

Socio-Economic and Financial Factor Analysis for Cancer Treatment in Bangladesh

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Abstract

Cancer remains a leading cause of mortality globally, with its burden particularly acute in low-and middle-income countries like Bangladesh. This study investigates the socio-economic and financial factors influencing cancer treatment accessibility and outcomes in Bangladesh. Drawing on epidemiological data, healthcare infrastructure analysis, and expert insight, the research highlights critical barriers such as limited healthcare access, financial constraints, and public health awareness deficits. Recommendations include expanding rural healthcare infrastructure, implementing targeted awareness campaigns, subsidizing treatment costs, and developing comprehensive insurance schemes. These interventions are vital for improving early diagnosis, equitable treatment delivery, and long-term cancer care outcomes in Bangladesh.

Keywords

Bangladesh, Cancer, Cancer Care Outcomes, Early Diagnosis, Equitable Treatment, Financial Barriers, Healthcare Access, Healthcare Infrastructure, Insurance Schemes, Low- and Middle-Income Countries, Public Health Awareness, Rural Healthcare, Socio-Economic Factors, Treatment Accessibility

1. Introduction

What is Cancer? According to the World Health Organization (WHO), cancer represents the largest global health burden, accounting for 244.6 million Disability-Adjusted Life Years (DALYs), 137.4 million in men and 107.2 million in women. It is one of the leading causes of death worldwide, responsible for nearly 10 million deaths in 2020, or approximately one in six deaths globally. The most common

types of cancer include breast, lung, colorectal (colon and rectum), and prostate cancers. In 2020, the highest number of new cases was:

- 1) Breast cancer—2.26 million cases.
- 2) Lung cancer—2.21 million cases.
- 3) Colorectal cancer—1.93 million cases.
- 4) Prostate cancer—1.41 million cases.
- 5) Non-melanoma skin cancer—1.20 million cases.
- 6) Stomach cancer—1.09 million cases.

The leading causes of cancer-related deaths in 2020 were:

- 1) Lung cancer—1.80 million deaths.
- 2) Colorectal cancer—916,000 deaths.
- 3) Liver cancer—830,000 deaths.
- 4) Stomach cancer—769,000 deaths.
- 5) Breast cancer—685,000 deaths.

Approximately 400,000 children are diagnosed with cancer each year. Cancer prevalence varies by region; for example, cervical cancer is the most common cancer in 23 countries. About one-third of cancer deaths result from key behavioral and dietary risk factors, including tobacco use, high body mass index (BMI), alcohol consumption, low intake of fruits and vegetables, and lack of physical activity. Additionally, around 30% of cancer cases in low-and lower-middle-income countries are linked to infections such as human papillomavirus (HPV) and hepatitis viruses. Cancer is a generic term for a group of over 100 diseases characterized by abnormal cell growth with the potential to invade or spread to other parts of the body. These diseases are also referred to as malignant tumors or neoplasms. A hallmark of cancer is the uncontrolled division of cells that may invade nearby tissues and metastasize through the blood or lymphatic systems to distant organs. Metastasis is the leading cause of cancer-related deaths. The development of cancer is influenced by both genetic factors and environmental exposures. These external agents fall into three main categories:

- 1) Physical carcinogens (e.g., ultraviolet and ionizing radiation).
- 2) Chemical carcinogens (e.g., asbestos, tobacco smoke, alcohol, aflatoxin in food, and arsenic in drinking water).
- 3) Biological carcinogens (e.g., infections from specific viruses, bacteria, or parasites).

Cancer can occur in almost any organ or tissue in the body. Each type has unique characteristics, including pathophysiology, origin, behavior, and prognosis.

The most common cancers by demographic are:

- 1) Men: Lung, prostate, esophagus, and rectal cancers.
- 2) Women: Breast, cervical, and lung cancers.
- 3) Children: Leukemia, brain tumors, and lymphoma.

Cancer presents a significant public health challenge in both developed and developing nations. In low-resource countries, the issue is expected to worsen, with cancer cases projected to double in the next 20 to 25 years. In Bangladesh, the

situation is particularly severe due to poverty, illiteracy, poor nutrition, and a lack of public awareness about health. Socio-economic and financial barriers further hinder cancer treatment in the country. This report aims to examine the challenges affecting cancer treatment in Bangladesh. By understanding these factors, effective strategies can be developed to improve cancer care accessibility, affordability, and overall patient outcomes.

2. Background

A study by [Nutbeam \(2000\)](#) among a low-literacy group found that health information can be effectively disseminated through adult education health literacy classes. The study, which involved 21 students and 3 teachers, revealed that students were motivated to share health-related knowledge with classmates, friends, and family members outside the classroom. The use of information and communication technology (ICT), including social media, may also serve as an effective means of disseminating public health information. Beyond health education, accessibility to healthcare services and screening facilities is crucial. Access to cancer screening, early detection services, treatment centers, and social support systems significantly influences the willingness and ability of high-risk individuals to undergo screening and receive appropriate care. However, [Rahman et al. \(2019\)](#) reported that the number of hospitals equipped with cancer screening and treatment services in rural areas is inadequate. This shortage results in delays in treatment for patients already diagnosed with cancer. In reality, most modern cancer treatment centers are concentrated in urban areas and city centers, especially where public amenities are more developed. In Bangladesh, hospitals offering cancer care are predominantly located in major cities. Several districts, particularly in rural regions, have limited access to comprehensive healthcare. Long distances to medical centers, combined with inefficient or nonexistent public transportation systems, further hinder access to essential healthcare services for rural populations ([Alam & Jahan, 2020](#)). When disseminating health information, the method of communication, the credibility of the presenter, and the nature of the relationship between the communicator and the audience all play crucial roles in enhancing public understanding and engagement. According to [Uddin & Hasan \(2018\)](#), the recommended travel distance between a patient's home and a hospital should be no more than 12 kilometers or a 20-minute journey under moderate speed, in order to minimize physical pain and financial burdens during travel. In addition to healthcare access, financial and socio-cultural factors also influence cancer screening behavior, treatment decisions, recovery, and overall survival outcomes ([Sung et al., 2021](#)), as cited in [Norsa'adah et al. \(2011\)](#). Cancer treatment may lead to reduced work capacity or job loss, resulting in decreased income and added financial strain ([Yen Siew & Abdullah, 2017](#)). Consequently, financial stability, accessible healthcare infrastructure, and favorable socio-cultural conditions significantly increase the likelihood of individuals undergoing cancer screening and receiving appropriate post-diagnosis care. Moreover, the popularity of alternative treatments contributes

to delays in seeking conventional medical care, particularly in Bangladesh. Education plays a key role in increasing cancer awareness. A study conducted in Nigeria by Rabeta Mohd & Hussain (2015) found that limited knowledge of breast cancer delayed screening and treatment among suburban women. Only 21.4% of participants knew that a painless lump could be an early symptom of breast cancer. The study also found that educated and employed women had greater awareness of breast cancer. In another study, 20 women who had never undergone Pap smear tests were found to have low levels of awareness regarding cervical cancer. Most were unaware of preventive measures or the fact that early detection significantly increases survival rates. Similarly, in Bangladesh, many breast cancer patients are diagnosed at later or advanced stages, highlighting a general lack of awareness about cancer symptoms and the importance of early screening in developing countries.

Late-stage diagnosis is a major contributor to the rising number of cancer-related deaths in developing nations (Norsa'adah et al., 2011). Therefore, increasing public education and awareness about cancer risk factors, healthy lifestyle choices, and the importance of regular screening, particularly for high-risk groups, is essential to reducing cancer incidence and mortality (Norsa'adah et al., 2011; Rabeta Mohd & Hussain, 2015). Many individuals in rural areas avoid visiting hospitals due to limited knowledge about cancer and general health. According to Uddin & Hasan (2018), medical treatments are often inaccessible to rural populations due to high travel costs and expensive treatments. Norsa'adah et al. (2011) found that out of 295 cancer patients interviewed, only 9 (3%) were diagnosed at Stage I, while 48 (16.3%) were diagnosed at Stage IV, 125 (42.2%) at Stage III, and 113 (38.3%) at Stage II. This reflects a trend of late detection and diagnosis. The concentration of hospitals in urban centers makes it more difficult for rural populations to access essential cancer services. Factors such as reliance on alternative treatments, high treatment and transportation costs, time constraints, and low awareness of early cancer symptoms continue to contribute to delays in diagnosis and treatment (Norsa'adah et al., 2011). The geographical location of hospitals thus plays a crucial role in influencing access to health information, cancer screening, and treatment services.

