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A Study on the Impact of Climate Change on Health of the Vulnerable Classes in Korea

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Abstract

Purpose. The purpose of this study was to investigate the impact of climate change on public health, particularly focusing on vulnerable populations in South Korea. The study aimed to examine the relationship between climatic variable temperature, precipitation, humidity, and wind speed—and the prevalence of environmental diseases(cardiovascular, respiratory, cancer-related, heat-related illnesses, and mental disorders) across different age groups (1-14, 15-39, and 40+). **Research Design, Data, and Methodology** Using data from meteorological stations and the Health and Medical Big Data Open System, covering the period from 2019 to 2023, the analysis involved statistical methods, including linear regression and correlation analysis, using R software. **Results**: The results showed strong interrelationships among climate variables, particularly negative correlations between precipitation, wind speed, and temperature. However, the correlation between climate factors and health outcomes was generally weak, with only modest associations between temperature and environmental diseases in the elderly population. Additionally, scatter plot analyses confirmed the lack of a significant relationship between temperature and disease prevalence. **Conclusion**: These findings suggest that the health impacts of climate change are likely mediated by additional factors such as socioeconomic disparities, healthcare accessibility, and urban conditions. The study emphasizes the complexity of climate-related health risks, calling for localized, multidisciplinary interventions, such as climate-resilient healthcare systems and infrastructure, to mitigate these challenges. By integrating age-specific analyses, this research provides unique insights and underscores the urgency of proactive measures to protect vulnerable populations from evolving climate-induced health risks.

Keywords : Climate Change, Vulnerable Populations, Public Health Impact, Variables

JEL Classification Code : I12, K32, Q54, Q56

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1. Introduction

Climate change refers to long-term alterations in global temperatures and weather patterns, primarily driven by anthropogenic activities such as the burning of fossil fuels and deforestation. It is characterized by a steady rise in average global temperatures, increased frequency and severity of extreme weather events, and unpredictable climatic variations. These changes have wide-ranging implications, including threats to biodiversity, disruptions in food security, degradation of water resources, and adverse effects on human health. Furthermore, climate change poses significant challenges to global ecosystems, urban infrastructure, and the achievement of sustainable development goals. Currently, an estimated 3.3 to 3.6 billion individuals are highly vulnerable to its impacts, underscoring the critical need for effective mitigation and adaptation strategies (Shivanna, 2022; Nashier & Lakra, 2020; Suleiman et al., 2024; Sarangi, 2023).

The year 2023 was the warmest on record, with a global average temperature of 14.98°C—approximately 1.48°C above pre-industrial levels, based on mid-18th-century baseline data (Copernicus Climate Change Service, 2023). This milestone reflects the continued rise in global temperatures due to increased greenhouse gas concentrations. The warming trend is further accompanied by more frequent and severe heatwaves, posing escalating risks to public health and the environment. Vulnerable populations, such as older adults and infants, face a disproportionate burden, experiencing twice as many heatwave days as compared to 1986–2005. Heat-related deaths among individuals over 65 have increased by 85% since 1990–2000, a trend largely attributed to anthropogenic climate change (Lancet Countdown, 2023; Ki-Hyun Kim et al., 2014).

In addition to heat-related illnesses, climate change exacerbates other health risks, including food insecurity and infectious diseases. Nearly half the global land area experienced extreme drought between 2013 and 2022, a significant increase from 18% in the 1951–1960 period. These conditions jeopardize water availability, sanitation, and agricultural productivity, placing millions at risk of malnutrition. The combination of changing climatic conditions and extreme weather events has also led to a rise in vector-borne diseases such as dengue, malaria, and vibriosis, further compounding health vulnerabilities. With the world on a trajectory toward 3°C of warming, delays in addressing climate change will pose escalating risks to the health and survival of billions of people.

The diverse impacts of climate change disproportionately burden vulnerable populations, including children, middle-aged adults, the elderly, and socioeconomically disadvantaged groups. These communities face heightened exposure to climate-related risks and challenges, making them particularly susceptible to the adverse effects of climate change.

1.1. Classification of diseases associated with climate change

Climate change presents considerable risks to human health, significantly influencing cardiovascular, respiratory, and infectious diseases. Cardiovascular effects include conditions such as hypertension, diabetes, and heart disease, with vulnerable populations at the greatest risk (Giorgini et al., 2017). Respiratory health is adversely affected by exacerbated chronic lung conditions, heightened allergic reactions, and reduced lung function (Gerardi & Kellerman, 2014). Those most at risk include children, older adults, and economically disadvantaged communities (Oyarzún G. et al., 2021). Additionally, climate change accelerates the spread of vector-borne and infectious diseases, while also indirectly impacting mental health through stress and displacement caused by environmental changes (Ki-Hyun Kim et al., 2014). Increasing global temperatures, extreme weather events, and environmental disturbances heighten exposure to carcinogens and established cancer risk factors. These climatic changes negatively influence air quality, water availability, and food security, which may contribute to a rise in cancer incidence. Furthermore, the impacts of climate change extend to cancer care by disrupting healthcare infrastructure and reducing patients' access to essential treatments. These challenges underscore the pressing need to address climate change's implications for public health, particularly its role in exacerbating cancer risks and care accessibility (Hiatt & Beyeler, 2020; Chakraborty, 2021).

