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ORGANIC PESTICIDES, TOXIC PRESERVATIVES AND CANCER RISK IN INDIAN POPULATION WITH SUGGESTIONS TO REDUCE THE RISK: A REVIEW ARTICLE

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ABSTRACT

As we know *The Cancer* is very dangerous word in the world. It is a most common public-health concern in the world including India, and increasing attention has been directed toward environmental and dietary exposures that may contribute to cancer development. Among these, agricultural pesticides and chemicals used in food preservation are important areas of investigation. India has undergone substantial agricultural intensification since the Green Revolution, accompanied by extensive use of chemical pesticides. At the same time, changing food habits, urbanization, commercialization of traditional foods, and increased consumption of packaged and processed foods have increased exposure to food additives and preservatives. This review article examines the possible relationship between pesticide exposure, food preservatives, and cancer within the Indian context. Evidence indicates that occupational and environmental pesticide exposure may be associated with several cancers, including hematological, respiratory, and other malignancies. However, it is important not to conclude that pesticides are responsible for India's overall cancer burden. Certain pesticides, including glyphosate, malathion, and diazinon, have been classified by the International Agency for Research on Cancer (IARC) as probably prone to cause cancer to humans, although hazard classification does not mean that every exposure causes cancer.[1] Toxic preservatives require similarly careful interpretation.

Some preservatives are legally permitted in India within specified conditions and limits. However, nitrites and nitrates used in processed meat can contribute to the formation of N-nitroso compounds, while processed meat itself is classified by IARC as prone to cause cancer to humans, particularly because of evidence concerning colorectal cancer.[2] The review concludes that decreasing unnecessary exposure, strengthening food monitoring, improving agricultural practices, and promoting traditional dietary patterns based on fresh, minimally processed foods can contribute to cancer prevention.

KEYWORDS: pesticides, food preservatives, cancer, India, agriculture, public health processed food, nitrites, food safety, environmental exposure.

INTRODUCTION

Cancer results from the interaction of genetic, environmental, occupational, lifestyle, and dietary factors. In India, the transition from predominantly traditional food systems toward industrialized agriculture and increasingly processed food consumption has created new questions concerning chemical exposure.

Pesticides are widely used to protect crops from insects, weeds, fungi, and other agricultural pests. Their use has contributed to agricultural productivity, but inappropriate handling, excessive application, inadequate protective equipment, and contamination of soil, water, and food can increase human exposure. Earlier Indian research documented widespread concern about pesticide residues in food commodities and their potential long-term health consequences.

