



Cancer in India: Causes, Prevalence, and Prevention Strategies

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ABSTRACT:

Cancer is a significant public health challenge in India, with rising incidence rates and mortality. Various factors contribute to the increasing burden of cancer in India, including environmental carcinogens, lifestyle choices and infectious agents. In this review article, the author provides an overview of the current status of cancer prevalence in India, discussing the most common types of cancer and their incidence rates. The author also discusses the importance of the topic and then highlights the primary, secondary, and tertiary prevention measures that can be taken to reduce the incidence of cancer in India. These measures include lifestyle modifications, early detection and screening programs, and cancer treatment facilities. Finally, the author concludes by emphasizing the need for a comprehensive and coordinated approach to tackle the growing burden of cancer in India. Overall, this review article provides a valuable resource for healthcare providers, policy makers and researchers working to address the burden of cancer in India.

Keywords: Cancer in India, Causes for rising cancer in India, Preventive measures, Govt. Initiatives.

I. Introduction:

Cancer is one of the leading causes of mortality worldwide and India is no exception to this trend. According to the Global Cancer Observatory, India accounts for nearly one-fifth of the world's cancer burden, with an estimated 1.39 million new cases and 784,800 cancer-related deaths in 2020. The incidence of cancer in India has been steadily increasing over the years, with projections suggesting that the number of new cancer cases in the country could reach 1.73 million by 2025. The current estimates for cancer in India increased by five per cent (14,61,427 in 2022 compared to 13,92,179 in 2020) (Mathur et al., 2020). This rising trend in cancer cases is a cause for concern and underscores the need for effective prevention and control measures. This burden is expected to increase in the coming years due to various factors such as population growth, ageing, unhealthy lifestyles and environmental carcinogens. Cancer affects people of all ages, genders, and socio-economic backgrounds, but the burden is higher among the elderly and those living in rural areas with limited access to healthcare facilities. To address the growing burden of cancer in India, the government and various non-governmental organizations have initiated several programs and campaigns to increase awareness about the disease, improve cancer screening and diagnosis, and provide better access to treatment and care. However, much more needs to be done to effectively prevent and control cancer in India.

In this review article, the author aims to provide an overview of the current scenario of cancer prevalence in India and the major risk factors associated with it. He also discusses various primary, secondary and tertiary preventive measures that can be adopted to mitigate the cancer burden in India. This review article is based on a comprehensive literature review of various research articles, government reports and other relevant sources.

II. Methodology:

This review article was conducted by searching various scientific databases, including PubMed, Google Scholar and Web of Science, using relevant keywords such as "cancer," "prevalence," "risk factors," "India," and "prevention." Articles published between 2010 and 2023 were included in this review. The search results were screened based on their relevance to the topic of cancer prevalence in India. Only articles written in English and those that reported on the incidence, prevalence, risk factors, and preventive measures of cancer in India were included. The exclusion criteria included articles reporting on animal studies, studies conducted outside of India and studies that did not report on the prevalence or risk factors of cancer. The selected articles were then reviewed and synthesized into the various sections of this review article, including the introduction, cancer prevalence in India, risk factors, prevention, and conclusion. The findings were presented using descriptive statistics, and graphs where appropriate.

III. Prevalence of Cancer in India

Cancer is a major public health concern in India. According to the Indian Council of Medical Research, the estimated number of new cancer cases in India in 2020 was 1.39 million, with an age-adjusted incidence rate of 106.6 per 100,000 population. The estimated number of deaths due to cancer in India was 784,821 in 2020, with an age-adjusted mortality rate of 62.3 per 100,000 population. According to the Indian Council of Medical Research-National Cancer Registry Programme (ICMR-NCRP), the number of cancer cases in the country is projected to go up from 14.6 lakh in 2022

to 15.7 lakh in 2025. Cancer is the second leading cause of death in India, after cardiovascular diseases. It is important to note that the incidence rates of some types of cancer are increasing in India. For example, the incidence rate of breast cancer has increased from 25.8 cases per 100,000 women in 1990 to 36.9 cases per 100,000 women in 2016. Similarly, the incidence rate of colorectal cancer has increased from 0.7 cases per 100,000 people in 1990 to 1.7 cases per 100,000 people in 2016. The incidence of cancer in India is increasing at an alarming rate. According to the National Cancer Registry Programme (NCRP), the number of cancer cases in India is expected to double by 2040.

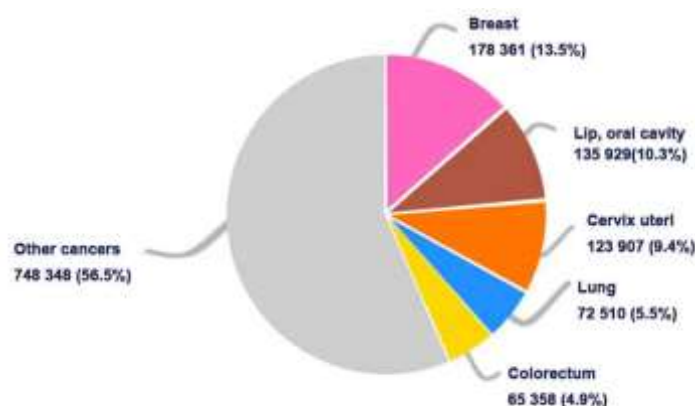
A. Types of Cancers and their incidence rates:

According to the latest report by the Indian Council of Medical Research (ICMR), the most common types of cancer in India are breast, lung, oral, cervical, and colorectal cancers. Other types of cancer that are prevalent in India include stomach, liver, prostate, ovarian, and uterine cancers.

