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Review Article

Cancer and Climatic Change Influence

Climate Changes and Cancer

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Abstract: With estimates ranging from 30% to 40%, addressing noncommunicable disease risk factors, such as cancer, industrialized countries has the potential to considerably lower premature mortality. The need to battle climate change has also become more urgent, with recent accords calling for a 45% decrease in CO_2 emissions by 2030 and the achievement of net-zero emissions by 2050. The current article shows how cancer prevention and mitigating climate change may work well together. The power of this approach's capacity to produce both short-term climate improvements and long-term health benefits through well-coordinated intersectoral policies. A growing body of evidence indicates that several variables, including environmental factors, affect cancer. Extreme weather conditions and rising global temperatures have increased exposure to environmental carcinogens and lowered air and water quality. Higher cancer risks can result from discharging pollutants and harmful materials into the environment. In addition, skin cancer occurrences have been related to varying weather patterns and continuous exposure to UV light. In addition to producing dietary imbalances and reducing the availability of nutrient-dense food, climate change has also disturbed ecosystems, which may be another factor in cancer development. In addition to the effects of climate change, alcohol, and cigarette use continue to be major contributors to the rise in cancer cases in recent years. Smoking tobacco is a significant risk factor for lung cancer and has been related to many other cancers, such as the mouth, throat, oesophagus, and bladder. Similarly, drinking too much alcohol raises your chance of getting many cancers, including those of the liver, breast, colon, and oesophagus. Alcohol and cigarette usage together can increase the chance of developing cancer. This review focuses on environmental carcinogens, the processing of food, an epidemic of skin cancer, photocarcinogenesis, global warming, air pollution, and methods of mitigating cancer.

Keywords: Climate change, global warming, air pollution, melanoma, non-melanoma skin cancer, and skin cancer

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1. INTRODUCTION

Recent years have seen the irrefutable truth of climate change emerge, spurring substantial study into its far-reaching consequences, including different health effects, the spread of infectious illnesses, and mortality from heat waves[1]. In addition, the incidence of non-communicable diseases, such as cancer, has become a major issue worldwide[2]. According to early studies, there were over 18 million new instances of cancer worldwide in 2018, with cancer rates rising most dramatically in low- and middle-income nations[3]. The critical effects of climate change on public health necessitate immediate action. The possible rise in infectious illnesses brought on by altered environmental circumstances is a current concern. As temperatures increase, disease-carrying insects like mosquitoes and ticks could widen their ranges, keeping communities at risk for illnesses like Lyme disease, dengue fever, and malaria[4]. Temperature and precipitation patterns can also affect how aquatic illnesses like cholera are spread and transmitted. Another effect of climate change that poses a severe hazard to human health is heat waves. Particularly in susceptible groups, including the elderly, small children, and people with established medical issues, high temperatures can result in heat-related illnesses and fatalities[5]. Additionally, the increase in severe weather events like hurricanes and floods can worsen existing health problems, destabilize healthcare systems, and make providing medical aid to impacted areas[6] more difficult. In addition to the problems caused by climate change, this cancer has become more prevalent globally. A concerning trend is the rise of new cancer cases, especially in low- and middle-income nations where the infrastructure and resources for healthcare may be constrained. To adopt practical preventative measures and improve cancer care and treatment, it is imperative to address the reasons behind the increase in cancer cases. Managing NCDs, including cancer, presents special difficulties for low- and middle-income nations[7]. Early identification and treatment of cancer can be hampered by a lack of access to healthcare, a lack of knowledge, and financial limitations, which can lead to worsened health outcomes for those impacted by the disease. Governments, healthcare providers, and international organizations must collaborate to create fair and long-lasting cancer prevention and treatment plans. A new field of study is the effect of climate change on cancer. Some studies indicate that environmental variables impacted by climate change, such as air pollution and exposure to carcinogens, may contribute to the development of some cancers, while direct linkages between climate change and cancer are currently under investigation. Policymakers and healthcare professionals may create comprehensive cancer prevention strategies with the help of understanding these possible linkages. Infectious illnesses and heatwaves pose serious hazards to communities worldwide, with climate change having far-reaching effects on public health[8].Thus this cancer is on the rise, calling for comprehensive plans to enhance global healthcare and preventative programs. The nexus of cancer and climate change must be addressed to ensure a sustainable and healthy future for everybody. Cooperative efforts and preventive actions are essential to lessen the effects of climate change on health and protect the welfare of present and future generations.

2. CRITICAL CARCINOGENS

Tobacco is renowned for leading to cardiovascular, pulmonary, and other ailments and about one-third of cancer deaths worldwide [9]. It also significantly affects the environment. 118,487 tonnes of direct emissions from the vehicle fleet and 229,116 tonnes of CO_2 equivalents from production were reported by Philip Morris International (PMI) as emissions in 2017[10]. Manufacturing generated 434,460 tonnes of indirect emissions, and offices generated 15,800 tonnes. The bulk, 3,611,000 tonnes, were from greenhouse gas emissions related to transportation, distribution, and purchasing commodities[11]. Tobacco production uses much water, at least 23,247 thousand cubic metres annually[12]. The tobacco business would not be viable if cigarette corporations included environmental externalities like water usage, air pollution, and land degradation in their expenses. Reduced meat intake may help avoid infectious and noncommunicable illnesses (NCDs)[13]. An IARC Monograph Working Group has determined that processed meat is carcinogenic to humans, whereas red meat is thought to be possibly carcinogenic[14]. For each of the world's more than seven billion people, about 3.5 chickens and 0.5 red meat animals are farmed annually as part of the enormous livestock output for animal-based sustenance. Due to resource competition, the livestock industry's explosive rise has significantly impacted natural ecosystems, leading to biodiversity loss and land degradation. There are more ecologically friendly sources of protein that might replace beef to solve these environmental issues and lessen the water footprint of animal protein. It has been proposed to provide dietary recommendations that benefit human and planetary health. Air pollution is another area where poor health, especially cancer and climate change, are related. Outdoor air pollution, in particular particles, has been found by an IARC Monograph Working Group to be carcinogenic to people[15]. Fossil fuel burning produces air contaminants that harm human health, including respiratory and cardiovascular conditions. Promoting transport modifications, including boosting the usage of active transport like walking and cycling, may aid in lowering air pollution and improving health outcomes at the same time. Active transportation can increase physical activity while lowering the risk of obesity, diabetes, cancer, and cardiovascular disease[16].