Numerous studies have documented the adverse health effects of heatwaves, which amplify the prevalence and severity of heat-related illnesses (Park & Chae, 2020), cardiovascular conditions (Kwon et al., 2015; Kim et al., 2018), respiratory ailments (Anderson, Bell, & Peng, 2013; Liang, Liu, & Kuo, 2009), mental health disorders (Lee, Lee, Myung, Kim, & Kim, 2018), and infectious diseases (Semenza et al., 2012; Baker-Austin et al., 2016). Heatwaves are also linked to increased mortality through various physiological and environmental pathways. For instance, during the extreme heatwave of 2018 in South Korea, over 1,000 fatalities were reported, underscoring the devastating impact of such climatic events on public health.

Recent research has highlighted the substantial and growing impact of climate change on public health in South Korea, with a particular emphasis on the heightened risks faced by vulnerable populations. Rising temperatures and prolonged heatwaves have been linked to an increased incidence of heat-related illnesses, as well as exacerbations of cardiovascular and respiratory conditions (Oh et al., 2023). The extreme heatwave of 2018 in South Korea further underscored these risks, breaking multiple records, including daily maximum and minimum temperatures, the number of heatwave days, and the occurrence of tropical nights (Yang, Yi, Chae, & Park, 2020). Projections derived from Representative Concentration Pathway (RCP) scenarios, particularly RCP 4.5 and RCP 8.5, forecast a marked rise in both the frequency and intensity of heat waves in the coming decades (Kim et al., 2024).

These trends highlight the urgent need to address the health implications of heatwaves, especially among vulnerable groups, aligning with the focus of my study on the public health risks associated with climate change in South Korea.

Particularly at risk are older adults, individuals living alone, and those with lower levels of education, with recent studies showing a significant increase in heat-related mortality within these populations (Park & Chae, 2023). The 2018 heatwave in Seoul had a pronounced impact on mortality rates, particularly among individuals aged 65 and older, with men and those between the ages of 75 and 79 being disproportionately affected (Park, 2024). The association between extreme heat events and elevated mortality rates emphasizes the urgent need for evidence-based public health interventions tailored to safeguard vulnerable populations from the detrimental impacts of climate change. This study seeks to further investigate the complex relationship between climate-related heat exposure and public health outcomes, with a focus on identifying effective strategies to mitigate risks and enhance resilience among at-risk groups in South Korea.

Table 1: Health Data from HIRA Health and Medical Big Data Open System

Disease	Disease Codes
Respiratory Diseases	J00-J99, J00-J06, J09-J11, A15, A16, A19, J44, J431, J432, J438, J439, J12-J18, J93, S270
Cardiovascular Diseases	I20-I25, I42-I43, I50-I52,
Cancer Diseases	C73, D0930, C22, D015, C25, D017, C00-C21, D000-D002, D010-D014, D017, D019, C1650, C1660, C1680, C1690, C1601, C1611, C1621, C1631, C1641, C1651, C1661, C1681, C1691, C1609, C1619, C1629, C1639, C1649, C1659, C1669, C1689, C1699, C18-C20, D010-D012, C53, D06, C54, D070, C56, C64, C67, D090, C61, D075, C62, D076, C400-C403, C408-C414, C418-C419, C49-C496, C498-C499, C43, C44, D04, C460, C840
Mental and Behavioral Disorders	F32, F33, F31,F150,G470 F400, F410, F840, F841, F530, F452, F42, F605, F431, F00-F99, G40-F41, F40, F41, F95, R258, G256, G500, G501, F60, F638, F00-F03, F900, F500, F501, F508
Heat Illness	T67
Environmental Diseases	J30, J45, J46, L20

Table 2: Health Data by Different Age-Group Classification

Disease	Years	Age group 1-14	Age group 15-39	Age group 40 and above
	2019	6555176	10831021	16466778
	2020	5524891	7946583	12977685
	2021	4993515	5640365	9065180
	2022	5513541	8638516	14156829
Diseases of the respiratory system	2023	6053522	10725122	17364343
	2019	1807	29200	1200880
	2020	1449	27618	1215252
	2021	1522	39434	1275736
	2022	2124	36418	1324119
Cardiovascular disease	2023	1789	29637	1388446
	2019	153237	808488	2638114
	2020	151318	880488	2638114
	2021	178628	917004	2844685
	2022	207397	1100303	2998649
Mental and Behavioral Disorders	2023	235363	1167177	2589960
	2019	9474	156055	1625878
	2020	9495	153471	1654395
	2021	9938	159662	1736984
	2022	10341	160144	1813295
Cancer disease	2023	10474	167670	1950407
	2019	2829243	2510891	3691486
	2020	2320577	1940114	3000552
	2021	2225608	1678960	2453594
	2022	2406639	2048775	3103067
Environmental diseases	2023	2722779	2609118	3768771
	2019	1921	4734	14604
	2020	1122	2876	10750
	2021	586	2807	10328
	2022	705	3297	11716
Heat illness	2023	1145	4568	15702