According to the National Cancer Registry Programme (NCRP) of the Indian Council of Medical Research (ICMR), the most common types of cancers in India are as follows:

1. **Breast cancer:** Breast cancer is the most common cancer among Indian women, accounting for 27% of all cancer cases in women. The age-standardized incidence rate (ASIR) of breast cancer in India is 25.8 per 100,000 population.
2. **Oral cancer:** Oral cancer is the most common cancer among Indian men, accounting for 30% of all cancer cases in men. The ASIR of oral cancer in India is 15.7 per 100,000 population.
3. **Lung cancer:** Lung cancer is the second most common cancer among both Indian men and women, accounting for 6.9% of all cancer cases in men and 6.1% of all cancer cases in women. The ASIR of lung cancer in India is 11.3 per 100,000 population for men and 6.2 per 100,000 population for women.
4. **Cervical cancer:** Cervical cancer is the second most common cancer among Indian women, accounting for 9% of all cancer cases in women. The ASIR of cervical cancer in India is 13.1 per 100,000 population.
5. **Colorectal cancer:** Colorectal cancer is the third most common cancer among both Indian men and women, accounting for 4.4% of all cancer cases in men and 3.9% of all cancer cases in women. The ASIR of colorectal cancer in India is 4.4 per 100,000 population for men and 3.4 per 100,000 population for women.
6. **Prostate cancer:** Prostate cancer is the third most common cancer among Indian men, accounting for 4.4% of all cancer cases in men. The ASIR of prostate cancer in India is 4.4 per 100,000 population.
7. **Leukemia:** Leukemia is the fourth most common cancer among both Indian men and women, accounting for 3.6% of all cancer cases in men and 2.9% of all cancer cases in women. The ASIR of leukemia in India is 3.6 per 100,000 population for men and 2.7 per 100,000 population for women.
8. **Ovarian cancer :** 4%
9. **Brain and nervous system tumors:** 3%
10. **Oesophageal cancer:** 3%

The incidence rates of different types of cancer vary across different regions of India. For example, oral cancer is more common in the northern and eastern regions of India, while breast and cervical cancers are more common in the southern and western regions of India. The incidence rates of lung and prostate cancers are higher in urban areas, while the incidence rates of stomach and liver cancers are higher in rural areas.



Number of new cases in 2020 (Source: Globocan 2020)

B. Geographic Distribution and Burden of Cancers in India

11. **Kerala:** Kerala had an estimated incidence of 26,978 cancer cases in 2020, making it the 11th highest state in terms of cancer incidence in India. The most common types of cancer in Kerala were breast, oral, cervical, and lung cancer. The incidence of breast cancer in Kerala was found to be higher compared to other states in India.

C. Mortality rates of different types of Cancer in India

The mortality rates of different cancers in India can vary by region, age group, and other factors. However, based on the latest available data from the National Health Profile (NHP) report published by the Central Bureau of Health Intelligence (CBHI) in 2019, the top five cancers with the highest mortality rates in India are:

1. Lung cancer: 25.8 deaths per 100,000 population
2. Breast cancer: 14.5 deaths per 100,000 population
3. Cervical cancer: 11.3 deaths per 100,000 population
4. Stomach cancer: 9.5 deaths per 100,000 population
5. Colorectal cancer: 8.3 deaths per 100,000 population

According to WHO Summary report on HPV & cervical cancer statistics in India (2008) one woman dies of cervical cancer every 8 minutes in India. For every 2 women newly diagnosed with breast cancer, one woman dies of it in India (Sung et al., 2021). Mortality due to tobacco use in India is estimated at upwards of 3500 persons every day (Govt. of India report, 2010). Cancers of oral cavity, stomach and lungs account for over 25% of cancer deaths in males and cancer of uterine cervix, breast and oral cavity accounts for 25% cancers in females (National Cancer Registry Programme Report, 2020). The age-standardized mortality rate (ASMR) of cancer in India was 62.2 per 100,000 population for males and 64.1 per 100,000 population for females in 2018. Cancer incidence and mortality rates are higher in urban areas compared to rural areas in India.

D. Risk Factors for Cancer in India

There are several risk factors for cancer in India, including:

1. **Age:** As the population in India continues to age, the risk of cancer increases. Many types of cancer are more common in older adults.
2. **Lifestyle factors:** Unhealthy lifestyle factors such as smoking, alcohol consumption, lack of exercise and unhealthy diet can increase the risk of developing cancer.
3. **Environmental factors:** Exposure to air pollution, water pollution, and industrial chemicals can increase the risk of cancer.
4. **Family history:** A family history of cancer can increase the risk of developing certain types of cancer.
5. **Infections:** Certain infections, such as hepatitis B and C, human papillomavirus (HPV) and Helicobacter pylori (H. pylori) can increase the risk of developing certain types of cancer.
6. **Occupational hazards:** Exposure to certain occupational hazards, such as asbestos, can increase the risk of developing cancer.

