



Scientific Facts on Tobacco

Active and Passive Smoking

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Level 2 - Details on Tobacco

- 1. **What are the current trends in active tobacco smoking?.....3**
 - 1.1 How many people actively smoke tobacco?.....3
 - 1.2 In what forms is tobacco smoked?.....3
 - 1.3 What affects exposure to tobacco?.....3
- 2. **What kinds of cancer does tobacco cause in smokers?.....3**
 - 2.1 Which cancers are caused by cigarette smoking?.....4
 - 2.2 Which cancers do not appear to be caused by cigarette smoking?.....5
 - 2.3 For which cancers does a link remain unclear?.....5
 - 2.4 Does cigar, pipe or bidi smoking also cause cancer?.....5
 - 2.5 For which cancers does a link remain unclear?.....5
- 3. **Does tobacco cause cancer in test animals?.....6**
- 4. **What other biological effects can active smoking cause?.....6**
- 5. **What is passive smoking?.....7**
- 6. **Does passive smoking cause cancer?.....7**
 - 6.1 Does passive smoking increase the risk of lung cancer?.....7
 - 6.2 What is known about passive smoking and other human cancers?.....7
 - 6.3 Does passive smoking cause cancer in animals?.....8
- 7. **Does passive smoking cause other health effects?.....8**
 - 7.1 Does secondhand smoke affect the heart and the respiratory system?.....8
 - 7.2 Does secondhand smoke affect women or the unborn child?.....8
 - 7.3 What other health effects are caused by secondhand smoke?.....8
 - 7.4 Does secondhand smoke cause biological effects in animals?.....9
- 8. **Conclusions on tobacco and cancer.....9**
 - 8.1 Conclusions on active smoking.....9
 - 8.2 Conclusions on passive smoking.....9

This Digest is a faithful summary of the leading scientific consensus report produced in 2002 by the International Agency for Research on Cancer (IARC): *"Volume 83 Summary of data reported and evaluation on Tobacco Smoke and Involuntary Smoking"*

The full Digest is available at: <http://www.greenfacts.org/en/tobacco/>



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- Each question is answered in Level 1 with a short summary.
- These answers are developed in more detail in Level 2.
- Level 3 consists of the Source document, the internationally recognised scientific consensus report which is faithfully summarised in Level 2 and further in Level 1.

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1. What are the current trends in active tobacco smoking?

1.1 How many people actively smoke tobacco?

Over one thousand million people worldwide smoke tobacco. The percentage of smokers has declined in many developed countries but is increasing in developing countries. In most populations, 20 to 66% of men smoke. Even though the share of women who smoke is increasing, this percentage is generally lower than among men.

1.2 In what forms is tobacco smoked?

Tobacco is most commonly smoked as manufactured or hand-rolled cigarettes. Other products, such as pipes, cigars and bidis are used less commonly or predominantly in particular regions.

1.3 What affects exposure to tobacco?

All current tobacco products expose smokers to carcinogens. The composition of tobacco smoke depends on the type of tobacco, the design of the smoking device, the presence of filters (in the case of cigarettes) and other factors (paper porosity, types of additives, ventilation, etc).

The yields of tar, nicotine and carbon monoxide from cigarettes have fallen over recent decades in most parts of the world. However, the amounts of tar and nicotine released by cigarettes are not helpful in assessing actual exposure to carcinogens in tobacco smoke. The actual doses of nicotine, carcinogens and toxins smokers are exposed to depend on the total volume of smoke drawn from cigarettes, which is determined by smoking intensity and method.

2. What kinds of cancer does tobacco cause in smokers?

Nearly 20 years ago, the International Agency for Research on Cancer (IARC) reported that tobacco smoking increased risks of cancers of the lung, oral cavity (mouth), pharynx, larynx, oesophagus (squamous-cell carcinoma), pancreas, bladder and renal pelvis (the kidney outlet). Smokers are much more likely to develop these cancers than non-smokers: between 3 times more for pancreas cancer and 20 times more for lung cancer.

It is now established that tobacco smoking also increases by about 2 to 3 times the risk of getting cancers of the nasal cavities (nose), nasal sinuses, oesophagus (adenocarcinoma), stomach, liver, kidney and cervix (neck of the uterus) and developing myeloid leukaemia.

See Table [[see Annex 1, p. 10](#)]

2.1 Which cancers are caused by cigarette smoking?

Lung	Larynx
Urinary tract (bladder, ureter and kidneys)	Pancreas
Oral cavity (mouth)	Stomach (mouth)
Nasal cavity (nose) and paranasal sinuses	Liver
Oesophagus	Cervix (neck of the uterus)
Pharynx (nasopharynx, oropharynx and hypopharynx)	Bone marrow (leukemia)

2.1.1 Lung: Lung cancer is the most common cause of cancer deaths in the world and 1.2 million people develop it each year. In populations where tobacco has been widely used for a long-time (e.g. among men in developed countries) smoking is responsible for 90% of the cases of lung cancer. The risk of lung cancer increases in proportion to the duration of smoking and the numbers of cigarettes smoked. The effects are similar in men and women.

