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The Effect of Modic Changes on Low Back Pain, Physical Activity, Muscle Endurance, and Aerobic Capacity: Cross-Sectional Research

Modic Değişikliklerin Bel Ağrısı, Fiziksel Aktivite Düzeyi, Sırt Ekstansör Kas Dayanıklılığı ve Aerobik Kapasite Üzerine Etkisi: Kesitsel Araştırma

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ABSTRACT Objective: Modic changes are structural degenerative changes that occur in the vertebral bone marrow. This study aimed to investigate pain severity, back extensor muscle endurance, aerobic capacity, and physical activity levels in patients with Modic changes. **Material and Methods:** Sixty (39 women, 21 men) patients were included. According to the result of the lumbar spine magnetic resonance imagination, patients with or without Modic changes were divided into two groups (Modic and control). Pain severity was evaluated with the visual analogue scale. Sorensen test was used to evaluate back extensor muscle endurance, The 6 minute walk test was used to evaluate the aerobic capacity, and the Turkish version of the short form the International Physical Activity Questionnaires was used to evaluate health-related physical activity level. **Results:** There was a difference in the pain severity, extensor back muscles endurance, and aerobic capacity between groups (respectively; p=0.001; p=0.001; p<0.001). While the pain severity of the control group was low, the endurance of extensor back muscles and the aerobic capacity were higher than the Modic group. There was no difference in strong, moderate, sitting, and total activity levels between groups (p>0.05), but there was a difference in walking activity level (p=0.014). In the control group, the mean of metabolic equivalent minutes in walking activity was higher than in the Modic group. **Conclusion:** In patients with Modic change, pain severity was higher, and back extensor muscle endurance with aerobic capacities were lower. No difference was found between physical activity levels of the patients with Modic change except walking. In addition, while the average age of patients with Modic changes was higher, there was no difference according to the smoking rate. Studies investigating the effects of different Modic type changes on muscular strength, endurance, lumbar stabilization, aerobic capacity and physical activity level are needed.

Keywords: Spine; low back pain; physical activity

ÖZET Amaç: Modic değişiklikler, vertebral kemik iliğinde meydana gelen yapısal dejeneratif değişikliklerdir. Bu çalışmanın amacı, Modic değişiklikleri olan hastalarda ağrı şiddeti, sırt ekstansör kas dayanıklılığı, aerobik kapasite ve fiziksel aktivite düzeyini araştırmaktır. **Gereç ve Yöntemler:** Altmış (39 kadın, 21 erkek) hasta çalışmaya dâhil edildi. Lomber omurga manyetik rezonans görüntüleme sonucuna göre Modic değişikliği olan veya olmayan hastalar 2 gruba ayrıldı (Modic ve kontrol grubu). Vizüel analog skalası ile ağrı şiddeti değerlendirildi. Ekstansör kas dayanıklılığını değerlendirmek için Sorensen testi, aerobik kapasiteyi değerlendirmek için 6 dk yürüme testi ve fiziksel aktivite düzeyini değerlendirmek için Uluslararası Fiziksel Aktivite Anketlerinin kısa formunun Türkçe versiyonu kullanıldı. **Bulgular:** Gruplar arasında ağrı şiddeti, ekstansör sırt kas dayanıklılığı ve aerobik kapasitede fark vardı (sırasıyla; p=0,001; p=0,001; p<0,001). Kontrol grubunun ağrı şiddeti daha düşük iken, ekstansör sırt kas dayanıklılığı ve aerobik kapasitesi Modic grubundan daha yüksekti. Gruplar arasında güçlü, orta, oturma ve toplam aktivite düzeyleri açısından fark yoktu (p>0,05), ancak yürüme aktivite düzeyinde fark vardı (p=0,014). Kontrol grubunda yürüme aktivitesinin metabolik eş değer dakika ortalaması Modic grubundan daha yüksekti. **Sonuç:** Modic değişiklikleri olan hastalarda ağrı şiddeti daha yüksek iken, aerobik kapasitesi ile sırt ekstansör kas dayanıklılığı daha düşüktü. Modic değişikliği olan hastaların, yürüme dışında fiziksel aktivite düzeyleri arasında fark bulunmadı. Buna ek olarak, Modic değişiklikleri olan hastaların yaş ortalaması daha yüksek iken, sigara içme oranı açısından fark yoktu. Farklı Modic tip değişikliklerin kassal kuvvet, dayanıklılık, lumbal stabilizasyon, aerobik kapasite ve fiziksel aktivite düzeyi üzerine etkilerinin incelendiği çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: Omurga; bel ağrısı; fiziksel aktivite

