THE ROLE OF LIFESTYLE CHANGES RELATED TO BEAHAVIORAL RISK FACTORS IN CANCER PREVENTION: A COMPREHENSIVE REVIEW

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ABSTRACT

Cancer is a complex disease that is becoming a leading and widespread cause of death worldwide, with approximately 40% of cancer cases attributable to changeable behavioural factor risks can be controlled by modification of our behaviour in light of risk factors associated with our lifestyle. This extensive research review analysis has investigated recent evidence and findings the concluded research results and directions published from the year 2018 to 2025 on lifestyle interventions primarily related to main five key modifiable risk factors i.e. dietary patterns, weight management, alcohol reduction, physical activity and smoking cessation. New evidence and results from randomized techniques of controlled studies and systematic reviews suggest that plant-based dietary arrangement, exclusively when connected with calorie restriction, show promising effects in reducing cancer-related biomarkers and risk, particularly for colorectal and breast cancer. Physical activity interventions consistently demonstrate protective associations and preventive approaches; however, the optimal parameters are still under investigation. Smoking cessation remains the most effective behavioural intervention for cancer prevention, while alcohol reduction strategies appear feasible in community settings. Weight management through intentional weight loss guidelines and directions seems to be a particularly beneficial, with mechanistic evidence linking reduced obesity to decreased inflammation and favourable metabolic changes. However, evidence from long-term randomized trials directly measuring cancer incidence is still limited for the most intervention types, and integrated studies and findings focusing on specific risk factors across substantial and huge populations over a prolonged time and duration are needed. Future research priorities include large, long-term trials in diverse and hugely affected populations, mechanistic biomarker studies, and implementation science approaches to translate efficacy findings into real-world prevention programs for the defining the best concept and approaches to demonstrate the guidelines of cancer prevention. This comprehensive and systematic review brings together existing evidence and identifies critical gaps and provides guidance to inform both healthcare practices and upcoming studies in lifestyle-based cancer prevention.

Keywords: Cancer, lifestyle, Biomarkers, Interventions, Dietary, Investigation

INTRODUCTION

Cancer is emerging as one among the key public health issues of important matter of concern worldwide. According to a study, an estimated 19.3 million recent emerging cancer issues were diagnosed in 2020, and this number is projected to increase significantly in the coming decades (Sung et al. 2021). While genetic factors primarily contribute to cancer risk, growing evidence and studies of related risk factors indicate that 30-50% of cancer cases could be prevented or reduced by modifying lifestyle and environmental factors (World Cancer Research Fund, 2018). Recognizing this, more intensive and comprehensive population-based research is being initiated on lifestyle modifications as cost-effective strategies for cancer prevention.

In the last ten years, considerable advancements have occurred in understanding the mechanisms linking lifestyle factors and carcinogenesis. Chronic inflammation, immune system dysfunction, hormonal imbalances, metabolic dysregulation and oxidative stress are the main routes by which lifestyle elements influence cancer development (Islami et al. 2018). Five modifiable risk factors—diet, physical inactivity,

consumption of alcohol, excess weight and tobacco use- are accountable for the majority of preventable cancer cases. However, translating observational associations into effective interventions requires robust experimental results and evidences from randomized techniques of controlled studies (RCTs) and well-designed implementation studies.

The primary objective of this comprehensive review is to examine in detail the recent evidence on mainly five key lifestyle intervention domains i.e. dietary interventions, including specific dietary patterns and nutrients, physical activity programs, smoking cessation strategies, alcohol reduction interventions, and weight management approaches. For each domain, the researcher critically evaluates and define the effectiveness and impact of the interventions, their specific effects on cancer, the underlying mechanisms, and identify critical research gaps to guide future prevention efforts. This review synthesizes studies and evidence on lifestyle interventions from 2018 to 2025 that target modifiable cancer risk factors, evaluating effectiveness information gathered from various types of cancer and populations, mechanistic insights, and implementation considerations.

