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CLIMATE CHANGE IMPACT ON HUMAN HEALTH: A GLOBAL CRISES

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Abstract

Climate change is a global threat. Natural and anthropogenic activities both are responsible for climate change. It adversely affects the agricultural system, human beings, and other species existing in this world. In the case of human beings, it affects both internal and external organs. It transmits many diseases, including infectious and vector-borne diseases. Malaria is spread throughout the tropical & subtropical regions by climate change. It impacts 247 million individuals worldwide 619,000 people were killed in 2021, up from 229 million infections and 409,000 decrease in 2019. An increase in temperature, more frequent rainfall, and storms increase the chances of respiratory, cardiac, nervous, and gastrointestinal problems such as diarrhea. The ozone layer is depleted by an increase in temperature and causes skin cancer. As the planet warms, it increases risks from extreme weather conditions, increasing sea altitudes, and altering disease patterns, increasing human health problems and mortality rates. Disaster managers must adapt to these conditions, monitoring trends and adjusting policies accordingly.

INTRODUCTION

“Climate Change” refers to long-term alternations in weather conditions (temperature, precipitation, etc.) that occur over decades or millions of years. The Earth's climate has changed over time, even before human activity played a part in it [1]. However, the UNFCCC [2] describes "Climate modifications caused by Human-induced alterations to the Earth's atmosphere, in addition to natural climate fluctuations." was defined. However, the IPCC defines climate change as changes produced by both natural variability and human activity [3]. Climate change has progressed from a solely scientific worry to a public agenda that is more likely to be an economic problem [2]. The fast temperature rise (0.5 °C) ever since the mid-1970s is mostly caused by manmade greenhouse gas emissions [4, 5]. Climate models in the 1990s accurately simulated atmospheric processes but had limited representations of oceanic, terrestrial, and cryospheric processes and sulfate aerosols. Climate models in the 1990s accurately simulated atmospheric processes but had limited representations of oceanic, terrestrial, and cryospheric processes and sulfate aerosols. Nevertheless, a lot remains to be discovered regarding how the Earth's climate system responds to changes in natural and manmade variables such as solar radiation, eruptions of volcanic rocks, airborne particles, diminished ozone layer, and atmospheric greenhouse gas levels. The 2003 European heat wave revealed that even high-income nations may be badly affected [6]. Global temperatures could increase between 1.4°C and 5.8°C by the year 2100, according to climate models [7].

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Review of Literature

Climate change and its causes

Though the terms "climate change" and "global warming" are occasionally utilized concurrently, they relate to far greater variations in the climate that have happened on the Planet in the past few years. Climate change implications have been apparent in recent years, with the average global temperature rising every decade since the 1970s. Sea ice and glaciers are melting, sea levels are rising, species are becoming extinct, droughts are making landscapes more vulnerable to wildfires, seasons are shifting, and extreme weather events are becoming more regular. These are issues caused mostly by the release of greenhouse gases into the environment, which leads to an increase in global temperatures. Researchers, academics, and various other parties appear to concur that climate change has begun right now and is mostly caused by human activities. However, a minority of people think that climate change is caused by natural forces [8].

Anthropogenic cause

Human activities such as deforestation, fuel combustion, refrigerators, and agricultural activities contribute to global warming as shown in picture below.

Greenhouse Gas Emissions

Air pollutants like ozone in the troposphere and black carbon (soot) contribute to the greenhouse gas phenomenon [9]. The biggest driver of air pollution and the greenhouse effect is worldwide excess greenhouse gas emissions (mostly CO_2, and CH_4 Gases), particularly from the combustion of fossil fuels for vitality and power production. Consequently, several obstacles to human well-being have emerged, including climate change and increasing temperatures. Many solutions have been proposed to mitigate excessive greenhouse gas emissions, including CO_2 and CH_4 use. This technology decreases CO_2 concentrations in the environment while also producing renewable energy (syngas). As a result, using CO_2 and CH_4 is a viable strategy to address the energy dilemma caused by an expanding population over time [10].