IV. Causes for the increasing cancer cases in India

The causes of cancer in India are multifactorial and include genetic, environmental and lifestyle factors. Environmental factors such as air and water pollution, exposure to radiation, and use of pesticides and other chemicals have been linked to an increased risk of cancer in India. Lifestyle factors such as tobacco use, alcohol consumption, unhealthy diet, and physical inactivity also contribute to the burden of cancer in India.

A. Environmental factors and carcinogens

1. Air pollution and its link to cancer:

Air pollution is a significant risk factor for cancer in India. A study published in The Lancet Oncology estimated that air pollution was responsible for approximately 6% of cancer cases in India in 2016. Air pollution is a complex mixture of gases, particles, and other toxic substances that can harm human health. Exposure to air pollution has been linked to various adverse health effects, including cancer. There are several ways in which air pollution can cause cancer. Some of the major mechanisms are discussed below:

- a. **DNA Damage:** Air pollution contains carcinogenic substances such as polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and heavy metals, which can damage DNA and other genetic material in cells. This damage can lead to mutations and abnormal cell growth, which can eventually lead to cancer.
- b. **Inflammation:** Exposure to air pollution can cause inflammation in the body, which is a key factor in cancer development. Inflammation can trigger the release of reactive oxygen species (ROS), which can damage DNA and other cellular components.

- c. **Weakening Immune System:** Exposure to air pollution can weaken the immune system, which can make individuals more susceptible to infections and cancer. A weakened immune system can also reduce the body's ability to repair DNA damage and remove abnormal cells.
- d. **Epigenetic Changes:** Air pollution can cause epigenetic changes, which alter the expression of genes without changing the underlying DNA sequence. Epigenetic changes can affect cell growth and division, and can increase the risk of cancer.
- e. **Hormonal Imbalances:** Some air pollutants, such as dioxins and polychlorinated biphenyls (PCBs), can disrupt the endocrine system and cause hormonal imbalances. Hormonal imbalances can increase the risk of certain types of cancer, such as breast and prostate cancer.

2. Water pollution and its link to cancer:

Water pollution is another major environmental carcinogen in India. Industrial waste, agricultural runoff and inadequate sewage treatment have all contributed to the contamination of water sources with carcinogens such as arsenic and lead.

Exposure to contaminated water can increase the risk of cancer. Water pollution can occur due to various sources such as industrial discharge, agricultural runoff, and sewage discharge. The chemicals and contaminants in polluted water can be harmful to human health and increase the risk of cancer. For example, exposure to arsenic in drinking water has been linked to an increased risk of skin, lung, bladder, kidney, and liver cancer. Similarly, exposure to polycyclic aromatic hydrocarbons (PAHs) in water can increase the risk of bladder and skin cancer. Exposure to other chemicals such as trihalomethanes, which can form when chlorine is used to disinfect water, has been linked to an increased risk of bladder cancer. In addition to chemicals, some microorganisms that can contaminate water, such as the bacteria *Helicobacter pylori*, have been linked to an increased risk of stomach cancer.

Therefore, it is important to ensure that drinking water is safe and free from contamination to reduce the risk of cancer and other health problems. Water treatment processes such as filtration, disinfection and testing for contaminants can help to ensure safe drinking water.

3. Pesticides and their impact on cancer incidence:

India is one of the largest users of pesticides in the world. Exposure to pesticides has been linked to several types of cancer, including leukemia, lymphoma and breast cancer. There are several pesticides that have been linked to an increased risk of cancer in India, including:

- a. **Glyphosate:** This is a commonly used herbicide that has been classified as a probable human carcinogen by the International Agency for Research on Cancer (IARC). Glyphosate is widely used in India for agricultural purposes.
- b. **Chlorpyrifos:** This is an organophosphate insecticide that has been linked to an increased risk of cancer, as well as developmental and neurological effects. Chlorpyrifos is used in India for controlling pests in crops such as cotton, paddy, and vegetables.
- c. **Endosulfan:** This is an organochlorine insecticide that has been linked to an increased risk of cancer, as well as reproductive and developmental effects. Endosulfan has been banned in several countries, including India, but it is still used illegally in some parts of the country.
- d. **Malathion:** This is an organophosphate insecticide that has been linked to an increased risk of cancer and other health effects. Malathion is used in India for controlling pests in crops such as cotton, fruits and vegetables.

It is important to note that there are many other pesticides that have been linked to cancer and other health effects in India and around the world. Proper use and handling of pesticides, as well as safer alternatives and integrated pest management practices, can help reduce the risks associated with pesticide exposure.

4. Radon exposure and cancer risk:

Radon is a naturally occurring radioactive gas that can seep into homes and buildings. Exposure to radon gas is a leading cause of lung cancer in non-smokers. It is produced by the decay of uranium and thorium in soil, rock, and water. In India, the main source of radon gas is the soil and rocks that contain high levels of uranium and thorium. Radon gas can seep into homes and other buildings through cracks and gaps in the foundation, walls, and floors, and can accumulate to high levels. Homes built on granite or other rocks that contain high levels of uranium and thorium are particularly at risk for elevated radon levels. Additionally, groundwater can also contain high levels of radon, which can pose a risk to people who consume it.

5. Exposure to Radiation and cancer risk:

Radiation can cause cancer by damaging the DNA in cells. Radiation comes in many forms, including ionizing radiation, which is a high-energy type of radiation that can penetrate the body and cause damage at the cellular level. Ionizing radiation can be found in various sources such as X-rays, CT scans and radiation therapy for cancer. When ionizing radiation passes through the body, it can cause ionization, which means it can knock electrons off atoms and molecules in the body. This can cause damage to the DNA in cells, which can lead to mutations that can cause cancer. The damage caused by ionizing radiation is often cumulative, meaning that the more exposure a person has over time, the greater their risk of developing cancer.