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Low back pain is one of the common health problems in the community. Muscle flexibility, strength, and volume decrease if the pain continues. These unfavorable changes cause deterioration of lumbar biomechanics, structural changes, ongoing and even increasing pain. As the pain becomes chronic, the muscular strength and endurance decrease more. As a result, pain severity increases even more.[1] In the long term, muscle atrophy occurs and causes new degenerative structural disorders, although the pain decreases. These degenerative structural disorders may cause pain intensity to increase again.[1]

Structural degenerative changes occurring in the long term also occur in the vertebral bone marrow. These changes were first described in three different types by Modic.[2] Modic Type 1 is an active degenerative process where oedema and inflammation occur in the marrow of the vertebra. Modic Type 2 is the marrow cells transforming into yellow and fatty after ischemia. Modic Type 3 is subchondral bone sclerosis (end-plateau changes). Also, at least two different Modic Types in different segments can be seen. It is called mix type.[3] From Type 1 to Type 3, the severity of degeneration increases gradually.[4] Modic changes are found in 22% of 40-year old people.[5] In the literature, Modic changes are known to be closely related to low back pain.[4-6] It was reported that althought 88% of patients with Modic changes had a pain during a year, 63% of patients without Modic changes had a pain in a year.[6] Therefore Modic changes could limit activity.[8] As a result, if the pain continues, it restricts physical activity, disrupts biomechanics, and causes increased pain than before.[1]

It's known that low back pain reduces endurance of back muscle, negatively affects physical activity level and aerobic capacity, and causes inactivity.[7-10] Although there is evidence of a strong association between Modic changes and low back pain, no studies were found on the effect of Modic changes on physical activity, back extensor muscular endurance, and aerobic capacity.[11] The aim of this study was to investigate the effect of Modic changes on physical activity, back extensor muscle endurance, and aerobic capacity.

MATERIAL AND METHODS

STUDY DESIGN

Observational case-control study.

ETHICS APPROVAL

The Noninvasive Clinical Research Ethics Committee of Üskudar University approved the study protocol (Date: 03/09/2018, Number: B.08.6.YÖK.2.ÜS.0.05.0.06/2018/791). The participants were informed about the scope and procedures of the study. All individuals were provided written informed consent before participating in the study, which was conducted according to the ethics guidelines and principles of the Declaration of Helsinki.

SAMPLE SIZE

Subjects were calculated to be in each group (Modic and control groups) with a 5% Type 1 and 90% Type 2 error limits for evaluating SD. Cohen's d was taken as 0.5. It was calculated that 30 patients should be in each group. Analyses were performed with the G*Power 3.1.9.2 software.

PATIENT SELECTION

While 93 patients were invited to this study, sixty of these patients (39 females, 21 males) accepted (Figure 1). Patients were divided in two groups. If there were Modic changes as the result of MRI, the patient was included in Modic group. If not, the patient was included in the control group. Patients who were between 30-65 years old, applied to the hospital with

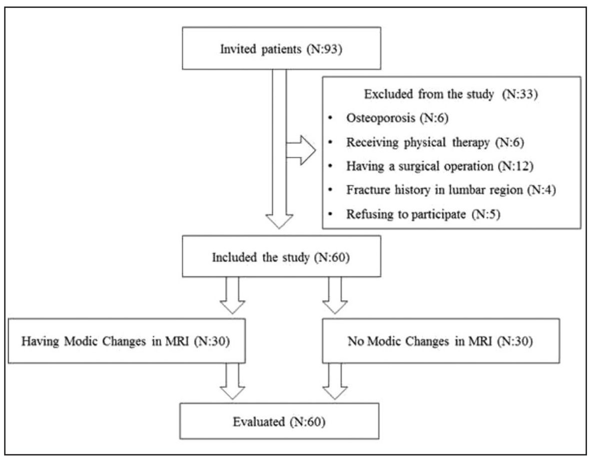

FIGURE 1: Flow chart of the study.

complaints of low back pain, and had a result of lumbar MRI were included in this study. Patients who had undergone physiotherapy and rehabilitation in the past 6 months, had a history of trauma or surgery in the lumbar region, did any exercises more than two times in a week, had an organ failure (heart failure, chronic renal failure, hepatic failure, etc.) or osteoporosis were not included.

