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Extreme Climate Changes: Effect on Acute Heart Diseases at Assiut University Heart Hospital

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Abstract

Background: There are numerous detrimental impacts of climate change on health, including heart health. The elderly, those with pre-existing medical illnesses including acute heartdisease, and those who have physically demanding jobs are especially at risk. **Aim:** The aim of this study was to assess effect of climate changes on acute heart diseases at Assiut University Heart Hospital. **Research design:** The study design used was descriptive and correlational. **Setting:** The study was carried out in the emergency heart unit and the coronary care unit, At Assiut University Heart Hospital. **Patients:** This study included 130 adult patients, both male and female, with acute cardiac diseases. **Tools:** Three instruments were employed: the patient outcomes tool, the assessment sheet for climatic changes, and the assessment sheet for acute cardiac diseases. **Results:** It was noted that three fifths of the studied patients (60.8%) were admitted to the coronary care unit during the summer. Additionally, research showed that temperature and partial thromboplastin time had a positive link (p=0.007). **Conclusion:** The study's conclusion was that a majority of the patients diagnosed with ST-Elevation myocardial infarction and who were hospitalized to the coronary care unit during the summer were from rural areas. Furthermore, there was a positive correlation between temperature and partial thromboplastin time. The length of stay in the cardiac intensive care unit was positively impacted by the rain and temperature. **Recommendation:** According to the current study, additional research is required to assess the consequences of climate change on individuals with acute heart diseases.

Keywords: Acute heart diseases, Climate changes & Extreme

Introduction

Severe climate change can have a direct negative impact on health by increasing the risk of heatstroke or dehydration, or it can have an indirect effect by exacerbating conditions like kidney, pulmonary, cardiovascular, or electrolyte imbalances **(Masson-Delmotte et al., 2021)**. People with pre-existing medical conditions, particularly those connected to the heart, are more vulnerable to heat-associated illnesses, which can result in more visits to emergency rooms and cardiac intensive care units. The risk of heat-related acute cardiovascular disease events, such myocardial infarction (MI), is increased by age, socioeconomic level, and underlying medical problems. **(Peter & Schneider, 2021) .**

Heat stress causes the body to react physiologically to variations in core body temperature, which increases cutaneous blood flow and perspiration. In reaction, the sympathetic nervous system kicks in to keep the heart pumping by increasing cardiac efforts in a way that makes the heart and stroke volume bigger. Rising or falling respiratory rates, vasodilatation, and coagulation **(Chen et al., 2018).** These alterations may result in abnormalities in the heart's autonomic nervous system, raise local blood pressure, produce systemic inflammation, and compromise coagulation reactions. When combined, these hemostatic disturbances may make susceptible people more likely to have atherosclerotic plaque rupture and subsequent myocardial infarctions **(Claeys et al., 2017).** Likewise, people who have heart failure and a low left ventricular ejection fraction are probably not going to be able to make up for the increased circulatory demand brought on by being in the heat **(Watts et al., 2019)**.

Blood pressure levels have also been related to brief variations in temperature. Research conducted on a variety of people and climates has shown that blood pressure and temperature are inversely correlated. An rise of 0.26 mmHg in the systolic and 0.13 mmHg in the diastolic blood pressure was linked to a 1 °C drop in the mean outside temperature75 **(Roth et al., 2020)** In people with preexisting cardio vascular illness, temperature swings had a greater impact on blood pressure levels. It is interesting to note that research indicates summertime blood pressure is greater than wintertime blood pressure, which raises the possibility that warmer temperatures could have the opposite effect and undermine established cardio protective mechanisms **(Bunker et al., 2016)**. Higher blood pressure levels may occur several hours later in the afternoon due to warmer nights. Furthermore, lower plasma levels of high density lipoprotein (HDL) and greater levels of low density lipoprotein (LDL) were linked to increases in mean ambient temperature (**Guo et al., 2016).**

Acute heart failure (AHF) has been found to be a separate predictor of death from heatstroke. Individuals suffering from heart failure may find it difficult to adapt to the elevated cardiovascular demands brought on by prolonged exposure to heat **(Khraishah et al., 2022)**. Patients with heart failure (HF) may be more susceptible to in-hospital mortality and heat-related sudden death due to peripheral oedema, arrhythmias, and increased cardiac strain and output. Higher temperatures were linked to higher B-type natriuretic hormone levels in HF patients **(Tegene, 2022)**.

