Shift Work and Cardiovascular Disease

Vardiyalı Çalışma ve Kardiyovasküler Hastalık Riski

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Abstract

Shift work has become a necessity in many industries; however, the shift work system disrupts the endogenous circadian rhythm by changing the sleep-wake cycle and can prepare the ground for cardiovascular diseases. Shift workers are at risk of some chronic disorders such as hypertension, elevated serum lipids and body weight, cardiovascular conditions, including coronary artery disease, acute myocardial infarction, and stroke and metabolic syndrome. Furthermore, it is thought that changes occur in the concentrations of melatonin, cortisol, ghrelin, and leptin due to the night shift work, and this is associated with the change in the circadian rhythm. In this condition, reconsidering some precautions can reduce the risk of cardiovascular disease. Recently, it has been shown that exercise can be effective in reducing the risk of cardiovascular disease in shift workers. The aim of this review is to determine the relationship with cardiovascular diseases and shift work system.

Keywords Shift work; circadian rhythm; cardiovascular disease risk

Öz

Vardiyalı çalışma şekli birçok sektörde gereklilik haline gelmiştir ancak vardiyalı çalışma sistemi uyku-uyanıklık döngüsünü değiştirerek endojen sirkadiyen ritmi bozmakta ve kardiyovasküler hastalıklara zemin hazırlayabilmektedir. Vardiyalı çalışanlar, hipertansiyon, aşırı kilo, hiperkolesterolemi, akut miyokard enfarktüsü, inme ve koroner arter hastalığı gibi kardiyovasküler olaylar için risk faktörlerine maruz kalmaktadır. Ayrıca gece vardiyasında çalışma ile melatonin, kortizol, grelin ve leptin konsantrasyonlarında değişiklikler olduğu ve bunun sirkadiyen ritmin değişmesi ile bağlantılı olduğu düşünülmektedir. Bu durumda, bir takım önlemlerin gözden geçirilmesi kardiyovasküler hastalık riskini azaltabilir. Son zamanlarda egzersizin vardiyalı çalışanlarda kardiyovasküler hastalık riskini azaltmada etkili olabileceğine dair kanıtlar bulunmaktadır. Bu derleme yazısında amacımız vardiyalı çalışma sisteminin kardiyovasküler hastalıklar ile ilişkisini incelemektir.

Anahtar Kelimeler *Vardiyalı çalışma; sirkadiyen ritim; kardiyovasküler hastalık riski*

INTRIODUCTION

Nowadays, with the development of the industry and the increase in production, shift work has become a necessity in many sectors. Approximately 20% of the working population in the European Union countries work in shifts.[1] To provide uninterrupted, effective, and accessible healthcare services to the public in hospitals, shift work is widely applied among healthcare personnel and other sectors. Shift work is defined as day and night working, at intervals and at different times, without a fixed schedule. This type of working causes acute and chronic sleep deprivation and poor-quality sleep. The prevalence of sleep disorder in individuals working in shifts is 10-18%. Furthermore, 32% of employees experience insomnia, and 26% experience excessive daytime sleepiness.[2,3]

Working with the shift system creates a disharmony between the sleep-wake rhythm and the endogenous circadian rhythm.[3] Thus, the disruption of the endogenous circadian rhythm can cause different health problems. Many studies on this subject have shown that shift work may cause diseases related to the cardiovascular system and gastrointestinal system and increase the risk of diabetes, metabolic syndrome, and cancer.[3-5] One of the first review suggesting an association between shift work and heart diseases was published in 1984.[6] Since then, numerous studies have been conducted on this issue, concluding that there is a strong association between shift work and cardiovascular diseases.[6,7] In addition to these, there are also studies investigating the effects of sleep on the immune system. In the study conducted by Öztürk et al., it was demonstrated that sleep deprivation caused a decrease in natural killer cells and adversely affected the immune system.[8]

In this review study, our aim is to address the health problems that may be caused by circadian misalignment due to shift work and also reveal the relationship between the shift work system and cardiovascular diseases.