2.1. Why Cancer Treatment Is Essential

The World Health Organization (WHO), through its cancer research arm—the International Agency for Research on Cancer (IARC) (2020)—maintains an updated classification of known and probable cancer-causing agents. The incidence of cancer increases significantly with age, largely due to the cumulative effect of long-term exposure to risk factors. Additionally, as people age, the body's cellular repair mechanisms become less effective, increasing susceptibility to malignant growths. Several modifiable risk factors contribute to the global cancer burden. These include tobacco use, alcohol consumption, unhealthy diets, physical inactivity, and air pollution. Chronic infections also play a significant role, particularly in low-

and middle-income countries. In 2018, approximately 13% of global cancer cases were linked to carcinogenic infections such as *Helicobacter pylori*, human papillomavirus (HPV), hepatitis B and C viruses, and the Epstein-Barr virus. Despite the burden, cancer outcomes can be significantly improved through early detection and appropriate treatment. Many types of cancer have high cure rates when diagnosed at an early stage and managed with the correct therapeutic strategies. Early diagnosis is crucial in all settings, as it allows for timely intervention and better patient outcomes. An accurate cancer diagnosis is essential for selecting the most effective treatment. Each type of cancer requires a specific approach, often involving a combination of surgery, radiotherapy, and/or systemic therapies such as chemotherapy, hormone therapy, and targeted biological treatments. Treatment decisions must consider both the type and stage of cancer, as well as the patient's overall health and preferences. Completing the treatment regimen within a defined timeframe is critical to achieving optimal therapeutic results. The primary goals of cancer treatment are to cure the disease or significantly prolong life. Equally important is improving the patient's quality of life. This can be achieved through supportive care that addresses physical, psychosocial, and spiritual needs. In cases where a cure is not possible, palliative care becomes essential to relieve suffering and extend life meaningfully. Public health strategies must include comprehensive community- and home-based care services. Pain relief, particularly in terminal cancer cases, is a fundamental component of palliative care. Over 80% of terminal cancer patients experience moderate to severe pain, and improved access to oral morphine is strongly recommended to address this issue. Cancer treatment is vital not only for curing the disease but also for prolonging life and improving its quality. When a complete cure is unattainable, good palliation—including life extension and relief from suffering—is necessary. By improving prevention, early detection, and access to effective treatments, we can help ensure that cancer survivors live longer and healthier lives.

2.2. Causes of Cancer

Cancer occurs when genetic mutations cause old, damaged, or abnormal cells to grow and divide uncontrollably. These mutations disrupt the body's natural mechanisms for regulating cell growth and death. The specific cause of cancer often varies depending on the type, and in many cases, the exact cause remains unknown. However, both genetic and environmental factors can increase an individual's susceptibility to cancer. One of the major environmental contributors to cancer is tobacco use. Tobacco smoking is the leading cause of lung cancer, accounting for approximately 85% of lung cancer cases. In developed countries, lung cancer is responsible for about 35% of all cancer-related deaths. In Bangladesh, it accounts for around 21% of cancer deaths among men. Tobacco chewing is also a significant cause of oral cancer and is responsible for about 13% of all cancer cases in Bangladesh. Commonly used tobacco products in the country include raw tobacco leaf (locally known as *Jarda* and *Kimam*), often consumed with betel leaf (*paan*),

betel nut, slaked lime, and catechu—ingredients strongly linked to oral cancer. Additionally, the use of Gul and Khaini is associated with cancers of the gums and cheeks, while snuff use may lead to nasal cancer. Poor oral hygiene and inadequate dental care further increase the risk of oral cavity cancers. Tobacco use is not limited to causing lung and oral cancers; it is also a known cause of cancers in the larynx, pharynx, esophagus, pancreas, kidney, and bladder. Cervical cancer is the most prevalent cancer among women in Bangladesh. Its development is associated with multiple risk factors, including repeated childbirth, which may lead to lacerations of the cervix and chronic cervicitis. Other contributing factors include early onset of sexual activity, early marriage, multiple sexual partners, sexually transmitted infections (STIs), infection with Herpes simplex virus and human papillomavirus (HPV), low socio-economic status, and poor personal hygiene. Preventative measures such as improving sexual health education, promoting hygiene, delaying marriage, limiting the number of childbirths, and increasing awareness about HPV vaccination can help reduce the incidence of cervical and other cancers.

2.3. Cancer Situation in Bangladesh

Reliable statistical data on cancer remain scarce for most developing countries, including Bangladesh. Due to the absence of a nationwide cancer reporting system and the widespread underdiagnosis of cases, the actual cancer burden in the country remains largely unknown. However, based on estimates provided by the World Health Organization (WHO), the cancer incidence, prevalence, and mortality in Bangladesh are approximately 200,000, 800,000, and 150,000 cases, respectively, for a population of around 130 million. According to World Health Statistics, the estimated number of new cancer cases in Bangladesh is about 167 per 100,000 people. These figures underscore the growing recognition of cancer as a significant public health challenge in the country. Population-based cancer data in Bangladesh are limited. A WHO study (World Health Organization, 2021) estimated that among individuals aged 30 and above, there are:

- 1) 49,000 cases of oral cancer.
- 2) 71,000 cases of laryngeal cancer.
- 3) 196,000 cases of lung cancer.

The study also revealed that 3.6% of hospital admissions in medical college hospitals for the same age group are due to these three cancers. Findings from a WHO-supported hospital-based cancer registry at the National Institute of Cancer Research and Hospital (NICRH) indicate that:

- 1) Lung cancer (30%) is the most prevalent cancer among men.
- 2) Cervical cancer (26%) and breast cancer (23%) are the most common among women.

Together, these three cancers account for approximately 37% of all cancer cases, regardless of gender. The Globocan study in 1998 further reported that Bangladesh has the highest mortality rates from respiratory tract cancers (trachea, lung, and bronchus) compared to other South Asian countries, including Sri Lanka, In-

dia, Afghanistan, Bhutan, Nepal, and Pakistan (Globocan, 2020). In response to the growing cancer burden, the Government of Bangladesh has developed a National Cancer Control Plan in collaboration with WHO Bangladesh. A population-based cancer registry has also been established with WHO's technical assistance to support the development of evidence-based policies and interventions for cancer prevention and control. According to the Bangladesh Cancer Society (2021), more than one million people are currently living with cancer in the country. Each year, approximately 300,000 people are diagnosed, and over 200,000 die from the disease. Despite these alarming figures, there is hope: a significant portion of cancer cases are potentially preventable through early detection, lifestyle modification, vaccination, and access to timely treatment.

2.4. Socio-Economic Factor of Bangladesh

Cancer care in Bangladesh is significantly influenced by a range of socio-economic factors that affect prevention, early detection, treatment access, and patient outcomes. These factors present both systemic and societal challenges that must be addressed to ensure equitable cancer care across the country. Healthcare Infrastructure: Bangladesh's healthcare infrastructure, particularly in rural and remote areas, remains underdeveloped. Limited access to diagnostic tools, cancer treatment facilities, advanced equipment, and qualified healthcare professionals severely hampers early detection, timely treatment, and follow-up care. As a result, many patients are diagnosed at later stages when treatment is less effective. The remainder of this paper is organized as follows: Section 2 presents the methodology used in the study. Section 3 discusses the results and key findings. Section 4 provides a conclusion along with implications for future research.

2.4.1. Education and Awareness

Low levels of education and public awareness regarding cancer symptoms, risk factors, prevention methods, and treatment options contribute to late-stage diagnoses and poor treatment adherence. Misinformation and lack of health literacy impede individuals from recognizing warning signs or seeking timely medical advice. Comprehensive, targeted awareness campaigns are essential to bridge this gap and encourage early health-seeking behavior.

2.4.2. Stigma and Social Perception

In many communities, cancer is still perceived as a death sentence or a punishment, leading to fear, denial, and isolation. This stigma often prevents individuals from seeking treatment or disclosing their diagnosis. Social taboos and negative perceptions also reduce emotional and practical support for cancer patients. Addressing this issue requires community education, the promotion of empathy, and the establishment of patient support systems.

2.4.3. Population Density

Bangladesh is one of the most densely populated countries in the world. High

population density puts immense pressure on the healthcare system, particularly in urban hospitals, resulting in overcrowding, long wait times, and limited availability of cancer care services. This situation compromises the quality of care and delays treatment delivery.

2.4.4. Rural-Urban Disparity

There is a significant disparity in healthcare access between urban and rural areas. Urban centers are better equipped with hospitals, cancer treatment facilities, and specialized personnel, whereas rural regions often lack even basic diagnostic services. This rural-urban divide leads to unequal access to quality care and worsens health outcomes for rural populations.

2.4.5. Cultural Barriers

Cultural beliefs and taboos surrounding cancer, especially among women, can discourage individuals from seeking medical attention. Topics related to reproductive health, breast examinations, or cervical screening are often avoided due to shame or modesty, particularly in conservative communities. These cultural norms contribute to underreporting and delayed detection.

2.4.6. Economic Constraints

While not explicitly listed in the original input, economic hardship is a central socio-economic barrier in Bangladesh. The high cost of cancer diagnostics, treatments, transportation, and medications forces many patients to delay or abandon care altogether. Financial insecurity also contributes to poor treatment compliance and loss to follow-up.

