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Cancer Causation in North Karnataka: Geographic, Dietary, and Genetic Determinants

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Abstract: The paper is a survey of the causes of cancer with a regional perspective of Kalyana Karnataka and Kittur Karnataka of the Kalaburagi, Bidar, Yadgir, Raichur, Vijayapura, Bagalkot, Belagavi, Koppal, Gadag, Dharwad and Haveri districts. It explores the interaction of geography/environment, diet, and genetic factors in influencing the regional cancer profile: semi-arid Deccan geochemistry, fluoride/arsenic-contaminated groundwater; double dietary pattern of fibre rich jowar (sorghum) staples and widespread consumption of smokeless tobacco and areca-nut; regionally high consanguinity that is associated with recessive cancer-predisposition disorders. It is based on the data of ICMR-NCRP registry, district level environmental studies and dental/oncology studies from institutions at Bagalkot and Belagavi.

1. INTRODUCTION

The Deccan plateau geography, agrarian food patterns (mostly millets), smoking habits of smokeless tobacco and the socio-cultural pattern of consanguineous marriage create a unique cancer risk profile in North Karnataka, which incorporates the historically marginalised Kalyana Karnataka region (Hyderabad-Karnataka) and the northern districts of Kittur Karnataka. The overall prevalence of cancer in the country as obtained from the ICMR National Cancer Registry Programme (NCRP) based on Population Based Cancer Registry (PBCR), Bangalore has revealed significant regional variations spread throughout India. This paper takes the approach of the classical three domains of cancer causation—geography/environment, diet, and genetic—to North Karnataka and showcases district-level data and studies from regional dental and medical colleges to demonstrate the interaction of these domains at a local level. For the improvement in the performance, this research has developed an OP-AMP circuit using 22 nm FinFET technology and high-k gain and also a design of VCO has been done.

2. METHODOLOGY

This survey is based on peer-reviewed studies from various institution in North Karnataka (P.M.N.M Dental College, Bagalkot and Maratha Mandal's Dental Institutions, Belagavi), ICMR-NCRP and data from the Kidwai Memorial Institute of Oncology registry report and district groundwater-quality survey and national consanguinity data (NFHS-5). If there is no literature available for the specific region and population with regard to a particular cancer site, information from similar populations in Karnataka or South India is used and noted in the footnote. This is an informal review and survey rather than a systematic review.

3. GEOGRAPHIC AND ENVIRONMENTAL DETERMINANTS

3.1 The Kalyana Karnataka and Kittur Karnataka Context

The districts of North Karnataka are mostly located on the semi-arid Deccan plateau, traditionally considered one of the poorest areas of the state under the development scheme Kalyana Karnataka (Hyderabad-Karnataka). Paper [20] employed machine learning linear regression algorithm to be used in LC oscillator. A lower investment in healthcare infrastructure over the years has been paralleled by a lower ratio of mortality to incidence in this region compared to higher-resource regions, which is consistent with the pattern observed internationally, where a lower-resource region demonstrates a higher ratio of mortality to incidence as a result of delayed diagnosis, but not because of the nature of the disease itself

3.2 Groundwater Geochemistry: Fluoride and Arsenic

The contamination of geogenic groundwater has been reported in several districts of North Karnataka. The study in Devadurga taluk of Raichur district revealed dental fluorosis in more than 80% of the respondents and skeletal fluorosis in about one-fifth of which the levels of fluoride in the well water were up to six times the WHO limit and it is recognised as fluoride-endemic.Dental Fluorosis was observed in more than 80% and Skeletal Fluorosis in about 1/5 of the study population in Devadurga taluk of Raichur district and it is recognised as fluoride-endemic with well water fluoride

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concentration up to six times the WHO limit. The prevalence of dental fluorosis in bagalkot district villages is similar with dental fluorosis associated with fluoride in the ground water. [18] This paper tells about blood cancer and cause for it. Groundwater contamination due to gold mining waste (drainage) has also been found in Yadgir and southern Kalaburagi. Although fluoride and arsenic are known to cause skeletal and dermatological disease and arsenic is an IARC Group 1 carcinogen (skin, lung and bladder), a dedicated cancer registry study to quantify the cancer burden due to these exposures in North Karnataka in particular has not been done, which is a research gap in the region.