DIETARY INTERVENTIONS AND CANCER PREVENTION

EVIDENCE FROM LONG-TERM RANDOMIZED TRIALS

Dietary modifications are one among the utmost studied lifestyle changes to prevent cancer and are recognized as a major contributing factor, with ongoing research investigating the protective effects of specific dietary patterns. A systematic review by Sauter et al. (2024), which examined long-term (≥1 year) dietary intervention RCTs, identified approximately 51 reports revealing significant patterns in intervention effectiveness. Specifically, low-calorie diets (LCDs) designed for Weight loss demonstrated positive impacts on cancer or cancer-related biomarkers in 71% of the primary reports, compared to only 38% for is caloric dietary modifications. This suggests that energy restriction and subsequent weight loss may be more efficient for preventing cancer than simply altering macronutrient composition.

CANCER SITE-SPECIFIC DIETARY EVIDENCE

COLORECTAL CANCER

For colorectal cancer (CRC), the most common gastrointestinal malignancy, dietary factors play a particularly prominent role. Kim et al. (2022) provide comprehensive guidance on dietary interventions for CRC prevention, identifying high fibre intake, whole grain consumption, reduced red and processed meat, and lower alcohol intake as key modifiable dietary factors. Mechanistic evidence supports multiple pathways through which diet influences CRC risk, including effects on bile acid metabolism, gut microbiome composition, and colonic epithelial cell proliferation.

BREAST CANCER

Significant studies have been carried out on dietary approaches for the prevention of breast cancer, and recent reviews have emphasized the significance of diet in both primary and tertiary prevention (Sharma et al. 2025). Most long-term dietary randomized techniques of controlled studies (RCTs) have focused on results of breast cancer and women, reflecting both the higher incidence of breast cancer in women and the hypothesized hormonal mechanisms linking diet to breast cancer risk by influencing estrogenic metabolism and body composition.

DIETARY CHEMOPREVENTION AND SPECIFIC NUTRIENTS

Alongside examining general dietary habits, particular nutrients have been studied for their potential as cancer-preventive substances. Calcium, vitamin D, folate, omega-3 polyunsaturated fatty acids (n-3 PUFAs), and various Phytochemicals have demonstrated encouraging outcomes in polyp prevention trials and biomarker studies (Kim et al. 2022). These nutrients could have protective benefits by means of direct effects on mucosal biology, modulation of inflammation, and epigenetic mechanisms, including DNA methylation. However, translating nutrient-specific findings into practical dietary recommendations requires considering food sources, bioavailability, and possible interactions to the other dietary elements.

COMMUNITY IMPLEMENTATION AND CULTURAL ADAPTATION

Translating the impact of dietary changes into real-world prevention requires approaches of culturally tailored and community-based awareness. Li et al. (2022) demonstrated the potential of a community-based liver cancer education initiative that significantly improved the dietary habits of members of racial/ethnic minority communities. At the 6-month follow-up, participants reported reduced consumption of red meat, higher intake of fruits and vegetables, and decreased consumption of beer and spirits. This study demonstrates that multi-component lifestyle interventions can successfully modify multiple risk

behaviours simultaneously in diverse, at-risk populations.

PHYSICAL ACTIVITY INTERVENTIONS AND CANCER RISK REDUCTION

Physical activity is another cornerstone and effective factor in lifestyle-based cancer prevention, with observational evidence consistently showing a negative correlation between levels of activity and cancer risk, particularly for colorectal, breast, and endometrial cancers. Nonetheless, converting these connections into effective intervention programs requires a clear comprehension of the optimal activity parameters and safety considerations, and necessitates further in-depth research.

EVIDENCE IN OLDER ADULTS

A systematic review by Arif et al. (2025) specifically examined whether physical activity prevents colorectal cancer in older adults, a population at high risk and with a number of significant risk factors for this type of cancer. While prior research studies have established a link between increased amounts of physical exercise and a lowered risks of CRC in the overall population, studies specifically focusing on senior individuals continue to face restrictions, and more comprehensive research is needed. There has a significant gap, as senior's adults might experience distinct activity tolerances, comorbidities, and biological responses to exercise interventions.