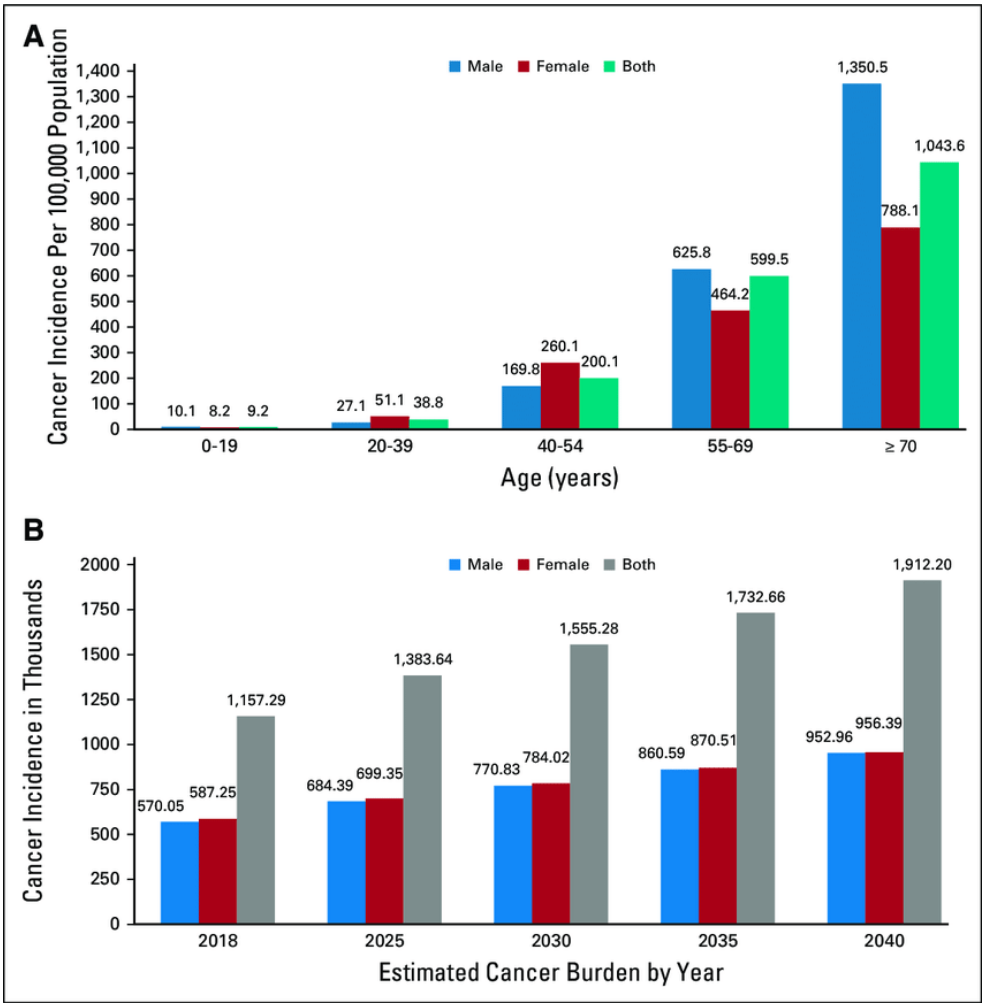


Fig. 1: Cancer incidence in Indian men and women in 2018. (A) Incidence rates are per 100,000 population grouped by age and sex. (B) Projected cancer burden by sex from 2018 to 2040. Data from WHO.

Food preservation is also an important part of Indian food culture. Traditional Indian households have historically preserved foods through drying, salting, pickling, fermentation, smoking, and the use of spices. These methods are not equivalent to industrial chemical preservation and, in many cases, have nutritional and cultural value. Modern food industries additionally use substances such as benzoates, sorbates, sulfites, propionates, nitrates, and nitrites to extend shelf life and control microbial growth. Indian food regulations specify permitted additives and their conditions of use.

Various suggestions are discussed in details in discussion section. The central scientific question is therefore not whether every pesticide or preservative causes cancer. Rather, it is whether particular chemicals, exposure levels, exposure durations, food-processing conditions, and individual susceptibility can contribute to carcinogenesis.

Few Pesticide Use in the India

India's agricultural transformation resulted in increased reliance on chemical pesticides. Historically, substances such as DDT and benzene hexachloride were important in pest and vector control. Subsequent decades saw the introduction of organophosphates, carbamates, pyrethroids, herbicides, fungicides, and other pesticide groups.

Pesticide exposure can occur through several pathways:

- occupational exposure during mixing, spraying, and harvesting (3);
- inhalation of pesticide aerosols;
- skin contact with contaminated plants, soil, equipment, and clothing;
- consumption of food containing pesticide residues;
- drinking contaminated water;
- environmental exposure among people living close to agricultural fields.

List of potent Carcinogens

- **Malathion:** An organophosphate insecticide used in public health and agriculture, associated with blood and other tissue cancers.
- **Diazinon:** An organophosphate insecticide restricted in many residential areas due to chronic toxicity concerns.
- **Parathion & Tetrachlorvinphos:** Organophosphate insecticides flagged for potential genotoxic mechanisms.
- **Glyphosate:** A widespread broad-spectrum herbicide linked in some studies to non-Hodgkin's lymphoma, though regulatory stances vary globally.
- **Ethylene Dibromide & Chlorothalonil:** Fumigants and fungicides showing carcinogenic activity in laboratory and occupational evaluations.
- **DDT & Organochlorines:** Historic persistent insecticides heavily linked to endocrine disruption and breast cancer risks, now banned in most nations but persistent in the food chain.

Farm workers may experience substantially greater exposure than the general population. A 2026 systematic review of occupational cancer literature in the Indian subcontinent identified associations between occupational exposure and several cancers, including lymphoma, lung cancer, gastrointestinal cancers, and other malignancies. The authors also emphasized that the number of high-quality Indian studies remains limited and that stronger research is needed.

Mode of action of Pesticides to cause Cancer

Cancer development is a multistep process. Certain pesticides may contribute through mechanisms such as.