Table 3: Health data by Gender-Specific Classification

Category	Mental Disorders	Respiratory Disease	Environmental Disease	Cardiovascular Disease	Cancer Disease	Heat-illness
Under 5 years old - Other	56520	18645201	2228637	1759	27845	429
Under 5 years old - Female	38558	17034823	2012786	2324	27249	319
5-9 years old - Other	535213	13908787	2089318	1042	43956	227
5-9 years old - Female	179015	12757211	1753090	901	31119	179
10-14 years old- other	576794	6724848	1001284	1121	46517	344
10-14 years old- Female	329253	5655679	747791	814	36349	165
15-19 years old- other	681954	4898555	694444	3088	52967	396
15-19 years old- Female	743461	4057750	541533	1635	35636	305
20-24 years old- other	1010435	2429911	441094	4720	56285	510
20-24 years old- female	1055913	2960529	441077	2396	67836	345
25-29 years old- other	1060085	2632323	453510	9199	80394	640
25-29 years old - female	1486675	3513384	521152	4218	147855	672
30-34 years old- other	976234	2908225	440371	16678	115719	757
30-34 years old- Female	1362193	4522446	607038	6755	281000	652
35-39 years old- other	856484	3334078	434837	33427	169227	775
35-39 years old- Female	1203100	5612119	701781	9982	474562	717
40-44 years old- other	967610	3643748	478276	78677	312753	1017
40-44 years old- female	1350910	5708137	765782	20310	1005715	807
45-49 years old- other	1010488	2991740	414560	134533	445355	1020
45-49 years old- Female	1221133	4358982	621913	35235	1494378	897
50-54 years old- other	1125484	3027162	434067	254744	820473	1387
50-54 years old- female	1340650	4369309	602244	70345	2034481	1171
55-59 years old- other	1086972	2761286	396777	369722	1208294	1583
55-59 years old - female	1291305	4198749	525370	117801	1980500	1441
60-64 years old- other	1375026	3342806	456501	560412	1977320	2015
60-64 years old- Female	1637367	4988488	590282	222988	2271626	2002
65-69 years old- other	1479177	3368890	451079	604611	2222181	1746
65-69 years old- Female	1730773	4291253	519331	293325	1809693	1744
70-74 years old- other	1480955	2793790	370344	531452	2013371	1505
70-74 years old- female	1836284	2989990	375352	339422	1306864	1431
75-79 years old- other	1584719	2318143	302106	462956	1682900	972
75-79 years old- Female	2609043	2244973	287527	373422	1035589	1482
80 years old and above- other	4519466	3220989	356878	614499	2001561	1458
80 years old and above- female	17628334	3832120	462766	1003057	1647835	2724

This paper will address the following key questions related to the impacts of climate change on public health in South Korea.

- How do changing climate variables such as temperature, precipitation, and humidity affect the health of vulnerable populations, including different age groups and gender-specific categories?
- What is the correlation between environmental factors (e.g., temperature, humidity, precipitation) and the incidence of climate-sensitive diseases such as respiratory diseases, cardiovascular diseases, and mental health disorders in South Korea?

By answering these questions, this paper aims to contribute to a deeper understanding of the specific impacts of climate change on public health in South Korea, focusing on vulnerable populations and gender-specific health outcomes.

2. Literature Review

The study by (Veronesi et al., 2022.) demonstrates a clear relationship between climatic variations and the demand for emergency health services among children and adolescents. Through an ecological approach analyzing emergency room visits and meteorological data, the research identified age- and season-specific patterns in health outcomes. Diseases such as acute nasopharyngitis, fever, and bronchopneumonia were more prevalent during specific seasons, with lower temperatures and reduced humidity significantly influencing their occurrence.

D'Amato et al., 2015) studies have highlighted a significant correlation between climate changes and the prevalence of comorbidities, including respiratory diseases and gastrointestinal infections, among others. These changes have also been associated with increased morbidity and mortality rates. According to the study (Kline & Prunicki, 2023), Climate change has emerged as a critical threat to children's respiratory health, with factors such as temperature, humidity, air pollution, and extreme weather events playing significant roles. Evidence indicates that events like heatwaves, wildfires, floods, and hurricanes pose heightened risks to children's respiratory systems. Similarly, Heatwaves significantly impact on the health of vulnerable populations, particularly elderly individuals, as shown by studies examining their effects on body temperature (BT), blood pressure, and sleep disturbances. Research (Kim et al., 2020) conducted during a heatwave revealed that elderly individuals, especially women and those with hypertension, experience increased BT and decreased diastolic blood pressure with rising indoor temperatures. A meta-analysis by Li et al. (2023) demonstrated a strong association between extremely high temperatures and thermal discomfort with an increased risk of mental and behavioral disorders. Climate-related events such as heatwaves, droughts, wildfires, and floods have been linked to heightened psychological distress, deteriorating mental health outcomes, more frequent psychiatric hospitalizations, and elevated suicide rates (Charlson et al., 2021). These impacts can manifest both immediately and over time, with acute climate events often triggering traumatic stress responses (Cianconi et al., 2020).