The types of cancer that can be caused by radiation exposure include leukemia, thyroid cancer, breast cancer, lung cancer and skin cancer. The risk of developing cancer from radiation exposure depends on the dose of radiation, the length of exposure and the age at which a person was exposed. Children and young adults are particularly susceptible to the harmful effects of radiation exposure.

To reduce the risk of cancer from radiation exposure, it is important to limit exposure to sources of ionizing radiation when possible and to use protective measures such as lead shields during medical imaging procedures.

B. Lifestyle factors

1. Smoking and tobacco use as a leading cause of cancer:

Smoking is one of the most well-established risk factors for cancer, as it contains a number of carcinogens that can damage DNA and cause mutations that can lead to cancer. Smoking has been linked to an increased risk of several types of cancer, including lung, bladder and pancreatic cancer. Smoking and tobacco chewing are major contributors to the high incidence of cancer in India. Tobacco contains several harmful chemicals, including nicotine, tar and carbon monoxide, which can damage DNA and other cellular components, leading to cancer development. Tobacco use is responsible for almost 30% of all cancer deaths in India. It is estimated that over 1 million people die each year in India due to tobacco-related illnesses, including cancer.

Cigarette smoking is the most common form of tobacco use in India and is a major cause of lung cancer, as well as other types of cancer such as oral, pharynx, larynx, esophagus, stomach, pancreas, kidney, bladder, and cervix. Second-hand smoke, or passive smoking, is also a significant cause of lung cancer and other respiratory diseases, particularly in children.

Tobacco chewing, particularly gutkha and pan masala, is also a major cause of cancer in India. These products contain a mixture of tobacco, areca nut, and other ingredients, and are commonly used in many parts of India. Chewing tobacco has been linked to several types of cancer, including oral cancer, oesophageal cancer and pancreatic cancer. The use of tobacco products in India is particularly high among men, but there has been a recent increase in tobacco use among women as well. The Indian government has implemented several measures to reduce tobacco use, including increased taxes on tobacco products, bans on smoking in public places and health warnings on cigarette packets. However, more needs to be done to reduce the prevalence of tobacco use and to prevent cancer deaths in India.

2. Unhealthy diet and physical inactivity as risk factors:

Unhealthy diets, particularly diets that are high in fat, sugar, and processed foods, are contributing to the high incidence of cancer in India. A diet that lacks sufficient fruits, vegetables, and whole grains can increase the risk of cancer by reducing the intake of important nutrients and antioxidants that protect the body from cancer-causing agents. A diet that is high in red and processed meat has also been linked to an increased risk of cancer, particularly colorectal cancer. A study conducted by the Indian Council of Medical Research found that people who consumed more than 80 grams of red and processed meat per day had a higher risk of developing colon cancer. Additionally, high consumption of sugary beverages, such as soft drinks, has been linked to an increased risk of several types of cancer, including pancreatic cancer and breast cancer. This may be due to the high sugar content of these drinks, which can increase insulin levels in the body and promote the growth of cancer cells. Other dietary factors that may contribute to cancer risk include low fibre intake, high salt intake and consumption of food that is contaminated with harmful chemicals and additives.

Adulteration of food in India is also a significant issue and has been linked to the development of cancer. Adulteration refers to the intentional addition of harmful substances to food products, often with the aim of increasing their quantity or improving their appearance or taste. Adulterants such as colorants, preservatives, and synthetic chemicals have been found in various food items, including spices, condiments, milk, and vegetable oils, which are commonly consumed in India. These adulterants have been linked to an increased risk of cancer, as many of them are known or suspected carcinogens. For example, food colorants such as Sudan dyes, which are used to give a red colour to spices and sauces, have been found to be carcinogenic. The preservative formalin, which is often added to fish and other seafood to prevent spoilage, has also been linked to an increased risk of cancer.

In addition to intentional adulteration, contamination of food products with environmental pollutants, such as heavy metals, pesticides, and dioxins, can also contribute to the development of cancer. These pollutants can enter the food chain through various sources, including water and soil pollution and can accumulate in the body over time, leading to chronic exposure.

To reduce the risk of cancer from adulterated and contaminated food, it is important to take precautions when purchasing and consuming food products. Consumers should buy food products from trusted sources and check for signs of adulteration, such as abnormal colour or odour. It is also important to properly wash and cook food items to reduce the risk of contamination. It is also important to adopt a healthy diet that includes a variety of fruits, vegetables, whole grains, and lean proteins to reduce the risk of cancer. The Indian government has launched several initiatives to promote healthy eating, including the Eat Right campaign, which aims to encourage people to make healthier food choices.

Physical inactivity is also a major risk factor for cancer, as it can lead to weight gain and obesity, which are well-established risk factors for several types of cancer, including breast, colon, endometrial, kidney and ovarian cancer. Physical inactivity or a sedentary lifestyle is associated with an increased risk of cancer. A sedentary lifestyle can also lead to insulin resistance and chronic inflammation, which can promote the development and growth of cancer cells.