2.5. Financial Factors in the Bangladesh Context

Financial constraints are one of the most significant barriers to effective cancer care in Bangladesh. Limited public health funding, high out-of-pocket expenses, and inadequate insurance coverage contribute to delays in diagnosis, incomplete treatment, and increased mortality rates. Below are the key financial challenges impacting cancer care access and affordability:

2.5.1. Affordability of Cancer Treatment

Cancer treatment is prohibitively expensive for the majority of Bangladesh's population. Costs associated with surgery, chemotherapy, radiation therapy, diagnostic tests, and supportive care create an immense financial burden on patients and their families. Many are forced to sell assets, borrow money, or discontinue treatment midway due to lack of funds. Limited government subsidies and minimal insurance coverage further worsen this situation.

2.5.2. Accessibility to Cancer Care

Geographic and financial barriers compound the inaccessibility of cancer treatment. Most advanced cancer care centers are located in major cities, making it difficult for rural patients to afford transportation, lodging, and meals during prolonged treatment. Expanding regional treatment centers and introducing mobile

screening units could significantly enhance access and reduce cost-related barriers.

2.5.3. Low National Health Expenditure

Bangladesh allocates a relatively small portion of its GDP to healthcare, which results in underfunded medical infrastructure, a shortage of skilled healthcare professionals, and limited diagnostic and treatment facilities—especially for noncommunicable diseases like cancer. This lack of investment contributes to the overall inefficiency and inaccessibility of cancer services across the country.

2.5.4. High Out-of-Pocket Expenses

Out-of-pocket spending accounts for the majority of healthcare expenditures in Bangladesh. Cancer patients are often required to pay for consultations, diagnostics, medications, and hospital stays out of their own pockets. This financial strain pushes many families into poverty and deters others from seeking or completing treatment. A full course of cancer therapy is unaffordable for many, particularly in lower-income households.

2.5.5. Cost of Medicines

Many cancer medications, particularly targeted therapies and imported drugs, are expensive and not widely available in public hospitals. The lack of local production of specialized cancer drugs contributes to price inflation, making essential medicines inaccessible to most patients. Even generic drugs may be priced out of reach for low-income populations.

2.5.6. Lack of Health Insurance Coverage

Health insurance coverage in Bangladesh is minimal, and a vast majority of the population remains uninsured. The absence of a universal or comprehensive national health insurance system places the entire financial burden on individuals and families. Establishing affordable, inclusive health insurance schemes with adequate cancer coverage is crucial for reducing financial hardship and improving treatment adherence.

3. Various Dimensions of Cancer Treatment

Cancer treatment encompasses a wide range of interventions designed to either cure the disease or provide palliative care to improve the quality of life for patients. The various dimensions of cancer treatment include surgical procedures, radiotherapy, systemic therapies (such as chemotherapy, hormone therapy, and immunotherapy), and emerging investigational strategies like gene therapy and photodynamic therapy.

3.1. Surgical Oncology

Surgical oncology is a specialized branch of cancer care that focuses on the surgical management of tumors. It plays a critical role in:

- 1) Diagnosing cancer through biopsies.
- 2) Determining the stage of cancer.

- 3) Removing tumors when possible.
- 4) Managing certain cancer-related symptoms.

Surgery may be curative for localized cancers or palliative when complete removal is not feasible.

3.2. Medical Oncology

Medical oncology involves the diagnosis, treatment, and management of cancer using systemic therapies. A medical oncologist typically administers:

- 1) Chemotherapy: The use of cytotoxic drugs to destroy cancer cells or inhibit their growth.
- 2) Hormone Therapy: Slows or halts the growth of hormone-sensitive cancers, such as breast or prostate cancer.
- 3) Targeted Therapy: Attacks specific molecular targets involved in cancer cell growth.
- 4) Immunotherapy: Stimulates or restores the immune system's ability to fight cancer.
- 5) Biological Therapy: Uses living organisms or substances derived from them to treat cancer.

3.3. Radiation Oncology

Radiation oncology, also known as radiotherapy, uses high-energy X-rays (most commonly photons) to destroy cancer cells. These are typically delivered through a Linear Accelerator. Radiotherapy is an essential component of multidisciplinary cancer care and may be used for:

- 1) Curative treatment.
- 2) Palliative symptom relief.
- 3) Pre-surgical tumor reduction.
- 4) Post-surgical elimination of residual cancer cells.

3.4. Emerging and Complementary Treatment Modalities

In addition to traditional treatments, several advanced and investigational therapies are being used to enhance patient outcomes:

- 1) Biomarker Testing: Identifies specific genes, proteins, or tumor markers to help guide personalized cancer treatments.
- 2) Hyperthermia Therapy: Involves heating body tissues up to 113°F (45°C) to damage and kill cancer cells with minimal harm to healthy tissues.
- 3) Photodynamic Therapy (PDT): Uses light-activated drugs to destroy cancerous or precancerous cells.
- 4) Stem Cell Transplantation: Replaces blood-forming stem cells destroyed by high-dose chemotherapy or radiation; commonly used in leukemia or lymphoma treatment.
- 5) Gene Therapy: A promising field under investigation that involves correcting or modifying genes to treat or prevent cancer.

3.5. Multidisciplinary Approach

Effective cancer care often requires a multidisciplinary team that includes:

- 1) Surgical oncologists.
- 2) Medical oncologists.
- 3) Radiation oncologists.
- 4) Pathologists.
- 5) Radiologists.
- 6) Palliative care specialists.
- 7) Psychosocial support professionals.

This team collaborates to provide individualized treatment plans tailored to the type, stage, and specific biology of each patient's cancer.

4. Modern Technologies Adopted in Cancer Treatment

Early and accurate diagnosis is essential for effective cancer treatment. However, many types of cancer still cannot be detected in their early stages, while others are identified in time but are often overtreated. This highlights the need for advanced healthcare infrastructure, cutting-edge diagnostic technologies, and increased patient proactivity. In recent years, modern technologies have made significant strides in cancer detection, treatment personalization, and monitoring. One such promising innovation is liquid biopsy, which is expected to gain even more momentum in the years to come.

4.1. Liquid Biopsy: A Revolution in Non-Invasive Cancer Diagnosis

Liquid biopsy is an innovative, minimally invasive technique that allows for the detection and monitoring of cancer through a simple blood sample. It involves analyzing circulating tumor DNA (ctDNA) or other biomarkers that are shed by cancer cells into the bloodstream.

What is Liquid Biopsy? When cells in the body die, fragments of their DNA, known as cell-free DNA (cfDNA), are released into the bloodstream. In cancer patients, a portion of this cfDNA originates from cancerous cells, referred to as circulating tumor DNA (ctDNA). By isolating and analyzing ctDNA, medical professionals can:

- 1) Detect cancer-related genetic mutations.
- 2) Determine the type and subtype of cancer.
- 3) Monitor treatment response and tumor progression.
- 4) Detect cancer recurrence at an early stage.

Advantages of Liquid Biopsy:

- 1) Minimally invasive: Unlike traditional tissue biopsies, which are often painful and surgically invasive, a liquid biopsy only requires a standard blood draw.
- 2) Real-time monitoring: Allows for continuous tracking of tumor evolution and treatment response without repeated surgical procedures.
- 3) Early detection: Can identify cancer in its early stages, especially when tumor tissue is unavailable or inaccessible.

4) Personalized treatment: Enables precision medicine by identifying specific genetic alterations for targeted therapy.

5) Faster turnaround time: Provides results more quickly than conventional biopsy, facilitating timely clinical decisions.

Application in Cancer Treatment: In the course of cancer treatment, re-biopsies are often required to reassess the tumor's genetic profile, especially if the disease progresses or stops responding to current therapy. However, performing multiple traditional biopsies is challenging for both patients and healthcare providers due to their invasiveness and associated risks. Liquid biopsy overcomes this barrier by offering a safer and more convenient alternative to monitor disease dynamics. Additionally, liquid biopsy plays a critical role in:

- 1) Guiding treatment adjustments.
- 2) Evaluating minimal residual disease (MRD).
- 3) Predicting relapse before clinical symptoms appear.
- 4) Enhancing clinical trial design and recruitment by stratifying patients based on their molecular profile.

As the technology matures, it is anticipated that liquid biopsy will become a standard component of cancer care, particularly for early detection, treatment personalization, and long-term disease monitoring.

4.2. Real-Time Cancer Diagnostics

Real-time cancer diagnostics refers to technologies and procedures that allow clinicians to detect, monitor, and analyze cancer progression or remission dynamically, often during treatment. These tools facilitate the early detection of minimal residual disease (MRD), the small number of cancer cells that may remain after treatment, and help identify tumor heterogeneity, where different parts of a tumor may have different genetic mutations or characteristics.

This approach enables:

- 1) Dynamic monitoring of tumor evolution during treatment.
- 2) Personalized therapy adjustments in response to real-time biomarker or genetic changes.
- 3) Better prediction of relapse through early identification of residual cancer cells.
- 4) Detection of therapy resistance, allowing oncologists to switch or combine treatment strategies.