It has been demonstrated that heat and heart medications may interact. Heat can impact drug distribution, absorption, and excretion, which can impact the therapeutic in response **(Honda et al., 2016).** Furthermore, heat may affect how the body adapts to drugs, increasing the chance of adverse medication reactions. For instance, the effects of cardiovascular medications that lower blood pressure can be markedly enhanced by heat-related vasodilation. This could lead to myocardial ischaemia or syncope with potentially dangerous consequences **(Kuch et al., 2021)**.

Significance of the study:

Numerous detrimental consequences of climate change on health exist, one of which is cardiac health. Individuals who are physically demanding in their employment, elderly, or have pre-existing medical issues such as acute cardiovascular illness (including acute heart failure) are more susceptible than others. However, the temperature-induced increase in mortality from acute cardiovascular system illnesses may be explained by variations in blood pressure, blood viscosity, and heart rate related to physiological responses to cold and warmth. Consequently, if temperature fluctuations are greater than what the cardiovascular system can tolerate, the risk of death will be significantly elevated **(Peter & Schneider, 2021).**

About 390 patients were diagnosed with acute coronary syndrome (ACS), acute heart failure (AHF), and arrhythmia in October and November 2021 at the Assiut Heart Hospital, compared to 407 patients who were hospitalized to the coronary care unit (CCU) and emergency heart unit in July and August of 2022. Extreme climate change may be the cause of the rise in acute cardiac disease. In the prevention of cardiovascular disease, climate change should be taken into consideration as a modifiable risk factor due to its association with an increasing incidence of acute cardiac disorders. To further our understanding of the direct and indirect effects of weather and environment on acute cardiac disorders, more research is necessary. Thus, the purpose of this research is to evaluate how severe climate change affects acute heart attacks**.**

Aims of the study:

Assess effect of climate changes on acute heart diseases at Assiut University Heart Hospital.

Research question:

- What is the incidence of acute heart diseases associated with severe seasonal climate changes?
- What is the effect of extreme climate changes on acute heart diseases?

Research design:

In the current study, a descriptive and correlational research design was used**.**

Setting

At Assiut University Heart Hospital, the coronary care unit and emergency heart unit served as the study's locations.

Subjects: 130 adult male and female patients with acute heart illnesses (Acute coronary syndrome, Acute heart failure, cardiac arrhythmia) who were age-grouped to be between 18 and 65 years old were selected at convenience**.**

Calculation of sample size:

$$n = \frac{np(1-p)}{n-1(d^2 \div z^2)+p(1-p)}$$

n=sample size.

Z=level of confidence according to the standard distribution (for a level of confidence of 95 %, z=1.96).

P=estimated proportion of the population that presents the characteristics of the study sample (when unknown we use p=0.5).

d=tolerated margin of error (for example we want to know the real proportion within 5%) =0.05.

Inclusion criteria:

Patients (18-65 years), with acute heart diseases

Execlusion criteria:

- Patients age below 18 years.
- Patients have neuromuscular diseases.
- Patients have chronic heart diseases.

Study tools:

The researcher in this study created and employed three instruments to look at how severe climate changes affect acute heart attacks.

First tool: patient assessment sheet for acute heart diseases:

The researcher created this tool following an evaluation of relevant literature **(Roth et al., 2020).** In order to create baseline data that could be compared, it was utilized to evaluate the investigated patients' demographics, clinical information, and homodynamic status. There were three primary components to this tool Part I: Demographic and clinical data sheet: demographic data included patient's code, age, sex, occupation, site of work, and living environment. **Clinical data involved**: The patient's diagnosis, medical background, prior hospitalization history, intensive care unit admission history, and the month of admission.

Part II: Hemodynamic state assessment: Evaluation of the hemodynamic state this section included oxygen saturation, blood pressure, and pulse. Apart from breathing and body temperature.

Part III: laboratory investigations:

This part included data related to the results of laboratory investigations (cardiac enzymes: Creatine Kinase (CK), Creatine Kinase MB (Blood) (CK-MP), troponin), Prothrombin time (PT), Partial Thromblastin Time (PTT), International Normal Ratio (INR), arterial blood gases (ABG) and low density lipoproteins and high density lipoproteins.

Tool two: Climate changes assessment tool:

The investigator created this instrument subsequent to examining pertinent literature **(Watts et al., 2019)**. It was applied in order to evaluate how acute heart attacks were affected by global warming. Temperature, humidity, and precipitation totals were measured. Egyptian Meteorological and Weather Authority captured it.

