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Examining The Relationship Between Perceived Physical and Cognitive Fatigue and Cognitive Flexibility in Sports Higher Education Institution Students

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Abstract

The aim of this study is to examine the relationship between perceived physical and cognitive fatigue and cognitive flexibility among students of higher education institutions in sports. The study consists of a total of 224 participants, including 91 females and 133 males, determined through a random sampling method. In the study, the data collection instruments used were "Athlete Cognitive Flexibility Inventory" and "Perceived Physical and Cognitive Fatigue Scale." Skewness-Kurtosis test, independent samples t-test, one-way analysis of variance (ANOVA), and Pearson correlation analysis were used in the data analysis. All statistical analyses were conducted using SPSS 22.0 software. A significance level of $p<0.05$ was considered. When the study results were examined, no significant difference was found in the scale scores according to the variables of department, sport type, and sport level of the participants. Significant differences were found in the total scores of the Athlete Cognitive Flexibility Inventory, total scores of the Perceived Physical Fatigue Scale, and sub-dimension scores of the Perceived Physical Fatigue Scale according to the gender variable. Significant differences were found in the total scores and sub-dimension scores of the Perceived Physical and Cognitive Fatigue Scale and the control sub-dimension scores of the Athlete Cognitive Flexibility Inventory according to the age and sport age variables. As a result of the correlation analysis, a significant negative and moderate relationship was found between the two scales. According to these results, it is expected that as the perceived physical and cognitive fatigue levels increase, the level of cognitive flexibility decreases. Athletes who are physically and cognitively fatigued may have difficulty generating alternative solutions and may also experience a decrease in control skills. By providing training on stress management techniques to athlete students as part of the course, their skills in coping with stress, problem-solving, and increasing cognitive flexibility can be developed. Active recovery techniques such as light exercises, yoga, meditation, and massage can alleviate the effects of fatigue in athlete students.

Keywords: Cognitive flexibility, perceived physical fatigue, perceived cognitive flexibility.

Spor Yükseköğretim Kurumu Öğrencilerinde Algılanan Fiziksel ve Bilişsel Yorgunluk ile Bilişsel Esneklik Arasındaki İlişkinin İncelenmesi

Özet

Bu çalışmanın amacı, spor yükseköğretim kurumu öğrencilerinde algılanan fiziksel ve bilişsel yorgunluk ile bilişsel esneklik arasındaki ilişkinin incelenmesidir. Çalışma, tesadüfi örneklem yöntemi ile belirlenen 91 kadın ve 133 erkek toplam 224 katılımcıdan oluşmaktadır. Çalışmada veri toplama aracı olarak "Sporcu Bilişsel Esneklik Envanteri" ve "Algılanan Fiziksel ve Bilişsel Yorgunluk Ölçeği" kullanılmıştır. Verilerin analizinde Skewness– Kurtosis testi, bağımsız örneklem t-testi, tek yönlü varyans analizi (ANOVA) ve Pearson korelasyon analizi kullanılmıştır. Tüm istatistiki analizler SPSS 22.0 programı ile yapılmıştır. Anlamlılık değeri $p<0.05$ olarak kabul edilmiştir. Çalışma sonuçları incelendiğinde katılımcıların bölüm, spor türü ve spor düzeyi değişkenlerine göre ölçek puanlarında anlamlı farklılık saptanmamıştır. Cinsiyet değişkenine göre sporcu bilişsel esneklik envanteri toplam puan, algılanan fiziksel yorgunluk ölçeği toplam puan ve algılanan fiziksel yorgunluk alt boyut puanlarında anlamlı farklılık saptanmıştır. Yaş ve spor yaşı değişkenine göre algılanan fiziksel ve bilişsel yorgunluk ölçeği toplam puan ve alt boyut puanları ile sporcu bilişsel esneklik envanteri kontrol alt boyutu puanlarında anlamlı farklılık saptanmıştır. Korelasyon analizi sonucunda iki ölçek arasında negatif yönde ve orta düzeyde anlamlı ilişki tespit edilmiştir. Bu sonuçlara göre algılanan fiziksel ve bilişsel yorgunluk düzeyinin artmasıyla bilişsel esneklik düzeyinin azalması beklenmektedir. Fiziksel ve bilişsel olarak yorgun olan sporcular, alternatif çözümler üretmekte zorlanabilir ve kontrol becerilerinde de azalma yaşayabilir. Sporcu öğrencilere ders kapsamında stres yönetimi tekniklerine yönelik eğitim verilerek, stresle başa çıkma, problem çözme ve bilişsel esnekliği artırma becerileri geliştirilebilir. Hafif egzersizler, yoga, meditasyon ve masaj gibi aktif iyileşme teknikleri, sporcu öğrencilerde yorgunluğun etkilerini hafifletebilir.

Anahtar Kelimeler: Bilişsel esneklik, algılanan fiziksel yorgunluk, algılanan bilişsel esneklik.

