Acta Scientific Dental Sciences (ISSN: 2581-4893)

Volume 7 Issue 1 Januray 2023

Research Article

Climate Change on Oral Health and Dentistry: Association and Mitigation

Chetan Vinay Deshmukh[1]*, Arun Suresh Dodamani[2] and Vibhuti Dilip Mistry[3]

[1]*Assistant Professor and Ph.D. Research Scholar, Department of Public Health Dentistry, A.C.P.M. Dental College, Dhule, Maharashtra State, India*

[2]*Principal, Professor and Head, Ph.D. Research Guide, Department of Public Health Dentistry, A.C.P.M. Dental College, Dhule, Maharashtra State, India*

[3]*Assistant Professor, Department of Periodontology, A.C.P.M. Dental College, Dhule, Maharashtra State, India.*

***Corresponding Author:** Chetan Vinay Deshmukh, Assistant Professor and Ph.D. Research Scholar, Department of Public Health Dentistry, A.C.P.M. Dental College, Dhule, Maharashtra State, India.

DOI: 10.31080/ASDS.2023.07.1538

Received: December 09, 2022

Published: December 22, 2022

Abstract

Introduction: The impact of climate change on oral health is of significant importance. Certain facets of climate change have culminated in the emergence of epidemics, destruction of forests, flooding of coastal areas and other fatalities. Impact of climate change on the lives of natives of a particular geographical region influences the overall health status of an individual. Global repercussions have an effect on the ecosystem. Effects of climate change on human health are both direct and indirect. Oral health is an essential component of general health as poor oral health effects growth, development and learning for children, communication, nutrition, self-esteem and various systemic conditions. Because of its effects on daily living, oral health is considered a determinant of quality of life.

Objectives: The purpose of this paper is to expand the discussion of global climate disruption to include considerations of oral health outcomes and dental practice crisis preparedness.

Method: A systematic review of all relevant literature was carried out. Data search for the present review was done both electronically as well as manually. Familiarisation with scholarly articles documenting climate impact on Oral health was carried out for formulation of next steps. Electronic search was conducted using databases such as PubMed and MEDLINE and articles published in peer-reviewed journals. Web-based search engines such as Google Scholar were also used to extract relevant articles using various keywords and their combinations. The terms such as 'oral health', 'dental', 'climate change', 'climate crisis', 'environmental changes' and 'public health' were combined with the MeSH terms by Boolean "AND" or "OR" and entered in both PubMed and Google Scholar. The collected documents included original articles, reviews, editorials, guest editorials, letters to editor, interviews, short reports, and short communications. Some data were also obtained by cross-checking the reference lists of the articles accessed. Studies that were not published in English language were excluded from the study.

Conclusion: Oral health indicators have the potential to form early warning systems for systemic disease surveillance. By bringing dental discipline expertise to the table, oral health professionals will collaborate with medical, nursing and public health colleagues to tackle these unprecedented challenges and reinforce the status of oral health as part of overall health.

Recommendations: Climate change affects health, including oral health. Provider awareness is essential for recognition and management of climate impacts on individuals and communities. Practice preparedness is critical for securing health system resiliency and navigating adverse climate events to ensure positive health outcomes. Oral health care delivery systems can be retooled to ensure equitable access and integrated delivery of service to the most vulnerable populations.

Keywords: Climate Change; Oral Health; Dentistry; Mitigation

Introduction

Climate change is nothing but deviations in the temperature and climate trends which have occurred over long periods of time. Climate change has been a dynamic process that has been attributed to various factors or "drivers" - natural or human. Natural drivers of Climate change include solar radiations and human drivers include the greenhouse gases, aerosols and other similar factors which have resulted as a byproduct of the rapid industrial revolution, mankind has achieved from the last century. As newer and advanced innovative technologies to observe climate change directly developed, more amount of evidence has surfaced demonstrating how global temperatures have increased significantly causing tectonic shifts in weather patterns, geological cycles and ultimately affecting every living organism on the planet [1].