1. Damage genetic material

Some chemicals or their metabolites can damage DNA or chromosomes.

e.g. Glyphosate and its metabolite aminomethylphosphonic acid (AMPA) have been shown to induce DNA strand breaks, micronuclei formation, and chromosomal abnormality in human lymphocytes and buccal cells. This direct genotoxic action is one reason IARC classified it as "probably carcinogenic to humans" (Group 2A).[4]

2. More Oxidative stress

Reactive oxygen species can damage DNA, proteins, and cellular membranes.[5]

e.g. Paraquat undergoes redox cycling within cells, accepting an electron to form paraquat radical that then reacts with molecular oxygen to generate superoxide anions. This drives a cascade of ROS production, causing lipid peroxidation, protein oxidation, and oxidative DNA lesions (e.g., 8-OHdG formation).[6]

3. Hormonal imbalance

Some pesticides can interfere with hormone signaling.

e.g. DDT and DDE mimic estrogen by binding to estrogen receptors, while DDE also acts as an androgen receptor antagonist. This dysregulates hormone-responsive gene expression and has been linked to increased risk of breast and reproductive cancers.[7]

4. Epigenetic changes

Environmental chemicals may alter gene regulation without changing the underlying DNA sequence.

e.g. Vinclozolin (a fungicide) alters DNA methylation patterns in germline cells, causing transgenerational epigenetic inheritance of disease susceptibility, including tumor development without altering the DNA sequence itself. It also affects histone modification patterns.[8]

5. Inflammatory response

Persistent chemical exposure may contribute to inflammatory processes associated with carcinogenesis.

e.g. Chronic low-dose exposure to the organophosphate insecticide chlorpyrifos triggers sustained activation of NF-κB signaling, leading to elevated expression of the pro-inflammatory cytokines TNF-α and IL-6, thereby promotes chronic oxidative stress and inflammation, which are closely linked to cancer development.[9]

6. Slowering cellular repair

Damage to DNA-repair pathways can allow mutations to accumulate.

e.g. Captan (a fungicide)'s active thiophthalimide moiety reacts with sulfhydryl groups in enzymes, inhibiting key DNA-repair proteins involved in base excision and mismatch repair pathways. Suppression of repair capacity allows spontaneous and induced mutations to accumulate rather than being corrected.[10]

An Indian study involving agricultural workers with cancer investigated pesticide residues and oxidative-stress biomarkers, including 8-OHdG, a marker associated with oxidative DNA damage.[11] 8-OHdG (8-hydroxy-2'-deoxyguanosine) is a primary biomarker used to measure oxidative DNA damage caused by free radicals and reactive oxygen species. It reflects systemic cellular stress and is measured via urine, blood, or tissue samples to assess risks for cancer, cardiovascular disease, and neurodegenerative disorders Such findings provide biologically plausible mechanisms, but individual observational studies cannot establish that pesticide exposure caused a particular person's cancer.

Epidemiological Evidence in Indian Population

1. Talwandi Sabo–Chamkaur Sahib Comparative Study

Thakur et al. (2008) compared cancer patterns in two Punjab regions with different agricultural practices. Among more than 183,000 people, the cotton-growing Talwandi Sabo area showed significantly higher cancer prevalence and mortality than Chamkaur Sahib. Female reproductive cancers were particularly common in Talwandi Sabo. The study also found strong associations between cancer risk and pesticide exposure, including agricultural use, direct spraying, and storing pesticides at home or farms. Farmers reported spraying cotton 30–35 times per crop cycle, far above the recommended 8–10 applications, with limited protective measures. Pesticide residues such as heptachlor, ethion, and chlorpyrifos were also detected in local water, vegetables, and patients' blood. This study emphasized that cancer risk was likely multifactorial and recommended better farmer education, regular pesticide monitoring, and regional cancer registries.[12]

2. Pesticide Residues in Human Blood

Bedi et al. (2015) assessed pesticide residues in blood samples from 50 individuals in Bathinda, Punjab, using gas chromatography and GC-MS. The predominant residue was p,p′-DDE (15.26 ng/mL), indicating mainly historical DDT exposure, while total DDT levels increased significantly with age, suggesting cumulative bioaccumulation. β-Endosulfan was detected particularly among individuals who sprayed pesticides without protective equipment, highlighting occupational exposure. Participants with symptoms such as joint pain, headache, and throat infections had higher pesticide residue levels. Although one participant with liver cancer showed a high p,p′-DDE concentration, the study did not consider this evidence of causation. The study highlighted persistent pesticide exposure as a public health concern and recommended larger studies to investigate its potential long-term health and cancer risks.[13]

Studies such as these are closely consistent with the **"Punjab Cancer Train"** phenomenon**,** which reflects concerns regarding the higher cancer burden observed in pesticide-intensive agricultural regions of Punjab.