MECHANISTIC PATHWAYS

The cancer-protective effects of rigorous physical exercise operate through several biological mechanisms. Continued rigorous physical exercise reduces the obesity and associated pro-inflammatory adipocytes, improves insulin sensitivity and glucose metabolism, regulates sex hormone levels, enhances immune function, and can directly influence metabolic process considering DNA repair and apoptosis (Anderson et al. 2021). The Physical activity also affects gut transit time, metabolic process and may reduce the exposure of the colon mucosa to carcinogens.

INTERVENTION PARAMETERS AND RESEARCH GAPS

Despite the consistent observational associations, the optimal physical activity parameters for cancer prevention remain largely undetermined and undefined. These questions persist the indication regarding most effective type of activity (aerobic versus resistance training), intensity (moderate versus vigorous), duration, and frequency. The many more intervention studies vary considerably in their exercise modalities and dosages, making synthesis difficult. Furthermore, trials designed to measure cancer incidence as a primary endpoint necessitate extremely large sample sizes and long follow-up periods, posing practical and financial challenges to generating definitive evidence. Anderson et al. (2021) emphasized the need for more trials that induce sustained changes in activity behaviour and incorporate mechanistic biomarker measurements alongside cancer endpoints. Such studies would help quantify and measure the magnitude of cancer risk reduction through physical activity interventions and define evidence-based activity prescriptions for prevention programs of cancer disease.

SMOKING CESSATION: THE MOST IMPACTFUL SINGLE INTERVENTION

Tobacco use remains the primary avoidable risk factors contributing to cancer worldwide, responsible for approximately 25% of all fatalities caused by cancer. Smoking is causally linked to at least 15 cancer types, with notably powerful connections for lung, head and neck, oesophageal, and bladder cancers. Smoking cessation represents the single most impactful behavioural intervention for cancer prevention, with substantial risk reduction achieved even when cessation occurs in middle or later life.

INTEGRATION WITH CANCER SCREENING PROGRAMS

The recent implementation research has been focused on integrating smoking cessation interventions into cancer screening programs to leverage teachable moments. The Project titled "SWITCH" study protocol describes a tobacco-free workplace program designed for implementation in lung cancer screening centres (Tan et al. 2025). This initiative of this project addresses a critical gap that showed many lung cancer screening centres do not consistently provide guideline-recommended smoking cessation and relapse prevention interventions during screening, missing opportunities to support current and former smokers at highest risk of tobacco-related cancers. Evaluating such integrated programs will be crucial to determine their effectiveness in achieving real-world smoking cessation rates and long-term abstinence outcomes.

POPULATION-LEVEL APPROACHES AND CULTURAL CONSIDERATIONS

In the regions with high tobacco burden, population-level approaches are essential to identify the possible risks of oral cancer and measure to demonstrate the guideline of prevention program. In India, the consumption of smokeless tobacco is prevalent contributes substantially to oral cancer incidence, researchers have explored leveraging celebrity influence for tobacco cessation and oral cancer prevention (Kumar et al. 2025). While through the initiatives of different trust and charitable societies celebrity endorsement offers potential for large-scale behaviour change and awareness raising, challenges include surrogate marketing of tobacco products, deeply embedded cultural norms around tobacco use, and the need for consistent, policy-backed approaches to complement individual behaviour change efforts.

ALCOHOL REDUCTION STRATEGIES AND CANCER PREVENTION

Alcohol consumption is causally linked to a higher risk for several cancer types, including liver, colorectal, breast, oesophageal, and head and neck cancers. The relationship between alcohol and cancer risk appears to be dose-dependent, with no clearly established safe threshold for cancer prevention. Consequently, alcohol reduction represents an important target for cancer prevention interventions.