Deforestation

Climate change is one of the utmost serious issues of the 21st era, with global financial, social, and environmental causes and consequences that disproportionately impact developing nations [11]. The world's climate and forests are inextricably linked. Deep communities of trees can only grow in circumstances where there is adequate soil moisture. As the average yearly rainfall falls below 1 meter, continuous forests are frequently displaced by tiny woody plants (shrubs, dry thickets, etc.), meadows (savannahs, grasslands, etc.), or deserts [12]. Deforestation causes an increase in atmospheric carbon dioxide as well as modifications to ground matter and energy equilibrium and therefore can contribute to worldwide and regional changes in climate. Previous modeling studies have discovered that the response of Earth's surface atmospheric temperature (SAT) to deforestation varies by latitude, with most models indicating that deforestation in high latitudes causes cooling, while deforestation in the lower regions results in warming, as well as mid-latitude responses, are unreliable. Previous results had been founded on models of large-scale land cover change that resulted in the removal of trees from whole latitude ranges. Using global climate simulations, we look at the consequences of eliminating 5% to 100% of high-, mid-, and low-latitude forests. While all high-latitude deforestation scenarios lower world mean SAT, low-latitude deforestation is expected to result in the reverse impact, decreasing SAT in low-latitude deforested regions. Mid-latitude SAT responses vary. Deforested regions get dryer and have lower SAT in every model, despite increasing temperatures of the soil in deforested mid- and low-latitude grid cells. When deforestation rates in high latitudes approach 45%, basic net productivity is substantial, and the cold and dry climate after deforestation causes a considerable increase in soil carbon, resulting in a net reduction in atmospheric CO2. The researchers discovered that changes in land cover have an impact on the intricate links between the dynamics of soil carbon and other climatic subsystems in the energy disparity [13].

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Industrial activities

Air pollution is an inherent byproduct of today's economic system that cannot be eliminated, although it may be reduced with strict measures. Pollution can be addressed by both societal and individual actions. There are several causes of air pollution, including factories, fossil fuels, agricultural waste, and other vehicle emissions [14].