3. Genotoxicity in agricultural farmers from Guntur district of South India

Jonnalagadda et al. (2012) conducted a case-control bio monitoring study among 152 men in the cotton-growing region of Guntur, Andhra Pradesh, including 76 farmers occupationally exposed to pesticide mixtures during spraying. Using chromosomal aberration and micronucleus tests, the study found significantly greater genetic damage among exposed farmers, with chromosomal aberrations of 2.8% compared with 0.72% in unexposed controls. The study associated this increased genotoxicity with inadequate protective practices and repeated exposure to complex pesticide mixtures under real-world agricultural conditions. These findings provide direct biological evidence that occupational pesticide exposure can induce chromosomal damage, supporting a potential mechanistic link between pesticide exposure, genomic instability, and carcinogenesis.[14]

Few Pesticides and Some Cancer Risks

The evidence is strongest for some pesticide–cancer relationships but remains heterogeneous across individual chemicals and cancer types.

IARC classified glyphosate, malathion, and diazinon as **Group 2A, probably prone to cause cancer to humans**, while tetrachlorvinphos and parathion were classified as **Group 2B, possibly prone to cause cancer to humans** (1, 15, 16).

Glyphosate, for example, was classified by IARC as probably prone to cause cancer based on limited evidence of cancer in humans, evidence from experimental animals, and mechanistic evidence (1). Importantly, a hazard classification indicates the potential of an agent to cause cancer under some circumstances; it does not quantify the cancer risk associated with a particular person's exposure.

Recent Indian research has also attempted to investigate pesticide residues in people diagnosed with lymphoma, leukemia, and breast cancer. Such studies are valuable for understanding exposure patterns, but larger prospective studies are required before definitive causal conclusions can be drawn for the Indian population.

Few Toxic preservatives in Indian

Food preservation has existed in India for centuries. Traditional practices include:

- Sun-drying vegetables, fruits, grains, and fish;
- Fermentation of foods and beverages;
- Salting;
- Pickling;
- Use of spices;
- Controlled dehydration;
- Preparation of souce / chutneys and preserved products.
- Mixing food derivatives.
- Cocktails/mocktails etc.

These practices should not automatically be regarded as harmful. Many traditional preservation techniques can reduce food spoilage and have cultural and nutritional significance.

The modern food industry, however, uses chemical preservatives to improve shelf life and maintain food safety. FSSAI regulations recognize a range of permitted food additives, including sodium benzoate, benzoic acid, sorbic acid, potassium nitrate, potassium nitrite, sodium propionate, and sulfur dioxide, depending on the food category and applicable limits.[15,16]

Therefore, the presence of a preservative on a food label does not automatically mean that the food is prone to cause cancer. Risk depends on the chemical, dose, frequency and duration of exposure, interactions with other compounds, and the food matrix.

Processed Meat – Nitrites – Nitrates etc.

Among food-preservation chemicals, nitrites and nitrates have received considerable attention in cancer research. Nitrite can participate in chemical reactions that generate **N-nitroso compounds**, some of which are prone to cause cancer. These reactions can occur during food processing and potentially within the digestive system. Here are the common examples.

- Bacon
- Hot dogs
- Salami and pepperoni
- Deli meats and ham
- Sausages and corned bee

The cancer risk associated with processed meat is also not attributable exclusively to preservatives. Smoking and high-temperature cooking can produce polycyclic aromatic hydrocarbons and heterocyclic aromatic amines, while other components of meat can participate in prone to cause cancer pathways. IARC classified **processed meat as prone to cause cancer to humans (Group 1)** on the basis of sufficient evidence that consumption causes colorectal cancer. Processed meat includes meat preserved through salting, curing, fermentation, smoking, or similar methods. This classification requires careful interpretation. It does not mean that eating a single serving of processed meat will cause cancer. It means that there is sufficient evidence of a causal relationship at the population level, with risk generally increasing with greater consumption.

Preservatives and Cancer

Public discussion sometimes treats all Toxic preservatives as carcinogens. This is scientifically inaccurate. For example, sodium benzoate, sorbic acid, sulfites, and propionates are used for specific technological purposes and are regulated by food-safety authorities. Their permitted use does not mean that they are equivalent in prone to cause cancer.

Specific Preservatives Under Study/Review.

- **Potassium sorbate**: Linked in recent cohort data to higher overall and breast cancer risks.