Real-time diagnostics improve long-term treatment success by identifying how the tumor adapts and evolves, making it possible to stay one step ahead of cancer's progression.

4.3. Understanding Genetic and Lifestyle Causes of Cancer

Cancer results from a complex interaction between internal (genetic) and external (environmental and lifestyle-related) factors.

Genetic and Inherited Factors: While these internal factors cannot be changed, understanding them help guide risk assessment, screening recommendations, and

targeted therapies. It includes:

- 1) Inherited gene mutations (e.g., BRCA1/2 for breast and ovarian cancer).
- 2) Hormonal imbalances.
- 3) Immune system dysfunction.

Lifestyle and Environmental Factors: Evidence increasingly shows that most cancers are not hereditary but are instead influenced by modifiable behaviors and exposures. Key lifestyle-related risk factors include:

- 1) Tobacco use.
- 2) Alcohol consumption.
- 3) Unhealthy diet.
- 4) Obesity.
- 5) Lack of physical activity.
- 6) Infections (e.g., HPV, Hepatitis B, and C).
- 7) Environmental pollutants and radiation exposure.

For instance, dietary factors are linked to approximately 70% of colorectal cancer deaths. Although the exact mechanisms are not fully understood, many ingested carcinogens, such as nitrates, nitrosamines, dioxins, and pesticides, are derived from food additives or cooking methods.

Specific Dietary Risks: High red meat consumption is associated with cancers of the colon, rectum, prostate, pancreas, breast, and stomach.

- 1) Cooking methods like grilling, smoking, or charring meat produce harmful substances such as heterocyclic amines and polycyclic aromatic hydrocarbons (PAHs).

- 2) Preservatives like nitrites and nitrates, commonly used in processed meats, are known carcinogens.

- 3) Food additives, such as azo dyes and artificial preservatives, have also been linked to carcinogenesis.

- 4) Saturated fats, trans fats, and refined sugars may increase the risk of various cancers by promoting inflammation, obesity, and hormonal imbalances.

Because lifestyle factors are largely modifiable, they present a significant opportunity for cancer prevention through public education, dietary improvements, and behavior change interventions.

4.4. Next-Generation Targeted Therapies

Targeted cancer therapies represent a major shift in oncology from conventional one-size-fits-all treatments to precision medicine. These therapies use pharmacological agents that interfere with specific molecules involved in cancer growth and spread, making them more selective and often more effective than traditional chemotherapy. Key Features of Targeted Therapy:

- 1) Focuses on molecular abnormalities specific to a patient's tumor.
- 2) Reduces damage to normal cells, minimizing side effects.
- 3) Enables personalized treatment plans based on genetic profiling.
- 4) Improves response rates and survival outcomes in many cancers.

Targeted therapies have shown particular promise in treating cancers such as:

- 1) Lung cancer.
- 2) Colorectal cancer.
- 3) Breast cancer.
- 4) Lymphomas.
- 5) Leukemias.

Types of Targeted Therapies:

1. Monoclonal Antibodies
 - a) Laboratory-made proteins that bind to specific antigens on cancer cells.
 - b) Block cell growth or deliver toxic substances directly to tumors.
2. Small Molecule Inhibitors
 - a) Enter cells and disrupt internal processes like enzyme activity.
 - b) Inhibit signaling pathways essential for cancer cell survival and proliferation.
3. Immunotoxins
 - a) Combine antibodies with toxic substances.
 - b) Directly kill cancer cells while sparing healthy tissues.

Recent advances in genomic sequencing allow researchers to tailor these therapies even more precisely to the genetic profile of a patient's tumor, leading to highly individualized cancer care with improved efficacy and reduced side effects.

4.5. Molecular Cancer Diagnostics

Molecular cancer diagnostics involve analyzing genetic, epigenetic, and protein-based biomarkers at the molecular level to detect and classify cancers with higher precision. This approach enables the identification of specific mutations, gene expressions, or molecular alterations associated with various cancers, allowing for earlier and more accurate diagnosis.

Benefits of Molecular Diagnostics:

- 1) Early Detection: Identifies cancer-related changes at a molecular level before physical symptoms appear.
- 2) Personalized Treatment Plans: Helps match patients to targeted therapies based on their tumor's molecular profile.
- 3) Prognosis and Monitoring: Provides information about the aggressiveness of cancer and the likelihood of recurrence.
- 4) Non-Invasive Techniques: Techniques such as liquid biopsy or blood-based molecular tests can detect tumor DNA without requiring invasive tissue samples.

Molecular diagnostics are increasingly being integrated into routine clinical practice and clinical trials, forming the backbone of precision oncology.

4.6. AI-Based Therapy Design

Artificial Intelligence (AI) is revolutionizing cancer care by enhancing diagnostic accuracy, optimizing treatment plans, and reducing patient risk. AI systems, powered by machine learning and deep learning, can process vast amounts of data from imaging, genomics, and electronic health records to generate insights that

were previously unimaginable.

Applications in Oncology:

1) Radiology: AI enhances the quality of medical images (e.g., CBCT, MRI) and aids in the accurate identification of tumors and abnormalities with reduced radiation exposure.

2) Treatment Planning: AI algorithms help in designing personalized radiation therapy and chemotherapy regimens by predicting tumor behavior and response.

3) Patient Monitoring: Integration with real-time imaging tools (onboard MRI, ultrasonography, optical surface imaging) allows AI to track tumor changes and adjust treatment accordingly.

4) Decision Support Systems: AI-powered systems assist oncologists in selecting the best treatment combinations and in predicting potential side effects or resistance.

AI is also making significant strides in automated diagnostics, reducing human error, and accelerating clinical decision-making.

4.7. DNA Cages

DNA cages represent a futuristic and highly targeted drug delivery system. These are nanostructures made of DNA strands that can encapsulate chemotherapy drugs and release them only when triggered by specific signals from cancer cells.

Key Features:

1) Targeted Therapy: DNA cages can be engineered to recognize biomarkers unique to cancer cells, ensuring that drugs are released only at the tumor site.

2) Minimized Side Effects: By sparing healthy cells, this method reduces toxicity and improves patients' quality of life.

3) Smart Release Mechanism: Triggers such as pH changes, temperature shifts, or enzymatic activity from cancer cells can unlock the DNA cage.

This innovation is still under active research but shows promise in overcoming one of the biggest limitations of current chemotherapy, non-selectivity.

4.8. Precision Surgery

Precision surgery, especially through stereotactic robotic systems, is advancing surgical oncology by enabling highly accurate tumor resection with minimal damage to surrounding tissues.

Advantages:

1) 3D Visualization: Robotic surgical systems use 3D cameras that provide high-resolution, magnified views of the surgical site.

2) Real-Time Feedback and Streaming: Operations can be monitored and streamed live for consultation or training.

3) Enhanced Dexterity: Robotic arms assist in suturing, dissecting, and retracting tissue with greater control than the human hand.

4) Minimally Invasive Techniques: Smaller incisions reduce recovery time, pain, and risk of infection.

Technologies like the da Vinci Surgical System are already in use worldwide, and research continues to refine these tools for even more precise applications in cancer care.

4.9. Embedded, Implanted, and Digestible Sensors

Smart sensors embedded, implanted, or ingested by the patient can provide real-time data about tumor behavior, treatment effectiveness, and drug delivery.

How They Work:

- 1) Patients consume or are implanted with sensors connected to simulation and treatment planning systems.
- 2) These sensors transmit data via magnetic radio frequency signals, constantly reporting the location, size, and physiological changes of the tumor.
- 3) This feedback allows clinicians to adjust treatment in real time and improve targeting precision.

Such sensors are pivotal in improving adaptive radiotherapy, where treatment is modified based on tumor response over time.

4.10. Measuring Lab Markers at Home

At-home cancer monitoring tools, such as test strips or point-of-care diagnostics, allow patients to track important biomarkers from the comfort of their homes.

Potential Benefits:

- 1) Convenience: Reduces the need for frequent hospital visits, especially for immunocompromised patients.
- 2) Real-Time Monitoring: Allows early detection of treatment response, disease progression, or relapse.
- 3) Empowered Patients: Enables greater patient involvement in disease management.

These tools are especially valuable for patients in rural or low-resource settings and for those undergoing long-term treatment or surveillance.

5. Methodology Section-Comprehensive and Detailed

This section elaborates on the scientific principles, rationale, objectives, and future applications of radiotherapy as a cancer treatment modality. It also outlines the professional role of a medical physicist in supporting, advancing, and educating others in the field of radiation oncology.

5.1. What is the Mechanism of Radiotherapy

Radiotherapy, also known as radiation therapy, is one of the most established and widely used treatments for cancer. It works by using ionizing radiation—typically high-energy X-rays or particles like protons—to destroy cancer cells or inhibit their growth.

How Radiotherapy Works:

- 1) At high doses, ionizing radiation damages the DNA inside cancer cells.

