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Cancer Trends in Northeast India: An Overview

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Abstract

Cancer is a growing global concern. India, being a third-world country, raises cancer-related burden significantly. The highest incidence of cancer accompanied by risk factors associated with Northeast India compounds this burden. In 2022, India reported 1.4 million new cases and 0.9 million deaths, with breast and oral cancers being the most common among females and males, respectively. At the same time, the Northeastern region witnessed the highest number of oesophageal cancer and breast cancer among males and females, respectively. When it comes to all types of cancer, Northeastern states are the leaders occupying the top position in the hierarchy of AAR. Similarly, mortality is also highest in these states. This high cancer burden of this region could be due to lifestyle, dietary habits, and genetic makeup. Strengthening treatment facilities, reducing costs, and raising awareness at the community level are crucial to addressing and improving cancer care in the Northeast.

Keywords: Cancer burden, Northeast India, risk factors, tobacco consumption, cancer trends.

Introduction

Cancer is a notorious disease affecting the global population and ranks second in disease-related mortality (Rahman *et al.* 2020). The incidence of cancer in India is increasing at an alarming rate. In India, As per the reports of IARC-WHO, 1.4 million cases of cancer were reported in 2022 with a mortality of 0.9 million (Sung e*t al.* 2021), making it the leading cause of deaths and morbidity. Among all cancer types, breast cancer is the most prevalent type of cancer in India followed by oral cancer (**Fig. 1**) (Ferlay *et al.* 2024). In the case of gender-dependent incidence, oral and lung cancers had the highest incidence among males, while breast and cervical cancers were the most common among females.

According to the Indian Council of Medical Research (ICMR), North-East has the highest cancer incidence in the country. Due to this, it has been termed the 'Cancer Capital of India' and emerged as a crucial region for cancer research. Considering both the genders in

this region, head and neck cancer occupied the top position followed by lung cancer, and stomach cancer (ICMR-NCDIR 2021). The distinct dietary patterns and lifestyles linked to the culture and demographics of the ethnic people in this area are factors that contribute to this cancer trend (Bhattacharjee *et al.* 2006; Shanker *et al.* 2021). In addition to these factors, genetic mutations and epigenetic modifications might also play an important role as a causative factor in cancer cases in the NE region.

Mutations in certain genes have been linked to several cancers in this region (Gauthaman and Moorthy 2020). Mutations in the BRCA1 gene compared to normal were identified in breast cancer patients of the NE region (Hansa *et al.* 2012) In gastric patients of Mizoram, somatic mutations in *TP53*, genes crucial in RTK/RAS/PI3-K signalling pathway and chromatin-remodelling were observed (Chakraborty *et al.* 2023).

Similarly, Epigenetic modifications play a crucial role in cancer development (Shankar and Gupta 2016). DNA methylation is one of the epigenetic changes that has been thoroughly researched in relation to the development of cancer. Several studies from the NE region have shown that tumour suppressors and DNA repair genes like *p16, MGMT, hMLH1, WT1,* and *RASSF1A*, are frequently methylated in head and neck cancer including oesophageal cancer (EC) (Choudhury and Ghosh, 2015; Das *et al.* 2013; Khongsti *et al.* 2018). Though studies on stomach cancer are limited, a study by Lamare et al. has reported novel genes that are differentially methylated in the population of Aizawl district (Lamare *et al.* 2022). Considering the background, this review aims to provide a comprehensive overview of the trends of cancer in Northeast India, risk factors and challenges specific to this region.

Epidemiology of cancer in North-East India

The incidence of cancer in NE is increasing at an alarming rate. According to the Indian Council of Medical Research - National Centre for Disease Informatics and Research (ICMR-NCDIR) report 2021, 67,361 cancer cases were reported in the NE states (Sathishkumar *et al.* 2022). Among the Population Based Cancer Registries (PBCR) in the NE states, Tripura PBCR reported the highest number of cancer cases (11,473), followed by Kamrup PBCR with 11,013 cases (Mathur *et al.* 2020). The NE region reported the highest age-adjusted incidence rate (AAR) of cancer compared to the rest of the country. The highest AAR in males was from the Aizawl district (269.4 per 100,000 population) and among females, the Papumpare district in Arunachal Pradesh had the highest AAR of 219.8 for all cancer types (**Fig. 2**) (ICMR-NCDIR 2021). These results imply that the probability

associated with cancer development in the NE region for all cancers in a lifetime is the highest in Kamrup urban (1/4 males and 1/6 females) followed by Mizoram state (1/5 males and 1/5 females) and Meghalaya (1/5 males and 1/9 females).