- **Sodium nitrite and potassium nitrate**: Long associated with processed meats; tied in recent data to elevated prostate and overall cancer risks.
- **Sulfites (potassium metabisulfite)**: Associated with a modest rise in overall cancer incidence in recent tracking studies.
- **Antioxidant preservatives**: Generally, show little to no direct association with cancer incidence.
- Recent epidemiological research has nevertheless renewed interest in whether long-term exposure to mixtures of food additives may be associated with cancer. A large 2025 NutriNet-Santé prospective cohort study investigated associations between intake of food-additive preservatives and cancer incidence. Such findings are important for further research, but associations observed in observational nutrition studies should not automatically be interpreted as proof that an individual additive causes cancer.

Transition in Indian Dietary Patterns

Indian food culture is undergoing rapid change i.e. freshly cooking food to readymade processed food in daily use and few local food verities to thousand times more continental varieties. . Traditionally, many meals were based on cereals, pulses, vegetables, fruits, spices, fermented foods, nuts, seeds, and freshly prepared dishes. Urbanization, longer working hours, food delivery, advertising, and the growth of packaged foods have increased consumption of commercially processed products (17).

This transition may increase exposure to several dietary risk factors simultaneously. These can include

- Excessive salt;
- Excess calories;
- Refined carbohydrates;
- Processed meats;
- Heavily processed packaged foods;
- Certain food additives;

Consequently, cancer prevention should not focus exclusively on pesticides or preservatives. Tobacco, alcohol, obesity, physical inactivity, infections, air pollution, ultraviolet radiation, genetic susceptibility, and other environmental exposures are also important determinants of cancer risk.

Pesticide Residues in Indian Food

Pesticide residues can remain on or within agricultural commodities after application. A 2024 study examining an Indian food basket reported detection of currently used pesticides in foods including cereals and pulses, with chlorpropham, chlorpyrifos, and carbendazim among compounds with relatively high detection frequencies in the investigated samples. EU Discovers Cancer-Causing Ethylene Oxide in 527 Indian Food Items. According to the European Food Safety Authority, ethylene oxide, a carcinogenic chemical, has been detected in 527 Indian-origin food products from September 2020 to April 2024. Primarily found in nuts and sesame seeds (313), herbs and spices (60), and dietetic foods (48), these contaminations led to the rejection of 87 consignments at the border, with many other products subsequently removed from markets.

The presence of a detectable residue does not automatically establish a cancer hazard. Risk assessment considers the concentration, frequency of consumption, toxicological characteristics of the chemical, and estimated dietary exposure. This distinction between **hazard** and **risk** is essential in communicating pesticide safety to the public.

Risk Ratio in Populations

Certain populations may experience higher exposure or greater susceptibility.

Table 1: Population Groups and Potential Exposure Concerns Related to Pesticides, Food Preservatives, and Processing Chemicals.

Population Group	Potential Exposure / Concern
Agricultural workers	Repeated occupational exposure to pesticides, particularly when personal protective equipment (PPE) is unavailable or incorrectly used.
Rural communities	Environmental exposure through contaminated soil, water, air, and food in areas with intensive cultivation.
Children	Potentially greater vulnerability to some environmental chemicals due to differences in metabolism, body size, development, and exposure patterns.
Food-industry workers	Occupational exposure to preservatives and processing chemicals, which may differ from consumer dietary exposure.
Consumers of highly processed foods	Regular consumption of processed meat and other heavily processed foods may increase exposure to multiple potentially harmful compounds simultaneously.

Practices as a Potential Preventive Resource

Indian culinary traditions offer several approaches that can support healthier eating patterns. Freshly prepared foods can reduce dependence on long-shelf-life products. Pulses, whole grains, vegetables, fruits, nuts, seeds, and fermented foods can form the basis of a nutritionally diverse diet.

Traditional fermentation is particularly important. Foods such as idli, dosa batter, dhokla, certain regional pickles, and fermented dairy products demonstrate that preservation and fermentation are deeply embedded in Indian food culture. However, traditional foods should not automatically be considered risk-free; excessive salt in some pickles and other preserved foods remains a separate nutritional concern. The goal should therefore be **safer modernization rather than rejection of tradition**.

Prevention Strategies

Cancer prevention related to pesticides and food chemicals requires action at several levels. The most important factors needs to be control both qualitative and quantitative level as per requirements at various level including monitoring system.

Agricultural level

- Promote integrated pest management.
- Use pesticides only when necessary and according to approved instructions.
- Encourage safer alternatives and biological control methods where appropriate.
- Provide farmers with protective equipment and training.
- Prevent pesticide storage near food and drinking-water sources.
- Improve monitoring of pesticide residues in food and water.