Tool three: Assessment patients outcomes questioner:

The researcher created this tool following a review of relevant literature **(Sun et al., 2018)**. By keeping track of the dates of admission and discharge, it was possible to evaluate the morbidity, mortality, and duration of stay in the cardiac intensive care unit.

Method:

Three phases comprised the conduct of this study:

Phase one: Preparatory phase:

- The researchers were started the study after evaluating relevant literature, including textbooks and journals.
- **Ethical consideration:**
  - The Ethics Committee of the Faculty of Nursing at Assiut University authorized the research proposal on (2022/12/25), with ID approval (1120240538).
  - There is no danger to the research subjects when the study is being applied.
  - The study adhered to standard ethical guidelines for clinical research.
  - After clarifying the purpose of the study, the responsible authorities at Assiut University Heart Hospital granted official permission to conduct the research.
- The patients under study provided written consent. It contained information about the purpose of the study and possible advantages associated with participation, as well as the option to decline participation. Throughout the study's execution, patient privacy, anonymity, and confidentiality of the data gathered were protected.
- **Tool validity:** The instruments were assessed for relevance, intelligibility, and usefulness by a panel of five Assiut University professionals in critical care and emergency nursing as well as cardiovascular medicine. The researcher modified certain things in response to their feedback.
- **The reliability of the tools** were evaluated using Cronbach's Alpha (0.922, 0.923, 0.922, respectively) to determine the three tools' consistency and stability.
- **Pilot study:** A pilot study was conducted on 10% of patients (13 patients) in previous mentioned setting and not included in the study.

Phase (II): Assessment phase

- All admitted patients to the previously mentioned units who fulfilled the requirements for inclusion were added to the research.
- In this stage, the investigator assessed the patients under study from the moment of admission and documented patient demographics and clinical information prior to any data gathering by extracting this data from the patient's sheet using tool 1 (Part 1).
- The investigator assessed the patients' homodynamic condition (blood pressure, oxygen saturation, and pulse). Additionally, for the first 48 hours following admission, use tool 1 (part 2) to measure temperature and respiration every four hours to evaluate the impact of extreme climate change on homodynamic state.
- Laboratory investigations: The research was recorded results of the laboratory investigations in the first 48 hours of patient's admission. Laboratory investigations which included (cardiac enzymes, troponin, Prothrombin time, Partial Thromblastin Time, International Normal Ratio, arterial blood gases and low density lipoproteins and high density lipoproteins.
- Climate changes assessment sheet: The research documented atmospheric temperature, humidity, and rain fall daily based on the Egyptian Meteorological and Weather Authority.

Phase (III): Evaluation phase

At this phase of the study, the length of the patients' ICU stay, their morbidity, and their death were evaluated.

Data collection:

- Throughout the nine months from January to September of 2023, data were gathered and the information was gathered during the initial 48 hours of being admitted.

Analytical statistics

- Computer programs were used to computerize and analyze the data.
- SPSS (ver.21) software was used to program the computer and gather the data.Descriptive statistics were used to portray the data as means and standard deviations for qualitative variables and frequencies and percentages for qualitative variables.
- When P was less than 0.05, the critical value of the test "P" was deemed statistically significant.
- Spearman Correlation analysis was performed to make comparisons the two groups or more of qualitative data

Results:

Table (1): Frequency distribution of studied patients regarding demographic characteristics at admission (n=130)

	No	%
Age group		
Less than 40 years	16	12.3
From (40>50 years)	28	21.5
From (50 ≤ 65 years)	86	**66.2**
Mean±SD(range)	**53.70±8.68(33-65)**	
Sex		
Male	87	**66.9**
Female	43	33.1
Occupation		
Employee	44	33.8
Farmer	50	**38.5**
Housewife	23	17.7
Skilled	13	10.0
Diagnosis		
ST-Elevation Myocardial Infarction	81	**62.3**
Non-ST-Elevation Myocardial Infarction	11	8.5
Unstable Angina	19	14.6
Acute Heart Failure	10	7.7
Acute arrhythmia	9	6.9
Site of work		
Cement factory	9	6.9
street vendor	7	5.4
School	35	26.9
Field	50	**38.5**
Fertilizer plant	6	4.6
House	23	17.7

