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Tobacco and asthma

What is asthma?

Asthma is a chronic lung disease affecting people of all ages. It involves inflammation in the airways that causes muscle tightening and narrowing, making it harder to breathe *(1)*. Asthma symptoms include wheezing, shortness of breath, chest tightness and coughing, which vary over time and are provoked by inhaled allergens, upper respiratory infections, unmanaged exercise and exposure to tobacco smoke and pollutants *(1, 2)*. During asthma attacks, the airways constrict further owing to worsening of inflammation in the airways, and this may be life-threatening *(3)*.

- *Babies born to mothers who smoke have smaller lungs and an increased risk of developing asthma during childhood. Pregnant women should receive targeted support to quit tobacco use. E-cigarettes, heated tobacco products and other nicotine-delivery devices likely also carry risks.*
- *Children exposed to second-hand tobacco smoke have an increased risk of developing asthma.*
- *Smoking during adolescence and adulthood increases the risk of developing asthma and exacerbates the condition, as well as causing other lung diseases such as chronic obstructive pulmonary disease (COPD) and lung cancer.*
- *For people living with asthma, smoking worsens symptoms and can make treatment with medications less effective. All smokers with asthma should be supported to quit smoking.*
- *Governments should implement effective tobacco control measures to protect all individuals, including those who are vulnerable.*
- *The tobacco and nicotine industries' aggressive tactics in the marketing of their products specifically target children, adolescents and young adults. Protecting youth from these harmful tactics is a top priority.*

Tobacco definitions

Smoked tobacco product: any product made or derived from tobacco which generates smoke. Examples include manufactured cigarettes, roll-your-own tobacco, cigars, shisha (also known as waterpipe), kreteks and bidis.

Second-hand smoke (SHS): the smoke emitted from the burning end of a cigarette or other tobacco product, usually in combination with the smoke exhaled by the smoker.

Smokeless tobacco: any product that consists of cut, ground, powdered or other tobacco that is intended to be placed in the oral or nasal cavity. Examples include snuff, chewing tobacco, gutka, mishri and snus.

Electronic nicotine delivery system (ENDS) (also known as e-cigarette or vaper): a device that heats a liquid to create an aerosol that is inhaled by the user, which typically contains nicotine and toxic substances that are harmful to both users and non-users who are exposed to the aerosols second-hand; the liquid is often flavoured.

Heated tobacco product (HTP): tobacco product that produces aerosols containing nicotine and toxic chemicals when tobacco is heated or when a device containing tobacco is activated. These aerosols are inhaled by users during a process of sucking or smoking involving a device. They contain the highly addictive substance nicotine, as well as non-tobacco additives, and are often flavoured. Some are termed heat-not-burn tobacco, although most do produce smoke.

Smoke-free policies: comprehensive policies that completely ban smoking in all indoor public places, workplaces, public transport and other public places, with no exceptions for designated smoking areas or rooms.

Third-hand smoke: the residual tobacco smoke pollutants that settle and remain on surfaces, such as furniture and carpets, as well as on smoker's skin and clothing in indoor environments. It can remain for weeks and even years, and contains nicotine and toxic chemicals, to which children are particularly prone to increased exposure, due to the tendency to touch those surfaces and put objects in their mouth.

Third-hand aerosol from e-cigarettes: the residual aerosol that contains toxic chemicals, which settle and remain on surfaces in indoor environments.

World Health Organization

Forum of International Respiratory Societies
United for Lung Health

Health impact of asthma

Asthma is a major global health concern and the most common chronic condition in children and adolescents, affecting roughly one in 10 children and adolescents, although with great intra- and international variations *(4)*. In 2019, approximately 262 million people were living with asthma *(5)*, resulting in 455 000 deaths *(1)*. These fatalities are of serious concern because many of them are preventable. For comparison, the estimate for chronic obstructive pulmonary disease (COPD) is 212 million prevalent cases, but with many more COPD deaths (3.7 million) annually *(6)*.

Asthma brings a substantial burden of disease, including both premature death and reduced quality of life across all age groups in all parts of the world *(7)*. Those with asthma experience notable impacts on their health-related quality of life, including physical activity, social well-being and general health *(8)*. Moreover, the emotional impact of a chronic condition like asthma can affect mental health *(9)*. Severe asthma attacks often require hospitalization because of uncontrolled airway inflammation, presenting additional health risks for patients and comorbidities owing to the increased need for systemic corticosteroids and other treatments, and incurring a high cost for patients themselves or their health care providers, particularly in low- and middle-income countries where long-term care is limited or unavailable *(1, 8, 9, 10)*. The economic impact of asthma includes direct medical costs, indirect costs related to productivity loss, and intangible costs associated with the decreased quality of life and unrealized productivity of persons with poorly controlled asthma *(8, 9)*. Fear of severe attacks may result in high levels of stress and anxiety among persons with asthma *(9)*. In many countries, poor implementation of prevention strategies and limited access to affordable quality-assured essential asthma medicines result in an unnecessary burden and unnecessary mortality from asthma *(11)*.

