

# Investigating the relationship between seasonal temperature changes and the referrals of patients with acute coronary syndrome

Hossein Saeidi, Hossein Shaker, Mojtaba Chardoli, Davood Saravi\*<sup>ID</sup>

Emergency Medicine Department of Firozgar Hospital, Iran University of Medical Sciences, Tehran, Iran

## Correspondence to:

Davood Saravi,  
Tel: 0098-911-3915303  
Email:  
davood.saravi@yahoo.com

**Received:** 4 August 2018  
**Accepted:** 10 November 2018  
**ePublished:** 2 December 2018

**Keywords:** Air, Temperature,  
Acute coronary syndrome,  
Season, Human health

## Abstract

**Introduction:** Due to the relationship between climate and human health, scientists are interested in evaluating seasonal and daily changes in air temperature and risk for cardiovascular diseases.

**Objective:** The aim of this study was to investigate the relationship between seasonal temperature changes and the rates of referring patients with acute coronary syndrome.

**Patients and Methods:** The present case-control study was performed on all consecutive patients suffering acute coronary syndrome that were hospitalized in a great referral hospital in Tehran between 2011 and 2015. The meteorological and mortality data were first matched with each other. Then the number of patients with acute coronary syndrome was determined by region and gender.

**Results:** Assessing the frequency of patients referred from 2011 to 2015 indicated the upward trend of referral to the hospital. Regarding the frequency of referrals in different months of the year (regardless of the year of assessment), the highest rate of referral for patients with unstable angina was in the month of October and then in November and the lowest referral was in August. The number of referees was significantly associated with the increase in minimum and maximum temperature, average air pressure, as well as with the decrease in air humidity during the years studied.

**Conclusion:** The risk of acute coronary syndrome attacks is highest in the cold months of the year, especially in the autumn and early winter, and is the lowest in the middle of summer. Over the years, increasing air temperature with increasing air pressure and reducing humidity can increase the risk of acute coronary syndrome.

**Citation:** Saeidi H, Shaker H, Chardoli M, Saravi D. Investigating the relationship between seasonal temperature changes and the referrals of patients with acute coronary syndrome. J Prev Epidemiol. 2018;3(2):e21.

## Introduction

Applied meteorology utilizes climatic knowledge in pursuit of a variety of goals, such as economic and medical fields. Among the most effective climatic elements, two elements of temperature and precipitation are the most important variables that have a significant impact on human health in the field of medicine (1,2). In fact, any change in the amount of these two factors can reduce or increase the incidence of human diseases such as cardiovascular, respiratory, digestive and other diseases (3). In this regard, another important issue that has been addressed by the applied climatic environment has been the problem of air pollution (4,5). Air pollutants include dust, gases, smoke and vapors, carbon fumes, radioactive particles and chemicals are dangerous for human life, plants and animals, and also are harmful and disruptive to their comfortable lives (6).

## Core tip

In a study on 2614 patients with acute coronary syndrome (unstable angina), we found that the risk of acute coronary syndrome attacks is highest in the cold months of the year, especially in the autumn and early winter, and is the lowest in the middle of summer. Over the years, increasing air temperature with increasing air pressure and reducing humidity can increase the risk of acute coronary syndrome.

Due to the relationship between climate and human health, scientists and experts in the field of climate and medicine are interested in evaluating seasonal and daily changes in cardiovascular diseases and their relation with the climate. Hence, seasonal changes in weather and cardiovascular-related mortality can be directly related to each other (7-10). In other words, reducing or increasing the temperature has a major contribution



to mortality and the stressful effect of temperature on the number of deaths is one of the causes of increased mortality. The relationship between cardiovascular disease and respiratory illness with temperature is a key policy for increasing the accuracy of temperature-related warning systems (11,12).

### Objectives

Awareness of geographical distribution of diseases for each country's health planning is required to inform the authorities about the situation of each disease in the whole world and in different parts of the country and to include the necessary health measures for residents of the areas in their health policies. Therefore, the aim of this study was to investigate the relationship between seasonal temperature changes and the rates of referring patients with acute coronary syndrome.

### Patients and Methods

#### Study design

The present case-control study was performed on all consecutive patients suffering acute coronary syndrome that were hospitalized in a great referral hospital in Tehran between 2011 and 2015. In this research, the meteorological and mortality data were first matched with each other. Then the proportion of patients with acute coronary syndrome was determined by region and gender. Using the daily meteorological data such as average, minimum and maximum temperature, the relation between minimum, maximum, and average of temperature with the number of patients were assessed. Finally, mean, minimum, and maximum of temperature was extracted by month and year and analyzed with the number of patients with acute coronary syndrome.