EVALUATION

The demographic characteristics (age, gender, height, weight, and using smoke) and health history (hypertension, diabetes mellitus, surgery, etc.) of patients were recorded. All evaluations were done in the following order by the same physiotherapist.

Pain Severity: Pain severity was evaluated with the visual analogue scale (VAS) that consists of a 10 centimeter (cm) line. Meaning of 0 cm was "no pain" and the meaning of 10 cm was "pain as intolerable". The patient was wanted to put a mark that defines her pain severity on the VAS. The scale was scored by measuring the distance from the 0 cm to the patient's mark.[12]

Back Extensor Muscle Endurance: Sorensen test was used to evaluate back extensor muscle endurance. The patient was laid in a prone position with his pelvis, hip and knees flat on the table, and the spina iliaca anterior superiors on the edge of the table. The patient's ankles were kept on the bed. Before the test, the patient was allowed to take support from tabouret with his hands to protect the upper body parallelism to the ground. The patient was asked to cross his/her arms on the chest. The patient was asked to keep this position. When the patient disrupted the test position, the test was completed and the time was recorded.[13]

Aerobic Capacity: The 6 minute walk test (6MWT) was used to evaluate the aerobic capacity (functional capacity). This test aims to reach the longest possible walking distance after 6 minutes. The patient was asked to walk between marked areas in a 30-meter corridor as fast as possible for 6 minutes, and the distance was recorded. The test was terminated in case of chest pain, dyspnea, leg cramps, excessive fatigue, sweating, and paleness. Before the test started, it was explained to the patients that if they felt shortness of breath during the test, they could rest, and this resting time would be included in the test time. The test was initiated with the command "Start" and ended with the command "Stop" at the end of the 6 minutes. The distance the patient walked was calculated and recorded.[14]

Physical Activity Level: The Turkish version of the short-form International Physical Activity Questionnaires (IPAQ) was used to evaluate health-related physical activity. It has a 9-item that assessed the minutes that spent in vigorous and moderate-intensity activity and walking during the last 7 days. Also, the number of minutes spent sitting in the past 7 days is recorded. For all categories, how many days and minutes patient spends at a specific activity category are defined. After then the amount of Metabolic Equivalents Minutes (METs) is calculated by multiplying the number of minutes with 8 (vigorous), 4 (moderate), 3.3 (walking), or 1.3 (sitting). For a total score, the METs-minutes of the first 3 categories is collected. The IPAQ has good test-retest reliability (Spearman's r ¼ 0.80) and moderate criterion validity (Spearman's r ¼ 0.30) with an accelerometer in healthy adults.[15]

STATISTICAL ANALYSIS

Statistical analyses were performed with the IBM-SPSS for Windows version 20 software (IBM Corp., Armonk, New York, United States). Descriptive statistics were given as mean and standard deviation for numerical data. The normal distribution of the obtained numerical variables was determined with visually (histogram and probability graphs) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk tests). Independent t-test was used to analyze weight, height, body mass index, age, pain severity, back extensor muscle endurance, aerobic capacity, and activity levels between groups. Mann-Whitney U test was used to analyze the gender and smoking rate of patients between groups. Statistical significance was set at $p<0.05$.

RESULTS

There were Modic Type 1 changes in 4 (13.3%) patients, Modic Type 2 changes in 23 (76.6%) patients, and Modic Type 3 changes in 3 (10%) patients. Modic changes were found at L2-L3 (10%) in 3 pa-

TABLE 1: Comparison results of weight, height, body mass ındex age, and smoking rate of patients with and without Modic type changes.