INTRODUCTION

In sports success, many factors such as optimism, pessimism, discipline, concentration, ambition, and discipline are influential. However, it is stated that the level of physical and cognitive fatigue is also an important factor for sports success (35). Fatigue is a phenomenon that reduces the desire to act and decreases performance (31). Perceived fatigue is often different from fatigue resulting from instantaneous exercise, activity, or competition (13). Perceived fatigue is described as a feeling of exhaustion that causes the slowing down of cognitive and physical functions in an athlete (19). Fatigue, which significantly affects an athlete's performance (37), is classified into physical and cognitive fatigue (7, 28). Physical fatigue is a process that reduces an individual's physical endurance, hinders participation in activities, and leads to deconditioning (26). This physical process is also characterized as fatigue that occurs with the cessation of movements (13). Cognitive fatigue, on the other hand, is a psychological state that arises from the mind being intense after prolonged physical activities (18). After prolonged mental activities, cognitive fatigue can manifest with problems such as lack of energy, loss of motivation, reaction issues, and memory difficulties (8). In other words, both physical fatigue and cognitive fatigue negatively affect an athlete's performance. Indeed, perceived physical and cognitive fatigue can weaken the body and create a decline in perception (35). At this point, an athlete's ability to make effective decisions under stress and quickly adapt to the game can be achieved with a high level of cognitive flexibility (39).

Cognitive flexibility is defined as "the tendency of the mind to change perception concerning different environmental conditions" (16). Asıcı and Ekiz (4) expressed cognitive flexibility as "the ability of an individual to change their thoughts and their approach to responsibilities." Stevens (32) defined cognitive flexibility as "adapting to different changing situations and having many perspectives towards the solution." Similarly, cognitive flexibility is mentioned as "the ability to think about various concepts and factors" (17) and "the ability to adapt to change" (12). Individuals with this mental skill can find new ways by changing difficult thoughts with more compatible ones. Thus, individuals can manage events more easily under pressure (39). In other words, an individual with a high level of cognitive flexibility recognizes, evaluates, and shapes their attitude accordingly. An individual with a low level of cognitive flexibility may give dysfunctional responses to situations they encounter (11). In the sports environment, the concept of cognitive flexibility emerges when athletes are anxious, and their attention focus weakens (38). Especially in combat sports, athletes encounter many situations where they need to make sudden decisions. Therefore, the effectiveness of the decisions made by athletes is associated with a high level of cognitive flexibility (23). At this point, the level of fatigue can cause the athlete to fail to react correctly (19). In light of all this information, it is thought that examining the relationship between perceived physical and cognitive fatigue and cognitive flexibility in students of sports

higher education institutions will contribute to the literature. As a result, the fact that no research has been found on the subject of the current study highlights its originality. Additionally, it contributes to the mental development of athletes. In this direction, examining the relationship between perceived physical and cognitive fatigue and cognitive flexibility in students of sports higher education institutions constitutes the aim of this study.

METHOD

Research design

In the research, a relational survey model, which is one of the quantitative research methods and has a descriptive quality, was used. The relational survey method is a statistical procedure used in quantitative research methods to determine the relationship between two or more variables (9).

Population and sample

The population of the research consists of university students studying in the field of sports sciences in Turkey. The sample group consists of 224 undergraduate students, including 133 males and 91 females, within the Faculty of Sport Sciences of Ordu University. In determining the sample size of the research, Büyüköztürk (9)'s statement of "at least 30 units in correlation studies" and "the number of units should be equal to the number of items X Likert scale options" in data collection tools consisting of Likert-type options was taken into account. In this sense, for the Athlete Cognitive Flexibility Inventory, 5x20=100 and for the Perceived Physical and Cognitive Fatigue Scale, 5x19=95, a total of 100+95=195 minimum participants should be reached. In this research, 224 participants were reached.

Data collection tools

Personal Information Form: The personal information form prepared by the researchers includes variables such as gender, age, department, sport type, sport level, and sport age.

Athlete Cognitive Flexibility Inventory (ACFI): The Cognitive Flexibility Inventory, developed by Dennis and Wal (12), was adapted into Turkish by Sapmaz and Doğan (30). The validity and reliability study of the Cognitive Flexibility Inventory in a sports environment was conducted by Yarayan et al. (39). The inventory consists of 20 items and 2 sub-dimensions. The sub-dimensions are alternatives (1,3,5,6,8,10,12,13,14,16,18,19,20) and control (2,4,7,9,11,15,17). The inventory includes reverse items (2,4,7,9,11,17). The items of the 5-point Likert-type inventory are specified as "1=Not at all suitable...5=Completely suitable". The inventory can be evaluated based on the total score. High scores on the inventory indicate a high level of cognitive flexibility. The Cronbach Alpha values of the inventory are .91 for the alternatives sub-dimension, .84 for the control sub-dimension, and .87 for the overall inventory (39). In this research, the Cronbach Alpha values were found to be .90 for the alternatives sub-dimension, .85 for the control sub-dimension, and .89 for the overall inventory.