#### Ethical issues

Human rights were respected in accordance with the Helsinki Declaration 1975, as revised in 1983. The informed consent was taken from the patients as well as from parents and first relatives. The study was approved by ethics committee of Iran University of Medical Sciences (Ethical cod # 9411307018). This study was conducted as the residential thesis of Davood Saravi in Iran University of Medical Sciences.

#### Statistical analysis

The collected data were reported by mean  $\pm$  standard deviation (SD), and percentage. Kolmogorov–Smirnov test was used to assess the normal distribution of data, which showed normal distribution of all data. Thus, continuous variables were compared using *t* test and categorical variables using chi-square test. The association of variables was tested by odds ratio and 95% confidence interval (CI). For the statistical analysis, the statistical software IBM SPSS Statistics for Windows (version 21.0. Armonk, NY: IBM Corp.) was used. Additionally, *P* values less than 0.05

were considered statistically significant.

### Results

A total of 2614 patients with acute coronary syndrome (unstable angina) were included in this study. The mean age of patients was  $63.16 \pm 13.41$  years in the range of 20 to 95 years. Concerning the outcomes of the disease, the frequency of hospital mortality was 70 cases (2.7%), 210 cases (0.8%) had left the hospital with their own personal satisfaction, and 2334 (89.3%) were discharged after recovery.

The frequency of patients referred in 2011 was 425 cases (16.3%), in 2012 was 477 cases (18.2%), in 2013 was 486 cases (18.6%), in 2014 was 606 (23.2%), and in 2015 was 620 cases (23.7%), indicating the upward trend of referral to the hospital ( $P=0.001$ ). Regarding the frequency of referrals in different months of the year (regardless of the year of assessment), the highest rate of referral for patients with unstable angina was in the month of October and then in November and the lowest referral was in August (Figure 1). The frequency of deaths in patients in 2011 was 19 (4.5%) in 2012 were 10 cases (2.1%), in 2013 were 10 (2.1%), in 2014 were 18 (0.3%) and in 2015 were 13 cases (2.1%), which did not show a significant difference between different years ( $P=0.18$ ). Regarding the death rates in different months of the year, as shown in Figure 2, the highest mortality rate was found in March and then in April and the lowest mortality rate was found in August. As shown in Table 1, comparing death rate between the two genders except for higher death rate in men than in women in 2011, we found no difference in death rate between the genders at other time points. The average age of survived patients was significantly higher than non-survived ones in all the studied years, except in 2015 that was similar in both groups (Table 2). We found no association between the proportion of patients referring to the hospital due to acute unstable angina and the trend in minimum horizontal view (as an indicator for air pollution). However, the proportion of referees was significantly associated with an increase in minimum and

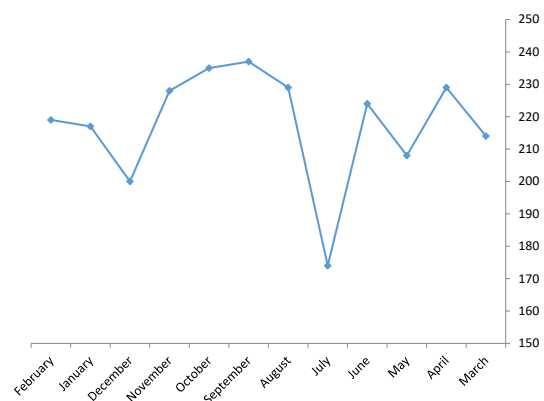
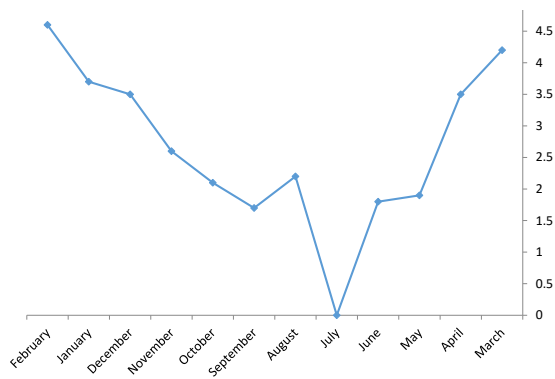


Figure 1. The change in patients' referral in different months.



**Figure 2.** The change in patients' death rate in different months

**Table 1.** The annual rate of mortality in men and women due to acute coronary syndrome

Year	Men	Women	P value
2011	6.4%	2.1%	0.027
2012	1.9%	2.4%	0.459
2013	1.4%	3.0%	0.123
2014	3.0%	3.0%	0.584
2015	1.6%	2.8%	0.223

**Table 2.** The mean age of survived and non-survived patients due to acute coronary syndrome

Year	Survived group	Non-survived group	P value
2011	71.63 ± 17.07	65.21 ± 13.00	0.039
2012	77.50 ± 9.63	64.34 ± 14.22	0.004
2013	74.10 ± 17.94	61.86 ± 13.09	0.004
2014	70.94 ± 13.45	64.26 ± 12.70	0.034
2015	66.08 ± 15.66	61.80 ± 12.74	0.234

maximum temperature and average air pressure, as well as with the decrease in air humidity during the studied years (Table 3).