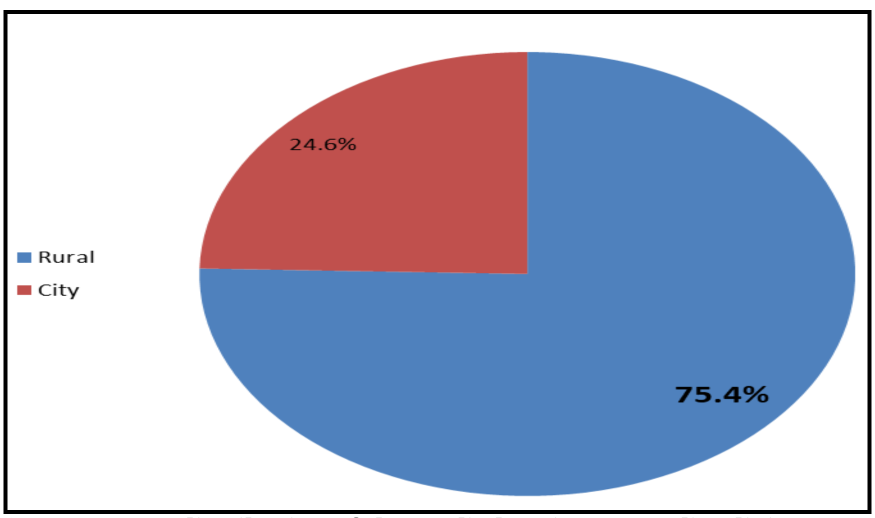

Figure (1): Frequency distribution of the studied patients rgarding living area (n=130).

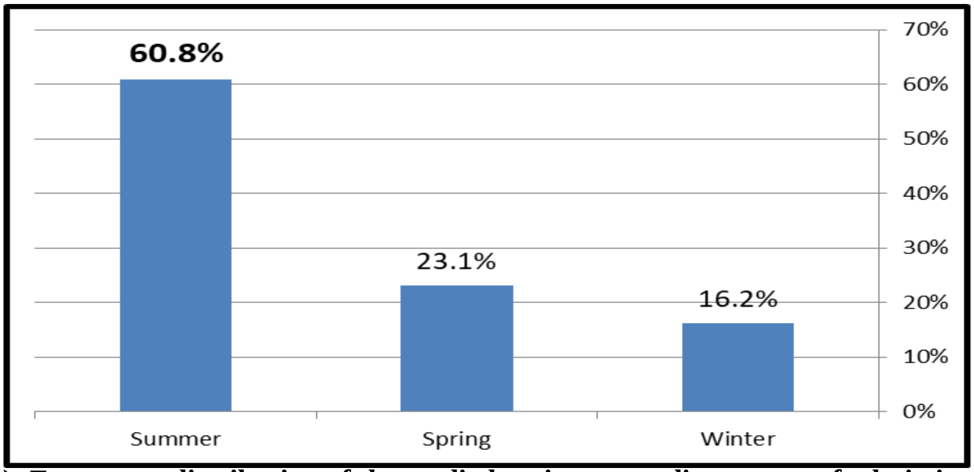

Figure (2): Frequency distribution of the studied patients rgarding season of admission (n=130).

Table (2): Mean and standard deviation of climate assessment data among studied patients (n=130)

Climate assessment data	Mean±SD	Range
Humidity		
1st day	**26.69±13.41**	10-65
2nd day	**27.8±14.18**	27.7-14.18
Atmospheric temperature		
1st day	**34.63±7**	19-49
2nd day	**35.15±7.68**	18-47
Rain fall in 9 months of data collection		
1st day **(yes)**	11(8.5%) days	
2nd day**(yes)**	11(8.5%) days	

Table (3): Correlations Co –efficient between demographic and climate assessment data among studied patients (n=130)

Correlations		Humidity	Rain	Temperature
Age	R	-0.110	-0.063	0.152
	P	0.219	0.477	0.085
Sex	R	0.012	0.021	0.001
	P	0.892	0.810	0.988
Occupation	R	-0.046	0.017	0.074
	P	0.606	0.851	0.404
Living area (rural)	R	.187*	0.147	-.310-**
	P	**0.035**	0.095	**0.000**
site of work	R	-0.013	-0.019	0.055
	P	0.884	0.832	0.534

Spearman correlation test for qualitative data between the two groups or more
**Statistically Significant Correlation at P. value <0.05* ***Statistically Significant Correlation at P. value <0.01*