MECHANISMS LINKING ALCOHOL TO CANCER

Alcohol may promote carcinogenesis through multiple mechanisms: acetaldehyde (a toxic metabolite of alcohol) causes DNA damage; alcohol impairs DNA repair mechanisms; it acts as a solvent facilitating entry of carcinogens into cells; chronic alcohol consumption causes oxidative stress and inflammation; and alcohol intake can increase circulating oestrogen levels, potentially influencing hormone-related cancers (Kim et al. 2022).

COMMUNITY-BASED INTERVENTION EVIDENCE

Li et al. (2022) demonstrated that community-based education interventions can achieve significant reductions in alcohol consumption among high-risk populations. Their liver cancer education initiative produced average reductions of 0.252 units of beer and 0.905 units of spirits consumption at 6-month follow-up among racial/ethnic minority participants. Importantly, alcohol reduction occurred alongside improvements in dietary behaviours, suggesting that comprehensive lifestyle interventions may achieve synergistic effects across multiple risk factors.

EVIDENCE GAPS AND RESEARCH NEEDS

While education and counselling interventions can lead to short-term behavioural changes, long-term follow-up research is required to establish whether interventions to reduce alcohol consumption result in a measurable decrease in cancer rates. Furthermore, research is needed on effective strategies for different patterns of alcohol use (e.g., heavy episodic drinking versus regular moderate drinking) and for different cultural contexts, where drinking patterns and social norms vary considerably.

WEIGHT MANAGEMENT AND OBESITY CONTROL

Excess body weight represents one of the key elements of modifiable cancer risk factors in contemporary populations, particularly in high-income countries where obesity prevalence has increased dramatically. Obesity is convincingly linked to increased risk for at least 13 cancer types, including colorectal, postmenopausal breast, endometrial, kidney, oesophageal adenocarcinoma, pancreatic, liver, ovarian, and thyroid cancers (World Cancer Research Fund, 2018).

MECHANISTIC LINKS BETWEEN OBESITY AND CANCER

Obesity promotes the cancer disease through several interconnected pathways. Adipose tissue acts as an active endocrine organ that secretes pro-inflammatory cytokines (including TNF-α and IL-6) and adipocytes (such as leptin and reduced adiponectin) that create a state of chronic inflammation in the body. Obesity and Fat is associated with insulin resistance and hyperinsulinemia, which can promote and instate tumour growth through insulin and insulin-like growth factor signalling. Furthermore, obesity alters and affect the sex hormone metabolism, leading to increased and misbalance estrogenic exposure in postmenopausal women. Recent Emerging evidences of many studies also suggests and indicate a role for obesity-related changes in gut microbiome composition and immune function in cancer development (McLeod et al. 2023).

EVIDENCE FROM WEIGHT LOSS INTERVENTIONS

Anderson et al. (2021) comprehensively reviewed and find that the state of evidence for cancer prevention through weight control, emphasizing both the promise and the evidence gaps. The systematic review by Sauter et al. (2024) provides the knowledge of an important signals i.e. low-calorie diets which designed to produce

weight loss showed beneficial effects on cancer or cancer-related biomarkers for more frequently than is caloric dietary modifications (71% versus 38% of primary reports). This suggests that energy restriction in metabolic process of our body and weight loss may be more important than specific macronutrient compositions for cancer prevention.

RESEARCH PRIORITIES

Anderson et al. (2021) identified key research needs for weight management and cancer prevention i.e. large trials with long-term follow-up process, studies testing strategies for weight loss identification (5–10% of body weight) and maintenance, mechanistically informed trials measuring biomarkers of cancer risk, and inclusion of diverse populations considering mainly age, sex, race/ethnicity, and baseline weight categories. Such trials will help to identify and quantify the magnitude and durability of cancer risk reduction associated with intentional weight loss guidelines.

