Cardio Climatology: An aim to relate climate change with cardiovascular diseases

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Abstract—**In the last decade, communities are becoming more vulnerable to adverse health conditions due to certain changes in the environment by pollution, heat waves, forest fires, loss of green cover, extreme weather conditions and several other climatic factors. Cardiovascular diseases(CVD) are one of the common problems that people of every age group are facing nowadays. The climate-related variables like exposure to cold, heat and heat waves are independently associated with higher rates of these diseases. The mortality and morbidity of CVD are aggravated by occupational heat exposure but are also due to low socioeconomic status, old age, pregnancy, pre-existing health conditions and unfavorable living environments. Each of the factors are directly and indirectly associated with the combined effects of global warming, increasing population, societal status and economic conditions. There are other climatic parameters, such as sunlight hours, atmospheric pressure, wind velocity, humidity, and rain or snow precipitation etc. which are reasonably affecting heart health conditions. The lack of past data on individual exposure to these weather parameters and extensive variation in climate profiles are limiting the study in this domain. The review of this research evaluates and predicts the state-wise CVD counts in India using the various direct and indirect parameters to analyze cardiac health consequences due to climate conditions.**

Keywords—CVD, Pollution, climate change, HDI, ML

I. INTRODUCTION

Climate change is indeed a significant and pressing global issue that poses significant challenges to both the planet and human well-being. It refers to long-term shifts in weather patterns and atmospheric conditions on Earth, primarily caused by human activities, particularly the emission of greenhouse gasses (GHGs) into the atmosphere. There has been an increase in the frequency of cyclones, droughts, incessant rain and flooding, forest fires, dust and sand storms, coastal flooding, hurricanes, avalanches and many other catastrophic events.

Cardiovascular disease is a major global health challenge and is expected to become even more prevalent in the coming years due to an acute change in climate. Exposure to extreme heat can increase the risk of cardiovascular events, such as heart attacks and strokes, particularly in vulnerable populations, including the elderly and those with pre-existing cardiovascular conditions. Climatic changes can worsen air quality by promoting the formation of ground-level ozone and increasing the frequency of wildfires, which release harmful pollutants. Long-term exposure to air pollution is associated with the development and progression of cardiovascular diseases. It can indirectly influence infectious diseases that have cardiovascular implications. For example, climate change can affect the distribution and transmission patterns of vector-borne diseases, such as Malaria or dengue fever, which can lead to complications like myocarditis or vasculitis. Climate change can impact food production and availability, leading to changes in dietary patterns and nutrition. Poor nutrition, including diets high in processed foods, added sugars, and unhealthy fats, is a risk factor for cardiovascular diseases. Chronic stress, anxiety, and depression can increase the risk of cardiovascular diseases. The relationship between climate change and health outcomes is multifaceted, and the specific impacts can vary depending on geographic location, socioeconomic factors, and existing healthcare systems.

The research paper on cardio climatology aims to analyze a comprehensive dataset that includes information on cardiovascular disease rates in multiple regions in India.

II. RELATED WORK

There is inadequate research on relating extreme weather as a potential threat to heart health. Weather forecasting information and action taken is not informed properly to health experts. Insufficient knowledge about CVD and climate change leads to inaccurate and untimely detection of diseases.

In the paper[1], the use of a neural network and big data on global mean monthly temperature in the construction of a top-down model is examined. Based on 30 years of monthly temperature data, the model produces graphical representations that precisely forecast the increase and fall of temperatures during the next ten years.

Paper [2] This paper analyzes global warming using data that has been gathered from the general population. The impacts of various factors on the global temperature are then examined using machine learning methods. The plots produced by the algorithms are also analyzed in the paper[3]. To combat this, a cardio climatology model is proposed for India given the increase in cardiovascular diseases.

Paper[4] suggests the potential for ML to reduce greenhouse gas emissions and help society adapt to a changing climate by collaborating with other fields to fill gaps in areas such as smart grids and disaster management.