Climate change has been evidenced and is further expected to impact or alter all ecosystems worldwide. Climate change is now known to significantly cause several calamities, causes of which were previously unknown e.g., the rising sea levels, altered rainfall patterns, droughts, floods, etc. The social and economic effects are also being studied extensively to assess and analyze how grave the situation has become. The gravity of the impact of Climate control on the economy can be gauged by the fact that Munich Re the largest insurance corporation have called for contingency plans against insurance claims due to calamities caused by Climate change [2]. The industrial evolution and the advent of technology equally provoked an advancement in medicine and public health. Modern Medicine and Public Health developed as rapid industrialization progressed. However the evolution of Public Health, developed in a proportion skewed economically and geographically.

Despite the great strides mankind has achieved in the field of medicine and Public Health worldwide, there is still a need for highlighting the impact of the environmental changes and its considerations [3] In its Third Assessment Report, the United Nation's IPCC concluded that "climate change is projected to increase threats to human health." [4]. Climate change can affect human health directly (e.g., impacts of thermal stress, death/injury in floods and storms) and indirectly through changes in the ranges of disease vectors (e.g., mosquitoes), water-borne pathogens, water quality, air quality, and food availability and quality. Global climate change is, therefore, a newer challenge to ongoing efforts to protect human health and thus puts a tremendous strain on the health burden of a nation [5]**.** Over 1,50,000 deaths and an astounding 5 million disabilities-adjusted life-years (DALY) have been attributed to climate change since the 1970s and majorly in developing countries [6].

Oral Health is an essential component of the general health. Not only does optimum oral health contribute towards optimum general health, Oral health is also known to affect several chronic diseases. [7] Oral Diseases in several countries are one of the top 5 health diseases and put a significant drain on the health burden of the countries. Several Oral diseases today have been proven to have a common risk factor with several of the general and chronic diseases such as diet and nutrition, tobacco use, etc. Effective Public Health measures that incorporate Oral Health along with Public Health measures alone are known to reduce the Health burden. Oral health not only determines how an individual can chew food but also speech, appearance and thus the ability to develop and flourish in life. It has long thus been proven that Oral Health affects the quality of life considerably [8].

Climate change thus poses a significant alarm for the Oral Health with its impact that needs to assessed extensively. The impact of Climate Change on Oral Health is multidimensional and cannot be enlisted. The impact can be direct or indirect or even remotely associated. The impact of Climate change on Oral Health and Dental Profession is an extensive area of study that urgently needs more studies to effectively and conclusively determine the association between the two and devise ways to mitigate the effect of Climate Change in Oral Health. It is also necessary for Oral Health professionals and Dental Care delivery system to be apprised of this association and be prepared for handling crises and mitigating this association.

Aim and Objectives

This review aims to assess the impact of global climate change on Oral health outcomes and recommend measures to counter the looming crisis.

Methodology

The present study being a systematic review, data search was carried out electronically and manually by familiarization with scholarly articles documenting climate impact on Oral health. Terms such as Oral Health, Dental Climate Change, Climate crisis,

environmental changes and public health were combined with the MeSH terms by Boolean AND or OR and entered in both PubMed and Google Scholar. The collected documents included original articles, reviews, editorials, guest editorials, letters to editor, interviews, short reports and short communications. Some data were also obtained by cross-checking the reference lists of the articles accessed. Studies that were not published in English Language were excluded from the study.

Results

Table 1 shows the search results using the Medical Subject Heading or MeSH terms and the various Boolean Operators. When using "Oral Health" and "Climate change", 6 articles were obtained which were found to be sufficiently relevant.

Table 2 Shows the 2 most relevant articles, out of the previous 6 that were cross checked for references and further sources were obtained for data to carry out meta-analysis for the review.