The link between smoking and asthma

Smoking and developing asthma

Smoking is the leading cause of preventable premature mortality in the world and causes serious diseases such as chronic respiratory diseases, lung cancer and other cancers *(12)*. Despite having chronic respiratory symptoms, some people with asthma begin and continue smoking, with prevalence rates in persons with asthma being similar to those found in the general population *(13)*. Smoking also places an individual at a significantly increased risk of developing asthma *(14, 15)*, and cross-sectional studies have reported a higher prevalence of asthma among women than men with the same smoke burden, suggesting greater susceptibility among women to this harm *(16, 17)*. Activation of inflammatory cells in the airways is thought to be responsible for this heightened risk of asthma associated with smoking *(18, 19)*.

Second-hand smoke exposure and asthma

Second-hand or third-hand *(20)* smoke or second-hand aerosol exposure from e-cigarettes presents a significant risk for people with asthma, even if they do not smoke themselves *(21)*. Third-hand smoke or third-hand e-vapour *(22)* is the residual tobacco smoke pollutants or e-vapour chemicals that remain on surfaces in the indoor environment, for instance in cushions and carpets, and in the smoker's or vaper's skin and clothing. Being around smokers can trigger asthma symptoms owing to the numerous harmful substances in second-hand smoke and the aerosol from e-cigarettes *(23, 24)*, and there is a heightened risk of asthma attacks from such exposures *(9, 24)*. Additionally, exposure to second-hand smoke may interfere with asthma management, making it challenging to control symptoms and maintain optimal lung function despite adherence to medications. Parental smoke exposure, when even one parent smokes at home, is associated with harm to children and especially to those with asthma *(21)*. This is especially the case when children are exposed in confined spaces in motor vehicles or the home *(25)*, where

third-hand smoke exposure is high *(20)*. Early-life exposure to tobacco smoke impairs lung development and increases the risk of respiratory infections, and contributes to long-term respiratory diseases including asthma and COPD *(24)*. Avoiding second-hand smoke exposure is an essential component of the prevention and management of respiratory diseases and especially for asthma *(24)*. Public health policies that provide for 100% smoke-free indoor public places form an essential component of society's protection of the welfare of persons with chronic lung diseases, and especially asthma *(9, 24)*.

Smoke exposure during pregnancy, childhood and adolescence

Smoking during pregnancy affects fetal development with an increased risk of long-term consequences *(26)*. Studies have shown that maternal smoking during pregnancy significantly increases the risk of low birth weight (<2500 g) and preterm birth *(27, 28)*. For pregnant women, exposure to tobacco smoke (either through smoking or through exposure to second-hand smoke) during pregnancy increases asthma risks for their children *(29)*, and infants exposed to smoke after birth face higher risks of respiratory infections and the development of asthma *(30)*. Tobacco exposure in utero is also associated with an increased risk of asthma and wheezing in children and adolescents, with the greatest effect being on the incidence of wheezing in children aged ≤2 years *(31)*. Research has shown that maternal smoking during pregnancy is associated with a heightened immune response (called Type 2 immune response) to allergens in neonates *(32)*. Enhanced Type 2 responses are associated with the development of asthma, and nicotine enhances Type 2 activity *(30)*.

A study of a large population-based sample of young teenagers has found that asthma and allergic diseases such as rhinitis and hay fever, but not lifetime eczema, were significantly associated with active tobacco smoking, even after controlling for second-hand smoking *(17)*. Active smoking has been linked to the severity of asthma in both adolescents and adults *(33)*. There is also epidemiological evidence that the effects of active smoking on asthma seen in adolescence persist throughout life *(33, 34)*. In various industrialized countries, the relationship between tobacco smoking and either the prevalence or the severity of asthma in adolescence is paralleled by the relation to asthma severity in adulthood *(17)*. At the national level, reductions in smoking have been associated with large reductions in asthma incidence and use of health services such as general-practitioner and emergency-room visits and hospitalizations in Finland *(35)*.

Smoking worsens asthma and increases development of new lung conditions

Smoking exacerbates symptoms and attacks in many asthmatic people, as their lungs are especially sensitive to cigarette smoke *(9)*. In the short term, smoking alongside asthma heightens the risk of asthma attacks while, in the long term, it elevates the chances of developing smoking-related conditions such as emphysema *(2)*.