A study on heat-related mortalities in Korea compared the relative risks of heat days across vulnerable groups (elderly, single-person households, less educated) over two decades, revealing an increased risk in the more recent period (2009–2018), contrary to prior trends of reduced health impacts (Park & Chae, 2023). This finding aligns with my research, which focuses on the effects of climate change on vulnerable populations in South Korea, particularly in relation to heat waves.

A study conducted in Korea quantified the burden of disease attributed to climate change using disability-adjusted life years (DALY), highlighting that heat-related cerebrovascular diseases, which accounted for 72.1% of the total burden in 2008, are projected to significantly increase by 2100(Yoon, Oh, Seo, & Kim, 2014). This study aligns with my research, which explores how climate factors like temperature and heatwaves affect vulnerable populations in South Korea, particularly in relation to respiratory and cardiovascular diseases. By assessing these impacts, my study aims to extend understanding of the broader health consequences of climate change, informing environmental health policy for vulnerable groups.

These findings provide valuable insights into how climate factors contribute to disease burden in vulnerable populations. Building on this evidence, my study explores the broader impact of climate change on health outcomes in vulnerable groups, focusing on age and gender disparities. By integrating climate variables and health data, this research aims to identify critical links between climate conditions and the prevalence of various diseases, contributing to the development of targeted public health interventions and adaptation strategies in the face of climate variability.

3. Material and Methods

3.1. Data Sources and Collection

In this study, climate and health data were sourced to examine the health impacts of climate change on vulnerable populations in South Korea. The climate data, specifically temperature, precipitation, and humidity records, were obtained from meteorological stations, providing a comprehensive set of annual data for the years 2019 to 2023. Health data were acquired from the Health and Medical Big Data Open System, which includes detailed information on various diseases over the same five-year period. The health data are categorized based on disease type, with (Table) 1 listing diseases and their corresponding codes. These include cardiovascular diseases (e.g., arrhythmias, ischemic heart disease, acute myocardial infarction), respiratory diseases (e.g., asthma, chronic obstructive pulmonary disease), mental disorders (e.g., anxiety, depression, dementia), cancer diseases (e.g., lung cancer, liver cancer, thyroid cancer, ovarian cancer), environmental diseases (e.g., allergic rhinitis, asthma persistence), and heat-related illnesses (e.g., heat stroke, dehydration).

For analysis, the data were divided into three age groups: children (under 5 to 14 years), middle-aged adults (15 to 39 years), and elderly adults (40 years and above). (Table 2 and Table 3) present the classification of health data by age group, gender, and disease category. Gender-specific data were also considered to assess differences between males and females across these age groups.

3.2. Statistical Analysis

3.2.1. Linear Regression

Data processing, analysis, and visualization were conducted using R software. Climate data (temperature, precipitation, humidity, and wind speed) and health-related data (general and gender-specific health outcomes) datasets were stored in Excel format. Using the [readxl] package in R, the data were imported into the R environment. The climate and health datasets were merged by the common variable Year to create two comprehensive datasets for general and gender-specific health outcomes.

In this study, we adopted two models for statistical analysis. Linear regression models were developed to assess the impact of climate variables on specific health outcomes, such as environmental diseases. Separate models were created for general health outcomes and gender-specific outcomes, focusing on vulnerable age groups. The [lm] function in R was employed to estimate the coefficients, measure statistical significance, and identify relationships between the dependent (health outcomes) and independent (climate) variables.

Predicted values were generated using the regression models to better understand the trends. Visualization was carried out using the [ggplot2] package to create scatter plots with overlaid regression lines, highlighting the relationships between variables.

3.2.2. Correlation Analysis

Correlation matrices were calculated to explore relationships among climate variables and health outcomes. The [corrplot] package was used to create visually intuitive heat maps, showing the strength and direction of correlations between variables.