3. PROCESSING OF FOOD

Industrialized food processing, sometimes known as "ultra-processing," aims to replace traditional food categories with ready-to-consume food items that are branded, convenient, aesthetically pleasing, and extremely profitable. This practice has grown quickly and widely[17]. According to recent research, in the US and the UK, ultra-processed foods (UPFs) make up 55% and 60% of total caloric consumption, respectively. These UPFs often have greater calorie densities because of their high content of saturated and trans fats, salt, and free sugars and poor content of fibre and micronutrients. There are concerns that higher UPF consumption might raise cancer risk worldwide and contrition to obesity. Certain ultraviolet filters (UPFs) incorporate food additives that are permitted yet contentious, including sodium nitrite found in processed meat, which has been linked to cancer in animal or cell models[18].Some UPFs—like distilled spirits—harm the environment and human health despite not being necessary for human use[19,20].Growing evidence suggests that consuming UPF is linked to negative health outcomes, including an increased risk of obesity, hypertension, diabetes, cardiovascular disease, and all-cause mortality during the past 10 years due to the emergence of worldwide interest in

UPF[21,22]. The link between UPF consumption and risks of overweight/obesity, type 2 diabetes, hypertension, and all-cause mortality has also been examined in several recent systematic reviews and meta-analyses [23,24.] Unsurprisingly, research has found that these negative health effects positively correlate with high UPF consumption. However, only a small number of epidemiological studies have specifically examined the link between UPF intake and CRC risk [25], with contradictory results.While other studies revealed a null finding [26], certain observational studies have demonstrated a favourable link between high intake of UPF and CRC risk [27.]

4. EPIDEMIC OF SKIN CANCER

The most frequent disease globally, skin cancer has become much more common in the last half of the 20th century, especially in those with fair skin[28]. It is a major global burden, accounting for over 126,000 fatalities in 2018[29]. Although UVR from the sun is considered the main cause, other variables like genetics, behaviour, and environment also play a role in its development. To avoid skin cancer, it's critical to take preventative actions, such as using sunscreen, donning protective gear, and minimizing sun exposure. Education is essential to promote sun safety and raise awareness of skin cancer's dangers. Early identification and prompt treatment can greatly enhance the prognosis for people with skin cancer. The risk of getting skin cancer can be decreased by following sun safety guidelines and engaging in diligent skin health practices.The kind of skin cancer with the highest burden of morbidity, death, and years of lost potential life is cutaneous melanoma (CM) [30]. However, as Australia's main preventive initiatives[31] have proven, CM may be substantially avoided by patient education, sun protection, screening, and public health campaigns. These all-encompassing programs, encompassing multimedia marketing, educational and organisational tactics, and environmental rules and regulations, had well-documented effects on sun protection behaviours [32,33]. Their beneficial effects were further underlined by a plateau in CM incidence in the middle of the 1990s and a drop in CM incidence in those between the ages of 15 and 24 [34].The inclusion of research and evaluation into the planning, execution, and development stages of the programs was one of the crucial elements in the success of these initiatives [35]. CM incidence rates have been increasing over the past several decades, and they've started to affect public health everywhere, particularly in North America [36,37]. Our study team's previous investigations have shown that Canada's total incidence rate per 100,000 people per year grew from 12.29 between 1992 and 2010 to 20.75 between 2011 and 2017 [38]. The greatest age-standardized incidences were seen in Prince Edward Island (PEI) and Nova Scotia (NS), with 30,94 and 27,66 incidents per 100,000 person-years, respectively. Other Canadian Atlantic provinces, however, had age-standardized incidence rates that were either lower than or equivalent to the national norm (16.63 and 19.99 per 10,000 person-years, respectively). These provinces included Newfoundland, Labrador (NL), and New Brunswick (NB).It is commonly recognised that UVR, or ultraviolet light, is the main cause of skin cancer and a recognised carcinogen[39]. UVA photons may produce Reactive oxygen species more readily, which can damage DNA by changing its bases, creating crosslinks, and breaking single strands. On the other hand, DNA directly absorbs UVB, which causes pyrimidine dimers to form[40]. Mutagenesis can happen when prolonged UV radiation exposure overloads the DNA excision repair mechanisms. This involves the dysregulation of apoptosis and decreased cell death due to the upregulation of proto-oncogene expression and the downregulation of tumour suppressor genes[41]. As a result, populations of clonal cells could multiply, which might aid in the emergence of skin cancer.Moreover, immunosuppression brought on by UVR contributes to the development of photocarcinogenesis. UVR may weaken the immune system, making it more difficult for the body to recognise and stop the formation of malignant cells. This increases the chance of developing skin cancer. Overall, the genesis and evolution of skin cancer are influenced by the intricate interactions between UVA and UVB photons and DNA, the disruption of DNA repair processes, and the ensuing impacts on immune response and cell regulation. Understanding these processes is essential to creating methods that effectively prevent skin cancer and promote sun safety behaviours.