Table (4): Correlations Co –efficient between hemodynamic data and climate assessment data among studied patients (n=130)

Correlations		Humidity	Rain	temperature
Pulse	R	0.105	0.077	-0.041
	P	0.242	0.382	0.642
Respiration	R	.237**	0.091	-.418-**
	P	**0.007**	0.303	**0.000**
Temperature	R	-0.007	0.050	-0.041
	P	0.935	0.572	0.648
Systolic Blood Pressure	R	-0.071	0.067	0.054
	P	0.431	0.450	0.546
Diastolic Blood Pressure	R	-0.144	-0.064	0.113
	P	0.105	0.470	0.203
Mean Arterial Blood Pressure	R	-0.123	-0.011	0.095
	P	0.169	0.901	0.282
Oxygen saturation	R	0.039	0.026	-0.101
	P	0.665	0.769	0.253

Table (5): Correlations Co –efficient between climate assessment data and cardiac markers of the studied patients (n=130)

Cardiac markers		Humidity	Rain	Temperature
Creatine kinase	R	-0.141	-0.178	0.154
	P	0.230	0.130	0.190
Creatine kinase myocardial band (CKMB)	R	-.837-**	0.112	-0.421
	P	**0.001**	0.141	0.173
Troponin	R	-0.106	-0.164	0.112
	P	0.299	0.108	0.275

Table (6): Correlations Co –efficient between coagulation with climate changes parameters among studied patients (n=130)

Coagulation parameters		Humidity	Rain fall	Temperature
Prothrombin time	R	-0.072	-0.041	-0.101
	P	0.485	0.690	0.327
Partial thromboplastin time	r	-0.131	-0.123	.286**
	P	0.227	0.252	**0.007**
International normalized ratio	r	-0.155	0.017	-0.041
	P	0.108	0.856	0.672

Table (7): Correlations Co –efficient between climate assessment data and the studied patients outcomes (n=130)

Outcomes		Humidity	Rain	temperature
Length of Stay	R	-0.098	-.287-**	.266**
	P	0.273	**0.001**	**0.002**
Morbidity	R	-0.021	.177*	-0.122
	P	0.815	**0.044**	0.168
Season of admission	R	-.573-**	-.582-**	.664**
	P	**0.000**	**0.000**	**0.000**

Table (1): Displays the frequency distribution of the patients under study in connection to demographic information. It was found that over half of the patients in the study were between the ages of 50 and 65 and were male (66.2%-66.9%) respectively, while (62.3%) were diagnosed with ST-Elevation Myocardial Infarction. The highest percent of them were farmer and work in the field (38.5%-38.5%) respectively.

Figure (1): Illustrates that two thirds of studied patients (75.4) live in rural.

Figure (2): Illustrates hat more than three fifths of the study patients
(60.8%) admitted to coronary care unit in summer.

Table (2): Regarding Humidity**;** the standard deviation and average of humidity in first and second day of patient admission to CCU were (26.69±13.41, 27.8±14.18) respectively. Regarding Atmospheric temperature; the standard deviation and average of atmospheric temperature in first and second day of patient admission to CCU were (34.63±7-35.15±7.68) respectively. The rain fell in 9 months of data collection about 11 days (8.5%).

Table (3): This table illustrates that there was a positive correlation between living area and humidity and temperature (p=0.035, 0.000) respectively.

Table (4): According to this table, there was a significant positive correlation (p=0.007, 0.000) found between temperature and humidity as well as respiration.

Table (5): This table shows that there was a significant positive connection (p=0.001) between humidity and CKMB.

Table (6): The temperature and partial thromboplastin time showed a positive connection (p=0.007), as this table showed.

Table (7): This table shows that the length of stay and temperature and rain had a positive link (p=0.001, 0.002), respectively. Season of admission positively correlated with temperature, humidity, and rain fall (p=0.000, 0.000, and 0.000, respectively).

Discussion:

In addition to raising temperatures, climate change has detrimental effects on other aspects of the environment, such as air pollution brought on by a rise in wildfire frequency. The morbidity and mortality of acute cardiovascular illness are causally linked to fine particulate matter. The goal of the current study was to assess effect of climate changes on acute heart diseases at Assiut University Heart Hospital.