The analysis was conducted using R software, leveraging libraries such as [ggplot2] for visualization, [dplyr] and [tidyr] for data manipulation, and [corrplot] for heatmap generation.This systematic approach enabled the identification of significant climate factors affecting public health outcomes, providing insights for addressing the vulnerabilities associated with climate change in South Korea

4. Results and Discussion

Table 4: Correlation Matrix of Climatic Variables and Health Outcomes Across Age Groups

Variable	Temperature (°C)	Precipitation (mm)	Humidity (%rh)	Wind Speed (m/s)	Age Group 1-14	Age Group 15-39	Age Group 40+
Temperature (°C)	1	-0.83	-0.54	0.85	0.015	0.0027	-0.008
Precipitation (mm)	-0.83	1	0.68	-0.91	-0.021	-0.0053	0.0093
Humidity (%rh)	-0.54	0.68	1	-0.86	-0.036	-0.043	-0.032
Wind Speed (m/s)	0.85	-0.91	-0.86	1	0.02	0.0033	-0.0097
Age Group 1-14	0.015	-0.021	-0.036	0.02	1	0.96	0.93
Age Group 15-39	0.0027	-0.0053	-0.043	0.0033	0.96	1	0.99
Age Group 40+	-0.008	0.0093	-0.032	-0.0097	0.93	0.99	1

1: Perfect positive correlation (variables increase together), 0: No correlation, -1: Perfect negative correlation (one variable increases, the other decreases).

The correlation heatmap reveals significant interrelationships among climatic variables and their potential associations with health outcomes across different age groups (1-14, 15-39, and 40+) (Table 4)(Figure 1). Temperature exhibited a strong negative correlation with precipitation (-0.83) and humidity (-0.54), indicating that higher temperatures are associated with reduced precipitation and humidity levels. Conversely, temperature showed a strong positive correlation with wind speed (0.85), suggesting that warmer conditions are linked to stronger winds. However, temperature displayed minimal correlation with health outcomes in all age groups, with values close to 0.015, 0.0027, and -0.008 for the 1-14, 15-39, and 40+ age groups, respectively, suggesting limited direct influence on disease prevalence. Precipitation demonstrated a strong positive relationship with humidity (0.68) and a strong negative relationship with wind speed (-0.91), indicating that wetter conditions are associated with higher humidity but lower wind speeds. Similar to temperature, precipitation showed no meaningful correlation with health outcomes, with weak values of -0.021, -0.0053, and 0.0093 across the three age groups. Humidity also exhibited a strong negative correlation with wind speed (-0.86), while its correlations with health outcomes were weak (-0.036, -0.043, and -0.032). Wind speed, like other climatic variables, showed negligible correlations with health outcomes (0.02, 0.0033, and -0.0097). Interestingly, the strongest correlations were observed among health outcomes across the three age groups, with values ranging from 0.96 to 0.99. This indicates that health trends in one age group are strongly related to those in others, suggesting the presence of shared systemic or environmental determinants. Overall, the results highlight strong interdependencies among climate variables but weak direct correlations between climate factors and health outcomes.

The scatter plot examining the impact of temperature on environmental diseases (cardiovascular, respiratory, cancer-related, heat-related illnesses, and mental disorders) in individuals aged 40+ further supports the findings from the correlation analysis (Figure 2). The plot demonstrates no significant trend or strong association between the two variables, as reflected by the nearly flat regression line. The distribution of actual data points around the predicted values indicates high variability, with temperature contributing minimally to the prediction of disease prevalence. This suggests that other factors, possibly non-climatic, may play a more prominent role in determining health outcomes for this demographic. The observed weak correlations between climatic variables and health outcomes in this study align with existing literature that highlights the importance of socio-economic and demographic factors in moderating the impacts of climate-related hazards. Neumayer and Plümper (2007) demonstrated that women are disproportionately affected by extreme events such as floods, droughts, and heatwaves, with disaster-related mortality rates higher for women than for men in countries where women have low socio-economic status. This gender disparity is linked to socially constructed vulnerabilities rather than physical differences and underscores the interplay between socio-economic patterns and climate risks. Their findings suggest that life expectancy reductions caused by natural disasters are more pronounced in women, especially in societies where gender disparities are prevalent. In contrast, other research by (Gifford et al., 2019) has observed a reduced overall rate of heat illness (HI) in women compared to men at the population level, encompassing deaths, hospital admissions, and mild HI cases over four decades. The higher rate of HI and related mortality in men is attributed to behavioral differences, such as delayed reporting of symptoms, less protective behavior, and reduced perception of HI risk. These findings suggest that men may benefit from adopting strategies traditionally practiced by women, such as earlier symptom recognition and better protective practices, as global temperatures continue to rise.

Overall, the results highlight the complexity of the relationship between climate and health. While climatic variables such as temperature, precipitation, and humidity are strongly interrelated, their direct influence on environmental diseases appears limited. The strong correlations observed among health outcomes across different age groups suggest the presence of broader, shared determinants that may not be directly climate-dependent. These findings underscore the need for further analysis incorporating additional variables, such as air quality, socioeconomic conditions, and healthcare access, to better understand the multifaceted nature of climate-sensitive health outcomes

