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CANCER SCREENING AND PREVENTION: A GLOBAL PERSPECTIVE ON CURRENT PRACTICES, CHALLENGES, AND FUTURE DIRECTIONS

Meena Gyawali,

MPH, MPRHGD

meegyawali@gmail.com

Asia International University, Bukhara, Uzbekistan

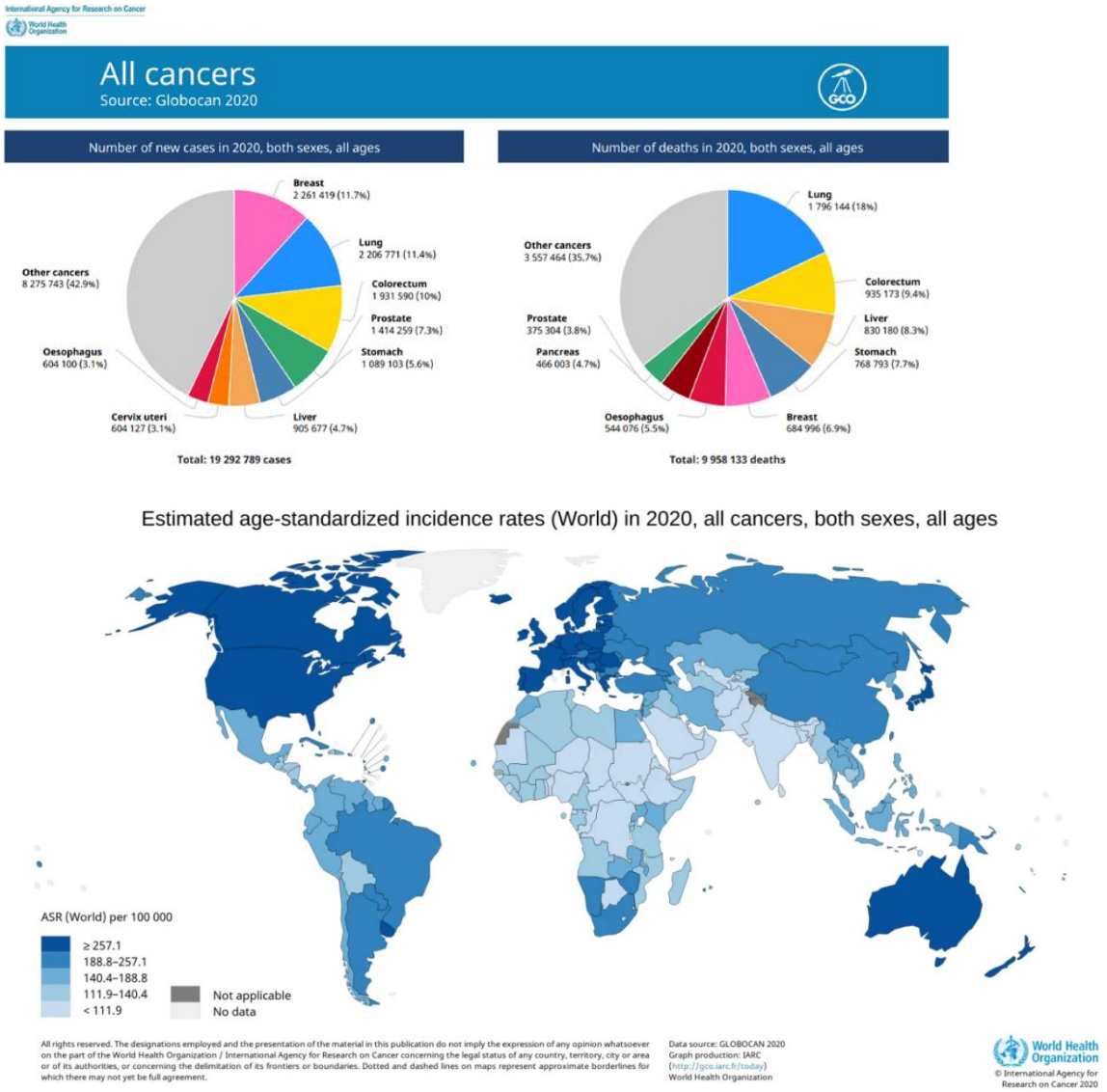
Abstract: Cancer remains a leading cause of morbidity and mortality worldwide, accounting for nearly 20 million new cases and 9.7 million deaths in 2022. Effective cancer prevention and screening strategies have significantly reduced the burden of several common malignancies through early detection and risk-factor modification. Primary prevention measures, including tobacco control, vaccination against oncogenic viruses, healthy lifestyle promotion, and environmental protection, play a critical role in reducing cancer incidence. Secondary prevention through organized screening programs for cervical, breast, colorectal, and lung cancers facilitates early diagnosis and improved survival outcomes. Despite substantial progress, major disparities persist between high-income and low- and middle-income countries (LMICs) regarding access to screening services, healthcare infrastructure, public awareness, and resource allocation. Emerging technologies such as artificial intelligence, molecular diagnostics, liquid biopsy, and risk-stratified screening offer promising opportunities to enhance effectiveness and accessibility. This review examines the current global landscape of cancer prevention and screening, highlights existing challenges, and discusses future directions aimed at reducing cancer-related morbidity and mortality worldwide.