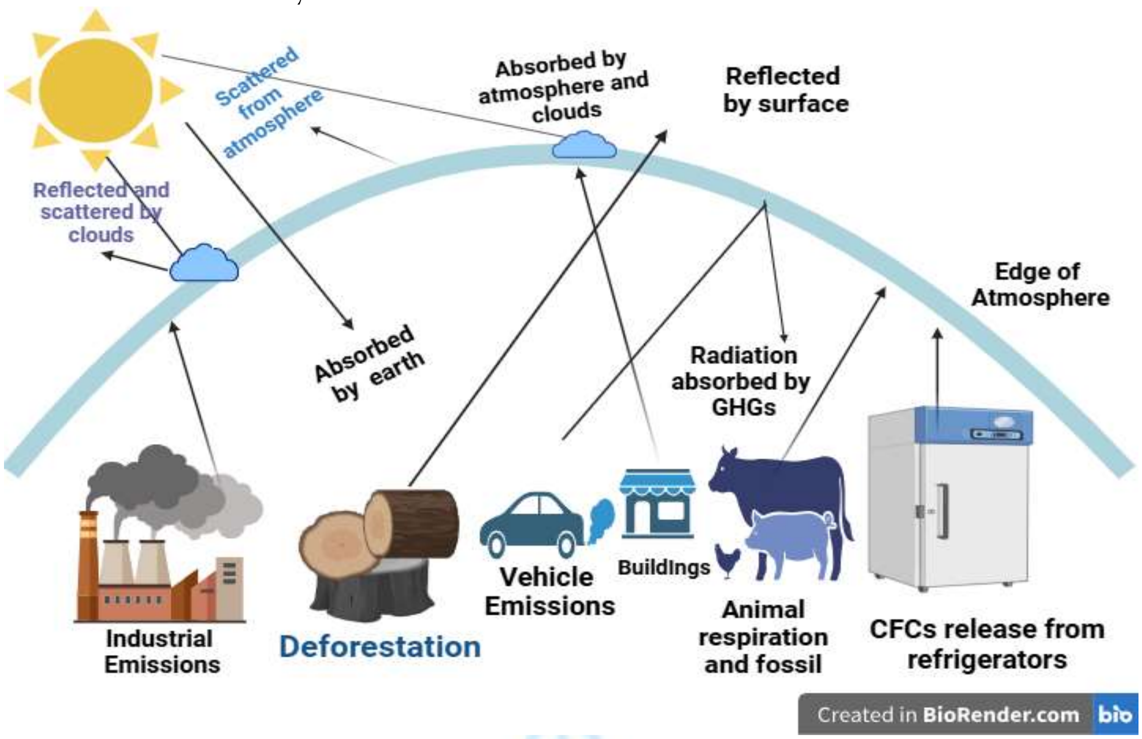

Figure 1 Anthropogenic cause of climate change

Consequences of climate change on health

The World Health Organization estimated that anthropogenic climate change has caused around 150,000 fatalities per year as a result of heat and precipitation patterns during the last 30 years. Climate change has been linked to many prevalent illnesses in people, ranging from death due to cardiovascular and respiratory disorders caused by heat waves to hunger caused by changed spread of infectious illnesses and crop disasters. Climate change is responsible for the disease's growth and recurrence due to a lack of long-term, high-quality datasets in addition to the considerable effect of changes in socioeconomic issues, immunity, and medication resistance. It remains questionable. The investigators stated that there is emerging information that the climate-health relationship raises concerns regarding health in light of future climate change projections and that warming trends in current times have previously grown globally. We're looking at how this is contributing to rising morbidity and mortality in various places of the world. Temperate latitudes, the Pacific and Indian Oceans, Sub-Saharan Africa, and big urban centers are also potentially vulnerable since urban heat island effects can exacerbate severe weather occurrences [15]. The most relevant sources of disease are anthropogenic methane, nitrous oxides, and emitted carbon dioxide along with chlorofluorocarbons. These GHGs are the main cause of global temperature rise, meteorological events such as droughts and storms, and the spread of allergens and infectious agents. Climate change contributes not only to a rise in respiratory and cardiovascular illnesses but also increases the probability of suffering from infectious diseases (such as malaria, typhus, and cholera), cancer, and other afflictive conditions. It is believed that the negative effects of cold

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weather on health, which is mainly illnesses associated with excessive cold exposure like the emergence of bronchopneumonia or articular disorders, can be curbed by global warming [16]. Both comparatively low and high temperatures are linked to diabetes. People with diabetes are more susceptible to heat-related diseases [17].

Impact on skin

Due to climate change ozone layer is depleted, and holes form in the ozone layer allowing UV radiation to reach on earth and directly affect human skin by causing skin cancer, acne, aging, and rashes. It also increases skin sensitization as shown in picture below.