Perceived Physical and Cognitive Fatigue Scale (PPCFS): The scale, developed by Tekkurşun Demir et al. (35), consists of 19 items and 2 sub-dimensions. The sub-dimensions are perceived physical fatigue (1,2,3,4,5,6,7,8) and perceived cognitive fatigue (9,10,11,12,13,14,15,16,17,18,19). PPCFS is a five-point Likert-type scale. Accordingly, the items measuring the perceived physical and cognitive fatigue levels of the athletes are evaluated as "1=Strongly disagree...5=Strongly agree". The lowest score that can be obtained from the scale is 19, and the highest score is 95. The Cronbach Alpha coefficient of the scale was determined as .95 for the perceived physical fatigue sub-dimension, .97 for the perceived cognitive fatigue sub-dimension, and .97 for the overall scale (35). In this research, the Cronbach Alpha values were found to be .90 for the perceived physical fatigue sub-dimension, .94 for the perceived cognitive fatigue sub-dimension, and .95 for the overall scale.

Data were obtained from the sample group of the study through the personal information form, the Perceived Physical and Cognitive Fatigue Scale, and the Athlete Cognitive Flexibility Inventory. The implementation of the scales was carried out using a random sampling method. The random sampling method is known as the probability of each individual in the population being selected at the same level (36). Data access was provided through WhatsApp and Google Drive.

Ethical approval of the research

Ethical approval for the study was obtained with decision number 2024-94 from the Ethics Committee for Social and Human Sciences Research of Ordu University. Permission to use the scales was obtained from the authors via email. The study was based on the principle of voluntariness.

Data analysis

In the normality analysis of the data obtained from the participants, Skewness and Kurtosis values were examined, and it was seen that the data were between -2 and +2. Data being between -2 and +2 is assumed to be normally distributed (14). In the study, parametric tests such as the Student's t-Test for paired comparisons, One-Way Analysis of Variance (ANOVA) for comparisons of three or more categories, and Tukey's multiple comparison test were applied. Pearson's correlation analysis was used to determine the relationship between the Perceived Physical and Cognitive Fatigue Scale and the Athlete Cognitive Flexibility Inventory. Differences at the significance level of 0.05 in the study were considered significant. All analyses were performed using the SPSS 21.0 statistical software package.

Table 1. The average values, internal consistency coefficients, and skewness-kurtosis values of the responses given by the participants to the scale items

Scales	Average	S.D.	Skewness	Kurtosis	Internal Consistency Coefficient	Evaluation
PCPF Scale Total	53,71	16,70	-0,087	-0,561	0,95	Reliable
ACEI Scale Total	73,93	10,53	0,258	-0,210	0,89	Reliable

PCPF: Perceived Physical and Cognitive Fatigue Scale, ACEI: Athlete Cognitive Flexibility Inventory

FINDINGS

Table 2. Demographic Information of Participants

Variable	Category	n	%
Gender	Female	91	40.6
	Male	133	59.4
Age	18-20	100	44.6
	21-23	84	37.5
	24 and above	40	17.9
Department	Teaching	86	38.4
	Management	138	61,6
Sport Type	Individual Sports	112	50.0
	Team Sports	112	50.0
Sports Level	Amateur	187	83.5
	Professional	37	16.5
Sport Experience	1-4 years	100	48.2
	5-9 years	84	32.1
	10 years and above	40	19.6
Total		224	100

Table 3. Comparison of Perceived Physical and Cognitive Fatigue Scale and Athlete Cognitive Flexibility Inventory Scores by Gender

Scales and Subdimensions	Gender	n	$\bar{x}$	sd	t	p
PPF	Female	91	24,51	6,833	2,161	**,032***
	Male	133	22,40	7,406		
PCF	Female	91	31,84	10,23	1,600	,111
	Male	133	29,50	11,10		
PCPF Scale Total	Female	91	56,36	15,67	2,007	**,046***
	Male	133	51,90	17,19		
Alternatives	Female	91	49,31	7,091	-1,395	,165
	Male	133	50,72	7,595		
Control	Female	91	23,00	5,448	-1,757	,080
	Male	133	24,32	5,595		
ACEI Scale Total	Female	91	72,31	9,525	-1,969	**,050***
	Male	133	75,04	11,06		

*p<0.05, PCPF: Perceived Physical and Cognitive Fatigue Scale, PPF: Perceived Physical Fatigue, PCF: Perceived Cognitive Fatigue, ACEI: Athlete Cognitive Flexibility Inventory

In Table 3, a significant difference in favor of female participants was found between the total scores of the Perceived Physical and Cognitive Fatigue Scale and the subdimension scores of perceived physical fatigue by gender (p<0.05). A significant difference in favor of male participants was found in the total score of the Athlete Cognitive Flexibility Inventory by gender (p<0.05).