The bulk of the patients in the current study were male and about sixty years of age. This may be connected to aging-related changes in the heart and blood vessels, such as a decrease in their elasticity and their capacity to adapt to changes in the arterial system's compliance, which raises the effort required to pump blood to the body's organs by increasing the resistance to the heart's pumping action. This may also be explained by the fact that female hormones shield females against acute coronary syndrome and that males are more exposed to stress in life. This conclusion was consistent with the findings of **Rus et al. (2024)**, who found that hospitalized persons' average age was 62.1±11.5 years and that men had a larger prevalence (72.2%) than women (27.8%).

According to the results of the current study, the majority of the patients were farmers or other field workers, and two thirds of the patients were living in rural areas. This could be because rural areas are severely impacted by climate change. The economy and traditions of rural areas are already being impacted by environmental change, extreme weather events, warming, and climatic volatility. Climate change, both observed and predicted, poses a serious threat to the infrastructure, livelihoods, and quality of life of many people. According to **Zhai et al. (2022)**, adult patients from rural areas have a higher risk of hospitalization for cardiovascular illnesses. This conclusion was consistent with their findings.

According to the results of the current investigation, ST-segment elevation myocardial infarction was detected in over half of the patients. This may have to do with the classification of risk variables that influence the incidence of acute coronary syndrome into modifiable (smoking, physical activity, psychological tension) and non-modifiable (age, gender, family history, and weather) categories. Weather conditions are one of the non-modifiable elements that have not gotten much attention in the literature till lately. The average temperature, average humidity, wind speed, and wind pressure are examples of meteorological characteristics that have been linked to acute coronary syndrome **Rus et al. (2024)**.

This was consistent with a study conducted by **Rus et al. (2024)**, which comprised 5300 hospitalized patients for acute coronary syndrome. 33.9% of them (1796 patients) were admitted for non-STEM (NSTEMI), while 66.1% of them (3504) were admitted for STEMI.

The current study's conclusions showed a favorable relationship between temperature and the length of stay in coronary care units. The observed phenomena could potentially be explained by physiological reactions to variations in the core body temperature, which could result in elevated heart rate, blood pressure, stroke volume, respiration rates, vasodilatation, and altered coagulation. The longer stays in the Coronary Care Unit may be due to post-discharge issues, which can be prevented by keeping an eye on these changes in patient situations. **Guo Y. et al. (2013)** provided support for this conclusion, stating that temperature has a direct impact on how long patients stay in coronary care units.

The study's findings demonstrated a favorable relationship between temperature, humidity, and dwelling area. This finding aligned with the findings of **Khraishah et al. (2022)**, who reported that the effects of climate change on cardiovascular health differ among demographic and socioeconomic groupings living in various regions of the world. This risk is exacerbated by additional socioeconomic factors, the style of home, the living region, and inadequate living and working conditions.

The current study's findings indicated that temperature, humidity, and respiration were positively correlated. High humidity levels may be the cause of this, as they reduce sweat evaporation. Increasing cardiac output is a physiological strategy to thermo regulate, and this raises breathing rate and cutaneous blood flow. This is in contrast to the findings of **Lepeule et al. (2018)**, who found that drops in lung function are associated with increases in temperature and relative humidity. It is possible that elevated amounts of black carbon contribute to these findings.

Regarding creatine kinase (MB), humidity and MB showed a positive association. However, **Pang et al. (2023)** found that elevated humidity levels above 60% cause discomfort in the human body, increase blood volume, decrease blood viscosity, and facilitate the removal of metabolites from blood vessels. The body will consequently produce a reduction in creatinine kinase (MB), reflecting the adverse correlated effect of humidity.

The results of this investigation showed a favorable relationship between temperature and partial thromboplastin time. This may be explained by variations in body temperature, which trigger the sympathetic nervous system to sustain cardiac output by increasing cardiac demands in response, such as augmentation or reduction of coagulation and respiration rates. **Ho, et al. (2023)** corroborated this finding by summarizing how easily an increase in temperature may impact the partial thromboplastin time test.

Conclusion:

The study's conclusions demonstrated how acute heart illnesses are impacted by climatic variations. The study's conclusion was that a majority of the patients diagnosed with ST-Elevation myocardial infarction and who were hospitalized to the coronary care unit during the summer were from rural areas. Furthermore, there was a positive correlation between temperature and partial thromboplastin time. The length of stay in the cardiac intensive care unit was positively impacted by the temperature and rain.

Recommendation:

According to the current study, additional research is required to assess the various consequences of climate change on patients suffering from acute heart illness. Reapply this study to a bigger probability sample that was collected from various Egyptian regions in order to make generalizations.

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