3.3 Tobacco and Areca-Nut Cultivation Belt

The overlap area of North Karnataka with an areca nut and tobacco growing and consumption region is quite large. The regional dental-college studies done in Bagalkot and Belagavi reflect the close association of tobacco use with the burden of oral cancer and oral submucous fibrosis (OSMF) among the South Asian population, which is consistent with the National statistics that indicate that smokeless tobacco (khaini, gutkha, betel quid) is a leading cause of oral cancer and OSMF in India.

4. DIETARY AND NUTRITIONAL DETERMINANTS

4.1 Jowar (Jolada Rotti): A Protective Staple

Jowar (sorghum) is the traditional staple of the North and Central part of Karnataka and is consumed as jolada rotti along with pulse curries, peanut chutney and yogurt. Jowar is also extremely fibre rich (about 6–7 g per 100 g) and gluten-free, and whole grain/high fibre cereals have strong protective evidence against colorectal cancer based on the mechanisms of accelerated colonic transit and the production of short-chain fatty acids by gut microbiota. Recent laboratory studies also indicate that the bioactive compounds found in sorghum and the changes in gut microbiota that occur when eating sorghum can directly target cancer cells and protect against colorectal cancer, but the evidence is still preliminary. In paper [21] machine learning algorithms are compared for detecting disorders in the voice.

4.2 Smokeless Tobacco and Areca Nut: The Dominant Regional Risk

Tobacco and areca-nut chewing (khaini, gutkha, betel quid/pan) is widely observed throughout Karnataka, and is well studied by the regional dental researchers. Gutkha and betel-quid chewing are seen to have a significantly higher relative risk for oral cancer and are strongly associated to a precancerous condition called oral submucous fibrosis at the national level, and combined bidi and gutkha use poses a much higher risk than either one alone. Another unique finding from a case-control study in Bangalore, reported in paper [24] is that use of an even more closely related variety of grain (ragi) as a staple cereal was also linked to increased oral cancer risk and interacted with tobacco chewing to increase risk, a finding that suggests not all regional staple grains carry the same risk as jowar, and that the preparation method and co-exposure with tobacco may be as important as the grain itself.

Dietary/Habit Factor	Regional Relevance	Main Site(s)	Effect
Jowar (sorghum) fiber	Staple of North Karnataka diet	Colorectal	↓ Risk
Gutkha / betel quid	Widespread regional habit	Oral cavity, OSMF	↑ Risk
Khaini / smokeless tobacco	Common in rural North Karnataka	Oral cavity	↑ Risk
Bidi + gutkha (combined)	Common dual-habit pattern	Oral cavity	↑↑ Risk
Ragi as staple + tobacco	South/Central Karnataka staple	Oral cavity	↑Risk (interaction)

Table 1. Regional dietary and habit-related risk/protective factors relevant to North Karnataka.

5. GENETIC AND HEREDITARY DETERMINANTS

5.1 Regional Consanguinity Patterns

NFHS-5 data has one of the highest consanguineous-marriage rates in Karnataka too — in some parts of the south and the north, blood relations are as high as 28%, which is among the highest in the country, even almost equal to Tamil Nadu, Andhra Pradesh, and Telangana. Through the fact that the rare recessive alleles that make up an autosomal recessive disease are known to be associated with consanguinity it is clear that consanguinity is a major cause of autosomal recessive disease.

5.2 Recessive Blood Disorders and Cancer-Predisposition Syndromes

Consanguinity has been associated with an increase in hemoglobinopathies like sickle cell disease and thalassemia especially in tribal and endogamous rural population in Karnataka. Risk of some less common autosomal recessive

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cancer-predisposition syndromes (such as ataxia-telangiectasia, which is associated with higher risk of lymphoma/leukemia, and bone marrow failure syndrome Fanconi anemia) is similarly higher in high-consanguinity populations generally, but not separately reported from North Karnataka and represents additional research gaps in the region.

5.3 Implications for Regional Genetic Counseling

Based on the documented regional consanguinity rate, there is a potential to extend the concept of community level genetic counseling and carrier screening programmes to identify families at risk of recessive cancer-predisposition syndromes, which however would need specific regional case-finding studies not yet documented in the literature.