2) These damaged cells lose their ability to divide and replicate, ultimately leading to cell death.

3) Once dead, the cells are naturally broken down and eliminated by the body's immune system.

Key Characteristics:

1) Radiotherapy is a localized treatment, meaning it targets the cancerous area with precision to avoid damage to surrounding healthy tissues.

2) It can be delivered externally via a machine (external beam radiotherapy) or internally through radioactive substances placed close to or inside the tumor (brachytherapy).

3) The precise delivery of radiation is made possible through the expertise of medical physicists, radiation oncologists, and specialized radiation technologists.

5.2. Objective of Topic Selection

The rationale behind selecting this topic is grounded in the vision of improving access to effective cancer treatment, especially for low-income and rural populations who often face systemic barriers to healthcare.

Primary Objectives:

1) To explore and advocate for individualized treatment strategies using all available resources (peer collaboration, faculty expertise, clinical experience, and research).

2) To understand and communicate patient-specific disease characteristics accurately, ensuring personalized treatment planning.

3) To study the multidisciplinary approach to managing advanced-stage lymphomas, incorporating radiotherapy into comprehensive care.

4) To identify the role of radiation therapy in treating advanced and bulky disease, where tumors may be large or resistant to other treatments.

5) To demonstrate understanding of both short-term and long-term complications of radiotherapy, including:

a) Fatigue.

b) Skin changes.

c) Secondary malignancies.

6) To recognize and monitor the late effects of combined modality therapies, such as when radiation is used alongside chemotherapy or surgery.

5.3. Vision and Professional Contribution

Upon completion of this study, the acquired knowledge and insights will be directly applied to enhance cancer treatment facilities and clinical practices within my department. As a medical physicist, I am uniquely positioned to contribute across three key domains:

A. Clinical Service and Consultation: Medical physicists play a critical role in patient care by:

- a) Collaborating with oncologists to plan and optimize radiation treatments.
- b) Ensuring accurate measurement and calibration of radiation output from machines to guarantee both safety and effectiveness.
- c) Verifying treatment plans for conformity with prescribed doses and anatomical targeting.
- d) Providing technical support during procedures involving external radiation beams or internal radioactive sources.

B. Research and Development: Innovation is a core responsibility of the medical physicist. Contributions include:

- a) Leading and participating in clinical research to improve radiation technologies and treatment outcomes.
- b) Developing new protocols and safety measures for modern radiotherapy techniques such as intensity-modulated radiation therapy (IMRT), stereotactic radiosurgery (SRS), and proton therapy.
- c) Exploring AI-based algorithms for enhanced imaging and adaptive planning.

C. Teaching and Training: The educational role of a medical physicist includes:

- a) Teaching future medical physicists, radiation oncology residents, and technologists in academic and hospital settings.
- b) Conducting training on the safe and effective use of diagnostic and therapeutic equipment.
- c) Leading courses in radiobiology, medical physics, and dosimetry for graduate and postgraduate students.
- d) Each of these domains reinforces the commitment to continuous improvement in cancer care, informed by scientific knowledge, innovation, and compassionate clinical practice.

5.4. Understanding Cancer Treatment Modalities

Cancer is treated using a combination of methods depending on the type, location, stage, and genetic profile of the disease. Common treatment approaches include:

- 1) Chemotherapy.
- 2) Surgery.
- 3) Radiation Therapy.
- 4) Hormone Therapy.
- 5) Immunotherapy.
- 6) Targeted Drug Therapy.
- 7) Bone Marrow Transplantation.

5.5. Radiotherapy in Detail: Types and Applications

A. Curative Radiotherapy: Used with the intent to completely eliminate the cancer. It is often applied in early-stage cancers and sometimes in combination with other treatments to achieve remission.

B. Adjuvant and Neo-adjuvant Radiotherapy:

- a) Adjuvant radiotherapy: Administered after surgery or chemotherapy to de-

stroy residual cancer cells.

b) Neo-adjuvant radiotherapy: Given before surgery to shrink tumors, making them easier to remove.

C. Palliative Radiotherapy: It is especially beneficial for patients with advanced-stage cancers where cure is not possible, but symptom management is critical.

This approach is not curative but aims to:

- a) Reduce pain.
- b) Control symptoms.
- c) Improve quality of life.

5.6. How Radiotherapy is Delivered

1) External Beam Radiotherapy (EBRT): Uses linear accelerators to deliver radiation from outside the body.

2) Internal Radiotherapy (Brachytherapy): Involves placing radioactive sources directly inside or next to the tumor.

3) Systemic Radiotherapy: Radioactive substances are taken orally or injected to travel through the bloodstream and target cancer cells.

Each method is chosen based on the tumor type, location, and patient condition, and requires precise planning supported by advanced imaging and physics.

5.7. What Other Types of Cancer Treatments Are Available

Modern oncology offers a wide array of treatment options beyond radiotherapy, each playing a unique role depending on the type, stage, and genetic makeup of the cancer. These treatments are often used alone or in combination to achieve the most effective outcome for the patient. Below is an in-depth overview of the most prominent cancer treatment modalities currently in practice.

5.7.1. Surgery (Surgical Oncology)

Surgical oncology is a medical specialty focused on diagnosing, staging, and treating cancer through surgical methods. Surgery is one of the oldest and most direct ways to treat solid tumors and remains a foundational element of cancer therapy.

Functions of Surgical Oncology:

1) Diagnosis (Biopsy/Exploratory Surgery): To confirm the presence and type of cancer.

2) Staging: To assess the size of the tumor, its location, and whether it has spread.

3) Curative Surgery: To remove the entire tumor, often when the cancer is localized.

4) Debulking Surgery: To remove part of a tumor when complete removal is not possible.

5) Palliative Surgery: To relieve pain or symptoms caused by cancer.

6) Reconstructive Surgery: To restore function or appearance after tumor removal.

Surgical oncologists are integral to multidisciplinary teams and often work alongside radiation oncologists, medical oncologists, and pathologists. Their expertise in cancer biology, imaging, and therapy planning ensures precise and effective surgical interventions.

5.7.2. Chemotherapy

Chemotherapy involves the use of cytotoxic drugs to kill rapidly dividing cancer cells. It is a systemic treatment, meaning it travels through the bloodstream to reach cancer cells anywhere in the body.

How It Works:

Chemotherapy drugs target the process of cell division. Since cancer cells divide more rapidly than most normal cells, they are more vulnerable to these drugs. However, some healthy cells (like those in the hair follicles, digestive tract, and bone marrow) may also be affected, leading to side effects.

Uses of Chemotherapy:

- 1) Neoadjuvant Therapy: Shrinks tumors before surgery or radiotherapy.
- 2) Adjuvant Therapy: Destroys residual cancer cells after surgery or radiation.
- 3) Standalone Treatment: For cancers that respond well to chemotherapy (e.g., testicular cancer, leukemia).
- 4) Palliative treatment: Manages symptoms in advanced stages.

Modes of Administration:

- 1) Intravenous (IV).
- 2) Intramuscular (Injection).
- 3) Intra-arterial (IA).
- 4) Intraperitoneal (IP).
- 5) Intrathecal (IT).
- 6) Oral (Pills or liquid).
- 7) Topical (Applied on the skin).

Chemotherapy is often used in combination with other therapies such as radiation or surgery to increase treatment efficacy.

5.7.3. Immunotherapy

Immunotherapy harnesses the power of the body's immune system to recognize and fight cancer cells.

Types of Immunotherapies:

- 1) Checkpoint inhibitors (e.g., PD-1/PD-L1 blockers).
- 2) CAR-T cell therapy.
- 3) Cancer vaccines.
- 4) Cytokines (e.g., interleukins and interferons).

Benefits:

- 1) Can offer long-lasting protection against cancer recurrence.
- 2) Especially effective for melanoma, lung cancer, kidney cancer, and some blood cancers.
- 3) May be less harmful to normal cells than chemotherapy.

5.7.4. Hormone Therapy

Hormone therapy blocks or alters the effects of hormones that fuel certain cancers, particularly:

- 1) Breast cancer (estrogen-receptor positive).
- 2) Prostate cancer (androgen-sensitive).

How It Works:

- 1) Blocks hormone production (e.g., with drugs like aromatase inhibitors).
- 2) Inhibits hormone receptors on cancer cells.
- 3) Surgically removes hormone-producing organs in some cases.
- 4) Hormone therapy can be used alone or alongside surgery, chemotherapy, or radiotherapy.

5.7.5. Targeted Therapy

Targeted therapy uses drugs that specifically target molecular pathways or genetic mutations in cancer cells. It aims to disrupt the processes that cancer cells use to grow, divide, and spread.

Examples:

- 1) HER2 inhibitors for breast cancer.
- 2) EGFR inhibitors for lung cancer.
- 3) BCR-ABL inhibitors for chronic myeloid leukemia.
- 4) These therapies are less likely to harm normal cells and are often customized based on molecular testing or genetic profiling of the tumor.

