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EFFECT OF DAYLIGHT SAVING TIME (DST) ON THE INCIDENCE OF ACUTE HEART ATTACK IN PATIENTS REFERRING TO EMERGENCY DEPARTMENT OF HOSPITALS AFFILIATED TO TEHRAN UNIVERSITY OF MEDICAL SCIENCES

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ABSTRACT

Background & Aim: Iran is among countries implementing daylight saving time (DST) according to its Constitution every year. The impact of this time change on the incidence of acute heart attack has been investigated in several countries, indicating an increase in the incidence of acute heart attack on days after time change. In this regard, the present study was carried out given that DST is annually implemented in Iran and no research has been done on the effect of time change on the incidence of heart attack so far.
Methods & Materials: In this analytical cross-sectional study, 125 patients with heart attack symptoms visiting the emergency department of the hospitals affiliated to Tehran University of Medical Sciences (TUMS) were investigated. These patients experienced acute heart attack 7 days after time change (*i.e.*, from March 20, 2012), 14 days before time change (*i.e.*, from March 6 to March 19, 2011), and 14 days after time change (from March 27 to April 10, 2012), as well as in autumn (from September 22 to September 28, 2012 and 14 days before and after this date). The data were collected from patients' records admitted to the hospitals affiliated to TUMS and then statistically analyzed.
Result: The total number of patients visiting the emergency departments of the hospitals affiliated to TUMS within 5 weeks around March and 5 weeks around September was 9699. The results of this study showed no significant difference between the number of patients with acute heart attack in the week after time change and their number during the 14 days before and after time change in spring and autumn ($p>0.05$). Moreover, although the rate of heart attack during the days of the first week after time change was higher than the similar days in the other 4 weeks, the difference was not statistically significant ($p>0.05$).
Conclusion: Although the results of the present study showed no correlation between DST in Iran and the incidence of acute heart attack, previous studies have shown the disrupting effect of DST on the circadian rhythm and consequently, on the cardiovascular function in humans. Therefore, it is necessary to conduct further studies.

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Introduction

The idea of daylight saving time (abbreviated DST) was first introduced by Benjamin Franklin in 1784 in an article titled "An Economical Project for Diminishing the Cost of Light." Change in summer time, known as summer time in most countries, is referred to the change of time in time zones, resulting in prolonged day in the evening and shortened day in the morning. This change is usually implemented in spring and reverts to standard time in autumn. In order to optimize energy

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consumption, clocks (the official time) are advanced in spring and summer in many countries (usually an hour) to spend more hours of the day during working hours, diminishing the need for energy consumption and lighting [1]. Today, nearly 86 countries change their official time; 55 in Europe, 8 in Asia and Middle East, 11 in North America and Caribbean region, 5 in South America, 4 in Australia and Pacific Ocean, and 3 in Africa [2].

Since 2007, clocks (the official time) in Iran are advanced one hour at 00.00 AM on March 21, and are reverted to the standard time at 00.00 AM on September 21.

Implementation of DST has proponents and opponents, and no comprehensive survey has been conducted in this regard in Iran. Proponents at the global level mention the following points for their advocacy [3]; saving on electricity, saving on oil and fossil fuel consumption, reducing carbon monoxide levels, reducing road traffic injuries and deaths, and reducing crimes. In contrast to these supporters, DST has also opponents who mention the following points [3]; confusion and inconsistency between working hours of different economic entities, impossibility of adapting to the agricultural sector (including cultivation and animal farming), difficulty adjusting the hours for the public, changes in people's behavior, especially when driving, danger to children and other people in semi-light mornings (in the street and school), sleep disorders, and changes in the circadian rhythm.

DST during changing seasons is a disruptive factor in the order of circadian rhythms in the body. Although about 1.6 billion people are dealing with DST throughout the world, unfortunately, there have been very few studies on its behavioral and physiological effects on humans, which have also produced contradictory results. The majority of these studies attributed time change to sleep-wake cycles, and some others to individual differences [4].