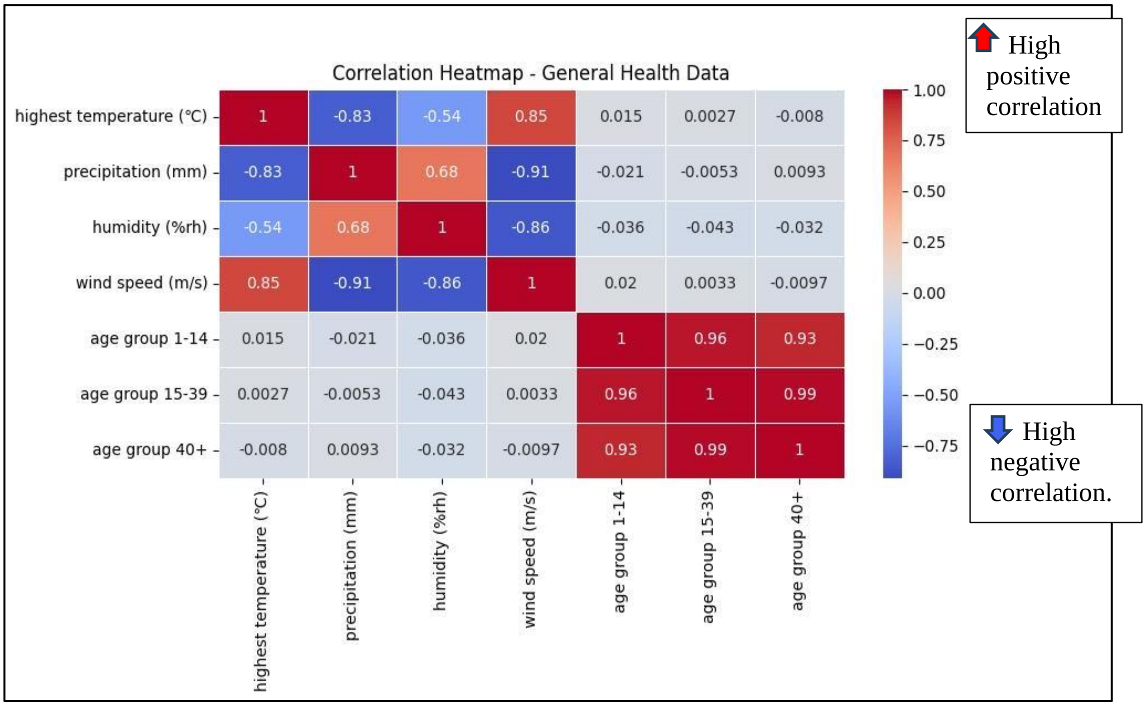

Figure 1: Correlation Heatmap of Climatic Variables and General Health Outcomes

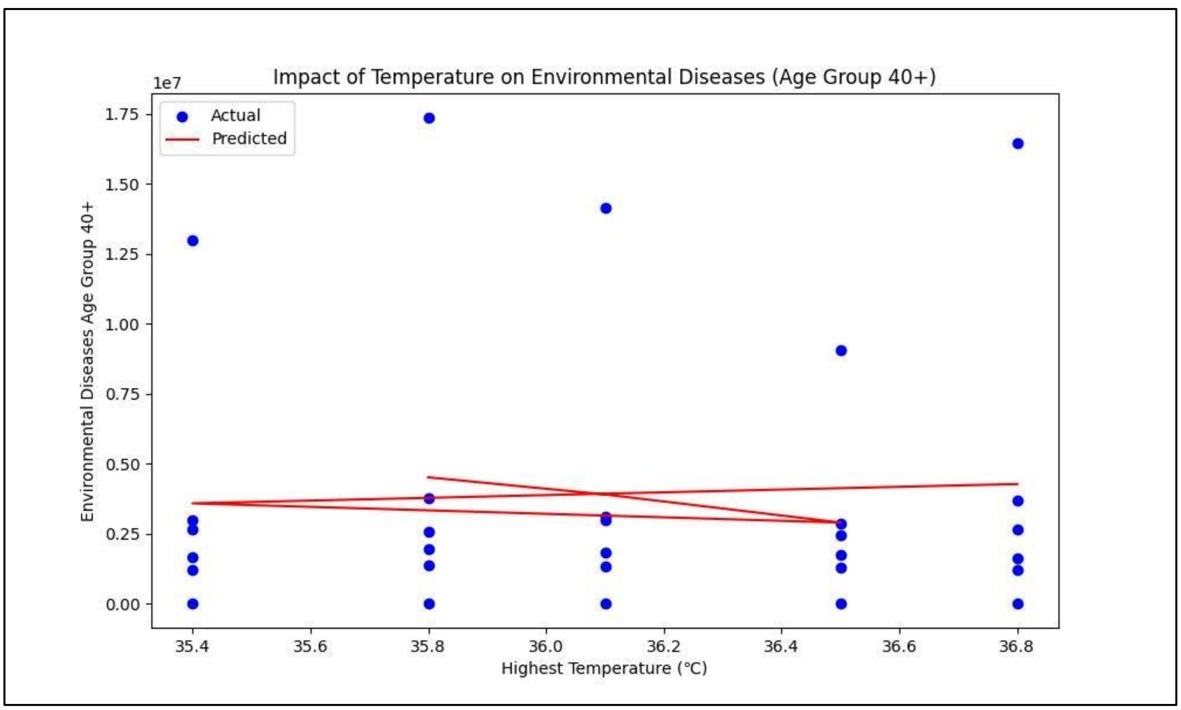

Figure 2: Impact of Temperature on Environmental Diseases (cardiovascular, respiratory… diseases) in Age Group 40+