Tablo 4. Comparison of scores on the perceived physical and cognitive fatigue scale and the athlete cognitive flexibility inventory based on participants' age variable

Scales and Subdimensions	Age	n	$\bar{x}$	sd	f	p
PPF	18-20	100	21,95b	6,864	3,222	**,042***
	21-23	84	24,59a	7,533		
	24 and above	40	23,75ab	7,120		
PCF	18-20	100	28,66b	10,07	4,870	**,009***
	21-23	84	33,30a	11,67		
	24 and above	40	28,95b	9,505		
PCPF Scale Total	18-20	100	50,61b	15,45	4,588	**,011***
	21-23	84	57,90a	17,89		
	24 and above	40	52,70b	15,62		
Alternatives	18-20	100	48,94	7,748	2,800	,063
	21-23	84	50,75	7,075		
	24 and above	40	51,92	6,877		
Control	18-20	100	24,05ab	5,770	4,350	**,014***
	21-23	84	22,59b	5,229		
	24 and above	40	25,62a	5,241		
ACEI Scale Total	18-20	100	72,99	11,13	2,940	,055
	21-23	84	73,34	9,632		
	24 and above	40	77,55	10,28		

*p<0.05, a,b letters indicate differences between groups in the same column. PCPF: Perceived Physical and Cognitive Fatigue Scale, PPF: Perceived Physical Fatigue, PCF: Perceived Cognitive Fatigue, ACEI: Athlete Cognitive Flexibility Inventory

In Table 4, significant differences were found in favor of the 21-23 age group in the total scores and subdimension scores of the Perceived Physical and Cognitive Fatigue Scale by age (p<0.05). Significant differences in favor of the 24 years and above age group were found in the control subdimension scores of the Athlete Cognitive Flexibility Inventory by age (p<0.05).

Table 5. Comparison of perceived physical and cognitive fatigue scale and athlete cognitive flexibility inventory scores by department

Scales and Subdimensions	Department	n	$\bar{x}$	sd	t	p
PPF	Teaching	86	22,94	7,060	-,524	,601
	Management	138	23,46	7,365		
PCF	Teaching	86	30,65	10,26	,214	,831
	Management	138	30,33	11,15		
PCPF Scale Total	Teaching	86	53,59	15,36	-,089	,929
	Management	138	53,79	17,53		
Alternatives	Teaching	86	49,09	7,433	-1,695	,091
	Management	138	50,81	7,346		
Control	Teaching	86	24,12	5,107	,726	,469
	Management	138	23,57	5,835		
ACEI Scale Total	Teaching	86	73,22	10,35	-,803	,423
	Management	138	74,38	10,65		

*p<0.05, PCPF: Perceived Physical and Cognitive Fatigue Scale, PPF: Perceived Physical Fatigue, PCF: Perceived Cognitive Fatigue, ACEI: Athlete Cognitive Flexibility Inventory

In Table 5, no significant differences were found between the total scores and subdimension scores of the Perceived Physical and Cognitive Fatigue Scale by department (p>0.05). No significant differences were found between the total scores and subdimension scores of the Athlete Cognitive Flexibility Inventory by department (p>0.05).

Table 6. Comparison of perceived physical and cognitive fatigue scale and athlete cognitive flexibility inventory scores by sport type

Scales and Subdimensions	Sport Type	n	$\bar{x}$	sd	t	p
PPF	Individual Sports	112	23,16	6,978	,847	,847
	Team Sports	112	23,35	7,519		
PCF	Individual Sports	112	30,44	10,49	-,012	,990
	Team Sports	112	30,46	11,13		
PCPF Scale Total	Individual Sports	112	53,61	16,14	-,092	,927
	Team Sports	112	53,82	17,31		
Alternatives	Individual Sports	112	49,50	7,099	-1,319	,189
	Team Sports	112	50,80	7,686		
Control	Individual Sports	112	23,58	5,469	-,528	,598
	Team Sports	112	23,98	5,671		
ACEI Scale Total	Individual Sports	112	73,08	10,25	-1,207	,229
	Team Sports	112	74,78	10,78		

*p<0.05, PCPF: Perceived Physical and Cognitive Fatigue Scale, PPF: Perceived Physical Fatigue, PCF: Perceived Cognitive Fatigue, ACEI: Athlete Cognitive Flexibility Inventory

In Table 6, no significant differences were found between the total scores and subdimension scores of the Perceived Physical and Cognitive Fatigue Scale by sport type (p>0.05). No significant differences were found between the total scores and subdimension scores of the Athlete Cognitive Flexibility Inventory by sport type (p>0.05).

Table 7. Comparison of perceived physical and cognitive fatigue scale and athlete cognitive flexibility inventory scores by sport level

Scales and Subdimensions	Sport Level	n	$\bar{x}$	sd	t	p
PPF	Amateur	187	23,41	7,318	,714	,476
	Professional	37	22,48	6,862		
PCF	Amateur	187	30,14	10,60	-,969	,334
	Professional	37	32,02	11,72		
PCPF Scale Total	Amateur	187	53,56	16,79	-,316	,752
	Professional	37	54,51	16,43		
Alternatives	Amateur	187	50,13	7,136	-,058	,954
	Professional	37	50,21	8,778		
Control	Amateur	187	23,72	5,511	-,353	,725
	Professional	37	24,08	5,884		
ACEI Scale Total	Amateur	187	73,86	10,26	-,227	,821
	Professional	37	74,29	11,93		

* p<0.05, PCPF: Perceived Physical and Cognitive Fatigue Scale, PPF: Perceived Physical Fatigue, PCF: Perceived Cognitive Fatigue, ACEI: Athlete Cognitive Flexibility Inventory

In Table 7, no significant differences were found between the total scores and subdimension scores of the Perceived Physical and Cognitive Fatigue Scale by sport level (p>0.05). No significant differences were found between the total scores and subdimension scores of the Athlete Cognitive Flexibility Inventory by sport level (p>0.05).