Many biological activities of the body are repeated throughout the day, month, or year, indicating that human body organs are active in response to time and their precise function. The biological cycles that are repeated nearly once every 24 hours, are called the circadian rhythm. Circadian rhythm is observed in many body functions, such as production and secretion of some hormones and sleep-wake cycles. Circadian rhythms have various features. They follow the body's internal clock or the heart rate regulation system. Therefore, even if there is no sign of time or the day length, these cycles will still exist [5-6]. However, it should be noted that the length of circadian cycles varies from person to person. Humans have an internal (biological) clock, which is located in hypothalamus. A wide range of physical activities such as sleeping, regulating body temperature, and controlling blood pressure and secretion of hormones are controlled by this internal clock. The body's internal clock operates according to the circadian rhythm. This rhythm is a little longer than 24 hours, but because the body's internal clock is continually affected by environmental changes, especially the light/dark (LD) cycle (day/night), and other factors, such as ambient temperature, and humidity, it is adapted and modulated by the above-mentioned external factors, though this adaptation is slow. The most important features of the circadian rhythm are: being inherent and self-inducing, resistance to change, and tendency to work slowly. Except for sleep, the secretion of hormones (especially melatonin and cortisol), urine production, central body temperature, and alertness also follow circadian rhythm. The inner rhythms are not exactly the same as environmental rhythms, so they must be continuously regulated by external stimuli. Sunlight is the most important factor for the adjustment of human circadian rhythm. Every day, early in the morning, sunlight advances the human biological clock about an hour, to compensate for the intrinsic delay in the circadian rhythm and to coordinate it with the surrounding world. Moreover, social behaviors, meals, daily activities, and knowing the time can help regulate the circadian rhythm [7].

The real significance of the human biological clock becomes clear when problems in people with a disrupted circadian rhythm (blind people, travelers, shift workers, and the elderly) are observed. Shift workers who are not adapted to night work are at the lowest level of consciousness and often cannot sleep during the day easily. This may explain the increased number of driving errors and fatal accidents at night, as well as the high prevalence of some diseases in shift workers.

One of the consequences of disturbance in the circadian rhythm is the impairment of cardiovascular system and hence the incidence of heart diseases, such as myocardial infarction or heart attack [8]. The effect of circadian rhythms in the cardiovascular system have long been known. Blood pressure, heart rate, blood volume and flow, heart muscle activity, and hormonal responses indicate that cardiovascular function follows daily rhythms. Daily variations of cardiac function are mainly marked by symptoms. According to information, abnormal electrical activity of the heart and chest wall pain in patients with coronary artery disease occur at around 4 AM, and heart attacks occur most frequently between 6 AM and 12 noon. These time patterns in cardiovascular function demonstrate the importance of time in evaluating, providing care, and treatment for this system [9-10]. Coronary artery disease (CAD) is the most dangerous and, at the same time, the most common life-threatening human disease. Heart attack occurs due to necrosis of a part of the heart following impaired blood circulation, mainly arising from occlusive coronary atherosclerosis or embolism [11].

Acute myocardial infarction is one of the most common diseases diagnosed in hospitalized patients in industrialized countries. Approximately, 1.1 million acute heart attacks occur every year in the United States. The mortality rate of myocardial infarction is about 30%. The importance of this issue is increasing in developing countries [12]. Atherosclerosis has currently a worrisome trend. Although coronary artery disease (atherosclerosis) was primarily specific to the elderly, the disease is occurring currently among younger people.