Keywords: Cancer prevention, cancer screening, early detection, public health, global health, cancer control.

Introduction

Cancer is a major global public health challenge. According to the International Agency for Research on Cancer (IARC), approximately 19.98 million new cancer cases and 9.7 million cancer deaths occurred worldwide in 2022 (1). The growing burden of cancer is driven by population aging, urbanization, lifestyle changes, and increasing exposure to environmental risk factors. While advances in treatment have improved outcomes, prevention and early detection remain the most cost-effective approaches to reducing cancer-related mortality (2).

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Cancer control strategies are broadly categorized into primary prevention, aimed at reducing cancer incidence, and secondary prevention, which focuses on early detection through screening. Together, these interventions contribute significantly to improved survival and reduced healthcare expenditures (3).

Primary Prevention of Cancer

Tobacco Control

Tobacco use remains the leading preventable cause of cancer worldwide and is responsible for approximately one-third of cancer deaths (4). Smoking is strongly associated with lung, oral, laryngeal, esophageal, bladder, pancreatic, and several other cancers. Comprehensive tobacco control policies, including taxation, smoking bans, health warnings, and cessation programs, have demonstrated substantial reductions in cancer incidence (5).

Vaccination

Vaccination against cancer-associated infectious agents represents one of the most successful preventive strategies. Human papillomavirus (HPV) vaccination significantly reduces the risk of cervical cancer and other HPV-related malignancies. Similarly, hepatitis B vaccination decreases the incidence of hepatocellular carcinoma by preventing chronic hepatitis B infection (6).

Lifestyle Modification

Approximately 30–50% of cancers are attributable to modifiable risk factors (7). Healthy dietary habits, regular physical activity, maintaining optimal body weight, limiting alcohol consumption, and reducing exposure to carcinogens contribute significantly to cancer prevention. Obesity has emerged as a major risk factor for colorectal, breast, endometrial, and several other cancers (8).

Environmental and Occupational Protection

Exposure to environmental pollutants, ultraviolet radiation, asbestos, and occupational carcinogens contributes substantially to the global cancer burden. Regulatory measures aimed at reducing exposure have been associated with decreased cancer incidence in several populations (9).

Current Global Cancer Screening Practices

Cervical Cancer Screening

Cervical cancer remains one of the most preventable cancers through effective screening and HPV vaccination. Screening methods include Pap smear cytology, HPV DNA testing, and visual inspection with acetic acid (VIA). The World Health Organization (WHO) advocates HPV testing as the preferred screening method due to its high sensitivity (10).