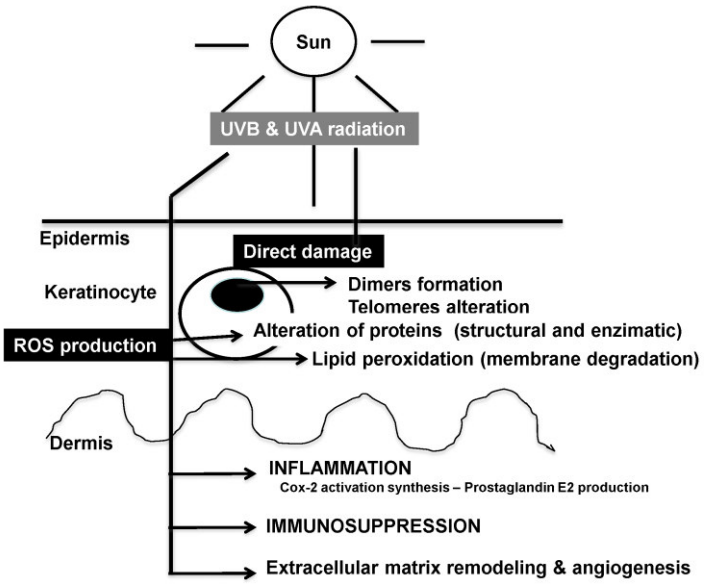

Fig1: Summary of the major deleterious effects of sun-generated ultraviolet (UV) radiation on the skin.[42]

5. GLOBAL WARMING

Because of continued human-caused greenhouse gas emissions, Earth's temperature has risen by more than 1°C (1.8°F) since 1880; much of this warming has been seen in the previous 45 years (NASA). While exceeding this goal may not be preventable, the IPCC (Intergovernmental Panel on Climate Change) has stressed the significance of keeping the increase in global temperature to 1.5°C (2.7°F) by 2100 to minimize negative consequences on human health (WMO and UNEP, 2018). There are mounting data that links the trend of rising global temperatures brought on by climate change to an increase in skin cancer cases globally. People frequently interact with temperature and ultraviolet radiation (UVR) outside because of these two variables' geographic and climatic relationships. However, further research is necessary to determine the precise degree to which temperature influences the occurrence of skin cancer[43]. It is difficult to determine how temperature affects the risk of skin cancer. Still, studies have revealed that sunbathing significantly raises skin temperature, demonstrating how co-exposure to heat and sunlight may often damage vast skin sections (Petersen et al., 2014). According to Van Der Leun and de Gruijl (2002)[44], there might be an 11% worldwide increase in the incidence of skin cancer by 2050 for every 2°C (3.6°F) increase in ambient temperature. Extreme heat events occur more frequently due to climate change, which has wider implications for detrimental health impacts[45]. Because of the higher temperatures and less availability to clean water, these occurrences may cause cyclical periods of dehydration, which might increase the risk of both acute and chronic kidney illness [46].

6. AIR POLLUTION

Air pollution refers to harmful or toxic substances in the air, which can harm human health, the environment, and ecosystems[47]. These pollutants can be natural or artificial and come from various sources, including industrial activities, transportation, agriculture, and energy production. Common air pollutants include particulate matter, nitrogen dioxide, sulfur dioxide, ozone, carbon monoxide, volatile organic compounds, and heavy metals[48]. Particulate matter consists of tiny particles suspended in the air, which can be inhaled into the respiratory system and cause respiratory and cardiovascular problems. Nitrogen dioxide and sulfur dioxide are primarily released from burning fossil fuels and contribute to smog and acid rain formation. Ozone is a major component of photochemical smog and can lead to respiratory issues when inhaled. Carbon monoxide is a colorless and odorless gas produced by incomplete combustion, and high levels can be dangerous, particularly in enclosed spaces. Volatile organic compounds are emitted from various sources, including paints, cleaning products, and vehicle emissions, and can contribute to forming ground-level ozone and particulate matter[49]. Heavy metals, such as lead, mercury, and arsenic, are released from industrial processes and can accumulate in the environment, posing serious health risks. Air pollution has numerous adverse effects on human health, including respiratory problems, cardiovascular diseases, and an increased risk of lung cancer. It also damages ecosystems, harms wildlife, and contributes to climate change. Addressing air pollution requires a combination of policies, regulations, and individual efforts to reduce emissions, promote clean energy sources, and improve air quality for the well-being of both people and the planet 50.

7. CITRUS AND CITRUS JUICE

Early study has shown that high levels of citrus consumption, particularly in the form of citrus drinks, are associated with an elevated risk of malignant melanoma (MM) and keratinocyte carcinoma (KC). It is thought that certain of the ingredients in citrus, such as furocoumarins, have an impact on this relationship. More intake of citrus products was linked to an increased risk of keratinocyte carcinoma in a prospective cohort study comprising approximately 40,000 men and 60,000 women 51. There was no discernible increase in risk among those who ingested citrus items fewer than twice a week. On the other hand, people who ate citrus products five to six times a week or more than 1.4 times a day had a higher chance of developing basal cell carcinoma (BCC) and squamous cell carcinoma (SCC) than those who consumed two to four products per week (Sun et al.,)[52]. Sun et al.'s studyalso looked at the consumption of furocoumarins derived from various foods that contain these compounds, including oranges, grapefruit, conventional and fortified orange juice, carrots, celery, and lemonade. A correlation between a larger consumption of furocoumarins and a higher risk of basal cell carcinoma was found by the investigation[53]. According to the available data, furocoumarins in citrus goods may be involved in the correlation between citrus product use and an increased risk of skin cancer.The most prevalent kind of cancer, and one highly related to morbidity and death worldwide, is skin cancer, including melanoma, squamous cell carcinoma (SCC), and basal cell carcinoma (BCC) [54].Therefore, identifying skin cancer risk factors is essential for the disease's prevention. Higher citrus intake was linked to an elevated risk of melanoma, BCC, and SCC in recent analyses from the Nurses' Health Study (NHS) and Health Professionals Follow-up Study (HPFS), 2 significant prospective cohort studies of men and women, respectively [55,56]. Furocoumarins are primarily found in citrus fruits[57,58]. When exposed to UV light, numerous furocoumarin congeners behave as phytoalexins, protecting against microbial infection [59]. Furocoumarins are photoactive, may intercalate DNA, and can cause mutations. Several experimental investigations have shown that furocoumarins are phototoxic and photocarcinogenic [60,61]. Additionally, epidemiological studies have found that people with psoriasis who had PUVA treatment, a furocoumarin that combines UVA and oral psoralen, had a higher chance of developing malignant melanoma, BCC, and SCC[62,63].