Search number	Query	Results
6	(("environment"[All Fields]) OR ("dental"[All Fields])) OR ("public health dental"[All Fields])	14,33,625
5	("oral health"[All Fields]) OR ("climate change"[All Fields])	1,07,994
4	("oral health"[All Fields]) AND ("climate change"[All Fields])	6
3	((((("oral health"[MeSH Terms]) AND ("climate change"[MeSH Terms])) AND ("publichealth"[MeSH Terms])) AND ("environment"[MeSH Terms])) AND ("environment and public health"[MeSH Terms])	0
2	((((("oral health"[MeSH Terms]) AND ("climate change"[MeSH Terms])) AND ("public health"[MeSH Terms])) AND ("environment"[MeSH Terms])) AND ("environment and public health"[MeSH Terms]) - Schema: all	0
1	((((("oral health"[MeSH Terms]) AND ("climate change"[MeSH Terms])) OR ("public health"[MeSH Terms])) AND ("environment"[MeSH Terms])) OR ("environment and public health"[MeSH Terms])	92,82,863

Table 1

Sr No	Title of Relevant Key Article(s)	Literature obtained by cross checking the references
1	Hackley DM. Climate Change and Oral Health. Int Dent J. 2021 Jun;71(3):173-177. doi: 10.1111/idj.12628. Epub 2021 Jan 27. PMID: 34024327.	17
2	Khanna S. Climate Change & Oral Health: CurrentChallenges & Future Scope. International Journal of Environmental Science and Development. 2010 Jun 1;1(2):190.	18

Table 2

Discussion

As mentioned earlier, the impact of Climate change and Oral Health is an intricate and complex association, it is still being explored at a nascent stage. An attempt has been made to enumerate the various ways through which Climate change can associated and affect Oral health.

They can be enumerated as follows

- Rising Global temperatures
- Imbalance in Food, Diet and Nutrition
- Contamination of Air due to the greenhouse emissions
- Ozone Depletion
- Water Crises - Floods and Droughts
- Advent of newer and resurgence of old infectious communicable diseases
- Socio-Economic effects.

A special mention for two more important aspects of the association of Climate Change and Oral Health

- COVID -19 pandemic phenomenon
- Dentistry practice aggravating the Environmental crisis.

These can also serve to be approaches for Dental Public Health strategists for making policy framework to mitigate the effects of Climate Change on Oral health.

Rising global temperatures

Rising Global temperatures can be ascribed to natural causes such as solar radiation, volcanic activities but more recently due to human industrialization and the use of conventional fuels that result in the release of Green House emission gases which virtually trap the solar radiation incident on the earth's surface from escaping back into the space and thus increasing temperatures worldwide resulting in a meltdown of the glaciers and frozen ice causing rising sea levels. Figure 1 (source: NASA Climate Change monitor) shows an exponential rise in the global temperature, especially after the second world war [9].

Figure 1

Heat can affect health in multiple ways such as extreme heat events like heat cramps. Heat exhaustion and even death due to heat stroke and hyperthermia. These episodes can pose as a medical emergency during dental treatment. Temperatures extremes can also aggravate already compromised conditions such as cardiovascular, respiratory, cerebra vascular diseases and diabetes mellitus and other metabolic disorders putting dental patients at an enormous medical disadvantage. Moreover, heat may also pose indirect challenges to Oral Health in the form of altering patient's behavior, altering transmission of diseases in a population, affecting health service delivery and critical social infrastructure like energy, transport and water. Heat is also known to aggravate antibiotic resistance in microorganisms as well as damage the efficacy of stored medications [10] - thus making it imperative for dental professionals to incorporate management of mild to moderate health related illnesses as a part of their training as well as keeping a strict surveillance on the emergency medications stored in the clinical setting. It will also be necessary for dental professionals to be extra cautious in using antibiotics judiciously.

Imbalance in food, diet and nutrition

Climate change causes the occurrence of several hazards and calamities that may affect the food supply chain at various stages from production to distribution to even consumption. This may occur trough multiple pathways such as - impaired rainfall patterns resulting in damage to agricultural produce, especially in developing countries where agriculture is still chiefly depended on rainfall as its primary source of water. Increased heat related and precipitation events have also known to affect the quality of the agricultural produce as well as the growth and development of livestock animals.

Increased global temperatures have also altered the temperature of Oceans, Lakes and other water bodies which have altered the quantity and quality of fish production thus affecting the coastlines which are heavily dependent on fish and fish products [11-13].

Impaired diet leading to malnutrition is a primary cause of various oral outcomes such as angular cheilitis, ulcerative gingivitis, painful ulcers, salivary gland dysfunction (vitamin deficiencies); delayed tooth eruption (protein deficiencies) Enamel hypoplasia, abnormalities in alveolar bone (vitamin D/Calcium deficiencies). Besides, periodontal disease is also known to evolve quickly in undernourished populations, thus signifying the importance of food security for Oral Health [14].