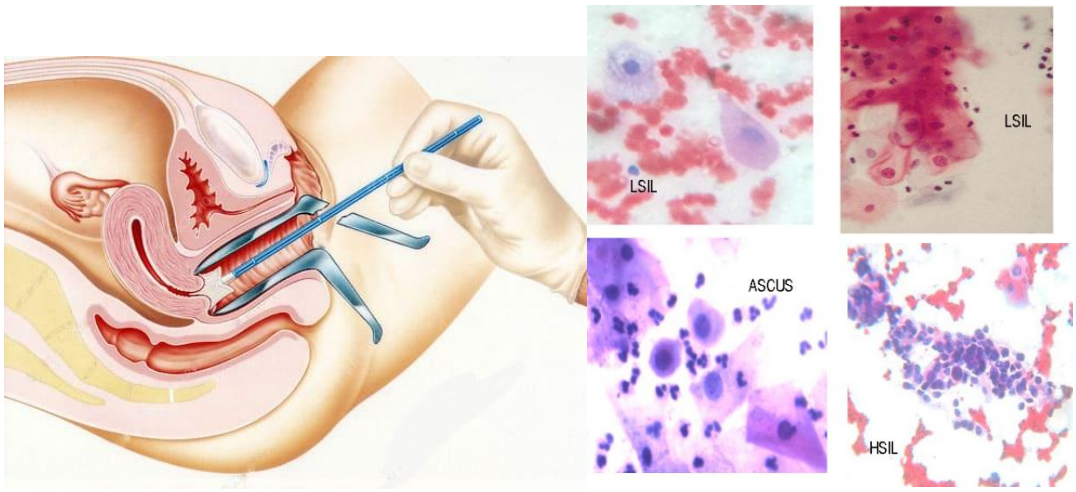


Fig: Pap smear cytology

Colorectal Cancer Screening

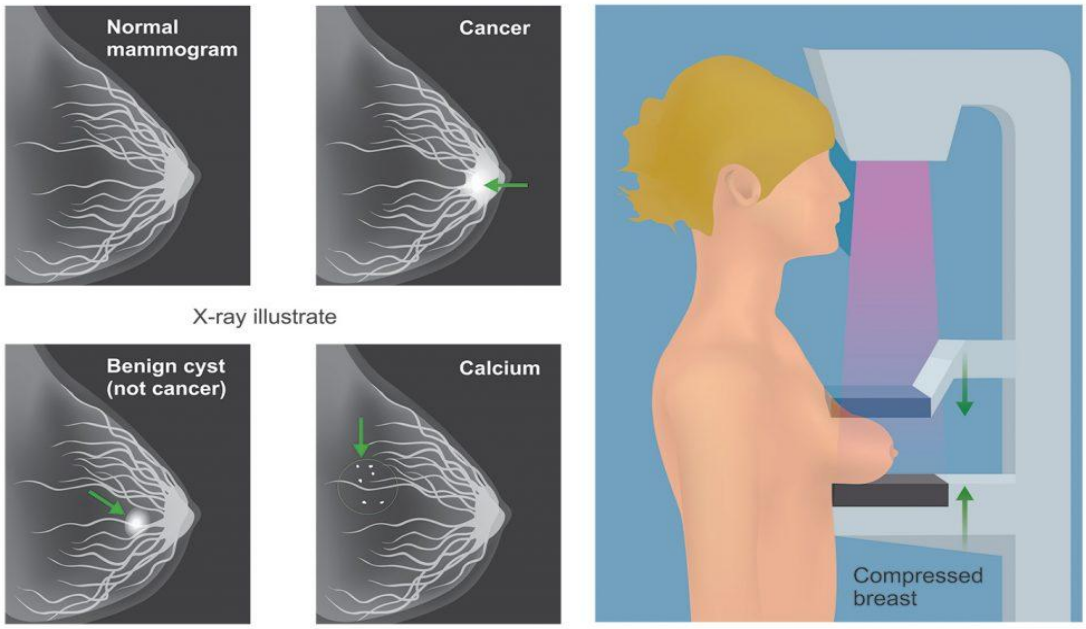
Screening modalities include fecal immunochemical testing (FIT), fecal occult blood testing (FOBT), sigmoidoscopy, and colonoscopy. Evidence demonstrates that colorectal cancer screening reduces both incidence and mortality through detection and removal of precancerous lesions (12).

Lung Cancer Screening

Low-dose computed tomography (LDCT) screening is recommended for high-risk individuals, particularly heavy smokers. Large clinical trials have shown significant reductions in lung cancer mortality through LDCT-based screening programs (13).

Breast Cancer Screening

Mammography remains the cornerstone of breast cancer screening and has been associated with reduced breast cancer mortality in organized screening programs. Many high-income countries implement population-based mammographic screening for women aged 50–69 years (11).



Global Disparities and Challenges

Despite proven effectiveness, substantial inequalities exist in cancer screening implementation. High-income countries generally have organized screening programs, while many LMICs face challenges related to inadequate healthcare infrastructure, workforce shortages, limited funding, and low public awareness (10).

