 50-year trends in smoking-related mortality in the United States. N Engl J Med, 2013; 368(4): 351–364.