Studies have shown that regular physical activity can reduce levels of circulating hormones, such as estrogen, that are associated with the development of breast cancer. Physical activity has also been shown to improve bowel function and reduce the risk of colon cancer. The Indian government has launched several initiatives to promote physical activity and reduce the risk of chronic diseases, including cancer. The Fit India campaign aims to encourage people to adopt an active lifestyle by participating in physical activities such as yoga, sports, and walking.

To reduce the risk of cancer, it is important to engage in regular physical activity, such as walking, cycling, or swimming, for at least 30 minutes per day. Additionally, it is important to reduce sedentary behaviour, such as sitting for long periods of time, by taking frequent breaks and engaging in light physical activity throughout the day. Regular physical activity can help to reduce the risk of cancer by helping to maintain a healthy weight and by reducing inflammation and oxidative stress in the body.

3. Alcohol consumption and its association with cancer:

Excessive alcohol consumption is another major risk factor for cancer, as it can damage DNA and increase the risk of several types of cancer, including breast, liver, colorectal and oesophageal cancer. It is important to note that the risk of cancer increases with the amount of alcohol consumed. Even moderate alcohol consumption has been linked to an increased risk of certain cancers, particularly breast cancer in women.

To reduce the risk of cancer, it is recommended that adults limit their alcohol consumption to no more than one drink per day for women and two drinks per day for men.

C. Infectious agents and their role in causing cancer

Certain infections such as human papillomavirus (HPV), hepatitis B and C and human immunodeficiency virus (HIV) can increase the risk of cancer. In India, infection-related cancers such as cervical cancer and liver cancer are prevalent. The NCRP report of 2020 estimated that infection-related cancers account for approximately 26% of cancer cases in India.

1. HPV and its association with cervical and other cancers:

Human papillomavirus (HPV) is known to cause several types of cancer. Human papillomavirus (HPV) infections in India, like in other countries, are usually transmitted through sexual contact. HPV is a common sexually transmitted infection, and it is estimated that up to 80% of sexually active individuals will be infected with HPV at some point in their lives. It is important to note that HPV infections can also occur through non-sexual means, such as from mother to child during childbirth or through skin-to-skin contact. However, sexual transmission remains the most common mode of transmission for HPV infections.

The most common types of cancer associated with HPV include:

- a. **Cervical cancer:** HPV is responsible for almost all cases of cervical cancer. Certain types of HPV, particularly HPV-16 and HPV-18, are known to cause changes in the cells of the cervix that can lead to cancer.
- b. **Anal cancer:** HPV is also a known cause of anal cancer. HPV infection is particularly common among men who have sex with men, and individuals with weakened immune systems.
- c. **Oro-pharyngeal cancer:** HPV is a major cause of oro-pharyngeal cancer, which is cancer of the back of the throat, including the base of the tongue and tonsils.
- d. **Other cancers:** HPV is also associated with several other types of cancer, including vaginal cancer, vulvar cancer, and penile cancer.

It is important to note that not all HPV infections lead to cancer and many people with HPV infection will never develop cancer. However, certain types of HPV are more likely to cause cancer than others, and individuals with persistent HPV infections are at higher risk for developing cancer. Vaccines are available to prevent infection with certain types of HPV, which can help reduce the risk of developing HPV-associated cancers.

2. H. pylori and its link to stomach cancer:

Helicobacter pylori (*H. pylori*) are a bacterium that is known to cause several types of cancer, including gastric cancer and mucosa-associated lymphoid tissue (MALT) lymphoma. In India, as in other parts of the world, *H. pylori* infection is a major risk factor for gastric cancer. Gastric cancer is the fourth most common cancer in India and it is estimated that *H. pylori* infection is responsible for up to 80% of all cases of gastric cancer. *H. pylori* is a type of bacteria that lives in the stomach lining and it is believed to cause cancer by producing toxins that damage the cells of the stomach lining.

In addition to gastric cancer, *H. pylori* infection is also associated with MALT lymphoma, which is a type of cancer that affects the lymphatic system. MALT lymphoma is rare, accounting for only a small percentage of all lymphomas, but it is more common in individuals with *H. pylori* infection.

It is important to note that not everyone with *H. pylori* infection will develop cancer, and many people with the infection will never experience any symptoms. However, individuals with persistent *H. pylori* infections are at higher risk for developing gastric cancer and should be monitored closely by a healthcare provider. Treatment for *H. pylori* infection, typically with antibiotics, can help reduce the risk of developing gastric cancer.

Helicobacter pylori (*H. pylori*) infection is a common bacterial infection in India, like in other parts of the world. The bacterium is mainly transmitted through contaminated food and water, and close contact with an infected person's vomit or faeces can also spread the infection.

In India, there are several factors that contribute to the high rates of *H. pylori* infections. These include:

- a. **Poor sanitation:** Poor sanitation practices, particularly in rural areas, can increase the risk of *H. pylori* infection. Contaminated water sources and poor hygiene practices can contribute to the spread of the bacteria.

- b. **Limited access to clean water:** Limited access to clean drinking water, particularly in rural areas, can increase the risk of H. pylori infection. Drinking contaminated water is a common mode of transmission for the bacteria.
- c. **Crowded living conditions:** Crowded living conditions, particularly in urban slums, can increase the risk of H. pylori infection. Close contact with an infected person can increase the likelihood of transmission.
- d. **Poor food hygiene:** Poor food hygiene practices, particularly in street food vendors, can increase the risk of H. pylori infection. Contaminated food and utensils can spread the bacteria.
- e. **Lack of awareness:** Lack of awareness about the risks associated with H. pylori infection, as well as the importance of practicing good hygiene and sanitation, can contribute to the spread of the bacteria.