According to the paper[5] causes of heat impact are increased cardiac load, reduced blood pressure, prothrombotic conditions, and systemic inflammatory responses. The next section describes the materials and methods used for the implementation of the system.

III. METHODOLOGY

According to the Global Heat Health Information Network, during the first 16 years of the new millennium, the number of people exposed to heat waves increased by 125 million. In addition to heat waves that both last longer and are more frequent, average minimum temperatures are also rising.

Hotter-than-usual temperatures can have serious implications on heart health. In fact, the World Health Organization (WHO) recognizes that temperature affects heart-related mortality more than any other cause of death. In 2019, approximately 18.6 million people died from cardiovascular disease (CVD) worldwide. Factors affecting climate change which directly or indirectly affect cardiovascular diseases include air pollution, extreme temperatures and other extreme weather events(like heat waves, cold spells, etc.) on CVD.Precipitation, humidity, changing wind patterns which leads to periods of air stagnation which can promote the accumulation of CO2 and water vapor pressure levels, PM2.5.The affected subpopulations per area is also an important statistic. All these factors and a wide array of pollutants have the potential to exacerbate disease in individuals with underlying cardiovascular conditions and contribute to the development of disease in those without known CVD. The indirect effects of climate change on cardiovascular health involve multiple complex exposure pathways including access to healthy food and clean water, transportation, housing, electricity, communication systems, medical assistance and other social determinants of health, all of which are essential for the maintenance of cardiovascular health. In this paper, the factors considered for CVD calculation are climatic disasters, PM2.5, Human Development Index(HDI), minimum, average and maximum temperature and health quotient of every state of India. HDI refers to a social economic index calculated based on the population and economic status of every state and health quotient measures a broad variety of health outcomes and risk factors over time and for different states. The data for the research was collected from reliable sources such as government institutions or research organizations. The dataset was analyzed and explored to identify any relationships, trends, or patterns that may exist between different variables as seen in Fig. 1 and are processed for all states. As seen in Fig. 3 and 4, the actual vs. predicted results of all the CVD values in rural and urban regions are plotted and their overall increasing trend can be visualized.

To choose the best regression model based on the research objectives and the nature of the dataset, the performance of different models is compared using evaluation metrics like MSE, R-squared, and RMSE. The performance measures were obtained from a random forest linear regression model where the R-squared score is 0.99 for the chosen model.

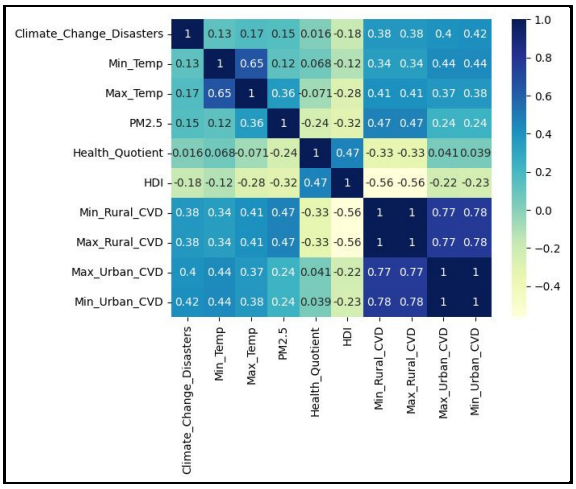

Fig. 1. Correlation of attributes with CVD values

IV. RESULTS AND DISCUSSION

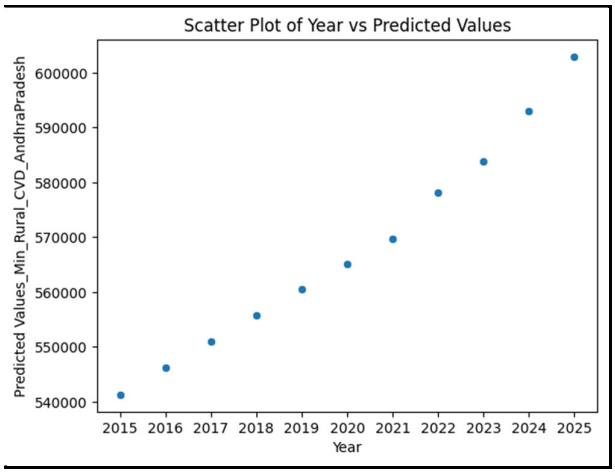

Fig. 2. Scatter plot of Minimum Predicted CVDs in rural regions of Andhra Pradesh