Circadian Rhythm

The term circadian is a combination of two Latin words, circa (about) and dies (day). The circadian rhythm refers to the changes caused by the rotation of the earth around its own axis, which lasts for about 24 hours, in the physiological and biological processes of living beings. Environmental conditions (such as daylight, light, dark) have significant effects on this rhythm. Rhythmic changes in the sleep-wake cycle in humans are the most basic and determinant circadian rhythm.[9]

The circadian timing system consists of "biological day" and "biological night" in a cyclical transition. The suprachiasmatic nucleus in the anterior hypothalamus is the main timer that plays an important role in the starting-ending cycle of the circadian rhythm at certain times in humans. It is known that the most important stimulus (Zeitgeber) in regulating the circadian rhythm is light. While people are active in the daytime under the effect of daylight, they are in a inactivite period at night with darkness. Therefore, during the transition between day and night, relatively large changes occur in many physiological mechanisms such as circulating melatonin, cortisol levels, and body internal temperature.[10] The alteration of melatonin secretion is result form the suppression by transmitting the light perceived by the retina during the daytime to the suprachiasmatic nucleus and then to the epiphysis. However, in the case of shift work, the sleep and wake cycle cannot occur in harmony with daylight. As a result, disharmony may occur in biochemical and physiological processes in the organism.

In addition to the central nervous system, it is known that peripheral timers located in peripheral tissues (such as the liver, pancreas, skeletal muscle, intestine, and adipose tissue) play a role in functions related to the circadian rhythm in the body. These timers usually work with signals from the suprachiasmatic nucleus. Thus, the circadian clock plays an important role in cardiac homeostasis through the expectation of daily workload.[10,11] Cardiovascular ac-

tivity in humans has a pronounced circadian rhythm. In studies conducted on healthy people, the resting heart rate is high in the daytime, in line with the circadian rhythm, and the lowest at night. In studies performed on rats with the suprachiasmatic nucleus removed, it was observed that the difference in resting heart rate between day and night disappeared.[10] This suggests that the suprachiasmatic nucleus has suppressive effects on the heart rate at night and stimulating effects during the daytime by affecting the secretion of hormones such as melatonin and cortisol. In people with cardiovascular disease, melatonin decreases at night, and the rhythm of release is disturbed.[12,13]

Shift Work and Cardiovascular Diseases

There are many studies examining the relationship between working with the shift system and cardiovascular disease risk factors. This relationship is mainly explained by circadian misalignment, nutrition, and habits such as smoking and caffeine consumption. In the meta-analysis conducted by Torquati et al. and including 21 studies with a total of 173 010 participants, shift workers and daytime workers were compared.[14] In this study, it was observed that shift work increased the risk of coronary heart disease morbidity by 26% and increased the risk of mortality by 20% compared to daytime work. Moreover, the risk of developing any cardiovascular disease occurred after the first five years of shift work, with an increase of 7.1% for every five-year shift work.[14]

Shift workers are at risk of some chronic disorders such as hypertension, elevated serum lipids and body weight, cardiovascular conditions, including coronary artery disease, acute myocardial infarction, and stroke and metabolic syndrome. In their cohort study, Vetter et al. (2016) examined nurses working in the night shift for a period of 24 years and observed that the risk of coronary heart disease increased as the working year in the night shift increased.[15]

1- Endocrine and metabolic disorders

In the studies carried out to date, changes in the concentrations of melatonin, cortisol, ghrelin, and leptin have been observed in shift workers.[16] Epidemiological studies have shown that cardiovascular events such as myocardial infarction, stroke, and arrhythmias in the early morning hours (especially between 6 am and noon) have the highest incidence of morbidity and mortality. Most studies show a positive correlation between stress and cortisol.[16-18] Cortisol concentrations are strongly associated with work stress and sleep loss, especially in the mornings. As a result of circadian misalignment and exposure to stress in night shift workers, morning salivary cortisol values have been found to be higher than daytime workers.[19] Therefore, it is stated that shift work, sleep, or changes in the circadian system cause an increase in cortisol secretion.[17,19]

Shift workers work actively during the hours when they should normally be in a resting state, and this will also change the eating pattern. There are studies showing that the meal eaten during the night (compared to the meal eaten during the day) causes a deterioration in lipid metabolism and may constitute a potential risk factor for cardiovascular diseases.[20-22]

Although the night shift work changes the eating pattern, it causes postprandial glucose levels to increase compared to daytime work.[23] Impaired glucose metabolism is an important risk factor for cardiovascular diseases.[10] Studies have shown that the reason for the increase in glucose levels during the night shift is the decrease in the sensitivity of beta cells to glucose and consequently the decrease in insulin secretion, which plays an important role in the regulation of glucose level.[23,24] Furthermore, it has been observed that a few days of rest period after the shift change this situation.[23]