D. Ageing Population:

India is experiencing a demographic shift with a rapidly ageing population. As people age increases, the risk of cancer increases. The National Cancer Registry Programme (NCRP) report of 2020 estimated that 55% of cancer cases in India occur in individuals aged 50 years and above. Ageing is a major risk factor for cancer. As age increases, our cells accumulate damage to DNA and other cellular components due to various factors such as exposure to environmental toxins, radiation, and oxidative stress. Over time, this damage can accumulate and lead to mutations that can cause cells to become cancerous.

One of the main reasons why ageing increases the risk of cancer is because our bodies' natural mechanisms for repairing damaged DNA become less efficient as age increases. For example, as people get older, the telomeres at the ends of our chromosomes become shorter, which can makes the cells difficult to repair DNA damage.

In addition to changes in DNA repair mechanisms, ageing can also affect the immune system, which plays a key role in detecting and eliminating cancer cells. As age increases, the immune system becomes less effective at recognizing and destroying cancer cells, which can allow them to grow and spread more easily.

The types of cancer that are most strongly associated with ageing include breast cancer, prostate cancer, lung cancer, and colorectal cancer. However, it is important to note that cancer can occur at any age and not all types of cancer are strongly linked to ageing. While we cannot stop the ageing process, there are steps we can take to reduce our risk of cancer as we age, such as maintaining a healthy lifestyle, getting regular cancer screenings, and avoiding exposure to environmental toxins and other carcinogens.

E. Genetic Factors:

Certain genetic mutations increase the risk of developing cancer. In India, the prevalence of some of these mutations is higher, contributing to the increasing number of cancer cases.

V. Prevention Strategies for Cancer in India

Prevention strategies for cancer in India can be broadly categorized into three main areas: primary prevention, secondary prevention and tertiary prevention.

A. Primary prevention measures

Primary prevention strategies aim to reduce the incidence of cancer by addressing the root causes of the disease. These strategies include:

- a. **Quitting smoking:** Tobacco use, including smoking, is a major risk factor for several types of cancer. Quitting smoking and avoiding exposure to second-hand smoke can significantly reduce the risk of developing cancer.
- b. **Maintaining a healthy weight:** Obesity is a risk factor for many types of cancer, including breast, colorectal and prostate cancer. Eating a healthy diet and exercising regularly can help maintain a healthy weight.
- c. **Eating a healthy diet:** A diet rich in fruits, vegetables, whole grains and lean proteins can reduce the risk of several types of cancer. Avoiding processed and red meats, as well as sugary and high-fat foods, can also help.
- d. **Limiting alcohol consumption:** Excessive alcohol consumption is a risk factor for several types of cancer, including liver, breast, and colorectal cancer. Limiting alcohol consumption to moderate levels can reduce the risk.
- e. **Protecting against the sun:** Exposure to ultraviolet radiation from the sun is a risk factor for skin cancer. Wearing protective clothing, seeking shade, and applying sunscreen can help protect against the harmful effects of the sun.
- f. **Getting vaccinated:** Certain types of cancer, such as cervical and liver cancer, can be prevented with vaccines. The human papillomavirus (HPV) vaccine can prevent the types of HPV that cause most cases of cervical cancer, while the hepatitis B vaccine can prevent hepatitis B, a risk factor for liver cancer.

- g. **Regular health checkups:** Regular health checkups can help detect cancer early, when it is more treatable. Women should undergo regular breast and cervical cancer screenings, while men should undergo regular prostate cancer screenings.

By adopting these primary preventive measures, individuals can significantly reduce their risk of developing cancer in India.

B. Secondary prevention measures

Secondary preventive measures for cancer in India include various screening programs that help to detect cancer at an early stage, when it is more likely to be treated successfully. Some of the common screening programs include:

- a. **Breast Cancer Screening:** Women over the age of 40 are advised to undergo mammography every one to two years to screen for breast cancer. Clinical breast exams and breast self-exams are also recommended.
- b. **Cervical Cancer Screening:** Women over the age of 21 are advised to undergo a Pap test every three years to screen for cervical cancer. Women between the ages of 30 and 65 can choose to undergo a Pap test along with an HPV test every five years.
- c. **Colorectal Cancer Screening:** Individuals over the age of 50 are advised to undergo screening for colorectal cancer. Common screening methods include stool-based tests and colonoscopy.
- d. **Prostate Cancer Screening:** Men over the age of 50 are advised to undergo prostate-specific antigen (PSA) testing to screen for prostate cancer. However, the efficacy of this screening test is still debated and individual risk factors should be considered.
- e. **Oral Cancer Screening:** Individuals with a history of tobacco and alcohol use or exposure to human papillomavirus (HPV) are at increased risk for oral cancer and should undergo regular screening.

It is important to note that screening programs should be individualized based on age, gender and other risk factors. Individuals should consult with their healthcare providers to determine the appropriate screening schedule for them.