Contamination of air due to the greenhouse emissions

It has long being known that Air pollution is a major cause for respiratory ailments across populations - especially Chronic Obstructive Pulmonary Disease. It has also known to trigger and ag-

gravate asthmatic episodes in patients suffering from Bronchial Asthma. Pollen season is known to induce allergic upper respiratory inflammatory diseases [15].

Pulmonary diseases - more specifically Chronic Obstructive Pulmonary Disease is known to be a causative factor to Chronic Gingivitis and Periodontal Disease [16]. Recent studies have also shown a significant presence of Dental Caries, Periodontal Disease and Plaque formation in patients with respiratory diseases [17].

Medications for Respiratory ailments - especially conventional cough syrups and antibiotics are known to be a source of sugar, which is a major risk factor for development of dental caries in children and adults who are suffering from chronic respiratory illness and are frequently taking these medications. Simultaneously, these medications have acidic pH thus also contributing towards enamel erosion thus increasing Oral Health burden [18].

Ozone depletion

Another major direct effect of Greenhouse emissions is the depletion of the protective Ozone layer in the atmosphere due to Chlorofluorocarbons released from aerosols and refrigeration and cooling devices [19]. The Ozone layer has for long been known as the 'protective layer' protecting the earth's surface and its inhabitants from the harmful ultraviolet radiations from the Sun and space. With the depletion of the Ozone layer, there arises a risk of exposure to the ultraviolet radiation. These radiations are known to be major causative factors for development of several epithelial neoplasias - primarily Basal Cell Carcinoma and Squamous Cell Carcinoma. Even a small increase in the Ultraviolet radiation can have considerable effects on human health. Further diminishing of the ozone layer will thus lead to increasing incidences in Oral and Maxillofacial Cancers and premalignant lesions [20].

Water crises - floods and droughts

Climate change has caused the melting of the only natural reservoirs of potable water on the earth's surface - the glaciers and has caused rising sea levels. Alternatively changing rainfall distribution patterns have caused inequitable water distribution - for agriculture and for household consumption causing floods in certain areas and droughts in other areas [21]. Water crisis is bound to aggravate the food crisis by affecting agriculture. Inadequate water supply also damages the quality of the crops that are produced, thus aggravating the food crisis and malnutrition in affected populations [22].

Perhaps one of the greatest challenges of water crisis is to manage is the accumulation of toxic chemicals that are dissolved out of native soil or rock materials. Fluoride, being already freely available in surface and ground water can also be released further, due to water events such as droughts thus increasing the incidence of fluorosis [23].

Advent of newer and resurgence of old infectious communicable diseases

The temporal and spatial changes in temperature, precipitation and humidity that are expected to occur under different climate change scenarios will affect the biology and ecology of vectors and intermediate hosts and consequently the risk of disease transmission [24]. Climate variability is also a a cause for development of newer fungi diseases [25].

Advent of newer diseases and resurgence of old infectious communicable diseases such as Malaria can prove to be a huge health burden. The impact of the global COVID-19 pandemic and its related outbreak of fungal Mucormycosis on Oral Health and Oral Health professionals has already been witnessed world over. Several of the vector borne illnesses as well as infectious diseases of parasitic, fungal, viral and bacterial origin have serious Oral Manifestations. Unless Oral Health Professionals are sensitized towards proper medical history noting, careful observing and analyzing - the dental clinical set ups will not only be endangering the dental professionals for the Oral Health professionals but will also act as points of super spreading of the diseases - especially viral diseases that spread via aerosols or contact.

Socio-economic effects

Alterations in the climate trends shall also have disastrous impacts on the economy and the society in general. Apart from creating a tremendous strain on the resources, it is thus also proven to aggravate or cause food crisis, malnutrition and agriculture crisis and thus leading to poor health and decreased labor productivity. Mass migrations due to lack of resources and an overall strain on the economy is also expected [26]. In fact it has also been predicted

by the World Bank that strong heatwaves caused due to imbalances in the climate trend shall also render countless unemployed and also cause health problems due to being beyond human sustainable capacity, in developing countries.

