



Editorial

Meteorological factors and seasonal variations in the risk of acute myocardial infarction

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Associations between climate and the incidence of acute myocardial infarction (AMI) were first reported in the 1930s. An increase in mortality due to AMI in winter is a well-recognized pattern of the seasonal periodic occurrence of AMI [1]. After the initial reports, a number of epidemiologic studies have reported higher mortality from coronary artery disease (CAD) in winter than in other seasons. The most important factor for this periodicity is the cold ambient temperature in winter. However, whether the maximum or minimum daily temperature or the difference between maximum and minimum temperatures is most deeply involved in this periodic occurrence of AMI remains unclear. A study in London showed an inverse association of the incidence of AMI with the lowest daily temperature [2], whereas a more recent report from Copenhagen suggested the association of an increase in daily 3-hour maximum apparent temperature with a decrease in admissions due to AMI in winter [3]. Moreover, inconsistent results have been reported regarding whether the colder weather in winter is an exclusively important factor that increases mortality due to CAD, in that several studies have also reported an increased incidence of AMI with increased temperature in summer. Possible explanations for these observations include changes in blood properties resulting in increased blood coagulability, which occurs at both low and high ambient temperatures [4,5].

There might be important factors other than seasonal changes in temperature that affect the chronobiology of seasonal periodicity in the occurrence of AMI. A comparison of data between a region with a significant seasonal difference in air temperature and that with little seasonal difference may provide meaningful information; indeed, similar seasonal periodicities in the occurrence of AMI were observed in various geographic regions with markedly different climates. Such factors may include changes in the exposure to sunlight [6]. A recent study

conducted in Sao Paulo, Brazil, where seasonal temperature oscillations remain only modest, showed a significant increase in AMI hospitalization in winter [7]. As one of such factors, an association between the atmospheric pressure and incidence of mortality due to AMI or CAD has been reported from the Lille-WHO MONICA project, which comprised 25,700 participants; in this project, a V-shape relationship was found between these two factors [8]. Thus, despite long investigations that have been carried out over the decades, not much is known regarding the significance of climate as a risk factor for coronary events. Meteorological factors that possibly increase the risk of AMI are shown in Table 1, along with their physiological effects.

In addition to seasonal changes in the incidence of AMI, there is a circadian periodicity with its peak in the early to late morning hours [9]. This circadian periodicity in the incidence of AMI may be in part caused by daily fluctuations of the cardiac autonomic system, because the cardiac sympathetic tone starts becoming dominant in the early morning. Thus, changes in meteorological parameters during these hours may be an important factor influencing the occurrence of AMI.

The wide variety of eras when studies were performed might have led to inconsistent results. Almost a century has passed since the initial reports and various factors that can directly modify the effects of climate, including clothes, air conditioning equipment, and public health, have been improved. In addition, progress in preventive medicine and changes in life style can affect the incidence of acute coronary syndrome (ACS) and its variations. Recently, in most patients with ST-segment elevation AMI (STEMI), immediate primary percutaneous coronary interventions (PPCI) are performed, whereas in those with non-ST-segment elevation ACS (NSTEMI-ACS), a deferred revascularization strategy with coronary artery bypass grafting is often preferred.

In this issue of the *International Journal of Cardiology*, Versaci et al. analyzed the overall and season-specific impacts of climate changes on the daily rate of PPCIs for STEMI based on data from three high-volume PCI centers, which re-evaluates the significance of meteorological parameters in the setting of contemporary PPCI era [10]. One of the strengths of this protocol may be the accurate count of the number of PPCI events. The results showed that lower minimum atmospheric pressure in the preceding days correlated with a high rate of PPCIs for STEMI in the overall analysis. Detailed analyses according to the season revealed that lower same day mean temperature and lower rainfall during the morning in winter, greater changes in the atmospheric pressure in the preceding days in spring, and higher minimum temperature on the same day in summer were associated with a high risk of STEMI. These observations support those of previous studies that reported the

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Table 1

Major meteorological factors and their physiological effects that may increase the risk of AMI.

Meteorological factors	Physiological effects associated with a risk of AMI
Low temperature	Red blood cell count↑, Blood viscosity↑, Platelet count↑ Plasma fibrinogen/Factor VII↑ Vasoconstriction (Blood pressure↑) Sympathetic activity↑ (Heart rate↑, Blood pressure↑)
High temperature	Red blood cell count↑, Blood viscosity↑, Platelet count↑ Vasodilation (Hypotension)
Low atmospheric pressure	Sympathetic activity↑ (Heart rate↑, Blood pressure↑)
High humidity	O ₂ arterial saturation↓ (Heart rate↑) Dehydration/Hemoconcentration Mental stress↑
Reduced exposure to sunlight	Plasma vitamin D level↓ Depression/Mental stress↑ Physical activity↓

AMI, acute myocardial infarction.

significance of various meteorological parameters as risk factors for AMI and that the significance of each parameter may vary among different seasons.

The study provides additional important information; however, several questions are yet to be answered. Because several meteorological parameters may interact with each other and this study was a retrospective observational study, it may be difficult to identify the most important risk factor among the parameters analyzed. For instance, a peak of rainfall can be associated with a low atmospheric pressure within a few days. The associations between climate and the occurrence of ACS other than STEMI in the current PPCI era could not be revealed from this study, because patients undergoing only emergency coronary angiography or those with PCI for unstable angina were excluded from the study. Therefore, the results may be influenced by the attenuation of the severity of ACS as well as its decreased incidence based on recent progress in preventive medicine. In addition, because patients were enrolled from only three hospitals that were within a relatively small area in that study, the results may not be applicable to other geographic areas. Therefore, further studies are needed to validate this study's observations.

In summary, because climate changes are related to the occurrence of STEMI probably as a trigger of the event in the current PPCI era, careful attention should be paid to these changes for the better prevention of STEMI. However, there may be unrevealed key factors in addition to cold temperature.

Declaration of Competing Interest

The author reports no relationships that could be construed as a conflict of interest.

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