DISCUSSION

SYNTHESIS OF EVIDENCE ACROSS INTERVENTION DOMAINS

The extensive research review of this analysis highlights both significant progress and persistent gaps in lifestyle intervention research for cancer prevention across the hugely affected populations. Several key themes emerge across different intervention areas of research for cancer prevention. The first, interventions relating to energy balance whether through calorie restriction, weight loss, or physical activity to be appear particularly beneficial, with mechanistic evidence supporting effects on inflammation, insulin signalling, and metabolic health. The second, dietary pattern approaches are to demonstrate more consistent benefits compared to single-nutrient interventions, likely reflecting the synergistic effects of multiple dietary components. The third, smoking cessation remains the most impactful individual behavioural change for cancer prevention, although opportunities exist to improve its implementation and reach the research priorities for cancer prevention.

MECHANISTIC INSIGHTS AND PRECISION PREVENTION

The recent research has made significant progress and important guidelines in understanding the mechanisms linking lifestyle factors to cancer risk globally. The identification that gut microbiome composition and bile acid metabolism influence the effect of diet on colorectal cancer risk is a crucial advance and should need to be aware the people for gathering information directed guidelines of behavioural risk factors in colon cancer for preventing it, as demonstrated by the mechanism-based BRIDGE-CRC trial (McLeod et al. 2023). Future research should continue to integrate mechanistic biomarker studies with intervention trials, enabling the identification of individuals most likely to benefit from specific interventions such as a precision prevention approach.

IMPLEMENTATION SCIENCE AND HEALTH EQUITY

Translating evidence of effectiveness into population-level cancer prevention requires a focus on implementation science and health equity in order to identify the key risk factors at the ground level. Culturally tailored interventions, such as the community-based liver cancer education program which described by Lee et al. (2022), show that the promise in driving behavioural change in diverse and underserved populations. However, achieving equitable cancer prevention necessitates addressing structural barriers, including food insecurity, limited access to safe spaces for physical activity, and other social determinants of health at the community-based ground level stages of affected populations. Future research should be prioritizing implementation in real-world settings and explicitly addresses the disparities in the cancer burden and introduce the high level programmed and structured prolonged continued research across the huge population globally to identify the pattern of cancer in respect of attributable modifiable risk factors.

LIMITATIONS AND EVIDENCE GAPS

The existing evidence of this research review analysis has several limitations and gaps. The long-term randomized trials for directly measuring cancer incidence rates are still scarce for most intervention types, reflecting the large sample sizes, long follow-up periods, and costs required for such studies and results are varied with the honesty and integrity of research analysis reviewed. Many existing trials focus on surrogate biomarkers rather than cancer endpoints is leading to uncertainty about their clinical importance and significance. Furthermore, most long-term dietary trials have primarily included female participants and focused on breast cancer outcomes, limiting the

generalizability of the findings to men and other cancer types considering the changeable risk factors mainly colon and breast cancer with concern to obesity immunity. The optimal intervention parameters i.e. intensity, duration, timing across the lifespan are also not yet fully defined for most intervention types.

Conclusion: Targeting modifiable risk factors which possible to change through the lifestyle activity is a key component of cancer prevention strategies, and recent published evidence reviewed research from the year 2018 to 2025 shows significant progress in understanding both effectiveness and mechanisms. Plant-based dietary patterns, combined with calorie restriction, appear particularly beneficial for the prevention of mainly colorectal and breast cancer. The measures related to physical activity consistently show protective associations with cancer prevention and the optimal parameters need further definition. Smoking cessation remains the most effective single behavioural intervention, with opportunities to improve its implementation in conjunction with screening programs. Reducing alcohol consumption and managing weight are crucial and important targets, and emerging mechanistic evidence supports their potential of cancer prevention.

As the global burden of cancer continues to rise, lifestyle modifications need to be guide across the population who is in high risk which offer cost-effective prevention and also accessible strategies for primary prevention. Realizing this potential requires continued investment in rigorous intervention research, mechanistic studies, and implementation science to translate evidence into practice and policy. With approximately 40% of cancers potentially preventable through lifestyle changes, the public health opportunity is immense and the need for action for prevention of cancer related to changeable risk factor is clear.

AUTHOR CONTRIBUTION

The all authors reviewed and analysed the final text of this review paper and approved it, having contributed equally to this comprehensive review analysis.