Table 8. Comparison of perceived physical and cognitive fatigue scale and athlete cognitive flexibility inventory scores by sport experience

Scales and Subdimensions	Sport Experience	n	$\bar{x}$	ss	f	p
PPF	1-4	100	21,95b	6,864	3,222	**,042***
	5-9	84	24,59a	7,533		
	10 years and above	40	23,75ab	7,120		
PCF	1-4	100	28,66b	10,07	4,870	**,009***
	5-9	84	33,30a	11,67		
	10 years and above	40	28,95b	9,505		
PCPF Scale Total	1-4	100	50,61b	15,45	4,588	**,011***
	5-9	84	57,90a	17,89		
	10 years and above	40	52,70b	15,62		
Alternatives	1-4	100	48,94	7,748	2,800	,063
	5-9	84	50,75	7,075		
	10 years and above	40	51,92	6,877		
Control	1-4	100	24,05ab	5,770	4,350	**,014***
	5-9	84	22,59b	5,229		
	10 years and above	40	25,62a	5,241		
ACEI Scale Total	1-4	100	72,99b	11,13	2,940	,055
	5-9	84	73,34b	9,632		
	10 years and above	40	77,55a	10,28		

*p<0.05, a,b letters indicate differences between groups in the same column. PCPF: Perceived Physical and Cognitive Fatigue Scale, PPF: Perceived Physical Fatigue, PCF: Perceived Cognitive Fatigue, ACEI: Athlete Cognitive Flexibility Inventory

In Table 8, significant differences were found in favor of the 5-9 years and 10 years and above sport experience groups in the total scores and perceived physical fatigue subdimension scores of the Perceived

Physical and Cognitive Fatigue Scale by sport experience ($p<0.05$). No significant differences were found between the total scores and subdimension scores of the Athlete Cognitive Flexibility Inventory by sport experience ($p>0.05$).

Table 9. Relationship between participants' perceived physical and cognitive fatigue scale scores and athlete cognitive flexibility inventory scores

		PPF	PCF	PCPF Total
Alternatives	r	-,117	-,253	-,214
	p	,079	**,001***	**,001***
Control	r	-,441	-,538	-,539
	p	**,001***	**,001***	**,001***
SBEE Toplam	r	-,315	-,462	-,435
	p	**,001***	**,001***	**,001***

*p<0.05, PCPF: Perceived Physical and Cognitive Fatigue Scale, PPF: Perceived Physical Fatigue, PCF: Perceived Cognitive Fatigue, ACEI: Athlete Cognitive Flexibility Inventory

Table 9 presents the correlation results between the perceived physical and cognitive fatigue scores of the participants and the scores of the athlete cognitive flexibility inventory. According to the results; a negative and moderate level significant relationship was found between the total score of perceived physical and cognitive fatigue and the total score of the athlete cognitive flexibility inventory ($r=-.435$, $p<0.05$). A negative and low level significant relationship was found between the total score of perceived physical and cognitive fatigue and the scores of the alternative sub-dimensions ($r=-.214$); a negative and moderate level significant relationship was found between the control sub-dimension ($r=-.539$) ($p<0.05$). A negative and moderate level significant relationship was found between the sub-dimension of perceived physical fatigue and the total score and control scores of the athlete cognitive flexibility inventory ($r=-.315$, $r=-.441$) ($p<0.05$). A negative and moderate level significant relationship was found between the sub-dimension of perceived cognitive fatigue and the total score and control scores of the athlete cognitive flexibility inventory ($r=-.462$, $r=-.538$); a negative and low level significant relationship was found between the scores of the alternative sub-dimensions ($r=-.253$) ($p<0.05$).

DISCUSSION AND CONCLUSION

This study was conducted to examine the relationship between perceived physical and cognitive fatigue and cognitive flexibility among students in sports higher education institutions. Additionally, differences in perceived physical and cognitive fatigue and cognitive flexibility were assessed according to variables such as gender, age, department, type of sport, level of sport, and sport age. No significant differences were found in scale scores based on department, type of sport, and level of sport variables. Significant differences were found in total scores of the athlete cognitive flexibility inventory, perceived physical fatigue scale, and perceived physical fatigue sub-dimension scores according to gender. Significant differences were also found in total scores and sub-dimension scores of the physical fatigue scale and control sub-dimension scores of the athlete cognitive flexibility inventory according to age and sport age variables. As a result of the correlation analysis, a significant negative and moderate relationship was found between the total scores of perceived physical and cognitive fatigue and the total scores of the athlete cognitive flexibility inventory. The literature review revealed that studies on perceived physical and cognitive fatigue are very limited. In this context, the results of this study were discussed and interpreted in light of the findings of the closest studies in the literature in terms of meaning.