## Discussion

As confirmed in various studies, cold and atmospheric changes, along with other risk factors for cardiovascular disease, cold and atmospheric changes are among the underlying risk factors for cardiovascular events that the referrals for patients with acute coronary syndrome

have been higher in the cold months, especially in the early hours of the morning. This finding has been shown empirically in emergency centers and in observational studies. Additionally, air pollution has been shown to be one of the most important risk factors for exacerbation of atherosclerotic diseases of the heart and the occurrence of various types of arrhythmias. It seems that the interaction of these two factors can increase the risk of acute coronary syndromes. What we did in the present study is firstly a clear presentation of the status of acute coronary syndrome (unstable angina) in patients referred to one of the major hospitals in the country. In the second phase, by assessing the weather conditions in Tehran during the five years studied, the relationship between the trend of patient referral changes and the frequency of mortality due to climate change was evaluated.

In the first place, what was clearly observed in our study was the trend of temperature changes over the five years that we showed the gradual and significant increase in air temperature during the period from 2011 to 2015 years. Furthermore, the air pressure increased but atmospheric humidity decreased during the five years of the study, which was due to increasing air pollution in Tehran, and decreasing in rainfall in this city. However, what was interesting and the main goal of the study was that the patients' referrals with the diagnosis of acute coronary syndrome were basically related to the cold months of the year, and was the lowest in the hottest months of the year. Accordingly, the highest rate of referral in those with unstable angina was in the month of October and then in November and the lowest referral was in August. But the more interesting point was that although the most frequent references were related to the cold months of the year each year, the trend of increasing temperature and increasing the number of referrals in patients over the next 5 years were consistent. In a cross-sectional and monthly view each year, cold is considered as a risk factor for acute coronary events, but over the years, the gradual increase in air temperature and air pressure and also a decrease in relative humidity have been factors in increasing the incidence of acute coronary syndrome. It should be kept in mind that, the cold, due to vascular contraction effects, accelerates the progression of atherosclerosis, but warming can lead to a person's gradual and long-term susceptibility to acute heart attacks because of mental stress and reduced

**Table 3.** Weather conditions during the studied years

Year	2011	2012	2013	2014	2015
Minimum horizontal view	7217.57	7776.71	7959.17	7895.89	7588.25
Maximum temperature	23.23	23.70	23.54	24.02	24.25
Minimum temperature	13.37	13.63	13.08	14.02	14.17
Average temperature	18.11	18.38	18.18	18.95	18.99
Air pressure	880.29	880.98	880.57	881.10	882.08
Snowfall	2.9	1.4	3.0	0.0	2.2
Humidity	36.06	34.87	34.00	33.12	33.65

volume of intestinal fluid.

Similar to our study, other studies have also emphasized the impact of environmental temperature and climate change on increasing the potential for acute coronary events. Farajzadeh et al (13) found that both higher and lower temperature can lead to a higher mortality rate. They also found a significant and strong correlation between the temperature and the proportion of deaths. Hence, the highest proportion of deaths was in the cold months of the year (December, January and February) as the temperature dropped, the mortality rate increased. In the study of Jahanbakhshi et al (14), a significant relationship between low air temperature and mortality from stroke was detected. In the study of Ghanbari et al (15), a direct correlation between the number of deaths due to various diseases and temperature was seen. Likewise Nastos et al showed that the incidence of acute coronary syndrome had significant changes in terms of seasons, with the highest incidence in the early winter and the lowest in August and May (16). In the study of Li et al, the highest incidence was related to winter and the lowest was related to autumn (17). They found a negative correlation between the proportion of cases of acute coronary syndrome and the average daily temperature. There was also an inverse relationship between the incidence of acute coronary syndrome and bariatric pressure. Therefore, the likelihood of the occurrence of acute coronary syndrome exacerbation in the cold months of the year as well as in areas with lower humidity is more predictable.

### Conclusion

As the final conclusion, the risk of acute coronary syndrome attacks is highest in the cold months of the year, especially in the autumn and early winter, and is the lowest in the middle of summer. Over the years, increasing air temperature with increasing air pressure and reducing humidity can increase the risk of acute coronary syndrome.

### Study limitations

During the research, we encountered some problems such as inconsistencies in implementation and time constraints.

### Authors' contribution

HS proposed the research and supervised the investigation. MC and DS conducted the research. All authors read and finalized the manuscript.

### Conflicts of interest

The authors declared no competing interests.

### Ethical considerations

Ethical issues (including plagiarism, misconduct, data fabrication, falsification, double publication or submission, redundancy) have been completely observed by the authors.

### Funding/Support

None.

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