C. Tertiary prevention measures

Tertiary prevention measures for cancer in India focus on managing the disease and improving the quality of life of cancer patients. These measures include:

- a. **Palliative care and Pain relief:** Palliative care is an essential component of cancer treatment. It aims to alleviate the symptoms and improve the quality of life of cancer patients. Palliative care can be provided by a team of healthcare professionals, including doctors, nurses, social workers, and psychologists. In India, more than 75% of cancer cases are advanced, making palliative care and pain management crucial to ensuring that patients live healthy lives. The cornerstone of cancer pain management is oral morphine, which needs to be made available at all sites. Oral morphine must be made available to persons who are in pain, thus administrators and medical professionals alike must be educated about its usage and restrictions must be made clear.
- b. **Rehabilitation:** Cancer treatment can cause physical and emotional trauma to patients. Rehabilitation aims to restore the physical, emotional, and social functioning of cancer survivors. This may include physical therapy, occupational therapy, speech therapy, and counselling.
- c. **Support groups:** Cancer patients and their families may benefit from joining support groups. Support groups provide emotional and practical support to cancer patients and their families.
- d. **Follow-up care:** Follow-up care is essential for cancer survivors. It involves regular medical check-ups and tests to monitor the cancer's recurrence and manage any side effects of treatment.
- e. **Survivorship care:** Survivorship care focuses on the long-term effects of cancer treatment on survivors' physical and emotional health. It aims to improve their quality of life and prevent future health problems.

In conclusion, tertiary prevention measures for cancer in India are crucial for managing the disease, improving the quality of life of cancer patients and preventing future health problems. These measures should be an integral part of cancer treatment and care.

VI. Government and NGO Initiatives in India

The Government of India and several organizations have taken a number of steps to reduce or prevent cancer cases in India. Some of the major initiatives include:

- a. **National Cancer Control Programme (NCCP):** The NCCP is a government-led initiative that aims to reduce the incidence of cancer and improve the quality of life of cancer patients. The program focuses on prevention, early detection, diagnosis, treatment, palliative care and research.
- b. **Tobacco Control Laws:** The Government of India has implemented several tobacco control laws, including a ban on smoking in public places and the sale of tobacco products to minors. The government has also implemented pictorial warnings on tobacco products.

- c. **HPV Vaccination:** The Government of India has launched a nationwide program to vaccinate girls against Human Papillomavirus (HPV), which can cause cervical cancer.
- d. **Cancer Screening Programs:** The government has launched several cancer screening programs, including the National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS), which provides screening for breast, cervical, and oral cancers.
- e. **Awareness Campaigns:** Several organizations, including the Indian Cancer Society, the Indian Council of Medical Research, and the National Cancer Grid, have launched awareness campaigns to educate the public about the risk factors for cancer and the importance of early detection and treatment.
- f. **Research and Development:** The government and several organizations are investing in research and development to improve the prevention, diagnosis and treatment of cancer in India.
- g. **Environmental Regulations:** The government has implemented regulations to reduce exposure to environmental carcinogens, including air and water pollution.

VII. Future Directions:

While there has been progress in cancer diagnosis and treatment in India, there is still a long way to go in terms of prevention and early detection. As India's population continues to grow and age, the burden of cancer is expected to increase. Therefore, it is essential to continue to invest in cancer research, prevention strategies and treatment facilities. Additionally, there is a need for more public awareness campaigns, particularly in rural areas, to educate people about the importance of healthy lifestyle choices and early detection.

VIII. Conclusion:

Cancer is a significant health concern in India, with millions of new cases and deaths occurring every year. The high incidence of preventable risk factors such as tobacco use, unhealthy diet and physical inactivity makes cancer a preventable disease to some extent. Addressing these risk factors and promoting healthy lifestyle habits can reduce the incidence of cancer in India. Moreover, improved cancer screening and treatment facilities, as well as better access to healthcare, can lead to better outcomes for cancer patients. Therefore, it is crucial to continue to invest in cancer research, prevention strategies and treatment facilities to address the growing burden of cancer in India.

IX. References:

1. WHO Summary report on HPV & cervical cancer statistics in India (18/03/2008)
2. Sung H, Ferlay J, Siegel RL, et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA Cancer J Clin.* 2021 May;71(3):209-249.
3. http://www.breastcancerindia.net/bc/statistics/stat_global.htm
4. Jha P, Jacob B, Gajalakshmi V, Gupta PC, Dhingra N, Kumar R, et al. A nationally representative case-control study of smoking and death in India. *New England Journal of Medicine.* 2008 March; 358(11):1137-1147. And Sinha DN, Palipudi KM, Gupta PC, Singhal S, Ramasundarahettige C, Jha P, et al. Smokeless tobacco use: a meta-analysis of risk and attributable mortality estimates for India. *Indian Journal of Cancer.* 2014; 51 (Suppl 1):S73-S77.
5. Report on causes of deaths in India 2001-2003. Office of the Registrar General of India, Govt. of India, 2010.
6. American Cancer Society. Alcohol Use and Cancer.
7. American Cancer Society. Lifestyle-related factors that can cause cancer.
8. Campisi, J., & d'Adda di Fagagna, F. (2007). Cellular senescence: when bad things happen to good cells. *Nature Reviews Molecular Cell Biology*, 8(9), 729-740.
9. Cohen A, Brauer M, Burnett R, et al. Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Diseases Study 2015. *Lancet.* 2017; 389(10082):1907-1918.
10. Food Safety and Standards Authority of India. Adulteration of Food. <https://www.fssai.gov.in/cms/adulteration.php>
11. Gupta PC, Ray CS. Smokeless tobacco and health in India and South Asia. *Respirology.* 2003 Jul;8(3):419-31.
12. Hu J, La Vecchia C, Augustin LS, et al. Soft drinks and risk of pancreatic cancer: a meta-analysis of observational studies. *Eur J Cancer Prev.* 2018 Jul; 27(4):322-330.
13. Indian Council of Medical Research. National Cancer Registry Programme (NCRP). <http://www.ncdirindia.org/ncrp/Index.aspx>