Similarly, mortality associated with cancer in the NE region was also relatively high. As per the 2020-NCRP Report, 27,672 deaths were recorded in NE due to cancer (Report of NCRP 2020). Among males, the age-adjusted mortality rate (AAMR) was the highest in Aizawl district (152.7 per 100000 population), followed by Mizoram state (121.4) and East Khasi Hills district (95). As for females, the same trend was seen with Aizawl district having the highest AAMR of 89.5 followed by Mizoram state (76.4) and East Khasi Hills district (51.5).

Common Cancer Types in the North-East India

Out of all the cancer types that are widespread in the Northeast, the most prevalent cancer in both men and women is head and neck cancer (a group of cancers that originates in the mouth, lips, sinuses, nasal cavity, salivary glands, larynx or throat), followed by lung and stomach cancer. As for head and neck cancer, East Khasi Hills District (78.5 per 100,000) and Kamrup Urban (62.4) reported the highest incidence rates in males, and as for females, Papumpare District (21.7) and Kamrup Urban (19.2) had the highest incidence rates (ICMR-NCDIR 2020). Aizawl District occupied the top position for lung cancer in both males (38.8) and females (37.9). In the case of stomach cancer, Aizawl district (44.2) and Papumpare district (27.1) had the highest incidence rate in males and females respectively.

Considering organ-specific cancer types, EC (cancer that originates in the tissue of the oesophagus) (13.6%) was the most prevalent in males followed by lung (10.9%) and stomach (8.7%). In females, cancer of the breast (14.5%), cervix uteri (12.2%), and gallbladder (7.1%) was the most common (**Fig. 3**) (ICMR-NCDIR 2021). The burden of EC in males was the highest in East Khasi Hills (AAR-75.4) and Meghalaya state (54.6). In the case of lung cancer, Aizawl, and Mizoram state had the maximum AAR of 38.8 and 32.1, respectively. As for stomach cancer, Aizawl, and Papumpare districts had the most AAR of 44.2 and 40.3 respectively. In females, Aizawl, and Papumpare district had the highest AAR of 30.7 and 29.6 respectively, for breast cancer. For the second most common cancer in females, i.e., Cervix uteri, Papumpare district (27.7) and Aizawl (27.4) had the maximum AAR. As for gallbladder cancer, which is the third most prevalent cancer, Kamrup urban (7.9) and Cachar district (5.6) occupied the top positions.

Risk Factors Contributing to Cancer Trends in North-East India

The risk factors involved in cancer development vary from lifestyle and personal habits to epigenetics, and genetics. In the NE region of India, most of the population is exposed to extensive consumption of tobacco and its related products, alcohol, and betel quid. Apart from these, lifestyle and diet unique to this region also contribute significantly to cancer development.

Consumption of alcohol, betel quid, and tobacco (smoke and smokeless forms) are the major risk factors in the NE region that are associated with cancers of the head and neck (Michaelraj *et al*. 2023; Shanker *et al*. 2021; Shunyu & Syiemlieh, 2013), oesophagus (Harris *et al*. 2024; Phukan *et al*. 2001), lung (Manjunath *et al*. 2022; Shanker *et al*. 2021), stomach and breast cancers (Thapa *et al*. 2016; Zodinpuii *et al*. 2022). 49.3 % of cancers reported from the NE region are related to tobacco use in males, and 22.8% in females (Mathur *et al*. 2020). The top three cancers that are related to tobacco use are the oesophagus, lung, and hypopharynx in males and the oesophagus, lung, and mouth in females (Fig 4). In addition to first-hand smoking of tobacco, second-hand exposure to smoking, and air pollution are also the major causes of lung cancer (Manjunath *et al*. 2022; Shanker *et al*. 2021). Meghalaya occupies the top position in the consumption of betel quid. Almost 63.2% of the adult population in Meghalaya consumes betel quid without tobacco and 70.8% consumes betel quid in any form (Singh *et al*. 2021). Additionally, almost 50% of the population (above 15 years) consumes tobacco (smoke/smokeless form) (ICMR-NCDIR, 2021). In Mizoram, 34.4% of the population (15 years and above) use smoked tobacco which is also the highest in the region (ICMR-NCDIR 2021).