Besides, climate change may also affect mental health by exposing people to trauma. Vulnerable people and places, especially in low-income countries will be worst hit [27].

COVID -19 pandemic phenomenon

The unprecedented situation arising out of the global COVID-19 pandemic and its series of lockdowns and isolations has proven to be a double-edged sword. On one hand, in the initial days of the pandemic, when the entire world was in lockdown and isolation, the environment witnessed a 'revival' of sorts due to the temporary cease in human activities. However, this relief was temporary, for when the restrictions were lifted, the situation world over has been even more distressing. A decline in world economies - developed and developing alike, mass unemployment, a looming sense of uncertainty and the subsequent trauma to the mental health of the community, the pandemic has verily shown that humanity is definitely not prepared for dealing with such large scale problems - thus exposing lacunae in global public health efforts. Besides the COVID-19 pandemic also saw dental clinic set ups being perceived to be super spreaders due to heavy dependence on the use of aerosols in almost all dental procedures [28-30].

Dentistry practice aggravating the environmental crisis

Apart from being potential super spreaders in aerosol-based diseases, dental clinics may also contribute towards environmental impacts by - plastic waste, X-ray films, solutions and other biomedical waste. Though individual clinic may not contribute significant environmental waste, accumulated waste may have a considerable environmental impact [31].

Dental Amalgam residue after restorations or extracted teeth with amalgam restorations also contribute to mercury release into the environment via contaminated water released from dental clinics [32].

Recommendations for measures towards mitigation

Hence, there is an urgent need to adopt measures to mitigate the climate change impacts especially on Oral health and dentistry. The measures can be as follows

- Familiarization of Oral health professionals towards the impact of climate change and its multidimensional effects on the Oral Health. While recording case history of every patient, it is essential that the Oral Health professionals also consider the impact of climate change in suitable differential diagnosis [34,35].
- Sensitizing Continuing Education Programs and Training to Health Professionals towards adopting and advocating climate friendly practices

Multinational surveys have reported several barriers for health professionals in engaging and advocating sustainable practices in health. However, most of the professionals agreed that continuing professional programs, patient education materials, policy statements and guidance can help overcome these barriers [33].

- Need for adopting strategies by the policy makers to ensure financial security and stability keeping in mind the impacts of climate change.
- Adopting of a eco-friendly or 'Green' Dentistry in practice - whereby reducing water waste, reducing energy consumption and ensuring proper disposal of waste resulting in overall reducing in the carbon footprint by dental professionals thus incorporating not only environmentally-effective but also cost effective measures.
- Dental Clinics also need to incorporate and advanced infection control measures - especially with respect to aerosol-based infections.
- The Oral Health professionals can also be trained in disaster management and prove to be a useful resource in providing basic medical first aid in disaster situations with minimum training.

Conclusion

Thus, it can be inferred that Climate change is indeed a disaster which has its origins in human actives. The impacts of climate

change have already been seen in the society affecting in multiple aspects of economy, society and public health. Climate change also affects Oral Health and dentistry in general. Thus, there is an urgent need to incorporate and adopt several measures to mitigate the effects of Climate Change on Oral Health.