	Group	n	Mean±SD or Frequency (per cent)	p value
Weight (kg)	Control	30	71.57±12.16	0.241¥
	Modic	30	75.63±14.33	
Height (m)	Control	30	1.65±0.83	0.550¥
	Modic	30	1.64±0.92	
BMI (kg/m²)	Control	30	26.09±4.20	0.121¥
	Modic	30	28.03±5.29	
Age (year)	Control	30	42.07±11.99	**0.004¥**
	Modic	30	50.67±10.03	
Female (n)	Control	30	17 (28.33%)	1.000β
	Modic	30	22 (36.66%)	
Male (n)	Control	30	13 (21.66%)	1.000β
	Modic	30	8 (13.33%)	
Smoking rate (n)	Control	30	9 (30%)	0.587β
	Modic	30	11 (36.7%)	

SD: Standard deviation; kg: Kilogram; m: Meter; BMI: Body mass index; ¥: Independent t-test; β: Mann-Whitney U test; p<0.05.

tients, at L3-L4 (10%) in 3 patients, at L4-L5 (33.3%) in 10 patients, and L5-S1 (46.7%) in 14 patients. Seven patients had hypertension, five patients had diabetes mellitus and one patient had coronary artery disease, forty seven patients had no history of chronic disease. There was no difference in weight, height, body mass index, gender, and smoking rate between groups (p>0.05). There was a difference in age between groups (p=0.004). The mean age of the Modic group was higher than the control group (Table 1). There was a difference in the pain severity, the endurance of extensor back muscles, and aerobic capacity between groups (respectively; p=0.001; p=0.001; p<0.001,). While the pain intensity of the control group was low, the endurance of extensor back muscles and aerobic capacity were higher than the Modic group (Table 2). There was no difference in strong, moderate, sitting, and total activity levels between groups (p>0.05). But there was a difference in walking activity level between groups (p=0.014). The mean of walking MET in the control group was higher than in the Modic group (Table 3). When Cohen's d was calculated as 0.916 according to pain severity and the type 1 error limit was taken 0.05, power of the study was calculated as 93%. Analyse was performed with the G*Power 3.1.9.2 software.

TABLE 2: Comparison results of pain severity, back extensor muscle endurance, and aerobic capacity between patients with and without Modic type change.

	Group	n	Mean±SD	p value
Pain severity (cm)	Control	30	5.47±1.79	**0.001**
	Modic	30	6.90±1.29	
Back extensor muscle endurance (sc)	Control	30	56.50±40.64	**0.001**
	Modic	30	26.20±19.97	
Aerobic capacity (m)	Control	30	435.57±65.65	**0.000**
	Modic	30	362.97±71.89	

SD: Standard deviation; cm: Centimeter; sc: Second; m: Meter; Independent t-test; p<0.05.

TABLE 3: Comparison of activity levels of patients with and without Modic changes.

Activity levels	Group	n	MET±SD	p value
Vigorous intense activity	Control	30	648±1,935.60	0.740
	Modic	30	824±2,144.48	
Moderate intense activity	Control	30	2,460±2,058.95	0.618
	Modic	30	2,232±1,904.57	
Walking	Control	30	1,255±1,188.77	**0.014**
	Modic	30	614±712.42	
Sitting	Control	30	3,454±2,157.92	0.579
	Modic	30	3,727±1,587.08	
Total	Control	30	7,818±3,381.16	0.636
	Modic	30	7,397±1,188.77	

SD: Standard deviation; MET: Metabolic equivalents minutes; Independent t-test; p<0.05.

DISCUSSION

In the present study, patients with Modic changes had a higher pain severity, had a lower back extensor muscle endurance and aerobic capacity than patients without Modic changes. While the walking activity levels of patients with Modic changes were lower, there was no difference between strong, moderate, sitting and total activity levels. Also, while the average age of patients with Modic change was higher than those without Modic changes, there was no difference in the gender and smoking rate.