Smoking has been strongly linked to negative clinical outcomes in asthma, including suboptimal asthma control *(13)*, accelerated decline in lung function *(19, 36, 37)*, increased exacerbations *(38)*, reduced response to inhaled corticosteroids *(39)*, greater health care utilization and a higher prevalence of chronic bronchitis. Multiple risk factors contribute to these adverse outcomes experienced by smokers with asthma, including current or former smoking status, cumulative exposure to cigarette smoke and coexistent social factors such as lower socioeconomic status and environmental exposures such as air pollution *(39)*. Smoking status and smoking duration are both strongly related in a dose-dependent manner to the level of asthma severity *(40)*. The strongest association with more severe asthma was observed in people who smoked more than 20 pack-years, and a strong association between active smoking and severity of asthma *(13, 40)*.

Tobacco smoke also changes the structure of the airway in people with asthma. This results in increased goblet cell numbers associated with

sputum production and increased epithelial thickness linked to breathlessness *(41)*. Therefore, in asthma, current smoking status and cumulative exposure to cigarette smoke are correlated with the development of persistent airflow obstruction over time. Some individuals may have clinical features suggestive of both smoking-related asthma and COPD, which is sometimes called asthma-COPD overlap *(42)*. Smoking increases airway inflammation in such patients *(18, 43)*. Patients with features of both asthma and COPD have more respiratory symptoms, more frequent exacerbations, worse quality of life, a more rapid decline in lung function, greater utilization of health care resources and higher mortality compared with patients with either asthma or COPD alone *(9, 44)*.

Electronic cigarettes (e-cigarettes) and asthma

E-cigarette use has increased in recent years, especially among adolescents and young adults *(45, 46)*. E-cigarette aerosols can contain carcinogens, such as formaldehyde, as well as elevated levels of fine and ultrafine particles that deliver harmful substances deep into the airways, making the lungs susceptible to injury *(47)* and increasing the likelihood of adverse respiratory effects in users of electronic nicotine-delivery devices *(24, 28)*. Several cross-sectional and longitudinal studies have reported respiratory symptoms, such as chronic cough, wheezing, asthma and shortness of breath, among adolescent and young adult e-cigarette users *(49, 50)*. Research shows that e-cigarette use was linked to an increased prevalence of asthma symptoms and exacerbated asthma *(51)*, independently of conventional cigarette use and other covariates such as age and gender *(52)*, and recent prospective studies in the United States of America (USA) have shown connections between e-cigarette use and respiratory symptoms *(53, 54)*, even when accounting for conventional tobacco use. Notably, dual users of conventional cigarettes and e-cigarettes showed the highest increase in prevalence of asthma symptoms *(55, 56, 57)*, further increasing the burden of asthma control among vulnerable adolescents.

Smoking and corticosteroid sensitivity

According to the Global Initiative for Asthma recommendations *(9)*, inhaled corticosteroid (ICS) medications are a highly effective treatment for asthma, reducing the risk and severity of exacerbations and asthma-related mortality. However, there is a relative corticosteroid insensitivity to ICS treatment in current smokers with asthma *(39)*. Research indicates that smokers with asthma have an impaired cutaneous vasoconstrictor response to topical corticosteroids compared with never-smokers with asthma. This suggests that the insensitivity to corticosteroids in smokers with asthma affects tissue sites and may be due to the increase in neutrophilic airway inflammation due to smoking *(39)*.

Evidence from randomized controlled trials is limited, as these mostly exclude current smokers with asthma *(39)*. However, people with asthma who smoke show less improvement in respiratory symptoms, lung function and exacerbation rates with ICS compared with those who do not smoke *(39, 58, 59, 60)*. This may be partially improved by using higher doses of ICS *(61)*; however, high dose usages will put these people at risk of developing long-term adverse effects from ICS treatment *(62, 63)*.

Impact of smoking cessation on asthma

It is essential that all people with asthma who smoke receive personalized advice and support to quit, emphasizing the benefits in the short- and longer term. In addition to the overarching health benefits associated with smoking cessation, quitting may offer specific asthma-related advantages. Smoking cessation is linked to reduced asthma symptoms *(64, 65, 66)*, better asthma-related quality of life *(64)*, improved lung function *(66)* and reduced airway hyper-responsiveness *(65)*. Additionally, former smokers with asthma often exhibit better symptom control compared to current smokers *(67)*. Since children with asthma are particularly vulnerable to second-hand and third-hand smoke, it is imperative to offer smoking cessation

treatment to parents and other household members who smoke *(9, 68)*. Smoking cessation can improve symptoms and lung function, but the low rates of smoking cessation highlight the need for improved strategies for managing these patients.