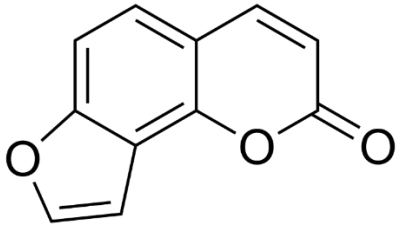

Fig 2: Furocoumarins

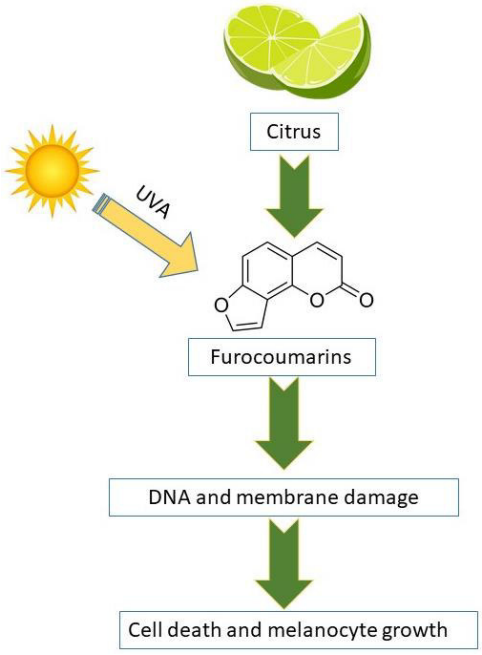

Fig 3: The role of furocoumarins in UV-induced damage

8. ALCOHOL

Numerous malignancies, including those of the breast, prostate, and gastrointestinal (GI) tract, have been related to alcohol usage. Furthermore, drinking alcohol has been linked to a higher chance of developing a serious sunburn[64]. Among the various alcoholic beverages, it was shown that drinking white wine and spirits was especially linked to an increased risk. However, red wine and beer did not significantly correlate with risk[65].Significantly, drinking alcohol between 18 and 22, particularly for women, was associated with risk. There was a dose-response pattern in the association between alcohol consumption and squamous cell carcinoma (SCC), whereby more alcohol consumption was linked to a higher risk[66]. Particularly, a correlation was found between elevated risk of SCC and eating white wine more than five times a week. Furthermore, despite considering the identical levels of alcohol use, women seemed to be at a greater risk than males[67].

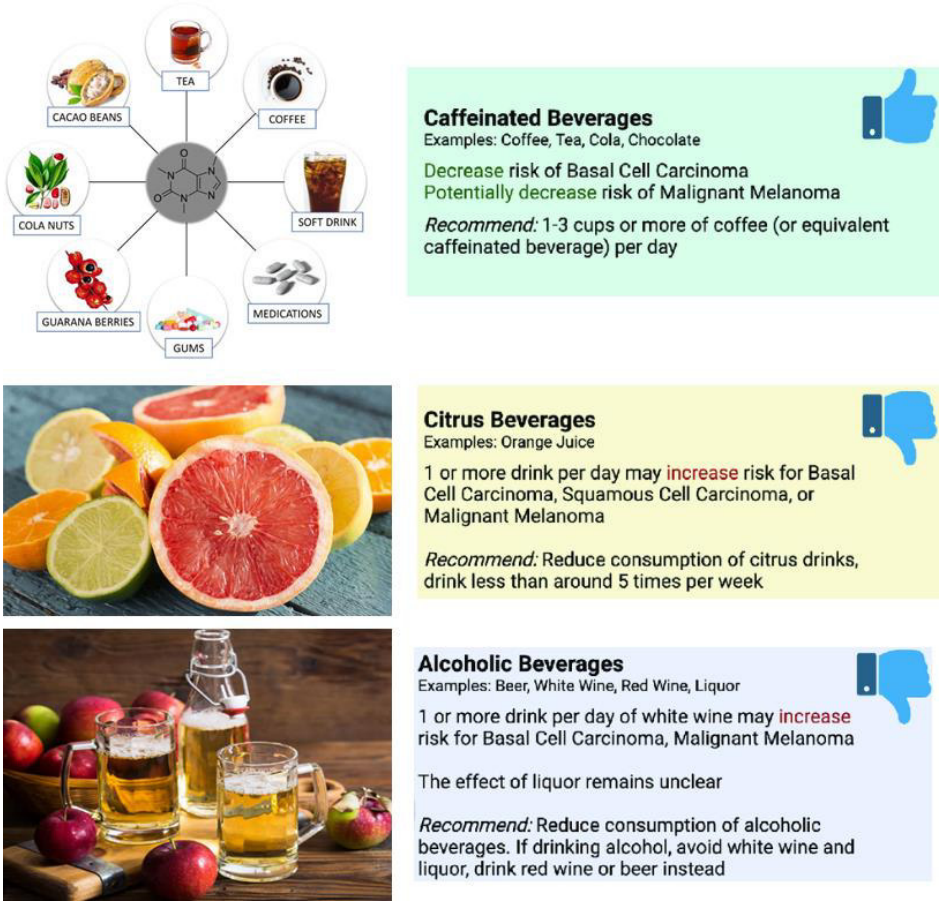

Fig 4: Summary of recommendations regarding beverage consumption and risk of skin cancers[68]