Low back pain is closely related to Modic changes.[6] While a significant relationship could not be found between lumbar disc degeneration and pain severity, it was reported that pain severity was higher in patients with Modic changes.[16,17] In this study, the pain severity of patients with Modic changes was significantly higher than the patients without Modic changes. This difference in pain severity may be due to the degeneration in the vertebral segment seen in Modic changes. Especially, from Type 1 to Type 3, the severity of degeneration increases gradually.[4] Of the patients who participated in this study, 76.6% had Modic Type 2 changes. Although the severity of degeneration increases from type-1 to type-3,5, Herlin et al. emphasized in their study that there was no significant difference in low back pain severity between types.[6] In the present study, pain severity may have increased more due to degeneration severity. But, pain severity could not be examined between types of Modic changes as enough patients were not present in each Modic types. It is thought that studies investigating the differences in types of Modic changes are needed.

Muscle endurance is defined as maintaining repetitive strength or activity, and an increase in muscle strength also causes an increase in endurance.[18] Low back pain is known to restrict physical activity, to cause inactivity in daily life, and to reduce back extensor muscle endurance.[7,16] In the literature, there was not study found evaluating trunk extensor muscular endurance in patients with Modic changes. In the present study, the trunk extensor muscular endurance levels in patients with Modic change were significantly lower. There could be several reasons. Firstly, the mean age of patients with Modic changes was significantly higher than the patients without Modic changes. As the age progresses, the mass and strength of the muscle decrease.[19] Secondly, it may be due to the difference in pain severity between groups. It is known that there is a significant inverse relationship between pain severity and muscular endurance.[20] The higher pain severity in patients with Modic changes may have caused this difference to be evident. Finally, it may be due to the difference in walking activity levels of the patients participating in this study. Since the trunk extensor muscles, one of the anti-gravity muscles, work actively during walking, it is known that walking increases the back extensor muscle endurance.[21] In this study, the lower walking distance in 6MWT and the lower MET level in walking activity was determined in patients with Modic changes. Therefore, back extensor muscle endurance could be lower. All of these changes might have occurred together and could have negatively affected the back extensor muscle endurance in patients with Modic changes.

In the present study, aerobic capacities of patients with Modic changes were significantly less than patients without Modic type changes. Low back pain is known to restrict physical activity, to cause inactivity in daily life.[10] Inactivity that becomes after low back pain also negatively affects aerobic capacity.[9] In patients with Modic changes, the pain severity was higher and there was a lower walking level. Another important factor affecting aerobic capacity is ageing. Aerobic capacity starts to decrease after the age of 40, and people lose nearly 30% of aerobic capacity at the age of 65.[22] Increasing degenerations such as cell deaths, disc ruptures, disruption of connective tissue order caused by morphological and biochemical changes caused by aging may cause Modic changes with aging.[23] Therefore, Modic changes are known to increase significantly with ageing.[24] In this study, patients with Modic changes were significantly older than patients without Modic changes. In patients with Modic changes, the higher mean of age, pain severity, and inactivity may have been caused the aerobic capacity to be significantly lower in this group. All of them may cause a decrease in aerobic capacity. It is known that degeneration from Type 1 to Type 3 increases.[4] In the literature, this study and other studies were seem to focus on patients with or without Modic changes.[17] However, it is thought that the differences in Modic changes variation types should be revealed. It is thought that new researches are needed to investigate the effects of different Modic type changes on aerobic capacity.

Although it was known that low back pain affects negatively physical activity level, there was no study investigating the physical activity levels of patients with Modic changes in the literature.[8] However, there is information that it limits the activity.[6] In the present study, in which physical activity levels of patients with and without Modic changes were examined with IPAQ, and no significant difference was found in other parameters (vigorous moderate ıntense activity, sitting, and total) other than walking activity. Walking activity level in patients with Modic changes was lower statistically. It is known that low back pain limits the level of physical activity, and there is a close relationship between Modic changes and pain severity.[4] In this study, patients with Modic changes may have decreased levels of walking activity due to high back pain severity than patients without Modic changes. Another reason for lower walking activity could be ageing. Because the mean age of patients with Modic changes was higher in this study. This difference may have occurred due to a decrease in the level of physical activity with ageing.[25] In particular, studies on all three Modic type changes and healthy people is thought to able to provide more explanatory information on the level of physical activity.

