

Tobacco and infertility



Infertility is defined as a failure to achieve pregnancy after 12 months or more of regular unprotected sexual intercourse. One in six people experience infertility in their lifetime.



Infertility is caused by multiple factors. Cigarette smoking and exposure to second-hand tobacco smoke are associated with infertility in women.



While the adverse effects of cigarette smoking on women's reproductive health are well documented, evidence is still emerging regarding use of other tobacco products, including waterpipe and smokeless tobacco, and nicotine products such as e-cigarettes. Current data suggest potential risks to fertility, but further research is required to fully characterize these effects.



For men, cigarette smoking is associated with harmful effects on semen and sperm and on sexual function, which can lead to infertility.



Women who quit smoking may have a lower risk of infertility compared with women who continue to smoke.



WHO recommends that healthcare providers inform individuals and couples planning pregnancy about the reproductive risks of tobacco use and offer evidence-based support to help them quit.



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What is infertility?

Globally, one in six people of reproductive age will experience infertility at some stage in their life. Infertility is a disease of the male or female reproductive system defined by the failure to achieve a pregnancy after 12 months or more of regular unprotected sexual intercourse (1, 2).

Fig. 1. One in six people of reproductive age experience infertility at some stage in their lives^a

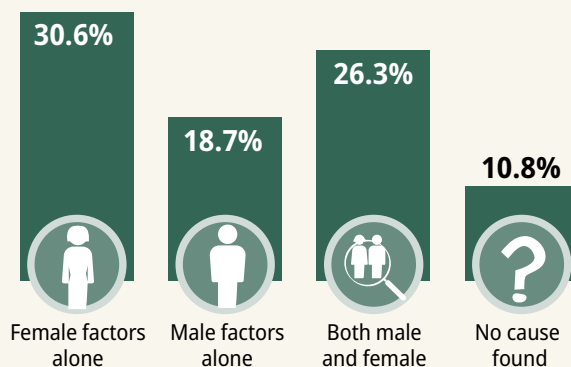


^a See more details in WHO infertility prevalence estimates 1990–2021

Because of infertility, a person may not be able to exercise or achieve their right to decide on the number, timing and spacing of their children.

Infertility may be caused by male and/or female reproductive factors. About 30% of cases of infertility result from female factors, about 18% from male factors, and about 26% from a combination of both male and female factors. These factors may include hormonal imbalances or anatomical abnormalities. In the male reproductive system, infertility is most commonly caused by problems in the ejection of semen, absence or low levels of sperm, or abnormal shape (morphology) and movement (motility) of the sperm. In the female reproductive system, infertility may be caused by a range of abnormalities of the ovaries, uterus, fallopian tubes and/or the endocrine system. However, in about 10% of cases the cause is unknown or unexplained (3, 4).

Fig. 2. Infertility may be caused by male, female or unexplained factors



Some research has indicated that these reproductive abnormalities may be caused by defects at birth, genetics, the environment or lifestyle habits. Modifiable risk factors such as unhealthy diet, physical inactivity and excessive alcohol intake, may affect fertility and negatively impact the ability of a person to achieve a pregnancy resulting in a live birth. Smoking or being exposed to second-hand smoke and use of smokeless tobacco or nicotine products have also been linked to infertility.

Tobacco and nicotine-containing products may take many forms (see “Definitions” below). Tobacco use includes use of both smoked products that produce smoke through combustion (such as cigarettes, cigars and waterpipes) and smokeless tobacco products that are placed in the nasal or oral cavity (such as snuff and chewing tobacco). Electronic cigarettes (e-cigarettes or vapes) heat a liquid to produce an aerosol that is inhaled. Depending on the product type, the aerosol may contain varying levels of nicotine (derived from tobacco or synthesized) along with other potentially harmful substances, such as formaldehyde. Exposure to toxicants can occur directly through use of tobacco products (first-hand exposure) or indirectly through involuntary inhalation of second-hand smoke or aerosol.