Dietary factors such as low consumption of fruits, high consumption of hot and spicy foods, fermented foods, smoked meat, soda, *H. pylori* infection and hot beverages containing nitrosamines also contribute to EC, stomach cancer and head and neck cancer development in these regions (Dikshit *et al*. 2011; Misra 2014; Phukan *et al*. 2006; Roy *et al*. 2024; Rup Kumar Phukan and Mahanta 2001). The people of Mizoram highly consume ‘Tuibur’ (tobacco water), smoke a local cigarette known as ‘Meiziol’ or ‘Zozial,’ and fermented pork fat called ‘sa-um’ which has been highly associated with the risk of stomach cancer, and breast development in many studies (Lamare *et al*. 2022; Phukan *et al*. 2006; Thapa *et al*. 2016; Zodinpuii *et al*. 2022; Zomawia *et al*. 2023). Aging and reproductive factors, which include late menopause, early menarche, and late age at first pregnancy, are also a risk factor for breast cancer (Sun *et al*. 2017). A study reported delayed marriages, and obesity after menopause as risk factors for breast cancer in the NE region (Biswas *et al*. 2025).

Mutations and family history also play a crucial role in cancer development. For instance, breast cancer, and head and neck cancer have been associated with family history in the NE region (Biswas *et al*. 2025; Pachuau *et al*. 2022; Zodinpuii *et al*. 2022). Family history may be related to genetic factors such as *BRCA1* and *BRCA2* genes (Metcalfe *et al*. 2010; Pourmasoumi *et al*. 2024). A study in the NE region has reported an association of mutations in the *BRCA1* gene with breast cancer (Hansa *et al*. 2012). Epigenetics, which is influenced by lifestyle and personal habits, largely overshadows genetics as a causative factor for cancer (Okugawa *et al*. 2015). Few studies from the NE region have found aberrant methylation of genes crucial in the cell cycle, DNA repair, and tumour suppression to be associated with cancers (Choudhury and Ghosh 2015; Das *et al*. 2013; Khongsti *et al*. 2018).

Challenges in Cancer Infrastructure and Management

The prevalence of different types of cancers is very high in the NE region. However, the infrastructure, specialized facilities, and trained professionals are limited in the region. The region has few cancer hospitals and palliative care centres; however, many seek treatment outside the region due to quality and availability factors (Ngaihte *et al*. 2019). A larger number of patients have to travel far distances to avail treatment, which may result in delays in cancer diagnosis and increased costs. Also, the cost of cancer treatment is very high, and therefore significant financial burdens are being faced by patients (Pongener 2024). This may lead to poor prognosis and poorer health outcomes. Though the region has a high incidence of cancer, many are unaware of the disease, especially among the illiterates and rural areas; an indication of low awareness programs and screening among the population.

To reduce the trouble of cancer in the region, resources have to be directed to increase the number of specialized cancer treatment facilities at the primary, secondary and tertiary levels. Reducing the costs of treatment, particularly for low- and middle-income populations will greatly reduce the cancer scenarios in the region. Apart from these, awareness at the grassroots level is of utmost importance to nip the cancer in the bud. Communities can engage in awareness and sensitization programs to increase health literacy among the population. These programs can aim at early screenings, and treatment, ultimately reducing the cancer burden.

Conclusion

Comparatively, the NE region of India is leading the chart in the incidence of cancer and its associated mortality. The alarming trend of increasing cancer cases in the region calls for an

urgent need to address the issue. Since most cancer is associated with lifestyle, dietary and personal habits, therefore, community awareness is important to mitigate cancer at the grassroots level. Awareness programs and screening involving various stakeholders are pivotal in controlling and preventing the multiple cancers prevalent in the region. Additionally, continued research and intervention to identify key diagnostic and prognostic biomarkers of common cancers specific to this high-risk population will greatly reduce the toll of cancer in the area.

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