In the study, a significant difference was found in favor of female athletes in the total scores of the perceived physical and cognitive fatigue scale and perceived physical fatigue scores according to gender. Accordingly, it can be said that the level of perceived fatigue is higher in female participants compared to male participants. The results obtained can be associated with the differences in physical capacities and recovery rates between male and female participants. Higher levels of emotional and psychological stress in female athletes may translate this stress into perceived fatigue. Additionally, physiological differences, hormonal changes, and psychological factors may affect the fatigue levels of female athletes. No studies in the literature

have been found that include the perceived physical and cognitive fatigue scale and the gender variable. When examining studies related to perceived physical and cognitive fatigue, it was determined that male participants had higher fatigue scores compared to female participants in the study conducted by öcal and göncü (27), and that the results do not align with the findings of this study. The differences between the findings can be associated with the data collection tools and study groups.

In the study, a significant difference was found in favor of male participants in the total scores of the athlete cognitive flexibility inventory according to gender. Accordingly, it appears that the cognitive flexibility level of male participants is higher than that of female participants. It is thought that differences in sports branches, training techniques, and strategies may have influenced these results. In other words, there may be differences in training and coaching programs for male and female athletes. Male athletes may be working with more varied and challenging training techniques that develop cognitive flexibility. These long-term and intensive experiences may enhance the cognitive flexibility of male participants. When examining studies in the literature that include the cognitive flexibility and gender variable, it has been determined that male participants have higher cognitive flexibility scores compared to female participants in studies conducted by Güler (15), Kara (21), and Asıcı and İkiz (4), and that the results are similar to the findings of this study. In contrast, studies by Yılmaz et al. (41), Yılmaz et al. (42), Karadağ (22), and Atalı (5) found no significant differences in cognitive flexibility scores according to gender, and the results do not align with the findings of this study. The differences between the findings can be explained by the use of different inventories or scales to measure cognitive flexibility, different cultural contexts, and variations in the intensity, duration, and type of sports training.

In the study, a significant difference was found in favor of the 21-23 age group in the total scores and sub-dimension scores of the perceived physical and cognitive fatigue scale according to age. When evaluated for the total score of the perceived physical and cognitive fatigue scale and the perceived cognitive fatigue sub-dimension, the 21-23 age group had higher averages compared to the 18-20 and 24 and older age groups. Specifically, the 21-23 age group had higher averages in the perceived cognitive fatigue sub-dimension compared to the 18-20 age group. According to the results obtained, it can be said that the 21-23 age group is in a period where their academic life and sports activities are intense. In other words, participants face various situations such as exams, projects, training sessions, and matches. Therefore, it is thought that students in the 21-23 age group may feel more physical and cognitive fatigue. The higher average in the perceived cognitive fatigue sub-dimension for the 21-23 age group compared to the 18-20 age group can be explained by the fact that the 21-23 age group is generally in the final years of their undergraduate education. Indeed, student-athletes may be involved in various activities such as graduation projects, thesis work, and intensive course schedules. Additionally, factors such as graduation anxiety, job search concerns, and future plans may increase cognitive fatigue. A literature review revealed no studies that included the perceived physical and cognitive fatigue scale and the age variable. When examining studies that are presumed to be related to perceived physical and cognitive fatigue, it was determined in the study by Taşpınar (34) that there were no significant differences in exhaustion scores according to the age variable, and that the results do not align with the findings of this study. The differences between the findings can be explained by data collection tools, the time factor, and study groups.

In the study, no significant differences were found in the total scores and alternatives sub-dimension scores of the athlete cognitive flexibility inventory according to the age variable. However, a significant difference was found in the control sub-dimension scores in favor of the 24 years and older age group. Accordingly, it was observed that participants aged 24 and older had higher control scores compared to the 21-23 age group. These results indicate that age does not have a significant impact on general cognitive flexibility and the ability to generate alternatives, but it does have an effect on the ability to exert control. It is thought that participants aged 24 and older have gained more experience in their sports careers in areas such as stress management, decision-making under pressure, and emotion regulation. Indeed, these experiences may positively influence participants' cognitive control abilities. When examining studies in the literature that include the cognitive flexibility and age variable, a significant difference in control scores according to age was identified in the study by Güler (15). In the study conducted by Kaya (23), no significant differences were found in the cognitive flexibility scores of participants, and it was found that the results are similar to the findings of the current research. In contrast, studies by Yılmaz et al. (41) and Akçakaya (1) found no significant

differences in control scores according to age, and it was observed that the findings do not align with the findings of the current research. The differences between the findings are thought to be due to the data collection tools, the distribution of age groups, and the timing of the studies.

In the study, no significant differences were found in the total scores and sub-dimension scores of the perceived physical and cognitive fatigue scale according to the department variable. Accordingly, it appears that the department variable is not a determinant of the perceived levels of physical and cognitive fatigue. This result can be associated with the fact that students in teaching and management departments generally participate in similar educational content and activities. Indeed, students in sports higher education institutions mostly take similar theoretical and practical courses during their undergraduate education processes. In this sense, the level of fatigue they perceive related to sports activities may be similar. No studies were found in the literature that include the perceived physical and cognitive fatigue scale and the department variable. When examining studies that are presumed to be related to perceived physical and cognitive fatigue, it was determined in the study by Yılmaz et al. (43) that there were no significant differences in burnout scores in sports according to the department variable, and it can be said that their results support the findings of the current research.