The link between smoking and infertility in women

Since the landmark 1964 report by the Surgeon General of the United States of America (5), smoking has been found to adversely affect many health outcomes, including fertility in women. In 1979, the Surgeon General's report presented a growing body of evidence from multiple studies that suggested that women who smoked were more likely to be infertile and experience abnormal menses and concluded that smoking may impair fertility (6). Since then, numerous reviews of the scientific literature have consistently shown that smoking increases the risk of infertility in women. In 1998, a systematic review of 12 studies dating back to 1985 reported that the risk of infertility among female smokers was 1.5 times higher on average (from 1.2 to 1.7 times higher) compared with the risk in non-smokers – an important increase in risk (7). In 2001, a second report by the Surgeon General of the United States provided more evidence about the risks of smoking for infertility. It noted that women who smoke have increased risks for conception delay and that the chances of infertility are greater both for women trying to conceive their first child (primary infertility) and for women trying to conceive an additional child (secondary infertility) (8).

More recently, a systematic review of studies conducted between 2000 and 2026 also showed that the risk of infertility is 1.4 times higher in women who currently smoke (N. Santesso, Unpublished data, 2026). This means that if the risk of infertility is 15% for women who do not smoke then 21% will experience infertility if they smoke. Although the existing evidence base focuses primarily on cigarette smoking, the presence of similar toxicants across tobacco products suggests that the mechanisms underlying infertility in smokers could also apply to users of other tobacco products.

Smoking cessation

An important question is whether women should stop smoking to improve the chances of

conceiving. Studies have shown that women who smoke while trying to conceive have a higher risk of infertility or will take longer to conceive (9, 10). Studies have also shown that women who smoked in the past but are not currently smoking may have a 25% lower risk of infertility compared with women who are currently smoking (N. Santesso, Unpublished data, 2026). This means that smoking cessation could improve chances of a woman becoming pregnant.

Exposure to second-hand smoke

The systematic review also found studies showing an increase in infertility when women do not smoke themselves but are exposed to second-hand smoke (1.2 times higher risk) (N. Santesso, Unpublished data, 2026). In addition, women who are exposed to second-hand smoke may have a lower chance of conceiving each month that they are trying (11, 12). This evidence highlights the importance of strategies both to prevent initiation of smoking and to help women and their partners who currently smoke to quit smoking.

E-cigarettes and waterpipe smoking

To date, most studies investigating the risk of infertility have focused on tobacco smoking. There has been a relatively small amount of research looking at the association between infertility and the use of e-cigarettes. In a study conducted in the United States that included more than 4500 women, ever use of e-cigarettes was associated with a 20% reduction in fecundability compared with never



use (13). Two studies that included women who smoked cigarettes or waterpipes (also known as hookahs or shisha) found a similar increased risk of infertility (14, 15). However, no studies were identified that directly and specifically

assess the association between waterpipe smoking and infertility in women. Additional high-quality research is needed to determine whether waterpipe use affects female fertility.



The link between smoking and infertility in men

It can be challenging to conduct studies to determine whether tobacco use in men results in fewer pregnancies and live births with their female partners. The link between smoking and infertility is usually deduced based on differences in semen parameters or sexual function according to men's smoking status. A recent review of 44 studies involving over 60 000 men synthesised the evidence for a link between different lifestyle factors and reproductive dysfunction, such as semen abnormalities and sexual dysfunction (16). In this review, smoking was found to be associated with an increase in reproductive dysfunction, and this finding was consistent across different populations, including Europeans, Asians and Caucasians. Most of the evidence indicated that more men who smoked had erectile dysfunction (also known as impotence) and ejaculation problems than men

who did not. In addition, the review found that smoking may increase the risk of azoospermia (absence of sperm in semen /ejaculate), asthenozoospermia (poor sperm motility) and teratozoospermia (abnormal sperm shape).

There is also some evidence of the impact of waterpipe smoking on male fertility. Studies have found that waterpipe smoking may be associated with lower sperm quality, such as less semen volume, lower sperm motility and fewer sperm with a normal shape (17). More recently, another study confirmed that hookah smoking may reduce sperm volume, but it found that motility may not be affected (18). To reach firm conclusions, more research is needed to determine the effects of waterpipe smoking on sperm parameters in men.