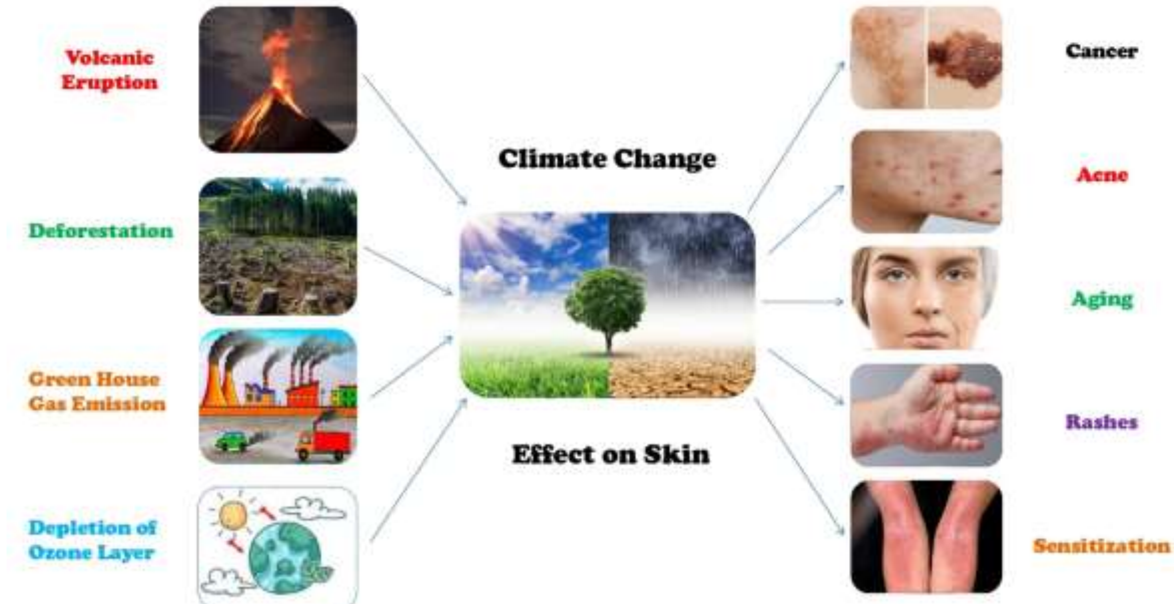

Figure 2 Skin problems caused by climate changes

Impact on cardiopulmonary health

Climate change adversely affects the respiratory and cardiac systems as shown in **Error! Reference source not found.**. The World Health Organization's analysis of climate change and well-being forecasts that, from 2030 to 2050, alterations in the global climate will likely contribute to roughly a quarter of a million extra fatalities annually [18]. The impact of climate change on breathing health occurs through both direct shifts in meteorological conditions and ecosystems, and indirectly by elevating risk factors. These indirect factors encompass heightened air contamination, variations in airborne allergen distribution, spread of respiratory pathogens, land degradation, climate-driven disasters like cyclones, inundations, tempests, and blazes, along with the societal and economic susceptibility of populations. The consequences for breathing health involve worsening of long-term lung disorders, onset of immediate respiratory illnesses including contagions, intensified allergic reactions, and untimely deaths [19].

Impacts of Climate Change on Mental Health

Climate change is expected to have a detrimental influence on substantial portions of the population's psychological well-being [21]. In the present day, one of the most pressing issues is climate change. Most of the scientific community is concerned about the impacts of climate change on vulnerable life forms as well as society. Increased temperature, heat waves, floods, tornadoes, hurricanes, droughts, fires, loss of forests and glaciers, decreased rivers and streams,

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and deserts can negatively affect the physical and mental health of human beings. Still, there is a noticeable lack of psychiatric research on psych-political concerns of climate change. Climate change impacts are immediate and can be unforeseen, as well as distant in time. Sudden extreme events can trigger phenomena comparable to traumatic stress which leads to obviously defined psychopathology symptoms. In addition, the effects of being increasingly exposed to harsh or lengthy weather phenomena may be deferrable leading to post-traumatic stress disorder in some or to future generations [22].

Climate Change & Transmission of Diseases

Climate change has broad implications for human health, although the majority of these consequences remain negative. Climate change has been connected to many prevalent human ailments, ranging from cardiovascular mortality and respiratory disorders brought on by heat waves to hunger caused by changed transmission of infectious diseases and crop failures. The climate-health relationship is an increasing health issue in light of future climate change forecasts, with warming patterns over recent decades already contributing to increased morbidity and death in numerous areas of the globe [15].

Infectious Diseases

Climate change is increasing the worldwide incidence of infectious illnesses and endangering health security [23]. Climate change and unusual weather conditions have an important impact on infectious illnesses. Because infectious pathogens (protozoa, bacteria, and viruses) and their transporters (mosquitoes, ticks, and sandflies) lack thermoregulatory systems, temperature changes have a substantial influence on reproductive and rates of survival.

Climate change and Malaria transmission

Climate influences the distribution and seasonal transmission of malaria because both the vector and the pathogen are temperature-sensitive [24]. Malaria is one of the most common parasite illnesses produced by Plasmodium spp., endangering billions of people in hot and temperate regions. The illness impacted 247 million individuals worldwide and killed 619,000 people in 2021, up from 229 million infections and 409,000 fatalities in 2019 [25, 26]. Climate change's influence on human health has garnered more attention in recent years, with the potential effects of vector-borne illnesses just now becoming clear. Malaria, the most severe vector-borne illness, was responsible for one million fatalities worldwide in 2006 and is anticipated to be particularly vulnerable to climate change because of the sensitivity of its transmission dynamics to climatic circumstances. The biological activity and geographic spread of the malaria parasite and its vector are susceptible to climatic factors, particularly temperature and precipitation [27]. A simple mathematical model is initially used to investigate how temperature affects Anopheles maculipennis' capacity to spread vivax malaria. This suggests that even minor temperature rises at low temperatures might significantly enhance the chance of transmission. This is significant because vulnerable people who are underserved by health care and live in regions with unstable or no malaria are more likely to have subsequent outbreaks. In contrast, locations with steady transmission may be unaffected by rising temperatures. Global warming is thought to produce floods along the coast, changes in precipitation, and, subsequently, changes in land usage. To comprehend how these changes, affect transmission at the local level, one must first understand the ecology of the regional vectors. These are essentially environmental factors that increase the spread of malaria in one mosquito species and can reduce transmission in another [28].