Stopping smoking at any age avoids further increasing the risk of lung cancer. The younger the age at which a person quits, the greater is the benefit.

2.1.2 Urinary tract: Tobacco smoking is a major cause of several cancers of the urinary tract (bladder, ureter and kidneys). The risk depends on duration of smoking and number of cigarettes smoked. As for lung cancer, stopping smoking at any age avoids further increasing the risk.

2.1.3 Oral cavity (mouth): Tobacco smoking causes cancer of the oral cavity in men and women. The risk is increased when smokeless tobacco is used or when smoking is combined with alcohol consumption. There is a strong relationship between risk and duration of smoking and number of cigarettes smoked. The risk tends to decrease after quitting.

2.1.4 Nasal cavity (nose) and paranasal sinuses: Sinonasal cancer is increased among cigarette smokers and several studies have shown that its frequency increases with the amount smoked.

2.1.5 Pharynx (nasopharynx, oropharynx and hypopharynx): The risk of cancer in the pharynx increases with cigarette smoking, depending on duration and number of cigarettes smoked. The risk decreases with time after quitting.

2.1.6 Oesophagus: Tobacco smoking increases the risk of oesophageal cancer in relation to dose. Stopping smoking does not result in a rapid decline in this risk. The risk is increased when smokeless tobacco is used or when smoking is combined with alcohol consumption.

2.1.7 Larynx: Laryngeal cancer is causally related with cigarette smoking with the risk increasing with dose. Use of alcohol in smokers and early age at starting smoking increase the risk.

2.1.8 Pancreas: Cigarette smoking causes cancer of the pancreas in proportion to consumption

2.1.9 Stomach: Many studies have now provided evidence of the role of cigarette smoking in causing stomach tumours, after allowing for other confounding factors. The risk is proportional to the duration of smoking and number of cigarettes smoked.

2.1.10 Liver: Many recent studies have now shown that cigarette smoking gives a moderate increased risk of liver cancer, in relation to the duration of smoking and the number of cigarettes smoked.

2.1.11 Cervix (neck of the uterus): A large number of studies have demonstrated that smoking induces one type of cervical cancer but the evidence is not consistent for other cervical carcinomas.

2.1.12 Bone marrow (leukaemia): Adult myeloid leukaemia is causally related to smoking. No clear evidence has been found for a link with lymphoid leukaemia or lymphoma.

2.2 Which cancers do not appear to be caused by cigarette smoking?

Most studies have found no association of breast cancer with smoking. Moreover, smoking appears to reduce the frequency of cancer of the lining of the uterus, especially after menopause.

2.3 For which cancers does a link remain unclear?

It is not clear whether cigarette smoking increases the risks of colorectal or prostate cancer due to the presence of confounding factors (additional variables that may be responsible for the effect).

2.4 Does cigar, pipe or bidi smoking also cause cancer?

Cigar and/or pipe smoking cause cancers of the oral cavity (mouth) and the upper digestive tract (oropharynx and hypopharynx, larynx and oesophagus). The risk increases with the amount smoked and when smoking is combined with alcohol consumption. Cigar and/or pipe smoking also causes lung cancer and there is evidence that it may cause pancreatic, stomach and bladder cancer.

Bidi smoking causes cancer of the oral cavity (mouth), upper digestive tract (pharynx, larynx and oesophagus), lung and stomach. The risk increases with duration and amount of bidi smoking.

2.5 For which cancers does a link remain unclear?

The combination of different cancer factors can produce an effect greater than the sum of their individual effects.

In particular, synergies have been found between smoking and:

- exposure to arsenic, asbestos and radon at the workplace for lung cancer;
- alcohol consumption for cancers of the oral cavity, pharynx, larynx and oesophagus;
- human papillomavirus infection for cervix cancer (neck of the uterus).

The evidence for synergy was inconclusive for other factors, such as hepatitis B and alcohol for liver cancer.

3. Does tobacco cause cancer in test animals?

Effects of tobacco smoke on test animals are not fully representative of those in humans, because exposure and tumour development are different. Nevertheless, results of animal studies help to understand the carcinogenic potential of tobacco smoke.

Different animal species exposed to tobacco smoke in different ways may develop tumours. Hamsters consistently developed tumours of the larynx, while some of the studies on rats and mice showed small increases in lung tumours. The evidence for malignant lung tumours in dogs is more uncertain.