5.7.6. Ablation Techniques

Ablation is usually used for small tumors or patients who cannot undergo surgery due to health risks. Ablation refers to destroying cancerous tissue without traditional surgery. Common forms include:

Types of Ablations:

- 1) Cryoablation: Uses extreme cold to freeze and kill cancer cells.
- 2) Radiofrequency Ablation (RFA): Uses heat generated by radio waves.
- 3) Microwave Ablation: Similar to RFA but uses microwave energy.

5.7.7. Alternative Therapies

Alternative therapies are non-conventional treatments often used in conjunction with standard care, although some patients may choose them independently. These therapies should always be discussed with a healthcare provider, as they may interfere with conventional treatments or be ineffective on their own.

Examples:

- 1) Herbal supplements.
- 2) Acupuncture.
- 3) Homeopathy.
- 4) Ayurvedic medicine.

5.7.8. Clinical Trials

Clinical trials are research studies that evaluate new cancer treatments or new

combinations of treatments.

Benefits:

- 1) Access to the latest treatment innovations.
- 2) Close monitoring and support.
- 3) Potential to contribute to medical progress.

Patients with rare, advanced, or treatment-resistant cancers may benefit from participation in trials for emerging therapies like molecular radiotherapy, targeted radionuclide therapy, or personalized immunotherapies.

5.7.9. Systemic Radiation Therapy

Also known as molecular radiotherapy, these methods allow radiation to reach cancers that are difficult to treat with localized external beams.

In addition to external radiotherapy, systemic radiation therapy involves the use of radiopharmaceuticals, radioactive drugs that travel through the bloodstream to kill cancer cells. Common Forms:

- 1) Radioactive iodine (I-131): For thyroid cancer.
- 2) Radiopharmaceuticals for bone metastases: To relieve pain.
- 3) Targeted radionuclide therapy: For prostate cancer and gastroenteropancreatic neuroendocrine tumors (GEP-NETs).

6. Literature Review

This literature review aims to explore the current landscape of cancer treatment, research, and socio-economic dynamics in Bangladesh. The study synthesizes data from multiple institutional and national sources, with a particular focus on accessibility, financial challenges, treatment infrastructure, and research gaps in oncology. It also supports the broader objective of strengthening the KYAMCH Cancer Center to align with international standards of cancer care. The review draws upon datasets and reports obtained from several key institutions working in cancer epidemiology, diagnosis, and treatment in Bangladesh:

6.1. National Institute of Cancer Research and Hospital (NICRH)

One of the primary centers for comprehensive cancer care and population-based cancer surveillance in Bangladesh. NICRH provided data on:

- 1) Overall cancer incidence and trends.
- 2) Oral and lung cancers.
- 3) Childhood cancers.
- 4) Gender-specific cancers such as breast and cervical cancer.

6.2. National Institute of Preventive and Social Medicine (NIPSOM)

Known for its contributions to cancer epidemiology and prevention research, particularly focusing on public health interventions. Data collected included studies on:

- 1) Breast and cervical cancer.

- 2) Prevalence rates in rural and urban populations.
- 3) Early detection practices and awareness levels.

6.3. Bangladesh Society of Radiation Oncology (BSRO)

A national body representing radiation oncologists and promoting the development of radiotherapy services.

Provided insights on:

- 1) Cervical cancer and lung cancer treatment trends.
- 2) Availability and limitations of radiotherapy services.

6.4. Bangladesh Cancer Society (BCS)

While BCS had limited case studies available, it provided documentation of combined treatment cases involving chemotherapy and radiotherapy, highlighting treatment pattern limitations in many regional cancer centers.

7. Key Findings and Discussion

As part of my role as Chief Medical Physicist & In-Charge of the Medical Physics Division at KYAMCH Cancer Center, I undertook this study to evaluate the feasibility of transforming our facility into a high-standard cancer care center, following recognized public and international treatment protocols. During my MBA course in data analysis and clinical observation, several systemic and structural gaps were identified:

7.1. Treatment Accessibility

a) Limited Oncology Centers:

Bangladesh has a severe shortage of specialized cancer hospitals, with most facilities concentrated in major urban centers.

This Centralization leads to long waiting periods, delayed diagnosis, and increased patient burden, particularly for those from rural or low-income backgrounds.

b) Shortage of Human Resources:

There is a critical deficit of trained oncologists, medical physicists, radiotherapy technologists, and oncology nurses.

Many centers operate below capacity or depend on general practitioners with minimal cancer-specific training.

c) Limited Access to Advanced Treatments:

High-end treatments such as targeted therapies, stereotactic radiotherapy, immunotherapy, and advanced diagnostic imaging are limited to only a few public or private hospitals.

Patients must often travel abroad or to Dhaka-based institutions for complex treatment protocols.

d) Financial Barriers:

Out-of-pocket healthcare costs remain the predominant mode of financing,

which severely restricts access to long-term cancer care for low-income patients.

Insurance coverage is minimal and insufficient to cover high-cost treatments like chemotherapy and radiotherapy.

7.2. Late Diagnosis and Lack of Screening Programs

1) Most cancer cases in Bangladesh are diagnosed at Stage III or IV, by which time curative treatments are often less effective.

2) Widespread lack of screening programs, especially for breast, cervical, and colorectal cancers, contributes to poor outcomes.

3) Cultural stigma and poor health literacy further delay diagnosis and treatment initiation.

7.3. Infrastructure Limitations

a) Incomplete Treatment Facilities:

1) Many cancer centers lack integrated treatment capabilities, such as offering both chemotherapy and radiotherapy under one roof.

2) This forces patients to travel between multiple facilities, leading to treatment discontinuation, logistical burden, and delays.

b) Equipment and Technology Gaps:

1) Shortage of linear accelerators, imaging devices, and brachytherapy machines has been noted, especially outside major cities.

2) Maintenance and calibration services for radiological equipment are often delayed due to dependence on foreign technicians or parts.

7.4. Research Gaps in Oncology

While Bangladesh has made progress in publishing cancer-related research, the current literature remains heavily skewed toward a few common cancer types.

Available research includes:

- 1) Cervical cancer.
- 2) Lung cancer.
- 3) Head and neck cancers.
- 4) Breast cancer.
- 5) Iron metabolism in osteosarcoma.

However, several critical areas remain severely under-researched:

Pediatric oncology: There is a notable absence of treatment protocols, epidemiological data, and planning expertise in childhood cancer.

Cancer prevention strategies: Few studies focus on community-based prevention and awareness models.

Palliative and supportive care: Research into quality-of-life interventions, pain management, and terminal care is limited.

Health economics and cost-effectiveness: There is insufficient analysis of the economic burden and treatment affordability for cancer patients.

The current landscape of cancer treatment in Bangladesh is fragmented, under-

funded, and unevenly distributed, especially across rural and low-income populations. The analysis from national and institutional datasets reveals critical shortcomings in infrastructure, access, human resources, and research. This literature review supports the urgent need to reform and expand oncology services through:

- 1) Public-private partnerships.
- 2) Investment in radiotherapy infrastructure.
- 3) Training programs for oncology professionals.
- 4) Establishment of comprehensive cancer centers.
- 5) Initiation of large-scale pediatric oncology research.

8. Discussion

The Discussion section interprets the findings and insights from the literature review, data analysis, and epidemiological context of cancer in Bangladesh. It explores the wider implications of prevention, diagnosis, treatment challenges, public awareness, and policy considerations. Each subsection below addresses a specific element of the discussion, providing depth and context.

8.1. Cancer Risk Exists Across a Population Continuum

Cancer risk does not solely belong to a high-risk group; rather, it exists on a continuum across the general population. While those with genetic predisposition, occupational hazards, or specific lifestyle factors may face higher individual risks, a large proportion of cancer cases arise from people with relatively moderate risk factors. This phenomenon is explained by Geoffrey Rose's prevention paradox, more cases of cancer arise from the many exposed to low risk than the few at high risk.

a) Implication for Policy and Prevention: Interventions should not only target high-risk individuals but must aim to reduce risk across the entire population through public health education, lifestyle modifications, and universal screening efforts.

b) Effective cancer control strategies need to focus on both individual-level and population-wide interventions.

8.2. Overview of What Works in Cancer Prevention

To prioritize cancer prevention effectively, it is essential to understand:

The extent of the problem: This includes epidemiological data on cancer incidence and mortality, exposure to risk factors, and their relative contribution to the overall cancer burden.

The avoidable portion: Quantifying how much of the future cancer burden can be prevented by eliminating or reducing exposure to certain risk factors.

Effectiveness of interventions: Evaluating which strategies have been proven successful in reducing cancer incidence and mortality.

Factors Influencing Intervention Implementation:

Social and cultural acceptability: Interventions must be designed with respect

to cultural norms, values, and health beliefs.

Political will and financial investment: Government and policy-maker support, combined with adequate funding, is crucial for scaling up prevention strategies.