In the study, no significant differences were found in the total scores and sub-dimension scores of the athlete cognitive flexibility inventory according to the department variable. Accordingly, it appears that the department variable does not have a determining effect on cognitive flexibility scores. Students in sports higher education institutions may be subjected to similar course contents and educational methods. These similar educational experiences may create similar effects on cognitive flexibility. Both management and teaching department students may focus on developing skills that require cognitive flexibility, such as career goals, teamwork, leadership, and problem-solving, inherent to the nature of sports. When examining studies in the literature that include the cognitive flexibility and department variable, no significant differences in cognitive flexibility scores were found according to the department variable in the studies conducted by Yılmaz et al. (41) and Tabak (33), and it can be said that the findings are similar to the findings of this research.

In the study, no significant differences were found in the total scores and sub-dimension scores of the perceived physical and cognitive fatigue scale according to the type of sport variable. Accordingly, it can be said that the type of sport variable is not a determinant of perceived levels of physical and cognitive fatigue. This result can be associated with the unique challenges of both individual and team sports. Indeed, each sport discipline has its own psychological and physical difficulties. For example, individual sports generally focus on personal motivation, concentration, and individual performance, while team sports place more emphasis on cooperation, communication, and team dynamics. Therefore, the level of perceived fatigue may be similar for participants involved in both types of sports. No studies were found in the literature that include the perceived physical and cognitive fatigue scale and the type of sport variable. When examining studies that are presumed to be related to perceived physical and cognitive fatigue, it was determined in the study by Yılmaz et al. (43) that there were no significant differences in burnout inventory scores according to individual and team sports, and it is thought that the results are parallel to the findings of the current research.

In the study, no significant differences were found in the total scores and sub-dimension scores of the athlete cognitive flexibility inventory according to the type of sport variable. Accordingly, it appears that the type of sport variable does not have a determining effect on cognitive flexibility scores. Cognitive flexibility requires athletes to adapt to various situations and quickly change their strategies during training and competitions. The necessity for athletes to adapt to different situations encountered during training may similarly develop their cognitive flexibility. In other words, athletes involved in both individual and team sports need to quickly change their strategies and tactics. When examining studies in the literature that include the cognitive flexibility and type of sport variable, no significant differences in cognitive flexibility scores according to the type of sport were found in the studies conducted by Yılmaz et al. (42) and Kaya (23). Similarly, studies by Akyol (2), Karadağ (22), and Bayer (6) found that the type of sport was not a determinant of cognitive flexibility scores, and it can be said that the findings support the results of the current research.

In the study, no significant differences were found in the total scores and sub-dimension scores of the perceived physical and cognitive fatigue scale according to the sport level variable. Accordingly, it can be inferred that the sport level is not a determinant of perceived levels of physical and cognitive fatigue. In other

words, the perceived levels of physical and cognitive fatigue in amateur and professional athletes are similar in nature. This result can be associated with the fact that professional athletes are accustomed to physical and cognitive intensity throughout their sports careers. Additionally, the lower sustainability of sports careers in amateur athletes compared to professional athletes may affect their perceptions of fatigue levels. The fact that amateur and professional athletes participate in similar theoretical and practical courses in sports higher education institutions can also be considered as another factor in obtaining these results. A literature review revealed no studies that include the perceived physical and cognitive fatigue scale and the sport level variable. When examining studies presumed to be related to perceived physical and cognitive fatigue, it was found in the study by Saatoğlu Akıllı and Karagün (29) that there were no significant differences in burnout scores between amateur and professional participants, and it was observed that the results support the findings of this study.

In the study, no significant differences were found in the total scores and sub-dimension scores of the Athlete Cognitive Flexibility Inventory based on the sport level variable. Accordingly, it can be concluded that the sport level variable does not have a determining effect on cognitive flexibility scores. Both amateur and professional athletes can undergo general mental and physical adaptation processes associated with sports. Amateur athletes, upon gaining sufficient experience in a specific sports discipline and developing various cognitive and strategic skills during this process, can reach similar levels of cognitive flexibility as professional athletes. A review of the literature on cognitive flexibility and the sport level variable shows that Yılmaz et al. (42) found significant differences in cognitive flexibility scores among athletes based on their sport level. The difference in findings may be due to participants' specific sports disciplines and the sporting experiences related to those disciplines.

In the study, significant differences were found in the total scores and sub-dimension scores of the Perceived Physical and Cognitive Fatigue Scale based on the age of sports participation. When evaluated, participants who have been engaged in sports for 5-9 years were found to have higher averages compared to those who have been involved in sports for 1-4 years and 10 years or more, both in terms of the total perceived physical and cognitive fatigue scale and the perceived cognitive fatigue sub-dimension scores. Specifically, for the perceived physical fatigue sub-dimension, it was observed that participants engaging in sports for 5-9 years had higher averages compared to those engaging in sports for 1-4 years. According to these results, it can be said that individuals engaged in sports for 5-9 years may feel more physically and mentally fatigued due to the cumulative effect of long-term sports participation. This situation can be associated with participants being in an age range where they can achieve their peak athletic performance. Athletes may strive for maximum effort especially during their undergraduate education process to achieve sporting success. Therefore, they may be involved in a rigorous process both physically and cognitively. Consequently, athletes may operate under more stress, which can increase their sense of fatigue. There were no studies found in the literature that specifically included the Perceived Physical and Cognitive Fatigue Scale and sports age as variables. When examining studies related to perceived physical and cognitive fatigue, Yılmaz et al. (43) and Koçyiğit and Pepe (25) did not find significant differences in exhaustion inventory scores in sports according to sports age, which contrasts with the findings of this study. The difference between findings can be explained by differences in data collection tools, sample groups, socio-cultural characteristics, types of sports, and experiences.