5. Conclusions

In conclusion, this study provides critical insights into the complex relationship between climatic variables and public health outcomes, focusing on vulnerable populations in South Korea. While climatic factors such as temperature, precipitation, humidity, and wind speed are strongly interrelated, their direct influence on the prevalence of environmental diseases is limited, as evidenced by weak correlations and non-significant trends in regression analyses, particularly for older populations. These findings suggest that the health impacts of climate change are likely mediated by additional factors, such as socioeconomic disparities, healthcare accessibility, and urban environmental conditions, rather than by direct climatic effects alone.

This research makes a unique contribution by integrating age-specific analyses within the South Korean context, highlighting shared systemic or environmental factors that drive health outcomes across age groups. These results emphasize the urgent need for policymakers to adopt localized, climate-adaptive interventions, such as enhancing healthcare services for at-risk populations, improving urban planning to mitigate heat and pollution risks, and building resilient infrastructure to withstand extreme weather events. Furthermore, addressing socioeconomic inequities and improving public awareness of climate-related health risks should be key components of these strategies.

Although the study focuses on South Korea, the findings resonate with global challenges posed by climate change, demonstrating the universal need for multidisciplinary and context-sensitive approaches to public health. Future research should expand upon these results by incorporating additional factors such as air quality, socio-economic data, and behavioral adaptations, to better understand the pathways through which climate change affects health. This study underscores the urgency of proactive measures to protect vulnerable populations from the evolving health risks of a changing climate.

6. Limitations

This study has several limitations that must be acknowledged. First, the analysis relies primarily on aggregated data, which may mask underlying variations at the regional or individual levels. The use of city-level and national datasets limits the ability to capture localized impacts of climate change on health outcomes, which could vary significantly based on geographic, socioeconomic, or infrastructural differences.

Second, while the study focuses on climatic variables such as temperature, precipitation, humidity, and wind speed, other critical environmental factors like air pollution, extreme weather events, and urban heat island effects were not included. These factors could significantly influence health outcomes and interact with climatic variables in ways that were not accounted for in this analysis. Third, the health data used in the study were aggregated by age and gender, which, while helpful for broad comparisons, may overlook differences within subpopulations, such as occupational exposures or pre-existing health conditions. Additionally, potential confounding variables, such as healthcare access, dietary habits, or socioeconomic status, were not incorporated into the model, which could limit the explanatory power of the findings. Lastly, the temporal scope of the study is constrained by the availability of historical data, and the study assumes linear relationships between climatic variables and health outcomes. However, the impacts of climate change on health are often non-linear and may involve delayed or cumulative effects that cannot be fully captured through this approach. Future research should aim to address these limitations by using more granular data, incorporating additional variables, and exploring non-linear models to provide a more comprehensive understanding of the interactions between climate change and public health.

References

Anderson, G. B., Bell, M. L., & Peng, R. D. (2013). Heat-related emergency hospitalizations for respiratory diseases in the Medicare population. American Journal of Respiratory and Critical Care Medicine, 187(10), 1098–1103.

Baker-Austin, C., et al. (2016). Heat wave-associated vibriosis, Sweden and Finland, 2014. Emerging Infectious Diseases, 22, 1216–1220.

C3S (Copernicus Climate Change Service). (2024). The 2023 annual climate summary: Global climate highlights 2023

Chakraborty, P. (2021). “Climate change”: A potential risk factor for cancer? Cambridge Open Engage. https://doi.org/10.33774/coe-2021-c44zr

Charlson, F., Ali, S., Benmarhnia, T., Pearl, M., Massazza, A., Augustinavicius, J., & Scott, J. G. (2021). Climate change and mental health: a scoping review. International journal of environmental research and public health, 18(9), 4486.

Cianconi, P., Betrò, S., & Janiri, L. (2020). The impact of climate change on mental health: a systematic descriptive review. Frontiers in psychiatry, 11, 490206.

D’Amato, G., Holgate, S. T., Pawankar, R., Ledford, D. K., Cecchi, L., Al-Ahmad, M., & others. (2015). Meteorological conditions, climate change, new emerging factors, and asthma and related allergic disorders: A statement of the World Allergy Organization. World Allergy Organization Journal, 8(1),

Gahlawat, I. N., & Lakra, P. (2020). Global Climate change and its effects. Integrated Journal of Social Sciences, 7(1), 14-23.

Gifford, R. M., Todisco, T., Stacey, M., Fujisawa, T., Allerhand, M., Woods, D. R., & Reynolds, R. M. (2019). Risk of heat illness in men and women: A systematic review and meta-analysis. *Environmental Research, 171*, 24–35.