The risk factors for acute heart attacks are classified into two groups of changeable and unchangeable risk factors. Unchangeable risk factors include old age, male gender, family history of early atherosclerosis, and changeable risk factors

include hypertension, dyslipidemia, diabetes, smoking, obesity, inadequate physical activity, and hyperinsulinism. The role of biological rhythms in the cardiovascular system function has been proven. Studies show that cardiovascular diseases and heart attack are more commonly observed among shift workers than day workers. Shift working is a factor that disrupts the order of the natural cycle of the body, especially the circadian rhythms. It has been shown that cardiovascular disease in shift workers does not occur only because of inappropriate eating habits. There are other reasons such as lack of sleep, increased stress, hypertension, smoking, and reduced physical activity that are among the major contributors to this disease.
In the end, given the very low awareness of the current situation in Iran and the lack of studies on the impact of DST on the incidence of heart attacks, the present research investigated the effect of DST on the incidence of heart attacks in Iran.

Methodology
In this analytical cross-sectional study, the effect of DST in Iran on the number of patients with acute heart attack visiting the emergency departments of the hospitals affiliated to TUMS during 2011-2012 was investigated. The study population consisted of all patients (n=9699) visiting the emergency departments of the hospitals affiliated to TUMS within 5 weeks around March (n=4925) and 5 weeks around September (n=4774). The included patients were diagnosed with acute heart attack by the chief assistant and attendant professor of emergency department and admitted to the hospitals affiliated to TUMS. The sample size of patients diagnosed with myocardial infarction during the study period was 125 cases, of which 68 cases were observed in March and 57 in September. The ratio of the number of patients visiting the emergency departments of the hospitals affiliated to TUMS with acute heart attack to the total number of patients visiting these departments during 7 days after time change (i.e., from March 20, 2012), 14 days before time change (i.e., from March 6 to March 19, 2011), and 14 days after time change (from March 27 to April 10, 2012), as well as in autumn (from September 22 to September 28, 2012 and 14 days before and after this date) were investigated in terms of the number of patients per day. The data were collected from patients' records in the hospitals affiliated to TUMS and then analyzed. All data were analyzed using SPSS 16. Measures of central tendency (mean, median) and measures of statistical dispersion (standard deviation, variance) were used to analyze descriptive data and t-test and Chi-square test were used to analyze analytical data.

Results
The findings of this study showed that the number of patients referring to emergency departments in the first week of time change in spring (n=4925) was higher than in autumn (n=4774). Comparison of week days after time change showed that the lowest and highest number of patients were observed on the third (n=544) and seventh (n=902) days of spring, and the sixth (n=109) and second (n=1050) days of autumn, respectively.
The incidence rate of heart attack in the first week of time change in spring and autumn was 1.40 and 1.22, respectively. Although this rate was higher than the other 4 weeks in the same seasons (1.37 and 1.18), the difference was not statistically significant. Despite insignificant difference in the incidence of heart attack between the week of time change and the other 4 weeks in spring and autumn, the results were consistent with previous studies on this issue, which showed no correlation between DST and the incidence of acute heart attack [13-14].
As Table 1 shows, during the first week of time change, 783 patients visited the emergency departments of the studied hospitals, of whom 11 had an acute heart attack. A total of 4925 patients visited the emergency departments during the other 4 weeks, of whom 57 had an acute heart attack.

Table 1. Frequency distribution of the number of patients visiting the emergency departments within 5 weeks around March

Spring	Heart attack		Total
	Yes	No	
First week after time change	11	772	783
Other 4 weeks	57	4085	4142
Total	68	4857	4925

Based on Chi-square test (Table 2), there was no significant difference between the number of heart attacks in these two periods (first week and 4 other weeks) ($p \leq 0.05$).

Table 2. Difference between the number of patients within the 5 weeks around March using Chi-square test

Pearson Chi-Square	Value	Degree of freedom	Sig
	0.004	1	0.950

According to Table 3, during the first week of time change, 819 patients visited the emergency departments of the studied hospitals, of whom 10 had an acute heart attack. A total of 3955 patients visited the emergency departments during the other 4 weeks, of whom 47 had an acute heart attack.