Household level

- Wash fruits and vegetables thoroughly before consumption.
- Peel produce when appropriate, recognizing that peeling can also reduce some nutrients.
- Diversify the diet rather than repeatedly consuming a narrow range of foods.
- Limit frequent consumption of processed meats.
- Prefer fresh or minimally processed foods when practical.
- Read food labels and avoid unnecessary dependence on highly processed products.

Regulatory level

India already maintains regulatory systems governing food additives, food products, contaminants, toxins, and pesticide residues through FSSAI and related authorities. Continued surveillance, transparent reporting, laboratory capacity, and enforcement are important for consumer protection.[18,19]

Research level

India needs large, well-designed prospective studies that measure actual pesticide exposure and follow populations over time. Recent Indian reviews have emphasized the limited number of high-quality studies and the need for better monitoring of occupational carcinogens.

Research should also distinguish between

- Qualitative exposure
- Occupational exposure and dietary exposure;
- Individual pesticides rather than treating all pesticides as one group;
- Quantitative exposure
- Individual preservatives versus the overall dietary pattern;
- Hazard identification versus actual population risk.
- Duration of exposure

Discussion with suggestions

The available evidence supports concern about some pesticide exposures and certain food-processing practices, but it does not justify the statement that "pesticides and preservatives cause cancer" in a general or universal sense.

Adopt Integrated Pest Management, Safe Handling and Disposal

- **Identify pests** accurately before acting.
- **Monitor populations** to treat only when damage exceeds a safe threshold.
- **Use physical barriers** like netting, row covers, or hand-picking.
- **Encourage beneficial insects** and predators to manage pests naturally.
- **Calibrate equipment** regularly to ensure accurate and uniform delivery rates.
- **Select targeted spot treatments** rather than broad, blanket spraying.
- **Avoid windy or rainy conditions** to prevent chemical drift and water run-off.

- **Spray during cooler hours** (early morning or evening) to reduce evaporation and protect foraging bees.
- **Wear protective gear** like gloves, masks, goggles, and long sleeves.
- **Mix only what is needed** for immediate use to eliminate leftover waste.
- **Maintain buffer zones** near water bodies, wells, and homes.
- **Dispose of containers properly** according to local rules without pouring rinsate into drains.

The strongest evidence concerns particular agents and exposure circumstances. For pesticides, several chemicals have been classified as prone to cause cancer or probably prone to cause cancer, and Indian studies have reported associations between occupational pesticide exposure and cancer. For food preservation, the clearest established relationship involves processed meat, which IARC classifies as prone to cause cancer to humans, with colorectal cancer being the principal cancer supported by sufficient human evidence.

At the same time, India's cancer burden is multifactorial. It would be scientifically inappropriate to attribute the country's increasing cancer incidence to pesticides or Toxic preservatives alone. The Government of India's response to Parliament specifically stated that MEDICAL AUTHORITIES had not conducted a study establishing that pesticide use in crops was responsible for an increase in cancer cases nationally.

Therefore, public-health policy should be based on exposure assessment and evidence rather than fear. The appropriate objective is to reduce avoidable exposure while preserving agricultural productivity, food safety, affordability, and cultural dietary practices.

CONCLUSION

Pesticides and Toxic preservatives represent important areas of environmental and dietary health research in India. The exposure in very high concentration of one or more than one carcinogen or long term exposure of even small concentrated one or more than one carcinogens are the main etiological factor for triggering oncogenes.

A routine physical exam can spot some signs or risk factors of cancer, but it cannot reliably detect all cancers. A standard doctor checkup includes a physical inspection, listening to the heart and lungs, and checking lymph nodes, skin, or the abdomen. These checks can find visible skin changes or abnormal lumps, but many internal cancers do not show symptoms or

physical signs during a basic exam. The number of carcinogens found so far is assume to be very less compared to unscreened carcinogens in the world. Occupational exposure to certain pesticides has been associated with cancer in epidemiological studies, and several specific pesticides have received prone to cause cancer hazard classifications from IARC. Government by rules and regulations the mandatory condition should be there to print content of carcinogens must be printed on food and edible all varieties before it enters in to markets.

It is also important to note that togetherness of pesticides and preservative with heavy metals may aggravate the conditions and risk for many diseases along with the cancer. Of course the genetic factors role is significant with all above multifactorial etiology in cancer biology.