Bibliography

1. Change IP. "Climate change 2007: The physical science basis" (2007): 32-33.
2. Change AD., *et al.* "Avoiding dangerous climate change". Cambridge University Press (2006): 7-8.
3. "Intergovernmental Panel on climate change". Synthesis Report. Fourth assessment Report. Geneva: IPCC (2007).
4. "IPCC W. Third assessment report". Summary for policymakers (2001).
5. Majra JP and Gur A. "Climate change and health: Why should India be concerned?" *Indian Journal of Occupational and Environmental Medicine* 13.1 (2009): 11.
6. Patz JA and Olson SH. " Climate change and health: global to local influences on disease risk". *Annals of Tropical Medicine and Parasitology* 100.5-6 (2006): 535-549.
7. Petersen PE. "The World Oral Health Report 2003: continuous improvement of oral health in the 21st century-the approach of the WHO Global Oral Health Programme". *Community Dentistry and Oral Epidemiology* 31 (2003): 3-24.
8. Sheiham A. "Oral health, general health and quality of life". *Bulletin of the World Health Organization* 83 (2005): 644.
9. Change NG. "Vital signs of the planet" (2007).
10. World Health Organization. "Public health advice on preventing health effects of heat: new and updated information for different audiences". *World Health Organization. Regional Office for Europe* (2011).
11. Tirado MC., *et al*. "Climate change and food safety: A review". *Food Research International* 43.7 (2010): 1745-1765.
12. Gregory PJ., *et al*. "Climate change and food security". *Philosophical Transactions of the Royal Society B: Biological Sciences* 360 (2005): 2139-2148.
13. Vermeulen SJ., *et al*. "Climate change and food systems". *Annual Review of Environment and Resources* 37.1 (2012): 195-222.
14. Sheetal A., *et al*. "Malnutrition and its oral outcome-a review". *Journal of Clinical and Diagnostic Research* 7.1 (2013): 178.
15. Brunekreef B and Holgate ST. "Air pollution and health". *The Lancet* 360 (2002): 1233-1242.
16. Wang Z., *et al*. "Periodontal health, oral health behaviours, and chronic obstructive pulmonary disease". *Journal of Clinical Periodontology* 36.9 (2009): 750-755.
17. Manger D., *et al*. "Evidence summary: the relationship between oral health and pulmonary disease". *British Dental Journal* 222.7 (2017): 527-533.
18. Mali GV., *et al.* "Effect of conventional and sugar free pediatric syrup formulations on primary tooth enamel hardness: An in vitro study". *Journal of Indian Society of Pedodontics and Preventive Dentistry* 33.4 (2015): 331.
19. Solomon S. "Stratospheric ozone depletion: A review of concepts and history". *Reviews of Geophysics*. 37.3 (1999): 275-316.
20. Diffey B. "Climate change, ozone depletion and the impact on ultraviolet exposure of human skin". *Physics in Medicine and Biology* 49.1 (2003): R1.
21. Medina Jr MA. "Global water crisis and climate change". *Journal of Hydrologic Engineering* 15.3 (2010): 167-170.
22. Hanjra MA and Qureshi ME. "Global water crisis and future food security in an era of climate change". *Food Policy* 35.5 (2010): 365-377.
23. Jury WA and Vaux Jr HJ. "The emerging global water crisis: managing scarcity and conflict between water users". *Advances in Agronomy* 95 (2007): 1-76.
24. Githeko AK., *et al*. "Climate change and vector-borne diseases: a regional analysis". *Bulletin of the World Health Organization* 78.9 (2000): 1136-1147.
25. Nnadi NE and Carter DA. "Climate change and the emergence of fungal pathogens". *PLOS Pathogens* 17.4 (2021): e1009503.

26. Patel S., *et al*. "Socio-Economic Impacts of Climate Change". *Climate Impacts on Sustainable Natural Resource Management* (2021): 237-267.

27. Berry HL., *et al*. "Climate change and mental health: a causal pathways framework". *International Journal of Public Health* 55.2 (2010): 123-132.

28. Checchi V., *et al*. "COVID-19 dentistry-related aspects: a literature overview". *International Dental Journal* 71.1 (2021): 21-26.

29. Spagnuolo G., *et al*. "COVID-19 outbreak: an overview on dentistry". *International Journal of Environmental Research and Public Health* 17.6 (2020): 2094.

30. Fini MB. "What dentists need to know about COVID-19". *Oral Oncology* 105 (2020): 104741.

31. Chin G., *et al*. "The environmental effects of dental amalgam". *Australian Dental Journal* 45.4 (2000): 246-249.

32. Chadna MG., "Establishing an ecofriendly dental practice: a review". *IJSS Case Reports and Review* 1.11 (2015): 78-81.

33. Kotcher J., *et al*. "Views of health professionals on climate change and health: a multinational survey study". *The Lancet Planetary Health* 5.5 (2021): e316-323.

34. Khanna S. "Climate Change and Oral Health: Current Challenges and Future Scope". *International Journal of Environmental Science and Development* 1.2 (2010): 190.

35. Hackley DM. "Climate change and oral health". *International Dental Journal* 71.3 (2021):173.