Giorgini, P., Di Giosia, P., Petrarca, M., Lattanzio, F., Stamerra, C. A., & Ferri, C. (2017). Climate changes and human health: a review of the effect of environmental stressors on cardiovascular diseases across epidemiology and biological mechanisms. Current pharmaceutical design, 23(22), 3247-3261.

Hiatt, R. A., & Beyeler, N. (2020). Cancer and climate change. The Lancet Oncology, 21(11), e519-e527.

Kim, D., et al. (2024). Risks of heat waves in South Korea using structural equation modeling and entropy weighting. Stochastic Environmental Research and Risk Assessment, 29(4), 19–

Kim, K. H., Kabir, E., & Ara Jahan, S. (2014). A review of the consequences of global climate change on human health. Journal of Environmental Science and Health, Part C, 32(3), 299-318.

Kim, S., Kim, S. Y., Oh, J., Chae, Y., Park, J., Kim, D., & Kim, Y. M. (2020). Effects of the 2018 heat wave on health in the elderly: implications for adaptation strategies to climate change. Environmental Analysis, Health and Toxicology, 35(4).

Kline, O., & Prunicki, M. (2023). Climate change impacts on children's respiratory health. Current opinion in pediatrics, 35(3), 350-355.

Kwon, B. Y., Lee, E., Lee, S., Heo, S., Jo, K., Kim, J., & Park, M. S. (2015). Vulnerabilities to temperature effects on acute myocardial infarction hospital admissions in South Korea. International journal of environmental research and public health, 12(11), 14571-14588.

Lee, S., Lee, H., Myung, W., Kim, E. J., & Kim, H. (2018). Mental disease-related emergency admissions attributable to hot temperatures. Science of the Total Environment, 616–617, 688–694.

Li, D., Zhang, Y., Li, X., Zhang, K., Lu, Y., & Brown, R. D. (2023). Climatic and meteorological exposure and mental and behavioral health: A systematic review and meta-analysis. Science of the Total Environment, 892, 164435.

Liang, W. M., Liu, W. P., & Kuo, H. W. (2009). Diurnal temperature range and emergency room admissions for chronic obstructive pulmonary disease in Taiwan. International Journal of Biometeorology, 53(1), 17–23.

Neumayer, E., & Plümper, T. (2007). The gendered nature of natural disasters: The impact of catastrophic events on the gender gap in life expectancy, 1981–2002. *Annals of the association of American Geographers*, *97*(3), 551-566.

Oh, J.-e., Kim, A.-y., Kang, S.-w., & Kim, H. (2023). Climate change health impact review: Focusing on health risks. Journal of the Korean Society for Climate Change, 14(6-1), 859–869.

Park, C. Y. (2024). The 2018 Heat Wave's Impact on the Mortality of Older People in Seoul, South Korea. Social work in public health, 39(5), 478-496.

Park, J., & Chae, Y. (2020). Analysis of heat-related illness and excess mortality by heat waves in South Korea in 2018. Journal of the Korean Geographical Society, 55(4), 391–408.

Park, J., & Chae, Y. (2023). Analysis of time-dependent effects of ambient temperatures on health by vulnerable groups in Korea in 1999–2018. Scientific Reports, 13(1), 922.

Romanello, M., Di Napoli, C., Green, C., Kennard, H., Lampard, P., Scamman, D., ... & Costello, A. (2023). The 2023 report of the Lancet Countdown on health and climate change: the imperative for a health-centred response in a world facing irreversible harms. The Lancet, 402(10419), 2346-2394.

Sarangi, U. (2023). Impact of climate change on global ecosystem and SDGs. International Journal of New Economics and Social Sciences IJONESS, 17(1), 49-72.

Semenza, J. C., et al. (2012). Climate change impact assessment of food- and waterborne diseases. Critical Reviews in Environmental Science and Technology, 42, 857–890.

Shivanna, K. R. (2022). Climate change and its impact on biodiversity and human welfare. Proceedings of the Indian National Science Academy, 88(2), 160-171.

Usman, S., Jayeoba, J. O., & Kundiri, A. M. (2024). Climate Change at a Global Concept: Impacts and Adaptation Measures. International Journal of Environment and Climate Change, 14(6), 445-459.

Veronesi, L. B., Martin, J. G., da Silva, G. P., Prieto, M. L. R., do Valle, A. P., Villas-Boas, P. J. F., & Corrente, J. E. (n.d.). The impact of climate change on the demand of children and adolescents for emergency services.

Yang, H.-J., Yi, C., Chae, Y., & Park, J. (2020). Comparison of statistical interpolation methods for downscaling of summer temperature data from the Korea Meteorological Administration's digital forecasts. Journal of the Association of Korean Photo-Geographers, 29(1), 19–

Yoon, S. J., Oh, I. H., Seo, H. Y., & Kim, E. J. (2014). Measuring the burden of disease due to climate change and developing a forecast model in South Korea. Public Health, 128(8), 725-733.