Cigarette smoke condensate both initiates and promotes tumour development in animals. It has caused skin tumours in mice and rabbits when applied to skin, tumours of the lung and lymph system in mice when applied to the mouth, and lung tumours in rats when injected into the lungs. Condensate from bidi smoke also induced tumours in several organs in mice.

Collectively, these results provide evidence of the carcinogenic effect of tobacco smoke in test animals.

4. What other biological effects can active smoking cause?

Active smoking causes adverse reproductive outcomes and various health effects other than tumours, including respiratory and cardiovascular diseases.

Nicotine is the major addictive component of tobacco. In the human body, it is transformed into the metabolite cotinine, which is used as a reference to indicate exposure to tobacco smoke since it is found only in smokers and in passive smokers (in blood, urine and saliva).

Air exhaled by smokers contains higher concentrations of the following chemicals: carbon monoxide, benzene and volatile organic compounds. Moreover, some important carcinogens present in tobacco smoke and their metabolites are found in the urine of smokers.

Carcinogens present in tobacco smoke can react with proteins and DNA to form "adducts". Such carcinogen adducts are present in many tissues of smokers at higher levels than in non-smokers, for instance in the respiratory tract, bladder and cervix (neck of the uterus). Some but not all studies have also found adducts in the umbilical cord blood of smoking mothers and in cardiovascular tissues. Adducts can damage cells by producing gene mutations and chromosomal abnormalities.

Smoking can alter the activity of many enzymes involved in normal body metabolism.

In humans, smoking produces gene mutations and chromosomal abnormalities. Urine from smokers is mutagenic. Relative to non-smokers, lung tumours of smokers have unique features specific to exposure to tobacco smoke. Tobacco smoke is genotoxic in humans and in test animals.

In test animals, exposure to tobacco smoke also alters a variety of enzyme activities, results in formation of DNA adducts in several tissues and alters lung function.

5. What is passive smoking?

Passive (or involuntary) smoking is exposure to secondhand smoke, also called "environmental" tobacco smoke. Such smoke is a mixture of smoke exhaled by smokers and smoke released from the smouldering cigarettes, cigars, pipes, bidis, etc.

Secondhand tobacco smoke consists of both gases and particulates, which change as they get diluted and distributed in the environment and with time. The quantity of secondhand smoke inhaled involuntarily varies and its composition depends on smoking patterns and cigarette type. Concentrations in air may be elevated substantially in enclosed spaces.

Secondhand smoke contains nicotine, as well as various carcinogens and toxins. Nicotine concentrations in the air in workplaces where smoking is permitted and in homes of smokers range on average from 2 to 10 $\mu\text{g}/\text{m}^3$.

6. Does passive smoking cause cancer?

6.1 Does passive smoking increase the risk of lung cancer?

Passive smoking involves exposure to the same numerous carcinogens and toxic substances which cause lung cancer in smokers. This implies some risk of lung cancer from exposure to secondhand smoke.

More than 50 studies have been published on lung cancer risk in people who have never smoked but who have been exposed to tobacco smoke, especially spouses of smokers. Most studies show an increased risk, particularly for persons with higher exposures. The overall finding is an increased risk of lung cancer in spouses of smokers of 20% in women and 30% in men. Non-smokers exposed at the workplace have a 12-19% increased risk of lung cancer.

This evidence is sufficient to conclude that passive smoking is a cause of lung cancer in never-smokers.

6.2 What is known about passive smoking and other human cancers?

The evidence of a possible link between **breast cancers** and passive smoking is inconsistent. Some studies have reported an increased risk, but this has not been confirmed by other large studies. Moreover, the lack of association between active smoking and breast cancer argues against a risk from passive smoking. Data are conflicting and sparse for cancers in other parts of the body.

Evidence for an association of **childhood cancer and parental smoking** is inconsistent and may be biased. A possible link between maternal smoking during pregnancy and childhood cancer has been suggested. Some studies also suggested that paternal smoking may be linked to a small increased risk for cancer of the lymphatic system, but results may have been biased.

6.3 Does passive smoking cause cancer in animals?

In laboratory experiments, animals are exposed to mixtures of smoke produced by machines to simulate secondhand smoking. Though such experiments do not fully simulate human exposure and the tumours induced are not completely representative of human cancer, results of animal studies help to understand the carcinogenic potential of secondhand tobacco smoke.

Lung tumours have been induced in mice when exposed to such tobacco smoke mixtures under different conditions.

Cigarette smoke condensates derived from sidestream and/or mainstream smoke produced skin tumours in mice when applied on the skin and lung tumours when injected into the lungs. An increased risk of cancer has been reported in dogs exposed to secondhand tobacco smoke in homes.