Population-level interventions to address tobacco use

Population-level interventions to address the impact of tobacco on asthma-related morbidity and mortality are essential. World Health Organization (WHO) offers well established tools for implementing tobacco control measures *(24)*. In 2008, WHO introduced the MPOWER package to support countries in implementing the demand reduction measures of the WHO Framework Convention on Tobacco Control (WHO FCTC) *(69)*. Progress is regularly reported through a biennial global tobacco epidemic report *(24)*. MPOWER contains six tobacco control demand reduction measures aligned with the WHO FCTC.

The WHO package of essential noncommunicable (PEN) disease interventions for primary health care includes a module focused on the management of asthma. PEN emphasizes the importance of informing individuals with asthma about the risks associated with smoking, exposure to indoor and outdoor allergens and the need to stop smoking *(70)*.

WHO recommends the following population-level and pharmacological interventions to ensure access to comprehensive cessation support *(24)*.

- **Brief advice:** this is usually a few minutes of advice on how to stop using tobacco, given to all tobacco users during a routine consultation or interaction with any health professional.
- **Toll-free quit lines:** a telephone counselling service that provides proactive and reactive telephone counselling.
- **Pharmacological interventions:** nicotine replacement therapy, bupropion, cytisine, cytisinicline or varenicline should be provided for all tobacco users who want to quit, according to the relevant guidelines.
- **mCessation and chatbots:** a two-way messaging system based on the mCessation content library *(71)* guides tobacco users through a six-month text message quit support programme. WHO has also developed chatbots in partnership with WhatsApp, WeChat and Viber to give tobacco users the best advice on how to quit tobacco.
- **WHO Quit Tobacco app:** the app targets all forms of tobacco, including smokeless and other newer products. It helps users identify triggers, set targets, manage craving and stay focused on quitting tobacco.

Emerging concerns and future directions

Exposure to tobacco smoke (either directly or second-hand) damages the lungs, increasing the risk of chronic respiratory diseases, such as asthma and COPD, and it is particularly harmful during lung growth and development (in utero and in childhood and adolescence). It is crucial to stop smoking as early as possible. Some countries are considering increasing the legal smoking age in the so-called Tobacco End Game strategy, as in New Zealand, where the Parliament passed the world's first legislation to raise the smoking age to stop those born after January 2009 from buying smoked tobacco products legally, to help eliminate smoking among the next generation *(72)*.

The key management strategies to reduce exposure to smoke among people with asthma include advice on smoking cessation and support in quitting, addressing risk factors through legislative measures, such as cigarette smoke (direct and second-hand), and targeting treatable elements related to behavioural and extrapulmonary comorbidities, such as physical inactivity, obesity, anxiety and depression *(73)*. Significant action is needed by individuals, health care professionals, communities, civil society, researchers and policy-makers to achieve a world free of tobacco.

The tobacco use rate is expected to decrease in all WHO regions between 2010 and 2025 *(24, 74)*. However, at least 38 million adolescents aged 13–15 years are reported to use any form of tobacco globally *(74)*. Projections indicate that, globally, the number of smokers will remain constant at 1.1 billion up to 2025, owing to increased population size and new smokers. Studies consistently

show that young people who use e-cigarettes are almost three times more likely to use conventional cigarettes later in life *(75)*. Urgent measures are necessary to prevent uptake of e-cigarettes and counter nicotine addiction, alongside a comprehensive approach to tobacco control and in the light of national circumstances *(75)*. These actions aim to prevent the long-term effects of developing chronic respiratory disease.

As an integral part of the wider indoor pollution policies and plans, laws that make indoor public places completely smoke-free are an important policy to help with asthma control and management of treatment outcomes *(24, 76, 77)*. There is evidence that, whenever smoke-free laws are implemented, they are followed by an almost immediate drop in second-hand smoke pollution levels and by marked improvements in respiratory health *(78)*. One of the earliest studies on second-hand smoke, conducted on bar workers in Scotland, reported a 26% decrease in respiratory symptoms, and asthmatic bar workers had reduced airway inflammation within three months of comprehensive smoke-free legislation being enacted *(24, 79)*. Today, there is robust evidence that comprehensive smoke-free laws result in reduced hospital admissions for acute coronary syndrome *(80)* and reduced mortality from smoking-related illnesses, and improve cardiovascular health outcomes *(81)*. Alongside smoke-free policies, banning any form of tobacco advertising, promotion or sponsorship and adopting consistent regulatory measures for new and emerging tobacco and nicotine products to protect the youth population are crucial.

It is imperative for health care providers and policymakers to guarantee that all individuals, including vulnerable populations, are safeguarded by legislation, and provided with the necessary knowledge and resources to quit tobacco and nicotine use and stay tobacco free.

Contributors

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