Financial barriers remain a major obstacle. Many countries lack sustainable financing mechanisms for population-based screening programs. Furthermore, cultural beliefs, fear of diagnosis, stigma, and poor health literacy negatively influence screening uptake (14).

Over diagnosis, false-positive results, unnecessary interventions, and psychological distress also present important concerns in cancer screening. Balancing benefits and harms remains a critical consideration when designing screening policies (11).

Future Directions

Artificial Intelligence

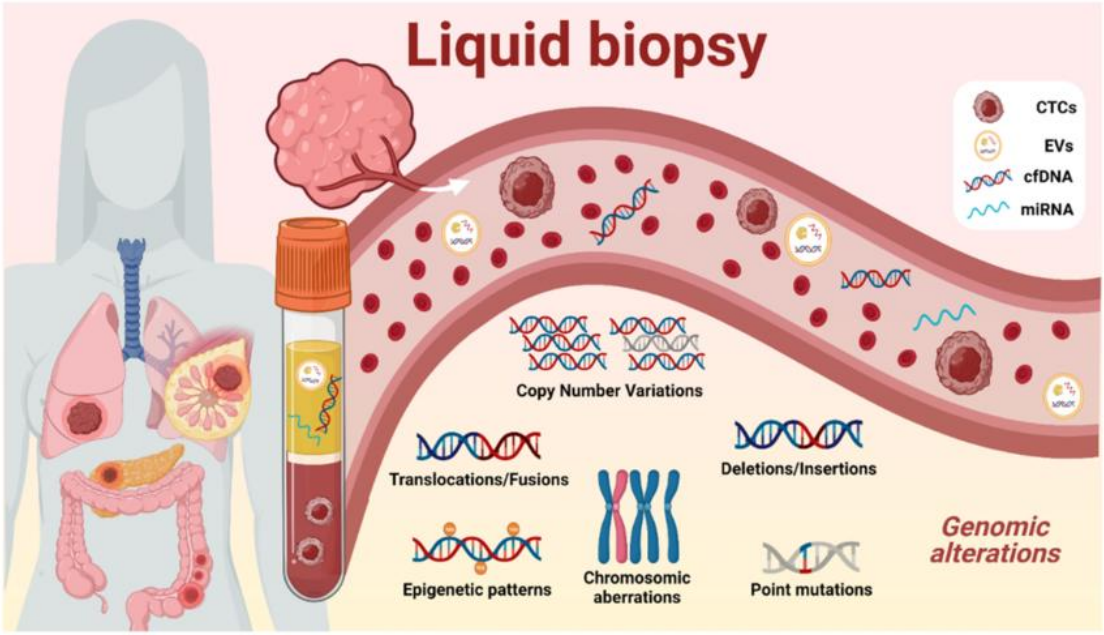
Artificial intelligence (AI) is increasingly being integrated into cancer screening programs. AI-assisted interpretation of mammography, pathology slides, and radiologic imaging has demonstrated improved diagnostic accuracy and efficiency (15).

Precision and Risk-Based Screening

Future screening strategies are expected to move toward personalized approaches incorporating genetic, molecular, and lifestyle risk factors. Risk-stratified screening may improve effectiveness while reducing unnecessary investigations and costs.

Liquid Biopsy

Emerging liquid biopsy technologies allow detection of circulating tumor DNA and other biomarkers from blood samples. These minimally invasive approaches hold promise for multi-cancer early detection and monitoring.



Expanding Screening in LMICs

International collaboration, digital health technologies, community engagement, and investment in healthcare infrastructure are essential for expanding screening coverage in resource-limited settings. Achieving WHO targets for cervical cancer elimination and broader cancer control will require sustained global commitment.

Conclusion

Cancer prevention and screening remain fundamental components of global cancer control strategies. Significant advances have been achieved through tobacco control, vaccination, lifestyle modification, and organized screening programs. However, disparities in access and implementation continue to limit the benefits of these interventions, particularly in LMICs. Emerging technologies such as AI, liquid biopsy, and precision screening offer promising opportunities to improve early detection and prevention. Strengthening healthcare systems, enhancing public awareness, and ensuring equitable access to preventive services will be critical to reducing the global cancer burden in the coming decades.

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