DECLARATION OF CONFLICT OF INTEREST

The author declares that they have no personal, commercial or financial interest in this research review analysis that could be considered a conflict of interest and appeared to influence the work reported in this review.

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REFERENCES

Anderson AS, Renehan AG, Saxton JM, O'Dwyer ST, Harvie M, Brennan VK, Reckless I, Sperrin M, (2021). Cancer prevention through weight control—where are we in 2020? British Journal of Cancer, 124(11), 1741–1752. https://doi.org/10.1038/s41416-020-01154-3

Arif M, Jafri W, Ahmad N, Ali SS, Khan S, (2025). A systematic review of whether physical activity prevents colorectal cancer in older adults. Cureus, 17(1), e95234. https://doi.org/10.7759/cureus.95234

Islami F, Goding Sauer A, Miller KD, Siegel RL, Fedewa SA, Jacobs EJ, McCullough ML, Patel AV, Ma J, Soerjomataram I, Flanders WD, Brawley OW, Gapstur SM, Jemal A, (2018). Proportion and number of cancer cases and deaths attributable to potentially modifiable risk factors in the United States. CA: A Cancer Journal for Clinicians, 68(1), 31–54. https://doi.org/10.3322/caac.21440

Kim SH, Moon JY, Lim YJ, (2022). Dietary intervention for preventing colorectal cancer: A practical guide for physicians. Journal of Cancer Prevention, 27(3), 139–149. https://doi.org/10.15430/JCP.2022.27.3.139

Kumar M, Singh A, Sharma P, Verma R, (2025). Leveraging celebrity influence for oral cancer prevention and smokeless tobacco cessation: Challenges and opportunities in India. Frontiers in Public Health, 12, 1531268. https://doi.org/10.3389/fpubh.2025.1531268

Li T, Lu W, Zhu L, Chen MS, Stewart S, Tran A, (2022). Abstract PO-161: A community-based liver cancer education initiative led to healthier dietary and alcohol use behaviors among racial/ethnic minority community members. Cancer Epidemiology, Biomarkers & Prevention, 31(1_Supplement), PO-161. https://doi.org/10.1158/1538-7755.disp21-po-161

McLeod A, Wolf PG, Chapkin RS, Besselsen DG, Raatz SK, Shen L, Hullar MA, Sun J, Ivey KL, Daniel CR, Shivappa N, Jiang R, Fodor AA, Knight JM, Liddle RA, Sandler RS, Keku TO, (2023). Design of the Building Research in CRC prevention (BRIDGE-CRC) trial: A 6-month, parallel group Mediterranean diet and weight loss randomized controlled lifestyle intervention targeting the bile acid-gut microbiome axis to reduce colorectal cancer risk among African American/Black adults with obesity. Trials, 24(1), 113. https://doi.org/10.1186/s13063-023-07115-4

Sauter ER, Butera G, Agurs-Collins T, (2024). Long-term randomized controlled trials of diet intervention reports and their impact on cancer: A systematic review. Cancers, 16(19), 3296. https://doi.org/10.3390/cancers16193296

Sharma R, Patel K, Gupta A, (2025). Dietary interventions for breast cancer prevention: Exploring the role of nutrition in primary and tertiary prevention strategies.

Healthcare, 13(4), 407. https://doi.org/10.3390/healthcare13040407

Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, Bray F, (2021). Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA: A Cancer Journal for Clinicians, 71(3), 209–249. https://doi.org/10.3322/caac.21660

Tan ASL, Mitra N, Schnoll RA, Barg FK, Evans NR, Brawner BM, Bekelman JE, Asch DA, (2025). Project SWITCH study protocol: A tobacco-free workplace program for dissemination and implementation in lung cancer screening centers. Methods and Protocols, 8(4), 70. https://doi.org/10.3390/mps8040070

World Cancer Research Fund/American Institute for Cancer Research. (2018). Diet, nutrition, physical activity and cancer: A global perspective. Continuous update project expert report 2018. World Cancer Research Fund International.