Effects of smoking when taking treatments to improve fertility

A variety of treatments are available for individuals and couples with infertility. The *WHO Guideline for the prevention, diagnosis and treatment of infertility* (19) provides recommendations for stepwise approaches to the evaluation and management of infertility in individuals and couples. Therapeutic approaches to infertility can include pharmacological treatments (such as oral drugs to induce ovulation), surgical treatments, and in vitro fertilization (IVF) and other forms of medically assisted reproduction. Research has shown that smoking may reduce the success of infertility treatments, but there is some

inconsistency across studies that could be related to the type of smoking. Research from 21 studies showed that cigarette smoking was linked to fewer live births (OR 0.54, 95% CI 0.30–0.99) and fewer pregnancies (OR 0.56, 95% CI 0.43–0.73), findings which indicate that the chances of successful treatment outcomes may be halved by cigarette smoking (20). However, a more recent, albeit smaller, study involving about 300 women showed no differences in fertilization or pregnancy rates between women who did and did not smoke cigarettes or between women who did or did not use e-cigarettes and/or waterpipes (hookahs) (21).

Current WHO recommendations addressing infertility and smoking

WHO has made numerous recommendations on the use of interventions at an individual level and at a population level to reduce the risk of infertility. Recommendations at an individual level include interventions to educate people about the risks of smoking in order to prevent infertility, to advise people who are experiencing infertility about the risks of smoking and exposure to second-hand smoke and to provide guidance on different approaches to quitting all forms of nicotine and tobacco use.

Below are key recommendations addressing infertility and smoking taken from the *WHO Guideline for the prevention, diagnosis and treatment of infertility* (19).



For the general population of reproductive age, WHO suggests providing information about fertility and infertility using low-cost strategies or whenever there is opportunity.



For couples with infertility, WHO suggests providing low-cost lifestyle advice before and during infertility treatment.



WHO recommends brief advice (between 30 seconds and 3 minutes per encounter) be consistently provided by healthcare providers as a routine practice to all tobacco users accessing any healthcare settings.

These interventions are low-cost, feasible and cost-effective, and they can substantially reduce tobacco use, yielding significant health gains at the population level. Additional evidence-based behavioural and pharmacological treatments are described in the *WHO clinical treatment guideline for tobacco cessation in adults* (22).



Recommended approaches include quit lines to provide telephone counselling, mobile messaging programmes, digital tools such as chatbots and apps, and approved pharmacotherapies, all of which can be implemented at scale.

At the policy level, WHO supports countries in implementing comprehensive tobacco control measures under the WHO Framework Convention on Tobacco Control (WHO FCTC) (23). The WHO FCTC outlines proven strategies to reduce tobacco use, including price and tax measures; comprehensive

bans on tobacco advertising, promotion and sponsorship; standardized packaging and labelling requirements; and protection from exposure to tobacco smoke. Together, clinical and population-level interventions are essential to reduce tobacco-related harm, including the impact of tobacco use on reproductive health.



Table 1. 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.
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. Users inhale these aerosols 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.
Electronic nicotine delivery system (ENDS) (also known as e-cigarette)	A device that heats a liquid to create an aerosol that is inhaled by the user. The aerosol 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.

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Annex 1

Summary of methods used to identify and summarize the evidence in this knowledge summary

We performed a search of OVID Medline and EMBASE to identify studies conducted from 2000 to November 2025 that assessed the association of smoking with infertility. The search included terms relating to infertility and to smoking or tobacco. One investigator screened all articles by title and abstract and reviewed relevant full-text articles. We included articles that defined infertility as the failure to achieve a pregnancy after 12 months or more of regular unprotected sexual intercourse. If studies were not available that used this definition, we included articles measuring other parameters (e.g. sperm quality for studies in males).

One investigator abstracted data for the association of smoking with infertility. Both adjusted odds ratio and raw data to calculate an odds ratio were abstracted from the included studies and from previously published systematic reviews. When possible, a meta-analysis of the results across primary studies was performed using a random effects model. Relative risks were reported and absolute risks were calculated using the average baseline risk across the studies. The certainty of the evidence was assessed using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) approach (“is” indicates high certainty; “likely” indicates moderate certainty; and “may” indicates low certainty). An odds ratio greater than 1.1 indicated an association of smoking with infertility.