In the study, no significant differences were found in the total scores and alternative subscale scores of the Sports Cognitive Flexibility Inventory based on sports age variable. However, significant differences favoring participants engaging in sports for 10 years or more were identified in the control subscale scores based on sports age. Accordingly, participants who had been involved in sports for 10 years or more were observed to have higher control scores compared to those who had been involved for 5-9 years. These results indicate that sports age does not have a significant impact on general cognitive flexibility and alternative generation skills, but it does affect the ability to control. Participants engaged in sports for a longer period, particularly showing higher scores in the control subscale, suggest that experience plays an important role in developing control abilities. It is believed that athletes who have been engaged in sports for 10 years or more encounter more stressful situations, make strategic decisions, and develop their control skills during this process. This process is expected to contribute to athletes' ability to adapt to sudden changes and unexpected

situations over time, thereby enhancing their flexibility and adaptation skills. Additionally, it can be said that long-term training and education processes play a significant role in the development of these skills.

When examining studies that include cognitive flexibility and sports age as variables in the literature, Kaya (23), Akyol and Taşkıran (3), and Bayer (6) found no significant differences in cognitive flexibility total scores based on years in sports, which aligns with the findings of the current study. However, Karadağ (22) found significant differences favoring participants with 11 years or more of sports experience in cognitive flexibility total scores. Similarly, Kara, M. (20) identified significant differences in cognitive flexibility total scores based on sports experience, which do not parallel the findings of this study. The differences among findings can be attributed to variations in the distribution of years in sports, types of sports disciplines, and socio-cultural characteristics.

In the study, a negative and moderate significant relationship was found between the total score of perceived physical and cognitive fatigue and the total score of athlete cognitive flexibility inventory. Additionally, a negative and low significant relationship was identified between the total score of perceived physical and cognitive fatigue and the scores of alternative subscales, and a negative and moderate significant relationship with the control subscale. Furthermore, a negative and moderate significant relationship was detected between the physical fatigue subscale and the total score and control scores of athlete cognitive flexibility inventory. Similarly, a negative and moderate significant relationship was observed between the cognitive fatigue subscale and the total score and control scores of athlete cognitive flexibility inventory, and a negative and low significant relationship with the alternative subscales. Based on these results, it can be concluded that perceived physical and cognitive fatigue negatively affect cognitive flexibility. Similarly, it can be stated that athletes tend to lose their mental flexibility when they are fatigued, which could adversely impact their performance. When athletes are physically and cognitively fatigued, their ability to cope with stress, make strategic decisions, and adapt to unexpected situations may decrease. Additionally, when athletes are fatigued, they may struggle to generate creative and alternative solutions and may experience a decline in their control skills. In summary, athletes who are physically and cognitively fatigued may find it difficult to generate alternative solutions and may experience a decrease in their control skills. Some students in sports universities may be amateur or professional athletes, while others may not engage in sports due to reasons such as injury. Therefore, theoretical and practical courses in higher education institutions may be perceived as fatigue for amateur athletes or non-athletes. Professional athletes, in addition to their individual activities related to their current sports discipline, also participate in theoretical and practical courses at higher education institutions. In other words, professional athletes are under intense pressure due to their training programs and educational processes. Therefore, physical and cognitive activities can be perceived as fatigue in participants. A literature review related to perceived physical and cognitive fatigue and athlete cognitive flexibility supports the findings of the current study. Yennurajalingam and Bruera (40) conducted a study indicating that psychological fatigue negatively affects cognitive activities such as attention and focus and emphasizes the need for athletes to recover physically and cognitively as soon as possible. Effective recovery not only ensures sustainability in athletes but also helps them resist negative conditions such as exhaustion and depression (24). In this sense, some suggestions can be given to minimize the negative effects of perceived physical and cognitive fatigue on cognitive flexibility in student athletes:

Athlete students can develop stress management techniques during classes, enhancing their coping with stress, problem-solving, and cognitive flexibility skills.

Light exercises, yoga, meditation, and massage, among other active recovery techniques, can alleviate the effects of fatigue in athlete students and provide mental relaxation.

Collaboration with sports psychologists can help athletes identify and manage symptoms of cognitive fatigue.

Games and brain exercises that promote strategic thinking can assist athletes in enhancing their cognitive flexibility and creative thinking abilities.

The use of wearable technologies to monitor athletes' fatigue levels and physical performance can aid in optimizing training programs.

Encouraging athlete students to participate in programs focused on adequate rest, balanced nutrition, and cognitive flexibility can be beneficial.

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