The performance of the above-mentioned machine learning models was evaluated and the fields for future years were compared and analyzed. The results of all the states can be visualized; as an example the CVD predictions for the State of Andhra Pradesh in Fig 2, which shows a considerable increase in values in future. There are many states where awareness, medical benefits and self-care has shown a decreasing trend in CVD

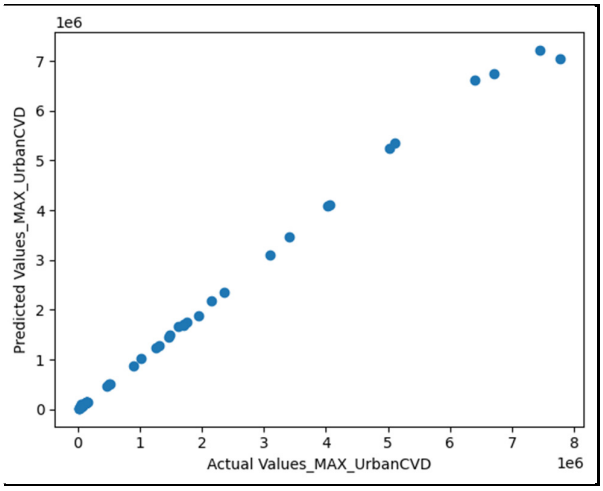

Fig. 3. Plot of Predicted vs. Actual Values for all years in Urban Regions

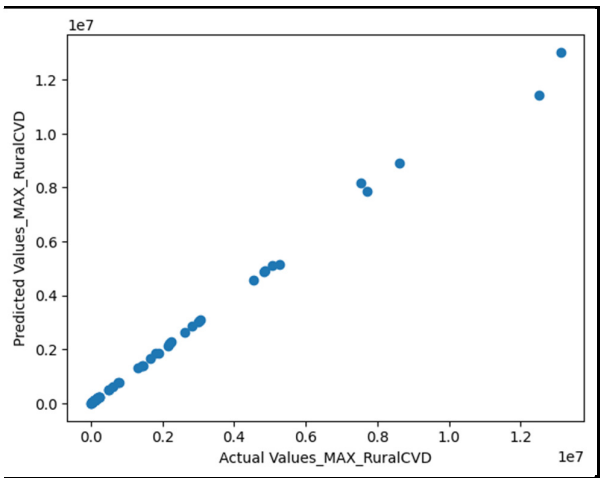

Fig. 4. Plot of Predicted vs. Actual Values for all years in Rural Regions

V. CONCLUSION

The results of this study must influence public health policies and government programs in order to lower the prevalence of cardiovascular disease. They can also make a significant impact on society thus creating awareness of how climate change affects human health. By gaining a better understanding of the relationship between climate variables and all types of cardiovascular diseases, proactive measures to protect the health and well-being of the global population in the face of the climate crisis can be established.

Global warming is a significant cause and contributor to numerous diseases all around the world. In the upcoming decades, it is anticipated that the effects of air pollution, global warming, and individual factors such as age, socioeconomic status, and health status would all work together to increase the number of heat-related fatalities. The general population's risk of cardiovascular disease events has already increased due to climate change, which highlights how urgently the government needs to adopt legislative changes. These environmental changes should be investigated globally.

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A dedicated data enthusiast with a strong aptitude for analysis and interpretation. With a keen eye for detail, I excel in uncovering meaningful insights from complex datasets, transforming raw information into actionable strategies. Their proficiency in data manipulation, visualization, and statistical analysis showcases their ability to navigate and distill intricate information. I'm committed to leveraging their data analysis expertise to inform informed decision-making and drive innovation in various domains.

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