14. Indian Council of Medical Research. National Cancer Registry Programme. http://ncdirindia.org/All_Reports/Report_2020/default.aspx
15. Indian Council of Medical Research. National Centre for Disease Informatics and Research. <http://www.ncdirindia.org/>
16. Indian Council of Medical Research. Red and Processed Meat and Colorectal Cancer Incidence: A Meta-Analysis. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4663412/>
17. International Agency for Research on Cancer. India Fact Sheet. <https://gco.iarc.fr/today/data/factsheets/populations/356-india-fact-sheets.pdf>
18. International Agency for Research on Cancer. Outdoor Air Pollution and Cancer. <https://www.iarc.who.int/featured-news/media-centre-iarc-news-outdoor-air-pollution-cancer/>
19. International Atomic Energy Agency. Radiation and Health. <https://www.iaea.org/topics/radiation-and-health>
20. Mathur P, Sathishkumar K, Chaturvedi M, Das P, Sudarshan KL, Santhappan S, et al. Cancer statistics, 2020: Report from National Cancer Registry Programme, India. *JCO Glob Oncol* 2020;6:1063–75.
21. McTiernan A. Mechanisms linking physical activity with cancer. *Nat Rev Cancer*. 2008;8(3):205-211.
22. Ministry of Youth Affairs and Sports. Fit India Movement. <https://www.fitindia.gov.in/>
23. National Cancer Institute. Cancer Risk Factors and Causes. <https://www.cancer.gov/about-cancer/causes-prevention/risk>
24. National Cancer Registry Programme. Consolidated Report of Population Based Cancer Registries: 2020. http://www.ncdirindia.org/NCRP/ALL_NCRP_REPORTS/PBCR_REPORT_2020/index.aspx
25. National Cancer Registry Programme. Three-Year Report of Population Based Cancer Registries: 2012-2014. http://www.ncdirindia.org/NCRP/ALL_NCRP_REPORTS/PBCR_REPORT_2012_2014/index.aspx
26. National Institute of Cancer Prevention and Research. Cancer Incidence and Mortality in India http://nicpr.res.in/images/reports/Cancer_incidence_and_mortality_in_India_2017.pdf
27. Rajmohan, H. R., & Karthikeyan, G. (2017). Water pollution in India: types, causes, and effects. *Applied Water Science*, 7(3), 1043-1055.
28. Renshaw, J. G. (2019). Why does aging increase the risk of cancer? *Frontiers in Oncology*, 9, 1255.
29. Sankar, S., & Ramalingam, V. (2019). Drinking water quality and human health in Indian scenario: a review. *Journal of Environmental Health Science and Engineering*, 17(1), 51-60.
30. The Hindu. Cancer incidence highest in northeastern States: report. <https://www.thehindu.com/news/national/cancer-incidence-highest-in-northeastern-states-report/article34853462.ece>
31. The Lancet Commission on Pollution and Health. The Lancet Commission on Pollution and Health: The Global Burden of Disease from Air, Water, and Soil Pollution. <http://www.thelancet.com/commissions/pollution-and-health>
32. The Lancet Oncology Commission on Global Cancer Surgery. Global Cancer Surgery: Delivering Safe, Affordable, and Timely Cancer Surgery. <https://www.thelancet.com/commissions/global-cancer-surgery>
33. Times of India. Cancer cases on the rise in India, 13.9 lakh new cases reported in 2020. <https://timesofindia.indiatimes.com/india/cancer-cases-on-the-rise-in-india-13-9-lakh-new-cases-reported-in-2020/articleshow/83690454.cms>
34. United States Environmental Protection Agency. Radiation Protection. <https://www.epa.gov/radiation/radiation-protection>
35. World Cancer Research Fund/American Institute for Cancer Research. Diet, Nutrition, Physical Activity and Cancer: a Global Perspective. <https://www.wcrf.org/dietandcancer>
36. World Cancer Research Fund/American Institute for Cancer Research. Continuous Update Project Expert Report 2018. Alcoholic drinks and the risk of cancer. <https://www.wcrf.org/sites/default/files/Alcoholic-drinks.pdf>
37. World Cancer Research Fund/American Institute for Cancer Research. Continuous Update Project Expert Report 2018. Physical activity and the risk of cancer. <https://www.wcrf.org/dietandcancer/physical-activity-and-cancer-risk>
38. World Health Organization. (2011). Guidelines for drinking-water quality (4th ed.). Geneva, Switzerland: World Health Organization.
39. World Health Organization. Air Pollution and Cancer. <https://www.iarc.who.int/featured-news/media-centre-iarc-news-air-pollution-and-cancer/>
40. World Health Organization. Cancer Prevention. <https://www.who.int/cancer/prevention/en/>
41. World Health Organization. Cancer. <https://www.who.int/news-room/fact-sheets/detail/cancer>