Public engagement: Community-level participation can drive early detection behaviors and destigmatize screening procedures.

8.3. Lifestyle Risk Factors and Prevention

Cancer prevention is significantly influenced by modifiable lifestyle factors. These include: Tobacco use; Alcohol consumption; Poor dietary habits; Obesity and physical inactivity; Exposure to carcinogens (e.g., pesticides, air pollution); Infections (e.g., HPV, Hepatitis B/C).

Strategies for Reducing Risk: Reducing these risk factors across a broad population base could dramatically lower cancer incidence in Bangladesh.

Education and Awareness Campaigns: Promote healthier food choices, tobacco cessation, and physical activity.

Vaccination Programs: For HPV and Hepatitis B.

Screening Initiatives: To identify cancers early, especially cervical, breast, and colorectal cancers.

8.4. Importance of Early Detection and Symptoms Recognition

Many cancers are asymptomatic in their early stages, making them difficult to detect until they have advanced or metastasized. Recognizing early warning signs plays a vital role in improving survival outcomes. Common General Symptoms Across Cancers:

- 1) Unexplained weight loss.
- 2) Persistent fatigue.
- 3) Pain (localized or generalized).
- 4) Skin changes or visible lumps.
- 5) Changes in bowel or bladder habits.
- 6) Persistent cough or hoarseness.

However, each cancer type presents its own set of symptoms, often specific to the organ or system affected.

8.5. Symptom Overview by Cancer Type

Below is an elaborated list of common symptoms associated with major cancer types. Understanding these is critical for public health campaigns and early diagnosis efforts.

8.5.1. Breast Cancer

- A lump or thickening in the breast or underarm.
- Nipple discharge, inversion, or scaling.
- Skin changes: dimpling, redness, or a feeling of warmth.
- Enlarged lymph nodes near the breast area.

8.5.2. Bladder Cancer

- Blood in urine (hematuria).
- Burning or painful urination.
- Frequent urge to urinate, even without passing much urine.
- Cloudy or foul-smelling urine.

8.5.3. Bone Cancer

- Localized bone pain or swelling.
- Pathological fractures.
- Fatigue, weight loss, frequent infections.
- Neurological symptoms if the spine is involved.

8.5.4. Brain Tumors

- Persistent or severe headaches, especially in the morning.
- Dizziness, vision changes, or balance issues.
- Personality changes, confusion, or speech difficulties.
- Seizures or abnormal neurological signs.

8.5.5. Colorectal Cancer

- Rectal bleeding or dark stools.
- Abdominal cramps, bloating, or a change in bowel habits.
- Unexplained weight loss or fatigue.
- Constipation alternating with diarrhea.

8.5.6. Kidney Cancer

- Blood in the urine.
- Dull ache in the side or lower back.
- A lump or mass near the kidney area.
- Possible high blood pressure or anemia.

8.5.7. Lung Cancer

- Persistent cough lasting more than 3 weeks.
- Coughing up blood.
- Chest pain, hoarseness, or wheezing.
- Swollen lymph nodes in the neck.

8.5.8. Leukemia

- Frequent infections and fevers.
- Unusual bleeding or bruising.
- Pain in joints or bones.
- Swollen lymph nodes.
- Enlarged spleen or liver.

8.5.9. Ovarian Cancer

- Abdominal bloating or swelling.
- Pelvic discomfort.
- Changes in bowel habits or urinary urgency.

- Fatigue and unexplained weight loss.

8.5.10. Oral Cancer

- Non-healing ulcers or lumps in the mouth.
- Loose teeth, difficulty chewing or swallowing.
- Foul breath or speech changes.
- Dentures no longer fit properly.

8.5.11. Prostate Cancer

- Difficulty urinating or frequent nighttime urination.
- Burning or painful urination.
- Blood in urine or semen.
- Pelvic pain or backache.

8.5.12. Pancreatic Cancer

- Abdominal or back pain.
- Yellowing of the skin and eyes (jaundice).
- Loss of appetite, nausea, and weight loss.
- Fatty stools or digestive problems.

8.5.13. Stomach Cancer

- Persistent indigestion, bloating, or discomfort.
- Nausea or vomiting with blood.
- Changes in appetite or early satiety.
- Black stools indicate gastrointestinal bleeding.

8.5.14. Uterine Cancer

- Abnormal vaginal bleeding or discharge.
- Pain during urination or intercourse.
- Pelvic or lower abdominal pain.
- Postmenopausal bleeding.

8.6. Final Observations

The diversity of cancer symptoms and risk factors requires a multi-pronged approach:

- 1) Clinical: Training for early detection and diagnostic capacity in local health facilities.
- 2) Policy: Investment in preventive strategies and equitable access to care.
- 3) Public Health: Mass awareness of early warning signs and routine screenings.
- 4) Research: Focus on population-specific risk profiles and outcomes in Bangladesh.

The integration of community-based education, national screening protocols, and support for treatment infrastructure will be key to addressing the rising burden of cancer in Bangladesh.

9. Prevention of Cancer

While doctors cannot always explain why one person develops cancer and another does not, decades of epidemiological research have identified many modifiable risk factors that significantly increase cancer risk. Cancer prevention involves both individual lifestyle changes and population-level policy interventions. Preventive strategies aim to reduce exposure to known carcinogens, promote healthy behaviors, and increase vaccination and screening coverage. Cancer prevention is a multi-sectoral and multi-dimensional effort, involving education, legislation, public health initiatives, and medical interventions. Below is a detailed breakdown of the most evidence-based strategies for cancer prevention.

9.1. Reducing Tobacco Use

Tobacco is the single most preventable cause of cancer globally. It is responsible for lung cancer and many other cancers, including those of the oral cavity, pharynx, larynx, pancreas, bladder, and esophagus.

Key Prevention Strategies:

- 1) Raising taxes on tobacco products to reduce affordability.
- 2) Creating 100% smoke-free environments in public spaces and workplaces.
- 3) Banning direct and indirect advertising and sponsorship of tobacco.
- 4) Large, graphic health warnings on packaging.
- 5) Anti-smoking campaigns targeting youth and vulnerable populations.

Impact: These interventions reduce initiation among youth and promote cessation among current users.

9.2. Promoting a Healthy Diet

A poor diet contributes to many cancers, particularly colorectal, gastric, pancreatic, and breast cancers.

Dietary Recommendations:

- 1) Reduce intake of saturated fats and eliminate trans fats.
- 2) Increase consumption of fruits, vegetables, whole grains, legumes, and nuts.
- 3) Limit free sugars and salt intake.
- 4) Avoid consumption of very hot foods or beverages.
- 5) Minimize exposure to aflatoxins (toxic mold in stored food).
- 6) Reduce intake of processed meats and salt-preserved fish.

Population-Level Strategies:

- 1) Subsidies and incentives for fruits and vegetables.
- 2) Nutritional labeling and food reformulation.
- 3) School and workplace meal standards.

4) The remainder of this paper is organized as follows: Section 2 presents the methodology used in the study. Section 3 discusses the results and key findings. Section 4 provides a conclusion along with implications for future research.

- 5) Public education on portion control and healthy cooking methods.

9.3. Increasing Regular Physical Activity

Physical inactivity is a key contributor to obesity and certain cancers, such as breast and colorectal cancer.

Promoting Physical Activity: Physical activity reduces insulin resistance, inflammation, and hormone levels that can contribute to cancer development.

- 1) Urban planning should encourage walking, cycling, and green spaces.
- 2) Mandatory physical education in schools.
- 3) Workplace wellness programs.
- 4) Public awareness campaigns promoting 30 - 60 minutes of activity daily.

9.4. Reducing Overweight and Obesity

Obesity increases the risk of several cancers, including breast (postmenopausal), colon, rectum, kidney, pancreas, liver, and endometrium.

Prevention Measures:

- 1) Multi-sectoral interventions: schools, communities, workplaces.
- 2) Family-based behavioral programs.
- 3) Limiting screen time and encouraging active play for children.
- 4) School-based interventions to promote physical activity and healthy food choices.

BMI is used as an index to determine a healthy weight (18.5 - 24.9). Childhood obesity prevention is particularly crucial.

9.5. Reducing Alcohol Consumption

Alcohol increases the risk of several cancers, including those of the mouth, pharynx, larynx, esophagus, liver, colon, rectum, and breast. According to WHA58.26, countries are urged to implement policies to reduce alcohol-related health and social problems.

Effective Strategies:

- 1) Increasing taxes on alcoholic beverages.
- 2) Regulating the advertising and marketing of alcohol.
- 3) Limiting availability (sale hours, outlet density).
- 4) Brief interventions for at-risk drinkers in healthcare settings.

9.6. Reducing Hepatitis B Virus (HBV) Infections

HBV infection is a major cause of primary liver cancer.

Primary Prevention:

- 1) Universal infant HBV vaccination.
- 2) Ideally, starting within 24 hours of birth.
- 3) WHO recommends including HBV in national immunization schedules.
- 4) Over 150 countries have implemented this measure.