2- Hypertension

According to the data of the World Health Organization, an estimated 1.13 billion people worldwide have hypertension, and hypertension is a major cause of premature death worldwide.[25] Night shift work triggers physiologi-

cal or psychological stress by altering sleep and biological rhythms and poses a risk for hypertension, diabetes, obesity, and cardiovascular diseases.[26,27] In addition, it is assumed that depression and psychiatric disorders may also support the development of cardiovascular diseases. In the study conducted by Nascimento et al., it was shown that the prevalence of hypertension increased in nurses working in shifts with burnout syndrome.[28]

Sleep and circadian variation play a significant role in the 24-hour pattern of blood pressure. The normal daily pattern of blood pressure occurs as an increase in systolic and diastolic pressure during the daytime with awakening, followed by a 10-20% decrease during the night and in sleep hours.[2] There are few studies investigating the acute and long-term effects of shift work on blood pressure during sleep. In the meta-analysis, in which they included 44 studies conducted between 1980 and 2018, Patterson et al. observed that systolic blood pressure was 17.5 mmHg higher and diastolic blood pressure was 15.4 mmHg higher during the shift, when the blood pressure measured during shift work was compared with the blood pressure measured during any sleep period outside the shift work. Furthermore, it was reported that shift workers should be observed for a long time after being exposed to different shift schedules.[2]

3- Atherosclerosis

Atherosclerosis plays an important role in coronary heart disease. The effect of inflammation in the development of atherosclerosis has long been known. The increase in inflammatory markers increases the risk of cardiovascular diseases, which has been shown to be higher in shift workers compared to daytime workers. Morris et al. (2017) showed in their study that circadian misalignment increased 24-hour high-sensitivity C-reactive protein (hs-CRP) and blood pressure levels in shift workers. The increase in hs-CRP, which is used as an inflammation marker, increases the risk of cardiovascular disease.[29]

Endothelial dysfunction has been stated as the earliest abnormality in a complex series of events resulting in atherosclerosis. Tarzia et al. (2012) measured brachial artery dilatation during ischemic forearm hyperemia (flow-mediated dilation) in their study on healthy young physicians working in shifts. This study demonstrated that a night shift adversely affected systemic endothelial function in healthy young physicians without any cardiovascular risk factors.[30] Vascular endothelial dysfunction can cause platelet aggregation, and platelet aggregation is one of the most important causes of thrombus formation in the vessel walls in patients with atherosclerotic diseases. Nakao et al. (2018) investigated the acute effect of night shift work on platelet function. Although platelet aggregation did not increase, they showed that thromboxane B2, a stable metabolite of thromboxane A2, increased compared to the basal level in healthcare professionals after the night shift. This platelet hypersensitivity may be one of the mechanisms underlying the significant relationship between night shift work and cardiovascular disease.[31]

Approaches That Can Reduce Cardiovascular Risk

Due to the effects of shift work on health, especially in terms of cardiovascular disease risks, taking certain precautions may be beneficial in reducing this risk. According to the results of a previous meta-analysis on this subject, shift work for more than five years significantly increases the risk of cardiovascular disease.[14] Considering this situation, it may be beneficial to organize shift work and daytime work periods in 5-year rotations, especially in the field of health.

Night shift workers may be less willing to exercise due to fatigue and insomnia and may not be able to exercise adequately. Whether exercise has a rhythm-regulator role has not been fully explained. However, a recent study has shown that exercise has a positive effect on cardiovascular risk factors in people working in shifts. In this study, it was determined that 4 minutes of high-intensity physical activity exercise, 3 days a week, reduced systolic blood

pressure, diastolic blood pressure, and glycated hemoglobin (HbA1c) values in participants.[32] In a study conducted by Lim et al. (2015) on 30 male participants working in the night shift, participants underwent short-term and intermittent exercise three days a week for 10 weeks in 10-minute sessions (30 minutes a day), and changes in body composition, blood pressure, and cardiovascular disease risk factors were evaluated.[33] The findings showed that exercise reduced plasma concentrations of cathepsins and adhesion molecules, which have an effect on the formation of atherosclerosis, and a decrease in body weight and fat ratio occurred. The findings obtained suggest that exercise may have a positive effect on improving cardiovascular risk factors in night shift workers.[32,33] There is a need for larger-scale and comprehensive studies on this subject.

CONCLUSION

In conclusion, the shift work system may cause a significant increase in the risk of cardiovascular diseases by disrupting the endogenous circadian rhythm. Night shift work and weekly changing irregular shift hours can contribute to this situation. It is important to increase knowledge on this subject and to organize shift work times in intermittent periods. Furthermore, studies showing that exercise may be beneficial in reducing the risk of cardiovascular diseases in shift workers should be taken into consideration, and people should be directed to be physically active.

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