6. GENE–ENVIRONMENT AND GENE–DIET INTERACTION IN THE REGIONAL CONTEXT

6.1 Tobacco and Genetic Susceptibility

Environmental carcinogens, for example tobacco, are partially mediated by epigenetic mechanisms (via aberrant DNA methylation) and partially by direct mutagenesis from non-epigenetic agents at the national and international levels, while genetic background mediates personal susceptibility to a certain dose of exposure. In a region of high smokeless tobacco prevalence – as in North Karnataka, India – this exposure to tobacco would be anticipated – based on similar studies conducted elsewhere [12]–[14] and yet untested in a North Karnataka population for interaction with other DNA-repair variants (here known to modulate oral-cancer risk), to manifest individual oral-cancer risk as a function of specific gene variants.

6.2 Diet–Habit Interaction

The Bangalore ragi–tobacco interaction finding (Section 4.2) is in fact an example of a diet-habit interaction among a Karnataka population: relative risk of oral cancer was greatly increased by having both the dietary exposure and the tobacco-chewing habit, but not with either alone; this demonstrates that regional staple-food patterns and regional tobacco habits do not act independently on cancer risk.

6.3 Implications for Regional Prevention

The Bangalore ragi–tobacco interaction finding (Section 4.2) is in fact an example of a diet-habit interaction among a Karnataka population: relative risk of oral cancer was greatly increased by having both the dietary exposure and the tobacco-chewing habit, but not with either alone; this demonstrates that regional staple-food patterns and regional tobacco habits do not act independently on cancer risk.

7. DISCUSSION AND CONCLUSION

- North Karnataka's cancer risk landscape is shaped less by classical Western dietary carcinogens (red/processed meat) and more by smokeless tobacco and areca-nut chewing, layered onto a fiber-rich but regionally variable millet-based staple diet.
- Geochemical groundwater contamination (fluoride, arsenic) is well documented in Raichur, Yadgir, and Bagalkot districts, but its direct contribution to the region's cancer burden remains under-studied compared to its documented skeletal and dental effects.
- Elevated regional consanguinity (up to ~28% of marriages) is an established driver of recessive hemoglobinopathies in Karnataka and, by extension, plausibly elevates risk of rare recessive cancer-predisposition syndromes, though dedicated regional data is lacking.
- The clearest documented gene-diet-habit interaction in a Karnataka population is the ragi-tobacco interaction in oral cancer, underscoring that regional staple foods and regional habits must be studied jointly, not separately.
- Key regional research gaps: no North Karnataka-specific cancer registry stratifying incidence by district, no dedicated fluoride/arsenic-cancer cohort study, and no consanguinity-cancer-syndrome case series for the region.

Cancer causation in North Karnataka reflects the same three interacting domains seen globally — geography/environment, diet, and genetics — but with a regionally distinct composition: geochemical groundwater exposure in place of industrial pollution, smokeless tobacco and areca nut in place of processed meat, and consanguinity-driven recessive risk in place of dominant hereditary syndromes as the leading genetic concern. Region-specific registry data, gene-environment interaction studies, and consanguinity-linked cancer case-finding are needed to close the identified gaps and support locally targeted prevention.