7. Does passive smoking cause other health effects?

7.1 Does secondhand smoke affect the heart and the respiratory system?

Exposure to secondhand smoke can cause coronary heart disease, increasing the risk of acute coronary heart disease events by 25-35%. Moreover, it can cause chronic respiratory symptoms.

7.2 Does secondhand smoke affect women or the unborn child?

There are few data on the effects of passive smoking on the hormonal system and on metabolism. Unlike female active smokers, female passive smokers do not weigh less than non-exposed women.

In mothers, no consistent effects of passive smoking on fertility or fecundity have been found. Similarly, there is no clear association between passive smoking and age at menopause.

Babies of mothers who smoke actively weigh about 200g less at birth than those of mothers who are non-smokers. Passive maternal smoking may also lead to a lower birth weight, but to a lesser extent.



7.3 What other health effects are caused by secondhand smoke?

Carcinogens present in tobacco smoke can react with proteins and DNA to form "adduct". Such carcinogen adducts have been found on blood proteins in passive smokers, children of smoking mothers and to a lesser extent in umbilical cord blood of smoking mothers. There are no clear differences in the levels of DNA adducts in the white blood cells of passive smokers and non-exposed individuals.

The break-down products of a carcinogen specific to tobacco are found in passive smokers, supporting a link between passive smoking and cancer.

Compounds able to damage chromosomes (mutagens) are present at higher concentrations in the urine of passive smokers than in that of non-exposed individuals.

Moreover, lung tumours found in passive smokers present specific similarities with those of active smokers.

In various in vitro and in vivo laboratory experiments, the smoke to which passive smokers are exposed has been shown to damage DNA (genotoxic).

7.4 Does secondhand smoke cause biological effects in animals?

In test animals exposure to secondhand tobacco smoke affects various enzyme activities, leads to the formation of DNA adducts in several tissues and results in urine containing markers of exposure to tobacco smoke. Animals exposed to secondhand smoke develop inflammation in the airways and a disease of the arteries (arteriosclerosis), as observed in passively exposed humans. Exposure to sidestream smoke was also reported to lower birth weight, alter lung enzymes during development, abnormally increase the number of certain lung cells and alter the function of the lung.

8. Conclusions on tobacco and cancer

8.1 Conclusions on active smoking

There is sufficient evidence in humans that tobacco smoking causes cancer at many sites, i.e. lung, mouth, pharynx, nose and paranasal sinuses, larynx, oesophagus, stomach, pancreas, liver, urinary tract (bladder, ureter and kidneys), cervix (neck of the uterus) and bone marrow (myeloid leukemia). There is evidence suggesting that tobacco smoking does not cause breast cancer or cancer of the uterus lining in women.

There is sufficient evidence in test animals that tobacco smoke and tobacco smoke condensates are carcinogenic.

Therefore, the International Agency for Research on Cancer (IARC) has classified tobacco smoking and tobacco smoke as "carcinogenic to humans" (Group 1).

8.2 Conclusions on passive smoking

There is sufficient evidence in humans that passive smoking causes lung cancer.

In test animals, there is limited evidence that mixtures of mainstream and sidestream tobacco smoke are carcinogenic but there is sufficient evidence that sidestream smoke condensates are carcinogenic.

In addition, possible carcinogenic effects of secondhand smoke in household pet dogs were noted.

Therefore, the International Agency for Research on Cancer (IARC) has also classified passive smoking as "carcinogenic to humans" (Group 1).

Annex

Annex 1:

Affected body part	Does tobacco cause this cancer?	Risk increases with		After quitting
		Duration and amount of smoking	Other factors	
Lung	yes	yes	-	risk stops increasing
Urinary tract (bladder, ureter and kidneys)	yes	yes	-	risk stops increasing
Oral cavity (mouth, lip and tongue)	yes	yes	smokeless tobacco use combination with alcohol consumption	risk decreases
Nasal cavity (nose) and paranasal sinuses	yes	yes	-	-
Nasopharynx	yes	yes	-	risk decreases
Oropharynx and hypopharynx	yes	yes	-	risk decreases
Oesophagus	yes	yes	smokeless tobacco use combination with alcohol consumption	risk remains elevated
Larynx	yes	yes	combination with alcohol consumption	risk decreases
Pancreas	yes	yes	-	risk decreases
Stomach	yes	yes	-	risk decreases
Liver	moderately	yes	-	risk decreases
Cervix (neck of the uterus)	for one type of cervix cancer only	-	-	-
Bone marrow (leukaemia)	for myeloid leukaemia only	Yes	-	-
Breast	no	-	-	-
Uterus lining	no	-	-	-
Colon and rectum	not clear	-	-	-
Prostate	not clear	-	-	-