9. CAFFEINE

In addition to being linked to a possible lower risk of malignant melanoma (MM), caffeine-containing drinks such as coffee, tea, and cola have also been linked to a lower risk of basal cell carcinoma (BCC)[69]. Women who drank three or more cups of coffee daily had a decreased risk of BCC than those who drank less than one cup. While decaffeinated beverages did not exhibit the same trend, there was a clear correlation between the reduction of BCC risk and caffeine-containing beverages (tea, cola, and chocolate). These results imply that caffeine, rather than other drink ingredients, is most likely responsible for the protective effect shown. The study also found that other caffeinated beverages exhibited comparable tendencies, indicating that caffeine's protective effects were not limited to coffee[70]. Furthermore, the protective effect appeared to follow a dose-dependent pattern, suggesting that larger caffeine dosages were linked to increased protection. This suggests that caffeine is the active component most likely in charge of the observed risk decrease.

10. CONCLUSION

In conclusion, nicotine has a well-documented detrimental effect on human health and is a major cause of global cancer, heart disease, and lung disease fatalities. Furthermore, its harmful impacts on the ecosystem are serious and cannot be disregarded. Similar to the advent of industrialized food processing, consuming ultra-processed foods (UPFs) poses major health risks due to research connecting them to type 2 diabetes, hypertension, and overweight/obesity. The worldwide health issue is being made worse by this trend of unhealthy food intake. A comparable set of risks to human health and well-being are being presented by climate change. The Earth's temperature has risen by more than 1°C due to human activity, making skin cancer cases more prevalent worldwide. It is crucial to combat climate change and keep the increase in global temperature to 1.5°C by 2100, as indicated by the IPCC, to prevent harmful effects on human health and the ecosystem. Additionally, air pollution, which results from several human activities, harms ecosystems and human health. To protect public health and the environment, it is imperative to combat air pollution, which poses a serious hazard due to its existence. Alcohol use, especially when excessive, has been associated with several cancers, and the fact that it increases the chance of developing a significant sunburn is worrisome. The link between some alcoholic beverages and a higher risk of developing cancer emphasizes the importance of increasing knowledge and careful drinking practices, particularly among young persons. A comprehensive and multifaceted response is necessary in light of these interrelated health and environmental issues. In addition to addressing cigarette use, promoting better diets, educating the public about climate change, and advocating for cleaner air and responsible alcohol use, public health efforts must also target these issues. We can work to build a more wholesome and sustainable future for people and the earth by acting jointly on these fronts.

11. AUTHORS CONTRIBUTION STATEMENT

Dr. Somenath Ghosh and Dr. Sanjeev Kumar Jha conceptualized the manuscript and gathered the data. Mohamed Osman Elamin Bushara and Dr. Asit Kumar Varsha Umesh Ghate and Dr Manam Mani Srikanth analyzed the data

and provided the necessary information regarding the research design. All the authors discussed and contributed to the final manuscript. All the authors revised the manuscript critically and approved it before submission.

12. CONFLICT OF INTEREST

Conflict of interest declared none.

