

# Poverty and cancers: A brief review

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## Abstract:

Poverty has been an important social determinant of health, including cancer. The poverty trap of cancer diagnosis and treatment owing to catastrophic expenditure and subsequent poor outcomes is well documented in the literature. This article aims to explore the role of poverty, leading to biological changes responsible for an increased risk of carcinogenesis. The role of poverty-causing cancers could open the avenues for more comprehensive prevention and control strategies, and subsequent policy implications, in high-burden and poverty-stricken regions in the country.

## Keywords:

Biological pathways, cancer, carcinogenesis, poverty

## Introduction

In 2020, India reported 2.7 million people being affected with cancer, with the Northeast India having the highest burden.<sup>[1]</sup> As the sustainable development goal (SDG) no. 3.4.1 specifically targets the reduction of premature mortality due to cardiovascular diseases, cancers, diabetes, and chronic respiratory diseases,<sup>[2]</sup> it becomes important to study the social determinants associated with cancers. Poverty has been termed as a “carcinogen” by the director of the National Cancer Institute.<sup>[3]</sup> The Multidimensional Poverty Index (MPI) measures poverty beyond traditional monetary measures, including deprivation of health, education, and nutrition. As per the MPI 2023 report, 16.4% of the Indian population are poor, with 4.2% living in severe poverty.<sup>[4,5]</sup> People living in persistent poverty are at a higher risk of having exposed to cancer-causing agents.<sup>[6]</sup>

## Lower-socioeconomic status and cancers

Association between lower socioeconomic status and tobacco consumption is

observed globally<sup>[7]</sup> as well as in low- and middle-income countries, including India.<sup>[8]</sup> Four out of the top five (esophagus, lungs, pharynx, and mouth) in males and two out of the top five anatomical sites among females (esophagus and lungs) in the north-eastern region in India are associated with tobacco. A disparity in the distribution of cervical cancer is observed globally, too, with a higher burden in the highest poverty quartile.<sup>[9,10]</sup> In addition to human papillomavirus, other established risk factors include early marriage, multiparity, unsafe sexual intercourse, and low age at first childbirth; all of these are associated with low-socioeconomic status.<sup>[11]</sup> Evidence also shows a higher proportion of gallbladder cancer (GBC) patients, one of the top anatomical cancer sites among Indian women, belonging to the lower socioeconomic status.<sup>[12,13]</sup> In fact, the unique geographical distribution of GBC within India is also indicative of an association with an overall low development index. The incidence of GBC is unusually high in north and northeastern India, states with MPI lower than the national average.<sup>[5,14]</sup>

## Poor nutrition and cancers

Evidence does not only indicate the effect of poverty on social determinants and outcomes of cancer but biological pathways leading to carcinogenesis could also be

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traced to poverty. Persistent deficiency in vitamins and minerals has been linked with the pathogenesis of various cancers.<sup>[15,16]</sup> Nutritional deficiency in terms of Vitamin B6, B9, and B12 has been associated with cancers of the lungs, esophagus, and colorectal cancers.<sup>[15]</sup> Deficiency of Vitamins B6, B9, and B12 leads to the addition of deoxyuracil in DNA, leading to breakage of DNA, and promoting tumorigenesis.<sup>[16]</sup> Deficiency of B12 leads to hypomethylation of DNA, leading to activation of transposable elements, which are often mutagenic, leading to early carcinogenesis.<sup>[17]</sup> It should be noted that almost half of Indians (47%) are Vitamin B12 deficient.<sup>[18]</sup> The protective effect of Vitamin C is also well documented in the literature as it reduces oxidative stress by removing free radicals and subsequently reducing the risk of cancers.<sup>[15]</sup> Vitamin C deficiency is well documented in the Indian population,<sup>[19]</sup> which could well be associated with poverty in the country, thereby increasing the risk of cancers in the lower socioeconomic strata. Vitamin A is effective in reducing the risk of cancers, especially gastric epithelia, by blocking tumor promotion by inhibiting proliferation through inducing apoptosis, differentiation, or both.<sup>[20]</sup>

Iron deficiency anemia has been linked with an increased risk of cancer in population-based studies conducted in Taiwan,<sup>[21]</sup> China,<sup>[22,23]</sup> US,<sup>[25]</sup> and Denmark.<sup>[24]</sup> Iron also plays a vital role in iron-sulfur cluster synthesis in the cells, a key component of enzymes involved in DNA duplication and repair. Iron deficiency leads to faulty synthesis of Fe-S cluster, inducing replication stress and subsequent instability, leading to malignancy.<sup>[25]</sup> It is interesting to note that some of the high incidence for GBC states such as Assam, Bihar, West Bengal, and Punjab also report higher than the national average for anemia prevalence (>57%).<sup>[26]</sup>

Depletion of zinc levels in serum has been linked with liver cirrhosis and other hepatobiliary cancers.<sup>[27-29]</sup> Deficiency of zinc leads to impairment of DNA-binding abilities of the p53 protein, leading to DNA damage and DNA damage repair mechanism, which is a potential risk for carcinogenesis.<sup>[30]</sup> An overall nutritional deficiency owing to poverty, therefore, increases the risk of cancers in an individual.

### Poor immunity and cancers

Poor immunity resultant of poverty is another aspect that draws attention in the context of increased risk of cancer. The role of immunity as a defense mechanism against cancer has been discussed by various authors.<sup>[31,32]</sup> Evidence indicate that immune cells can act against tumor cells through various mechanisms such as presenting tumor antigens, releasing cytokines that activate other immune cells, or through direct phagocytosis.<sup>[33]</sup> As seen in other diseases such as stroke when immune cells help

remove the damage cells to facilitate healing,<sup>[34,35]</sup> similar mechanisms could be working in cancers too. There are enough evidence to prove that cancer cells evade the immune system through various mechanisms.<sup>[36]</sup> It is possible that immune cells are fighting cancer cells on a regular basis without our knowledge.<sup>[37]</sup> Thus, a lower immunity could still be a causal factor for cancers among the poor.

Evidence also supports a higher prevalence of pro-oncogenic infections,<sup>[38,39]</sup> such as human papillomavirus, hepatitis C virus, Epstein-Barr virus, *Helicobacter pylori*, and *Salmonella typhi* infections among the lower socioeconomic strata throughout the world.<sup>[9,40-43]</sup>

Catastrophic expenditure leading to a poverty trap is a well-argued phenomenon. However, now it is time to focus on the causative role of poverty in carcinogenesis and increasing cancer burden. It is time to formulate creative solutions targeting poverty and link cancer control initiatives with global policies such as the SDGs.

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### Conflicts of interest

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