Control of Malaria Transmission

Mosquito populations may drop in areas that get increasingly dry. Upgraded bed net exposure and usage, elimination of still water and mosquito upbringing locations, and enhanced accessibility of active treatments may help (at a cost) to reduce population dangers from malaria direction proliferation [29]. Malaria control efforts in endemic regions can influence imported malaria,

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thus preventative measures are necessary to prevent transmission from resuming in malaria-free areas. Enhanced monitoring and study of genetic diversity in Plasmodium spp. Will help to improve malaria diagnosis and treatment in the future [30].

To combat residual infections, a variety of novel or better vector management measures have arisen, including (1) Improving control by killing, repelling, or removing adult vectors that enter houses to eat or rest. (2) Eliminate or repel adult insects that assault people outside. (3) Kill adult mosquitoes that harm animals (4) Kill grownups who eat sugar. (5) Eliminating immature mosquitos in watery settings.

Over the next decade, concerted efforts will be needed to rigorously select, develop, and evaluate them to control and ultimately eliminate residual malaria transmission. On the other hand, national programs such as the Onchocerciasis Control Program can evaluate strategies to address residual infections in a program setting through pilot studies that include substantial monitoring, evaluation, and operational research components. Malaria control efforts in endemic regions can influence imported malaria, thus preventative measures are necessary to prevent transmission from resuming in malaria-free areas. Enhanced monitoring and study of genetic diversity in Plasmodium spp. Will help to improve malaria diagnosis and treatment in the future [30]. Currently, these solutions lack sufficient evidence to warrant large-scale planned adoption.

Climate Change & Transmission of Dengue Disease

Dengue fever (DF) is a viral illness that has become a major community well-being concern due to a significant increase in incidence worldwide over the past few decades [12, 31]. Population growth, unplanned urbanization, and inadequate mosquito control in urban areas all contribute to the spread of dengue fever [32]. The World Health Organization (WHO) predicts that 2.5 billion individuals are at risk of contamination internationally[33]. Recently updated studies revealed that the burden has increased by up to three times compared to previous WHO estimates [34, 35]. Based on Halstead (2007), female Aedes aegypti is the primary spreader of the dengue fever virus (DENV). It is a member of the Flaviviridae family and, like most viruses, has four serotypes that cause DF, dengue shock syndrome, and, dengue hemorrhagic fever (DENV 1-4) [36]. A dengue preventative vaccine (Sanofi Pasteur's Dengvaxia (CYD-TDV)) was evaluated and registered in several countries, however, the WHO deemed it unsafe for seronegative individuals[37, 38]. Because vaccinations are not safe, preventative and control strategies are the only viable alternatives for reducing dengue. Climate change may increase the prevalence of dengue disease. Dengue fever rates may rise if improved access to tap water leads to increased home water storage. Climate change might have a significant influence on the success or failure of future dengue control initiatives (2013). Climate change is frequently discussed in terms of its implications 50 or 100 years from now. However, recent occurrences indicate that the damage is already underway, considerably sooner than anticipated. Pakistan is witnessing the harshest consequences of climate change, with severe rains causing catastrophic flooding throughout the country. Since the beginning of 2022, Pakistan has received rainfall equal to 2.9 times the national 30-year average. August 2022 was Pakistan's wettest August since 1961. The worst-hit province of Sindh had 726% more rainfall than the August normal [39]. The resultant floods harmed 33 million people, including 16 million children, killed almost 2,000 people, and wounded 13,000 more. 800,000 houses were demolished, and a further 1.3 million were injured. Over two million individuals become dispossessed [39].