13. REFERENCES

1. Available from: https://www.ipcc.ch/sr15/ [cited 11/8/2023].
2. Hunter DJ, Reddy KS. Noncommunicable diseases. N Engl J Med. 2013 Oct 3;369(14):1336-43. doi: 10.1056/NEJMra1109345, PMID 24088093.
3. Ezzati M, Pearson-Stuttard J, Bennett JE, Mathers CD. Acting on non-communicable diseases in low- and middle-income tropical countries. Nature. 2018 Jul 26;559(7715):507-16. doi: 10.1038/s41586-018-0306-9, PMID 30046068.
4. Gubler DJ. Resurgent vector-borne diseases as a global health problem. Emerg Infect Dis. 1998 Jul;4(3):442-50. doi: 10.3201/eid0403.980326, PMID 9716967.
5. Hall EJ, Carter AJ, O'Neill DG. Dogs Don't Die Just in Hot Cars-Exertional Heat-Related Illness (Heatstroke) Is a Greater Threat to UK Dogs. Animals (Basel). 2020 Jul 31;10(8):1324. doi: 10.3390/ani10081324, PMID 32751913.
6. Linnenluecke MK, Griffiths A, Winn M. Extreme weather events and the critical importance of anticipatory adaptation and organizational resilience in responding to impacts. Bus Strat Env. 2012 Jan;21(1):17-32. doi: 10.1002/bse.708.
7. Anderson BO, Ilbawi AM, El Saghir NS. Breast cancer in low and middle income countries (LMICs): a shifting tide in global health. Breast J. 2015 Jan;21(1):111-8. doi: 10.1111/tbj.12357, PMID 25444441.
8. Council On Environmental Health Global climate change and children's health. Pediatrics. 2015 Nov 1;136(5):992-7. doi: 10.1542/peds.2015-3232, PMID 26504130.
9. Vineis P, Wild CP. Global cancer patterns: causes and prevention. Lancet. 2014;383(9916):549-57. doi: 10.1016/S0140-6736(13)62224-2, PMID 24351322.
10. Burki TK. Philip Morris International purchases vectura. Lancet Respir Med. 2021 Dec 1;9(12):e122. doi: 10.1016/S2213-2600(21)00445-8, PMID 34600613.
11. Miklautsch P, Woschank M. A framework of measures to mitigate greenhouse gas emissions in freight transport: systematic literature review from a Manufacturer's perspective. J Cleaner Prod. 2022 Jul 2;366:132883. doi: 10.1016/j.jclepro.2022.132883.
12. Hendlin YH, Bialous SA. The environmental externalities of tobacco manufacturing: a review of tobacco industry reporting. Ambio. 2020;49(1):17-34. doi: 10.1007/s13280-019-01148-3, PMID 30852780.
13. Manyazewal T, Ali MK, Kebede T, Magee MJ, Getinet T, Patel SA et al. Mapping digital health ecosystems in Africa in the context of endemic infectious and non-communicable diseases. npj Digit Med. 2023 May 26;6(1):97. doi: 10.1038/s41746-023-00839-2, PMID 37237022.
14. Schubauer-Berigan MK, Richardson DB, Fox MP, Fritschi L, Guseva Canu I, Pearce N et al.. IARC-NCI workshop on an epidemiological toolkit to assess biases in human cancer studies for hazard identification: beyond the algorithm. Occup Environ Med. 2023 Mar 1;80(3):119-20. doi: 10.1136/oemed-2022-108724, PMID 36717257.
15. IARC 2018. IARC monographs on the evaluation of carcinogenic risks to humans. Vol. 114. Red meat and processed meat. Lyon: International Agency for Research on Cancer.
16. Willett W, Rockstr€om J, Loken B, Springmann M, Lang T, Vermeulen S, Garnett T, Tilman D, DeClerck F, Wood A et al. (2019) Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. Lancet 393, 447–492.d.
17. Monteiro CA, Cannon G, Moubarac JC, Levy RB, Louzada MLC, Jaime PC. The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. Public Health Nutr. 2018;21(1):5-17. doi: 10.1017/S1368980017000234, PMID 28322183.
18. Wang S, Luo C, Tan F, Cheng X, Ma Q, Wu D et al. Degradation of Congo red by UV photolysis of nitrate: kinetics and degradation mechanism. Sep Purif Technol. 2021 May 1;262:118276. doi: 10.1016/j.seppur.2020.118276.
19. Martínez Steele E, Baraldi LG, Louzada ML, Moubarac JC, Mozaffarian D, Monteiro CA. Ultra-processed foods and added sugars in the US diet: evidence from a nationally representative cross-sectional study. BMJ, (Open). 2016;6(3):e009892. doi: 10.1136/bmjopen-2015-009892, PMID 26962035.
20. Rauber F, da Costa Louzada ML, Steele EM, Millett C, Monteiro CA, Levy RB. Ultra-Processed Food Consumption and Chronic Non-Communicable Diseases-Related Dietary Nutrient Profile in the UK (2008–2014). Nutrients. 2018;10(5):587-600. Ref. doi: 10.3390/nu10050587, PMID 29747447.
21. Srour B, Fezeu LK, Kesse-Guyot E, Allès B, Méjean C, Andrianasolo RM, et al. Ultra-processed food intake and risk of cardiovascular disease: prospective cohort study (NutriNet-Santé). BMJ. 2019;365:l1451. doi: 10.1136/bmj.l1451, PMID 31142457.
22. Moradi S, Entezari MH, Mohammadi H, Jayedi A, Lazaridi AV, Kermani MAH, et al. Ultra-processed food consumption and adult obesity risk: a systematic review and dose-response meta-analysis. Crit Rev Food Sci Nutr. 2023;63(2):249-60. doi: 10.1080/10408398.2021.1946005, PMID 34190668.
23. Taneri PE, Wehrli F, Roa-Díaz ZM, Itodo OA, Salvador D, Raeisi-Dehkordi H, et al. Association between ultra-processed food intake and all-cause mortality: a systematic review and Meta-analysis. Am J Epidemiol. 2022;191(7):1323-35. doi: 10.1093/aje/kwac039, PMID 35231930.
24. Wang M, Du X, Huang W, Xu Y. Ultra-processed foods consumption increases the risk of hypertension in adults: a systematic review and Meta-analysis. Am J Hypertens. 2022;35(10):892-901. doi: 10.1093/ajh/hpac069, PMID 35750049.
25. Wang L, Du MX, Wang K, Khandpur N, Rossato SL, Drouin-Chartier JP, et al. Association of ultra-processed food consumption with colorectal cancer