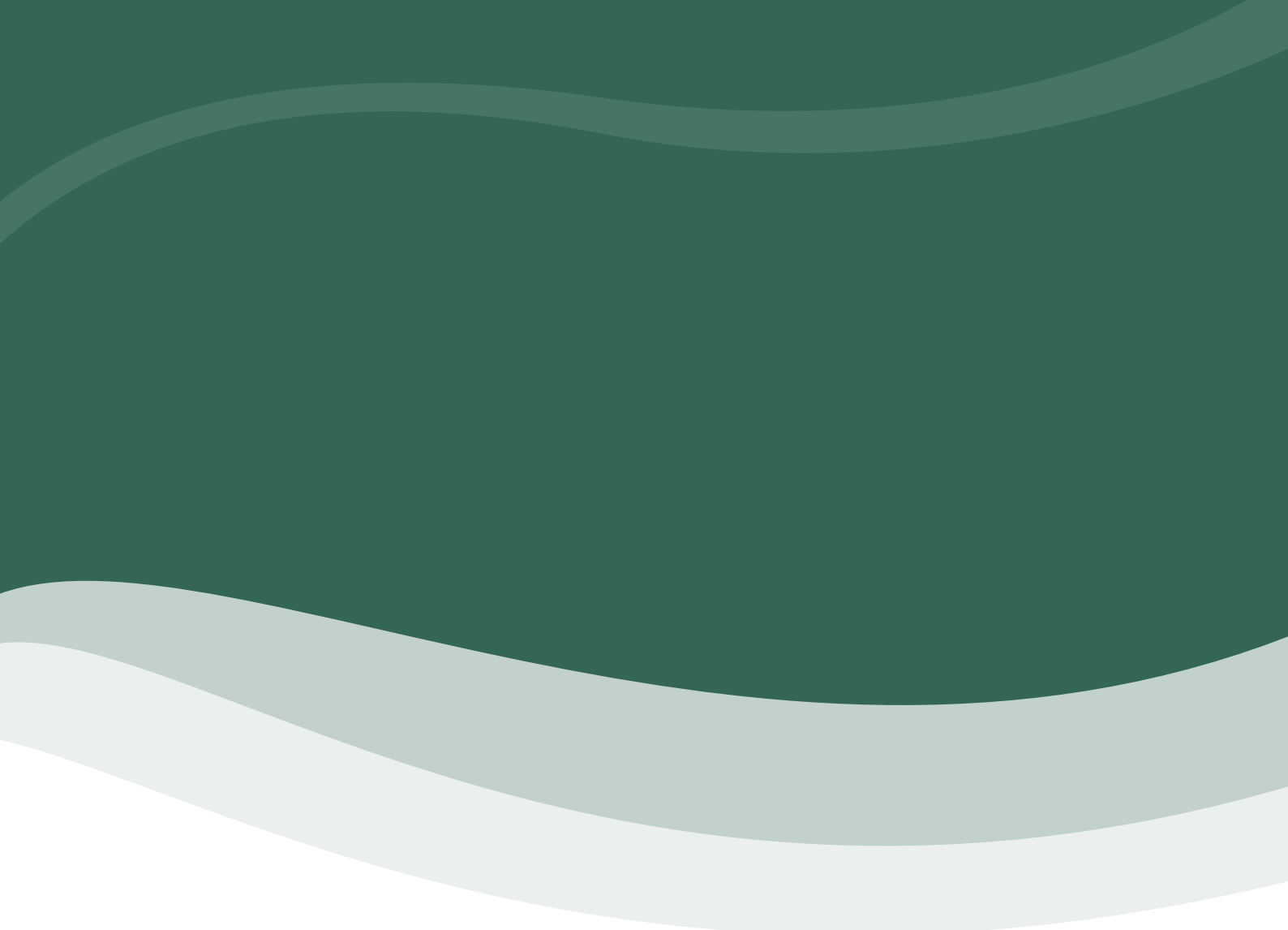
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The lead writer for this WHO tobacco knowledge summary was Nancy Santesso (Department of

Health Research Methods, Evidence, and Impact, McMaster University, Hamilton, Canada).

The following WHO staff contributed to the development of this WHO tobacco knowledge summary: Gitau Mburu (Department of Sexual, Reproductive, Maternal, Child and Adolescent Health and Ageing), Kerstin Schotte (Department of Health Determinants, Promotion and Prevention), James Kiarie (Department of Sexual, Reproductive, Maternal, Child and Adolescent Health and Ageing) and Vinayak Prasad (Department of Health Determinants, Promotion and Prevention).



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For further information, please contact:

Department of Sexual, Reproductive, Maternal, Child and Adolescent Health and Ageing:
Advancing Life Course Health and Reproduction (LHR)
Human Reproduction Programme (HRP)

World Health Organization

Avenue Appia 20 CH-1211,
Geneva 27
Switzerland
Email: srhcfrc@who.int

Website:

<https://www.who.int/health-topics/infertility/>
www.who.int