Personal & Lifestyle Rules

- **No tobacco:** Avoid all forms of smoking and tobacco use completely.
- **Limit alcohol:** Reduce or eliminate alcohol intake, as it links to multiple cancers.
- **Sun safety:** Use sunscreen and protective clothing; avoid tanning beds.
- **Healthy weight:** Exercise daily and maintain a balanced body weight.
- **Clean diet:** Eat whole grains, beans, fruits, and vegetables; limit red and processed meats.
- **Get vaccinated:** Vaccinate against cancer-linked infections like HPV and Hepatitis B.

Environmental & Workplace Rules

- **Use protective gear:** Wear certified respirator masks, gloves, and protective suits when handling hazardous materials.
- **Ensure ventilation:** Use chemical fume hoods, glove boxes, and HEPA air filters in labs or industrial workspaces.
- **Radon checks:** Test home and indoor environments for high radon gas levels.
- **Strict containment:** Keep carcinogenic substances sealed and properly labeled with hazard warning signs.
- **No food or drink:** Never consume food, drinks, or use cosmetics in areas where carcinogens are handled.

Toxic preservatives require a more differentiated assessment.[20] Many preservatives are legally permitted when used according to established standards, while nitrites and nitrates are of particular interest because they can participate in the formation of potentially prone to

cause cancer N-nitroso compounds. Processed meat, which commonly involves curing and preservation, has sufficient evidence for classification as prone to cause cancer to humans.[21]

Additive and Chemical Bans - Contaminant and Toxin Thresholds - Processing and Packaging Controls

- **Zero tolerance:** Outright prohibition of known genotoxic carcinogens and active bans on harmful veterinary drug residues (such as nitrofurans) in food animal production.
- **Additive restrictions:** Strict positive lists defining exact maximum permissible levels for direct preservatives, synthetic dyes, and artificial sweeteners.
- **Mycotoxin caps:** Mandatory rejection of grains, nuts, and milk exceeding strict safety limits for aflatoxins and other mold-derived toxins.
- **Heavy metal limits:** Enforced thresholds for lead, arsenic, cadmium, and mercury in processed and staple foods.
- **Acrylamide reduction:** Guidelines and benchmark levels requiring industrial adjustments in baking, roasting, and frying temperatures to limit toxic byproduct formation.
- **Packaging migration limits:** Restrictions on chemicals leaching from paper, plastics, and metal cans into consumable products.

Pesticides and preservative content should be mention on all packed varieties.

- Pesticides and preservative inspection centers and punishments guidelines should be there on packed food.
- Awards declarations and complaint help line required to eradicate the cheating.
- Fast tracts judiciary action needed for fast resolution of solution.
- Introduce new products only through proper agencies on trial bases for 3 to 6 months under government agencies.

For India, the most effective strategy is neither to reject modern agriculture and food technology nor to ignore their potential risks. Instead, India should strengthen pesticide-residue surveillance, protect agricultural workers, enforce food-additive standards, improve consumer education, support safer agricultural practices, and encourage diets rich in fresh and minimally processed foods.[22]

Indian cultural food traditions can contribute to this approach by emphasizing diversity, seasonal foods, pulses, vegetables, fruits, whole grains, fermentation, and home preparation.[23] A combination of scientific regulation and culturally appropriate dietary practices offers a practical path toward decreasing preventable environmental and dietary cancer risks.

Disclosure: This disease have multifactorial etiological reasons and also patient to patient cases are different. Hence other endogenous and exogenous factors accept Pesticides – Preservatives are not focused in this article.

REFERENCES

1. International Agency for Research on Cancer. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Volume 112: Some Organophosphate Insecticides and Herbicides. Lyon: IARC; 2017.
2. International Agency for Research on Cancer. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Volume 114: Red Meat and Processed Meat. Lyon: IARC; 2018.
3. Bhardwaj R, Kumar N, Joshi S, Gupta A, Manna S. A Systematic Review of Occupational Cancers in the Indian Sub-continent. Cureus. 2026 Jan. 8; 18(1): e101061-.
4. Santovito A, Ruberto S, Gendusa C, Cervella P. In vitro evaluation of genomic damage induced by glyphosate on human lymphocytes. Environ. Sci. Pollut. Res. Int., 2018 Dec; 25(34): 34693-34700.
5. Pandiyan A, Lari S, Vanka J, Kumar BS, Ghosh S, Jee B, Jonnalagadda PR. Genetic polymorphism in xenobiotic metabolising genes and increased oxidative stress among pesticides exposed agricultural workers diagnosed with cancers. Asian Pacific Journal of Cancer Prevention: APJCP. 2023; 24(11): 3795.
6. Bonneh-Barkay D, Reaney SH, Langston WJ, Di Monte DA. Redox cycling of the herbicide paraquat in microglial cultures. Molecular brain research. 2005 Mar 24; 134(1): 52-6.
7. Aubé M, Larochelle C, Ayotte P. 1, 1-dichloro-2, 2-bis (p-chlorophenyl) ethylene (p, p'-DDE) disrupts the estrogen-androgen balance regulating the growth of hormone-dependent breast cancer cells. Breast Cancer Research. 2008 Feb 14; 10(1): R16.
8. Ben Maamar M, Sadler-Riggleman I, Beck D, McBirney M, Nilsson E, Klukovich R, Xie Y, Tang C, Yan W, Skinner MK. Alterations in sperm DNA methylation, non-coding RNA