Control of Dengue Transmission

Environmental management is one of the popular vector control approaches used to reduce dengue disease in susceptible communities. There is currently no cure for dengue fever, thus focused environmental and ecosystem management is becoming increasingly vital [40]. This study focuses on the current preventative

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and control measures used to battle dengue disease. Although conventional control measures alone provide temporary sustainability, the advent of innovative biotechnological treatments like as germ-free insect technology, paratransgenesis, and genetically modified vector generation has increased the efficacy of traditional strategies. Although large-scale vector control tactics may have limits, emerging vaccine candidates demonstrate promising dengue preventive options. The quadrivalent dengue vaccine (CYD-TDV) is currently the most effective treatment for dengue infections. Nonetheless, obstacles and constraints restrict progress in the development of integrated therapies and vaccinations. As contemporary technology and vaccine formulations advance, we may look forward to a future devoid of the dengue virus [41]. The Vaccines to vaccinate (v2V) effort was recently reformed as the Dengue Control Partnership (PDC), which is now an autonomous multi-sponsor initiative. This shift in direction is consistent with the emerging understanding among dengue preventive experts that no one strategy is sufficient to control dengue disease [42].

Climate change and Lyme disease

Lyme disease is caused by the bacterium Borrelia burgdorferi, which is a complicated pathogenic illness. This virus spreads mostly by the bite of an infected vector (tick). Several variables contribute to understanding the global spread of Lyme disease. According to epidemiological research, Lyme disease frequently develops in shady and grassy locations with significant tick populations. Ticks transmit B. burgdorferi from asymptomatic hosts (rodents), which then spread to humans. Lyme disease is prevalent in the Arctic, and changes in ecosystems and candies are resulting in public health diseases. Symptoms may include fever, influenza, dermatitis, and, if persistent, inflammation of the heart and nerve system. PCR and serological assays for antibodies against Borrelia burgdorferi can be used to diagnose the illness [43].

Control of Lyme transmission

Effective antibiotics such as Augmentin, Vibramycin, and Ceftrex are used according on the stage of illness, patient condition, and therapeutic vaccination approach. One Health's Lyme disease viewpoint combines the well-being of humans, animals, and the environment by offering tick infestation monitoring tools, educational public efforts, and collaboration among researchers to create vaccines [43].

Present and future risks due to climate change to human health

Changes in disaster management are crucial, as current disaster vulnerabilities and dangers are frequently unknown. Climatic, Change, and Risk emphasizes that disaster managers must adjust policies to changing climatic circumstances while continuing to monitor trends to detect substantial changes in risk and respond effectively [44]. The scientific community is overwhelmingly in consensus that social-induced greenhouse gas releases are changing the Earth's climate. Anthropogenic emissions have contributed to the recent 0.5°C (global average) warming. Climate change has a wide-ranging and mostly negative influence on human strength. Recently documented changes in the Earth's climate, to which people have made important contributions, are influencing a wide range of health consequences. These include shifts in the distribution of some disease vectors (ticks in high latitudes, malaria mosquitos at high altitudes), as well as trends in extreme weather events and their accompanying increases in deaths, injuries, and other health repercussions. These include shifts in the distribution of some disease vectors (ticks in high latitudes, malaria mosquitos at high altitudes), as well as trends in extreme weather events and the corresponding increases in deaths, injuries, and other health repercussions. Climate change will exacerbate health issues in vulnerable areas, affect infectious disease epidemics, reduce food yields and nutrition, raise the danger of climate-related disasters, and harm mental health. The health industry must assist society in understanding the health dangers and the appropriate actions [45].

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Conclusion

Climate change may have altered the distribution and abundance of disease-carrying microorganisms such as mosquitoes and ticks. Rising temperatures and increased precipitation can create favorable conditions for these vectors to breed and spread diseases such as malaria, dengue fever, and Lyme disease. Vulnerable populations are at heightened risk, necessitating urgent action to reduce greenhouse gas emissions, strengthen public health systems, and invest in climate-resilient infrastructure that can control malaria by using insecticide-treated bed grids, indoor enduring spurting, and rapid handling of malaria gears. Additionally, eliminating breeding sites for mosquitoes, such as stagnant water, is crucial. We should protect human health and create a more sustainable future by tackling the underlying causes of climate change and implementing effective adaptation strategies. Climate change can amplify the negative effects of other stressors, leading to more serious health consequences, especially for vulnerable populations. Research needs to examine how climate change interacts with other stressors such as air pollution, poverty, and social inequality to amplify health risks.

Recommendations

On a national level, taxes on pollutant emissions introduced, conservation and purification systems must be introduced in countries, and on the international level alarming system should established.

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