Secondary Strategies:

- 1) Safe injection practices.
- 2) Infection control in healthcare.

- 3) Public awareness about safe sex practices.

9.7. Reducing Human Papillomavirus (HPV) Infections

HPV infection is the leading cause of cervical cancer, as well as cancers of the anus, penis, throat, and vagina.

Prevention Strategies:

- 1) HPV Vaccination: Primarily targeted at pre-adolescent girls (ages 9 - 14) before sexual debut.
 - 2) Condom use provides partial protection.
 - 3) Screening programs (e.g., Pap smear, HPV DNA testing) for early detection.
 - 4) Vaccines against HPV types 16 and 18 can prevent 70% of cervical cancers.
- Socio-cultural considerations should inform vaccine rollout.

9.8. Reducing Exposure to Environmental Carcinogens

Certain chemicals in the environment are known to cause cancer (e.g., arsenic in water, aflatoxins, air pollutants).

Key Approaches:

- 1) Legislation to ban or regulate carcinogenic chemicals.
- 2) Phasing out of unsafe industrial processes.
- 3) Public education campaigns about environmental hazards.
- 4) Ensuring clean drinking water, especially in rural and industrial regions.

9.9. Reducing Exposure to Occupational Carcinogens

Workers exposed to asbestos, benzene, formaldehyde, and other carcinogens are at risk of occupational cancer.

Preventive Measures (**Table 1**):

- 1) Strict enforcement of occupational health laws.
- 2) Substitution of hazardous chemicals with safer alternatives.
- 3) Use of personal protective equipment (PPE).
- 4) Routine risk assessments and audits.
- 5) Proper training and ventilation systems in industries.

9.10. Reducing Exposure to Radiation

Radiation, especially from medical imaging or occupational exposure, can be carcinogenic.

Ionizing Radiation:

- 1) Proper justification of medical imaging.
- 2) High technical standards for radiation-emitting equipment.
- 3) Implementation of ICRP and IAEA radiation protection guidelines.
- 4) UV Radiation (Sunlight): Over 90% of skin cancers are preventable.

Encourage:

- 1) Avoiding midday sun.
- 2) Use of sunscreen and protective clothing.

- 3) Public education about UV Index and risks, especially for children.
- 4) Prophylactic iodine may reduce thyroid cancer after nuclear radiation exposure.

Table 1. Summary table of cancer prevention measures.

Risk Factor	Preventive Action
Tobacco	Taxation, smoke-free laws, and advertising bans
Diet	Reduce fat/sugar, increase fruits/vegetables
Alcohol	Raise prices, limit access, brief interventions
Physical Inactivity	Urban design, school programs
Obesity	Family interventions, school campaigns
HBV	Universal infant vaccination, safe injection
HPV	Adolescent vaccination, screening
Environmental Toxins	Ban/reduce exposure, improve water quality
Occupational Hazards	PPE, substitution, legal enforcement
Radiation	Imaging justification, UV protection education

10. Recommendations

This section outlines strategic, evidence-based recommendations aimed at improving cancer treatment, prevention, and awareness in Bangladesh. These recommendations target systemic weaknesses in healthcare delivery, financing, infrastructure, public education, and multi-stakeholder collaboration.

10.1. Strengthening Healthcare Infrastructure

To improve cancer care accessibility and quality, particularly in underserved regions:

- 1) Establish more regional cancer centers, especially in rural and semi-urban areas.
- 2) Equip these centers with modern diagnostic technologies (e.g., PET-CT, MRI, digital mammography) and treatment modalities (e.g., linear accelerators for radiotherapy, chemotherapy infusion suites).
- 3) Address the shortage of trained oncologists, oncology nurses, medical physicists, and radiology technicians by investing in professional training programs.
- 4) Develop telemedicine and mobile cancer screening units to reach geographically isolated communities.

Goal: Reduce patient travel burden, diagnosis delays, and treatment discontinuation.

10.2. Education and Awareness Programs

- 1) Widespread misinformation and lack of awareness remain barriers to early detection and treatment.

2) Launch nationwide public health campaigns through mass media, social media, schools, and religious institutions.

3) Target key topics: symptom recognition, cancer risk factors, importance of screening, and available treatment options.

4) Train community health workers and schoolteachers to disseminate cancer awareness materials.

5) Develop culturally-sensitive, multilingual resources to reach diverse populations, especially in rural areas.

Goal: Improve early detection rates and reduce cancer-related stigma.

10.3. Financial Support Mechanisms

Cancer treatment is financially devastating for many households in Bangladesh.

1) Provide subsidized or free cancer treatment for low-income patients through public hospitals.

2) Introduce comprehensive cancer insurance coverage under the national health system.

3) Establish government and NGO-supported cancer treatment funds to support patients needing long-term therapies.

4) Promote cost transparency to help families plan for long-term care.

Goal: Prevent treatment abandonment due to financial hardship.

10.4. Collaboration and Partnerships

Collaborative frameworks can increase the reach and impact of cancer programs.

1) Strengthen ties between government, NGOs, international health organizations (e.g., WHO, IAEA), and academic institutions.

2) Facilitate joint research projects, workforce training, and technology transfer.

3) Encourage the sharing of best practices in cancer prevention and care through regional conferences and forums.

4) Develop partnerships with pharmaceutical companies to access affordable medications and diagnostic kits.

Goal: Pool resources for maximum health system impact.

10.5. Government Initiatives

Existing government efforts are commendable but need expansion and refinement.

1) Awareness Campaigns: Increase the frequency and reach of educational efforts about early detection, tobacco risks, HPV vaccination, and regular screening.

2) Subsidies and Assistance: Expand the scope of financial assistance and add coverage for rural patients.

3) International Collaboration: Continue engaging with global agencies for funding, capacity-building, and innovation access.

Goal: Government leadership is essential for nationwide impact and policy reform.

10.6. Increase Healthcare Budget Allocation

Currently, Bangladesh allocates a limited percentage of its GDP to healthcare.

Advocate for increased public health investment, especially in cancer-related services.

Prioritize funding for:

- 1) Infrastructure development.
- 2) Human resource training.
- 3) Research and surveillance.
- 4) Essential medicines and diagnostics.

Goal: Ensure equitable and sustainable cancer care for all citizens.

10.7. Public-Private Partnerships (PPPs)

The private sector plays a critical role in supplementing government efforts. Establish PPPs to:

- 1) Develop specialized cancer centers.
- 2) Conduct mobile screening camps.
- 3) Fund cancer research and innovation.
- 4) Incentivize private investment through tax benefits and shared-risk models.
- 5) Encourage private insurance companies to expand affordable cancer insurance packages.

Goal: Leverage private sector efficiency and funding to complement public health goals.

Table 2 is a summary of the recommendations.

Table 2. Summary of strategic recommendations.

Area	Action
Infrastructure	Build regional cancer centers, upgrade equipment
Education & Awareness	National campaigns, train health workers, and multilingual materials
Financial Support	Subsidized care, national cancer insurance, and financial aid funds
Collaboration	Joint research, international partnerships, tech sharing
Government Role	Scale campaigns, increase subsidies, improve international coordination
Budget	Increase healthcare GDP share, prioritize cancer services
Public-Private Partnership	Encourage investment in cancer care, expand private insurance participation

11. Conclusion

The author prepared this report to contribute meaningfully to the development of cancer treatment within our community. Based on the findings, the following key recommendations are proposed to address the medical, psychological, social, and financial challenges faced by cancer patients in Bangladesh:

Raise Public Awareness: Promote education to combat stigma and reduce the social discrimination experienced by cancer patients.

Provide Psychosocial Support: Health professionals should offer psychotherapy and body image acceptance programs to help patients cope emotionally and build a positive self-image.

Support Emotional Wellbeing: Specific attention must be given to the psychological effects of perceived loss of femininity among female patients, with tailored counseling and support services.

Increase Financial Assistance: The government should expand subsidies and offer free cancer treatment to reduce the economic burden on patients and families.

Implement Health Insurance: Establish a national health insurance policy to cover cancer care and ease the financial stress associated with treatment.

Support Employment Adaptation: Employers should provide flexible, low-stress roles for patients re-entering the workforce, recognizing their physical limitations.

Expand Rural Access: Improve healthcare infrastructure in rural areas to minimize travel and non-medical costs for patients living far from treatment centers.

Encourage Ongoing Research: Further studies are needed to explore effective strategies for reducing the socio-economic impact of cancer on patients.

While individuals at high risk for cancer make up a small percentage of the population, they exist along a continuum of risk shared by many. Public health efforts should not only target those at highest risk, but also aim to reduce risk factors and barriers across the entire population. Addressing the socio-economic and structural barriers to cancer care in Bangladesh is essential for delivering equitable, quality treatment. Through investment in healthcare systems, public education, financial support policies, and cross-sector collaboration, we can make meaningful strides toward better cancer outcomes and reduced suffering for patients and their families.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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