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REFERENCES

[1]. Cancer incidence estimates for 2022 & projection for 2025: Result from National Cancer Registry Programme, India. ICMR-NCDIR, PMC, 2023.
[2]. National Cancer Registry Programme, Population Based Cancer Registry reports. ICMR-NCDIR, Bengaluru.
[3]. Nandakumar, A., et al. (1990). A population-based case-control investigation on cancers of the oral cavity in Bangalore, India. Br J Cancer.
[4]. Anigol, P.S., Kotrashetti, V., Vanaki, B.N. Incidence and correlation of oral cancer with tobacco and malnutrition in Asia: a comprehensive review. Int J Community Med Public Health, 2026.
[5]. Smokeless tobacco (paan and gutkha) consumption, prevalence, and contribution to oral cancer. Epidemiol Health, 2017.
[6]. Patterns of Tobacco Use and its Relation to Oral Precancers. J Contemp Dent Pract.
[7]. Assessment of groundwater fluoride using GIS in Shahapur/Yadgir district, Karnataka, 2020.
[8]. Prevalence and severity of dental and skeletal fluorosis in a fluoride-endemic region of Karnataka (Devadurga, Raichur). Int J Community Med Public Health, 2025.
[9]. Prevalence of Dental Fluorosis and associated Risk Factors in Bagalkot District, Karnataka, India.
[10]. Groundwater depletes to dangerous levels in Karnataka; fluoride, nitrate, arsenic contamination pose health hazards. Fluoride Action Network, 2022.
[11]. Breaking the Cycle: The Need for Awareness on the Ill Effects of Consanguinity in India (NFHS-5 data). LSDSS India, 2023.
[12]. Sickle cell allele distribution in southern India: a population-based study in a rural-tribal context, Karnataka. PMC, 2025.
[13]. Genetic counseling in sickle cell disease: Insights from the Indian tribal population. PMC, 2023.
[14]. Bray, F., et al. (2024). Global cancer statistics 2022: GLOBOCAN estimates. CA Cancer J Clin.
[15]. Potential therapeutic use of millet with broad spectrum anticancer properties: current trends and prospects. Discover Food, 2024.
[16]. Vasudeva, G. et al. (2025). Design of OPAMP Based on 22 nm FinFET Technology. In: Kaiser, M.S., Singh, R., Bandyopadhyay, A., Mahmud, M., Ray, K. (eds) Proceedings of the Fifth International Conference on Trends in Computational and Cognitive Engineering. TCCE 2023. Lecture Notes in Networks and Systems, vol 1208. Springer, Singapore. https://doi.org/10.1007/978-981-96-0185-1_32
[17]. 17.Vasudeva G et.al "Design of FinFET Based Op-Amp Using High-K Device 22 nm Technology", Applied Mathematics, Modeling and Computer Simulation, 2023, doi:10.3233/ATDE231033
[18]. 18.Tripti R, Kulkarni and Bharathi, Gururaj and Aditi, Jaiswal (2025) Comparison of Implementation in Blood Cancer Causes and Diseases. International Journal of Trend in Scientific Research and Development, 9 (1). pp. 503-512. ISSN 2456-6470
[19]. Tripti R, Kulkarni and Arun Vikas, Singh and Vasudeva, G and Bharathi, Gururaj (2025) Sanitization and Sterilization Robot Ultra Violet Based. International Journal of Trend in Scientific Research and Development, 9 (2). pp. 1004-1010. ISSN 2456-6470
[20]. Jatkar, M., G, V., Kulkarni, T.R. et al. LC oscillator frequency prediction using machine learning linear regression algorithm. Discov Electron 2, 52 (2025). https://doi.org/10.1007/s44291-025-00092-9
[21]. Kulkarni, T.R., Vasudeva, G., Renukaprasad, G., Roopa, K.R., Srividya, B.V., Jatkar, M. (2026). Speech Detection of Pathological Voice Disorders Non-Invasively Using Machine Learning Algorithms. In: Joshi, A., Ragel, R.G., S., K. (eds) ICT: Applications and Social Interfaces. ICTCS 2025. Lecture Notes in Networks and Systems, vol 1874. Springer, Cham. https://doi.org/10.1007/978-3-032-19681-1_2
[22]. Kulkarni, T.R. et al. (2026). Modeling Subthreshold Leakage in MOSFETs: Supervised Regression with Noise-Aware Synthetic Datasets. In: Senjyu, T., Mahmud, M., Joshi, A. (eds) Smart Trends in Computing and Communications. SmartCom 2026. Lecture Notes in Networks and Systems, vol 1990. Springer, Cham. https://doi.org/10.1007/978-3-032-26908-9_42
[23]. Srivathsava N. L & Tripti Kulkarni," Novel Design of VCO with Output Peak to Peak Control", International Journal of Instrumentation, Control and Automation (IJICA) ISSN : 2231-1890 Volume-1, Issue-2, 2011
[24]. Tripti R, Kulkarni and Arun Vikas, Singh and Vasudeva, G and Bharathi, Gururaj (2025) Sanitization and Sterilization Robot Ultra Violet Based. International Journal of Trend in Scientific Research and Development, 9 (2). pp. 1004-1010. ISSN 2456-6470