Table 3. Frequency distribution of the number of patients visiting the emergency departments within 5 weeks around September

Autumn	Heart attack		Total
	Yes	No	
First week after time change	10	809	819
Other 4 weeks	47	3908	3955
Total	57	4717	4774

Based on Chi-square test (Table 4), there was no significant difference between the number of heart attacks in these two periods (first week and 4 other weeks) ($p \leq 0.05$).

Table 4. Difference between the number of patients in the 5 weeks around September using Chi-square test

Pearson Chi-Square	Value	Degree of freedom	Sig
	0.006	1	0.938

It should be noted that the homogeneity of the studied groups (study and control) was confirmed using Chi-square test in terms of demographic characteristics such as age, gender, marital status, and work experience ($p \leq 0.05$).
Moreover, the results of comparing the incidence of acute heart attack in spring showed that this rate is higher on the 4th, 5th, and 6th days of the week after time change than on the same days in the 4 other weeks, and this difference was not statistically significant. In autumn, on all days of the week after time change whose data were recorded, the incidence of acute heart attack was higher than on the same days in the other 4 weeks, but these differences were not statistically significant using Chi-square test.

Discussion

The present study aimed to investigate the relationship between DST in Iran and the incidence of acute cardiac attack complaints in the target population, assuming that DST does not increase the incidence of acute heart attack. Although the results of the study showed no correlation between DST and the incidence of acute heart attack, further research in this field is necessary, because previous studies have shown the effect of DST on disrupting the circadian rhythm and hence the cardiovascular function in humans.
Studies by Janszaki and El Jang (1966), and Janszaki et al. (2012) showed that the incidence of acute heart attack increased on the first three days of the week after time change in spring and decreased in the week after time change in autumn [13, 15].
According to the findings, there was no significant relationship between time change and the incidence of acute heart attack, but the role of biological rhythms in cardiovascular function has been demonstrated in previous studies, because these studies have shown that the cardiac function fluctuates throughout the day and follows a regular time rhythm [16].
For example, a study suggested the presence of an intracellular circadian clock in at least two groups of cardiovascular cells called cardiomyocytes and vascular smooth muscle cells. These circadian clocks can affect physiological responses of the heart. They can, for example, increase the activity of the sympathetic nervous system before awakening. Regulation of blood pressure is also another example of these rhythmic activities. Studies indicate that the lowest blood pressure is observed at night and the highest at about 9 AM and 7 PM. Time orders are also observed when it comes to heart rate, so that maximum heart rate is seen in the early hours of the day. In addition to the effect of internal factors on circadian cycles, environmental factors can also disrupt the coordination between external and internal clocks of the body and can cause cardiovascular disease. The high incidence of heart disease in shift workers, people with sleep disorders, and those with diabetes has been proven [17]. Therefore, existing evidence can definitely confirm the rhythmic function of the cardiovascular system and the role of external factors on the incidence of heart disease.
However, the difference in the results of studies examining the effect of DST on the incidence of acute heart attack can be attributed to different study conditions and characteristics of the subjects. For example, while the study by Salehian et al. [18] showed no correlation between circadian rhythm and acute myocardial infarction, Jido et al. [19] indicated a significant increase in the prevalence of acute myocardial infarction on the first day after DST in spring. They also mentioned confounding factors in their study, such as the distance of the investigated hospitals, the retrospective and observational method of research, inclusion criteria, and lack of access to demographic characteristics of patients, such as the history of other diseases and drug use, smoking, and family history that can affect the outcome of the study. Therefore, different results in this type of studies, which are affected by multiple variables, are not unlikely and unexpected. It is recommended that further studies with larger and more homogeneous samples should be carried out by considering and controlling these factors, so that the findings can be more accurately interpreted.

Conclusion

The present study aimed to investigate the relationship between DST in Iran and the incidence of acute heart attack complaints in the target population, assuming that time change does not increase the incidence of acute heart attack. Although the results of the study showed no correlation between DST and the incidence of acute heart attack, further research in this field is necessary, because previous studies have shown the effect of time change on disrupting the circadian rhythm and hence the cardiovascular function in humans.

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