Modic changes are common MRI findings in middle-aged lumbar spine and Modic Type 2 appears to be more dominant than others. Age plays an essential role in the pathogenesis of Modic changes.[24] In this study, there was a statistically significant difference in age between low back pain patients with and without Modic changes. Although low back pain begins in adolescence, it is most common in adults around the age of 41, prevalence studies on patients with low back pain with Modic changes show that the average age is around 50.[26,27] It is observed that the average ages obtained from the literature and the average ages of the groups in this study are parallel to each other. Age differences in groups can be considered normal in this study. However, it is known that aging effects negatively physical activity, aerobic capacity, and muscle endurance.[19,22,25] In this study, back extensor muscle endurance, aerobic capacity, and walking activity levels were lower in Modic changes group. These parameters may have been found to be low due to the high mean age of the Modic group. However, this difference may also be due to the higher pain level in Modic group. It is known that low back pain restricts physical activity, causes inactivity in daily life and reduces back extensor muscle endurance.[7,10] It is thought that new researches suitable for the age group are needed in different types of Modic changes.

In the literature, although there are studies indicating that there may be differences in the frequency of Modic changes according to gender, there are distinct studies that express the opposite.[28,29] In this study, no difference was found in the gender of individuals with and without Modic change. In light of the data obtained from the literature and the study, it is thought that gender does not affect the formation of Modic changes.

Smoking could disrupt the intervertebral disc oxygenation and increase toxicity, causing the appearance of Modic type changes.[30] Leboeuf-Yde et al. found that low back pain, disc degeneration, spinal inflammation, and Modic changes were higher in patients with smoking habit.[31] However, Jensen et al. in their 4-year prospective study, found no relationship between smoking and Modic changes.[29] Han et al. specified that there was no significant relationship between smoking status and Modic type changes.[32] In the present study, a similar result was found. No significant difference was found in patients with and without Modic changes in the rate of smoking.

Although Modic changes are seen at all levels of the spine, Udby et al. reported that Modic changes are seem in L4-S1 levels in 80% patients.[33] In the present study, Modic changes were found at the level of L4-L5 in 10 patients (33.3%) and at the level of L5-S1 in 14 patients (46.7%). The reason of Modic changes in lower lumbar levels is that there is a higher physical loading in this region.[34]

Patients with low back pain should also be evaluated in terms of Modic changes, and Modic subtypes. Early detection of Modic changes can lead to the early implementation of different treatment and rehabilitation programs. Modic changes should not just seem a MRI finding and it could be a pathology that should be treated in low back pain.[35] In this way, the formation of permanent degenerative changes can be prevented. Appropriate treatment and rehabilitation methods and programs can be applied according to the Modic types. The current study also has some limitations. In the study, there was a difference in age between groups. Age can effect back extensor muscle endurance, aerobic capacities, and physical activity levels. Studies are needed that match age between groups. In addition, the number of patients with Type 1 and Type 3 changes was low in the patient group with Modic change. Therefore, the differences between Modic types in terms of pain severity, back extensor muscle endurance, aerobic capacities, and physical activity levels could not be evaluated. Studies that investigate the long-term effects of Modic changes on flexor-extensor muscle strength, multifidus muscle cross-sectional area, bone density, disc height are needed.

CONCLUSION

The present study was the first study to evaluate the back extensor muscle endurance, aerobic capacities, and physical activity levels in Modic changes. Pain severity was higher in patients with Modic type change while back extensor muscle endurance and aerobic capacities were lower. No difference was found between physical activity levels of the patients with Modic type change except walking. Patients with Modic type change had a lower walking activity level. Also, while the average age of patients with Modic type change was higher, there was no difference in the smoking rate. It is thought that there is a need for studies examining the difference between Modic types in particular. Studies investigating the effects of different Modic type changes on muscular strength, endurance, lumbar stabilization, aerobic capacity and physical activity level are needed.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

***Idea/Concept:** Çetin Sayaca, Büşra Kızılcan; **Design:** Çetin Sayaca, Büşra Kızılcan; **Control/Supervision:** Çetin Sayaca; **Data Collection and/or Processing:** Büşra Kızılcan; **Analysis and/or Interpretation:** Çetin Sayaca; Büşra Kızılcan; **Literature Review:** Çetin Sayaca; Büüra Kızılcan; **Writing the Article:** Çetin Sayaca, Büşra Kızılcan; **Critical Review:** Çetin Sayaca, Büşra Kızılcan..*

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