risk among men and women: results from three prospective US cohort studies. BMJ. 2022;378:e068921. doi: 10.1136/bmj-2021-068921.
26. Fiolet T, Srour B, Sellem L, Kesse-Guyot E, Allès B, Méjean C, et al. Consumption of ultra-processed foods and cancer risk: results from NutriNet-Santé prospective cohort. BMJ. 2018;360:k322. doi: 10.1136/bmj.k322, PMID 29444771.
27. Hang D, Wang L, Fang Z, Du M, Wang K, He X et al.. Ultra-processed food consumption and risk of colorectal cancer precursors: results from 3 prospective cohorts. J Natl Cancer Inst. 2023;115(2):155-64. doi: 10.1093/jnci/djac221. PMID 36477589.
28. Garbe C, Leiter U. Melanoma epidemiology and trends. Clin Dermatol. 2009;27(1):3-9. doi: 10.1016/j.clindermatol.2008.09.001, PMID 19095149.
29. Ferlay J, Colombet M, Soerjomataram I, Mathers C, Parkin DM, Piñeros M, et al. Estimating the global cancer incidence and mortality in 2018: GLOBOCAN sources and methods. Int J Cancer. 2019;144(8):1941-53. Refer. doi: 10.1002/ijc.31937, PMID 30350310.
30. Guy GP, Ekwueme DU. Years of potential life lost and indirect costs of melanoma and non-melanoma skin cancer: A systematic review of the literature. Pharmacoeconomics. 2011;29(10):863-74. doi: 10.2165/11589300-000000000-00000, PMID 21846158.
31. Aitken JF, Youlden DR, Baade PD, Soyer HP, Green AC, Smithers BM. Generational shift in melanoma incidence and mortality in Queensland, Australia, 1995-2014. Int J Cancer. 2018;142(8):1528-35. doi: 10.1002/ijc.31141, PMID 29105744.
32. Smith BJ, Ferguson C, McKenzie J, Bauman A, Vita P. Impacts from repeated mass media campaigns to promote sun protection in Australia. Health Promot Int. 2002;17(1):51-60. doi: 10.1093/heapro/17.1.51, PMID 11847138.
33. Sneyd MJ, Cox B. A comparison of trends in melanoma mortality in New Zealand and Australia: the two countries with the highest melanoma incidence and mortality in the world. BMC Cancer. 2013;13:372. doi: 10.1186/1471-2407-13-372, PMID 23915380.
34. Iannacone MR, Green AC. Towards skin cancer prevention and early detection: evolution of skin cancer awareness campaigns in Australia. Melanoma Manag. 2014;1(1):75-84. doi: 10.2217/mmt.14.6, PMID 30190812.
35. Montague M, Borland R, Sinclair C. Slip! Slop! Slap! and SunSmart, 1980-2000: skin cancer control and 20 years of population-based campaigning. Health Educ Behav. 2001;28(3):290-305. doi: 10.1177/109019810102800304, PMID 11380050.
36. Dimitriou F, Krattinger R, Ramelyte E, Barysch MJ, Micaletto S, Dummer R et al. The world of melanoma: epidemiologic, genetic, and anatomic differences of melanoma across the globe. Curr Oncol Rep. 2018;20(11):87. doi: 10.1007/s11912-018-0732-8, PMID 30250984.
37. Guy GP Jr Thomas. C.C.; Thompson, T.; Watson, M.; Massetti, G.M.; Richardson, L.C. Vital Signs: Melanoma incidence and mortality trends and projections—United States. MMWR Morb Mortal Wkly Rep 2015. 1982-2030;64:591-6.
38. Conte S, Ghazawi FM, Le M, Nedjar H, Alakel A, Lagacé F; et al. Population-based study detailing cutaneous melanoma incidence and mortality trends in Canada. Front Med (Lausanne). 2022;9:830254. doi: 10.3389/fmed.2022.830254, PMID 35308490.
39. Forbes PD. Photocarcinogenesis: an overview. J Invest Dermatol. 1981;77(1):139-43. doi: 10.1111/1523-1747.ep12479351, PMID 7252247.
40. Pfeifer GP, Besaratinia A. UV wavelength-dependent DNA damage and human non-melanoma and melanoma skin cancer. Photochem Photobiol Sci. 2012;11(1):90-7. doi: 10.1039/c1pp05144j, PMID 21804977.
41. Melnikova VO, Ananthaswamy HN. Cellular and molecular events leading to the development of skin cancer. Mutat Res. 2005;571(1-2):91-106. doi: 10.1016/j.mrfmmm.2004.11.015, PMID 15748641.
42. Millsop JW, Sivamani RK, Fazel N. Botanical agents for the treatment of nonmelanoma skin cancer. Dermatol Res Pract. 2013;2013:837152. doi: 10.1155/2013/837152, PMID 23983679.
43. Fabbrocini G, Triassi M, Mauriello MC, Torre G, Annunziata MC, de Vita V, et al. Epidemiology of skin cancer: role of some environmental factors. Cancers (Basel). 2010;2(4):1980-9. doi: 10.3390/cancers2041980, PMID 24281212.
44. Van Der Leun JC, de Gruijl FR. Climate change and skin cancer. Photochem Photobiol Sci. 2002;1(5):324-6. doi: 10.1039/b201025a, PMID 12653470.
45. Petersen B, Philipsen PA, Wulf HC. Skin temperature during sunbathing-relevance for skin cancer. Photochem Photobiol Sci. 2014;13(8):1123-5. doi: 10.1039/c4pp00066h, PMID 24930491.
46. Harari Arjona R, Piñeiros J, Ayabaca M, Harari Freire F. Climate change and agricultural workers' health in Ecuador: occupational exposure to UV radiation and hot environments. Ann Ist Super Sanita. 2016;52(3):368-73. doi: 10.4415/ANN_16_03_08, PMID 27698295.
47. Aguirre AA, Ostfeld RS, Tabor GM, House C, Pearl MC, editors. Conservation medicine: ecological health in practice. Oxford University Press; 2002 Sep 26.
48. Khajeamiri Y, Sharifi S, Moradpour N, Khajeamiri A. A review on the effect of air pollution and exposure to PM, NO 2, O3. J Air Pollut Health. 2021 Jun 16;SO2, CO and heavy metals on viral respiratory infections.
49. He C, Cheng J, Zhang X, Douthwaite M, Pattisson S, Hao Z. Recent advances in the catalytic oxidation of volatile organic compounds: a review based on pollutant sorts and sources. Chem Rev. 2019 Feb 27;119(7):4471-568. doi: 10.1021/acs.chemrev.8b00408, PMID 30811934.
50. Alvarez-Herranz A, Balsalobre-Lorente D, Shahbaz M, Cantos JM. Energy innovation and renewable energy consumption in the correction of air pollution levels. Energy Policy. 2017 Jun 1;105:386-97. doi: 10.1016/j.enpol.2017.03.009.
51. Wu S, Cho E, Feskanich D, Li WQ, Sun Q, Han J, et al. Citrus consumption and risk of basal cell carcinoma and squamous cell carcinoma of the skin. Carcinogenesis. 2015 Oct;36(10):1162-8. doi: 10.1093/carcin/bgv109, PMID 26224304.
52. Sun W, Rice MS, Park MK, Chun OK, Melough MM, Nan H, et al. Intake of furocoumarins and risk of skin cancer in 2 prospective US cohort studies. J Nutr.