expression, and histone retention mediate vinclozolin-induced epigenetic transgenerational inheritance of disease. Environmental Epigenetics. 2018 Apr; 4(2): dvy010.

9. Mahmoud AA, Abd El-Twab SM, Alnasser SM, Alruhaimi RS, Abdel-Moneim A, Hassanein EH, Mahmoud AM. Attenuation of chlorpyrifos-induced liver injury, oxidative stress and inflammation by selenium nanoparticles via SIRT1/FXR/Nrf2 signaling pathway modulation. Naunyn-Schmiedeberg's Archives of Pharmacology. 2026 Jan; 399(1): 997-1010.
10. Fernandez-Vidal A, Arnaud LC, Maumus M, Chevalier M, Mirey G, Salles B, Vignard J, Boutet-Robinet E. Exposure to the fungicide captan induces DNA base alterations and replicative stress in mammalian cells. Environmental and Molecular Mutagenesis. 2019 Apr; 60(3): 286-97.
11. Pandiyan A, Lari S, Vanka J, Kumar BS, Ghosh S, Jee B, Jonnalagadda PR. Plasma pesticide residues–serum 8-OHdG among farmers/non-farmers diagnosed with lymphoma, leukaemia and breast cancers: A case-control study. Plos one. 2024 Oct 22; 19(10): e0295625.
12. Thakur JS, Rao BT, Rajwanshi A, Parwana HK, Kumar R. Epidemiological study of high cancer among rural agricultural community of Punjab in Northern India. International journal of environmental research and public health. 2008 Dec; 5(5): 399-407.
13. Bedi JS, Gill JP, Kaur P, Sharma A, Aulakh RS. Evaluation of pesticide residues in human blood samples from Punjab (India). Veterinary world. 2015 Jan 21; 8(1): 66.
14. Jonnalagadda PR, Jahan P, Venkatasubramanian S, Khan IA, Prasad AY, Reddy KA, Rao MV, Venkaiah K, Hasan Q. Genotoxicity in agricultural farmers from Guntur district of South India—a case study. Human & experimental toxicology. 2012 Jul; 31(7): 741-7.
15. Guyton KZ, Loomis D, Grosse Y, El Ghissassi F, Benbrahim-Tallaa L, Guha N, Scoccianti C, Mattock H, Straif K; International Agency for Research on Cancer Monograph Working Group. Carcinogenicity of tetrachlorvinphos, parathion, malathion, diazinon, and glyphosate. Lancet Oncol., 2015; 16(5): 490–491.
16. World Health Organization / International Agency for Research on Cancer. Q&A on the carcinogenicity of the consumption of red meat and processed meat. Lyon: IARC; 2015.
17. Soman S, Christiansen A, Florinski R, Bharat G, Steindal EH, Nizzetto L, Chakraborty P. An updated status of currently used pesticides in India: Human dietary exposure from an Indian food basket. Environmental Research. 2024 Feb 1; 242: 117543.
18. Food Safety and Standards Authority of India. Food Safety and Standards Regulations.

19. Food Safety and Standards Authority of India. Food Products Standards and Food Additives Regulations.
20. Pandya AV, Bhatt B. Drug related alteration of expression and cell adhesion molecule. World J. Pharm. Res., 2015; 4(10): 1884–1889.
21. Pandya AV, Bhatt B. Cisplatin induced apoptosis and cell adhesion molecule. World J. Pharm. Res., 2015; 4(10): 1877–1883.
22. Gupta PK. Pesticide exposure—Indian scene. Toxicology. 2004 May 20; 198(1-3): 83-90.
23. Burns CJ, Juberg DR. Cancer and occupational exposure to pesticides: an umbrella review. International Archives of Occupational and Environmental Health. 2021 Jul; 94(5): 945-57.

Fig. 1: WHO: Global Cancer Observatory, International Agency for Research on Cancer. https://gco.iarc.fr/