2020 Jun;150(6):1535-44. doi: 10.1093/jn/nxaa062, PMID 32221600.
53. Sumorek-Wiadro J, Zając A, Maciejczyk A, Jakubowicz-Gil J. Furanocoumarins in anticancer therapy – For and against. Fitoterapia. 2020 Apr 1;142:104492. doi: 10.1016/j.fitote.2020.104492, PMID 32032635.
54. Jemal A, Saraiya M, Patel P, Cherala SS, Barnholtz-Sloan J, Kim J et al. Recent trends in cutaneous melanoma incidence and death rates in the United States, 1992-2006. J Am Acad Dermatol. 2011;65(5);Suppl 1:S17:S17-25.e1. doi: 10.1016/j.jaad.2011.04.032, PMID 22018063.
55. Wu S, Cho E, Feskanich D, Li WQ, Sun Q, Han J et al. Citrus consumption and risk of basal cell carcinoma and squamous cell carcinoma of the skin. Carcinogenesis. 2015;36(10):1162-8. doi: 10.1093/carcin/bgv109, PMID 26224304.
56. Wu S, Han J, Feskanich D, Cho E, Stampfer MJ, Willett WC et al. Citrus consumption and risk of cutaneous malignant melanoma. J Clin Oncol. 2015;33(23):2500-8. doi: 10.1200/JCO.2014.57.4111, PMID 26124488.
57. Frérot E, Decorzant E. Quantification of total furocoumarins in citrus oils by HPLC coupled with UV, fluorescence, and mass detection. J Agric Food Chem. 2004;52(23):6879-86. doi: 10.1021/jf040164p, PMID 15537290.
58. Melough MM, Lee SG, Cho E, Kim K, Provatas AA, Perkins C et al. Identification and quantitation of furocoumarins in popularly consumed foods in the U.S. using QuEChERS extraction coupled with UPLC-MS/MS analysis. J Agric Food Chem. 2017;65(24):5049-55. doi: 10.1021/acs.jafc.7b01279, PMID 28581738.
59. Ostertag E, Becker T, Ammon J, Bauer-Aymanns H, Schrenk D. Effects of storage conditions on furocoumarin levels in intact, chopped, or homogenized parsnips. J Agric Food Chem. 2002;50(9):2565-70. doi: 10.1021/jf011426f, PMID 11958623.
60. Mullen MP, Pathak MA, West JD, Harrist TJ, Dall'Acqua F. Carcinogenic effects of monofunctional and bifunctional furocoumarins. Natl Cancer Inst Monogr. 1984;66:205-10. PMID 6531030.
61. Zajdela F, Bisagni E. 5-methoxypsoralen, the melanogenic additive in sun-tan preparations, is tumorigenic in mice exposed to 365 nm u.v. radiation. Carcinogenesis. 1981;2(2):121-7. doi: 10.1093/carcin/2.2.121, PMID 7273295.
62. Stern RS, PUVA Follow up Study. The risk of melanoma in association with long-term exposure to PUVA. J Am Acad Dermatol. 2001;44(5):755-61. doi: 10.1067/mjd.2001.114576, PMID 11312420.
63. Stern RS, PUVA Follow-Up Study. The risk of squamous cell and basal cell cancer associated with psoralen and ultraviolet A therapy: a 30-year prospective study. J Am Acad Dermatol. 2012;66(4):553-62. doi: 10.1016/j.jaad.2011.04.004, PMID 22264671.
64. Wu S, Li WQ, Qureshi AA, Cho E. Alcohol consumption and risk of cutaneous basal cell carcinoma in women and men: 3 prospective cohort studies. Am J Clin Nutr. 2015 Nov;102(5):1158-66. doi: 10.3945/ajcn.115.115196, PMID 26423390.
65. Klatsky AL, Armstrong MA, Friedman GD. Red wine, white wine, liquor, beer, and risk for coronary artery disease hospitalization. Am J Cardiol. 1997 Aug 15;80(4):416-20. doi: 10.1016/s0002-9149(97)00388-3, PMID 9285651.
66. Katada C, Yokoyama T, Mure K, Doyama H, Nakanishi H, Shimizu Y et al. Risk factors for the development of second primary esophageal squamous-cell carcinoma after endoscopic resection for esophageal squamous-cell carcinoma according to genetic polymorphisms related to alcohol and nicotine metabolism. Jpn J Clin Oncol. 2023 Jun 27:hyad070. doi: 10.1093/jjco/hyad070, PMID 37370215.
67. Siiskonen S, Han J, Li T, Cho E, Nijsten T, Qureshi A. Alcohol intake is associated with increased risk of squamous cell carcinoma of the skin: three US prospective cohort studies. Nutr Cancer. 2016;68(4):545-53. doi: 10.1080/01635581.2016.1158296, PMID 27145335.
68. Coffee. Citrus, and alcohol: a review of what we drink and how it may affect our risk for skin cancer – scientific figure on ResearchGate [cited Aug 2, 2023]. Available from: https://www.researchgate.net/figure/Summary-of-recommendations-regarding-beverage-consumption-and-risk-of-skin-cancers_fig1_372037442.
69. Song F, Qureshi AA, Han J. Increased caffeine intake is associated with reduced risk of basal cell carcinoma of the skin. Cancer Res. 2012 Jul;72(13):3282-9. doi: 10.1158/0008-5472.CAN-11-3511, PMID 22752299.
70. Wu S, Han J, Song F, Cho E, Gao X, Hunter DJ, et al. Caffeine intake, coffee consumption, and risk of cutaneous malignant melanoma. Epidemiology. 2015 Nov;26(6):898-908. doi: 10.1097/EDE.0000000000000360, PMID 26172864.