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INVESTIGATION OF SLEEP QUALITY AND MENTAL TOUGHNESS LEVELS OF YOUNG SOCCER PLAYERS IN TERMS OF CHRONOTYPES

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A. Study design/planning
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E. Preparation of manuscript
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Abstract:

Bacground: The purpose of this research was to determine whether there is a relation between chronotype type and factors known to have a great impact on sports performance such as sleep quality and mental toughness.

Methods: This cross-sectional study was conducted using the questionnaire technique. The population of this research consisted of 8.952 soccer players while the sample size consisted of 370 soccer players, with a confidence level of 95%. In this study, the "Turkish form of Morningness-Eveningness Stability Scale", "Mental Toughness Scale", and "Athlete Sleep Behavior Questionnaire- Turkish Version" scales were used as data collection tools.

Results: There was a positive and statistically significant relation between Morning-Type (M-Type) and Mental Toughness ($p<.005$). In terms of sleep behavior, a statistically significant relation was found between Evening-Type (E-Type) and sleep behavior (sport-related factors), between M-Type and Neither-Type (N-Type) and sleep behavior (sleep quality), between M-Type and sleep behavior (habitual sleep efficiency) ($p<.005$).

Conclusions: Based on the data of this research, it was found that soccer players with M-Type had higher mental toughness than soccer players with E-Type and N-Type. Furthermore, it was concluded that soccer players had low sleep quality in terms of sleep habits. It was found that E-Type soccer players were affected by sport-related factors, M-Type soccer players were affected by habitual sleep efficiency factors, and M-Type and N-Type soccer players were affected by inefficient sleep factors.

Introduction

The repetition of biochemical, physiological, and behavioral rhythms in a regular pattern is called the circadian rhythm or biological clock and is characterized by changes observed over 24 hours [1]. This rhythm is closely related to several physiological and behavioral processes such as body temperature, hormones, cognitive functions, and psychological state [1,2]. The biological diversity of this rhythm is expressed by the term "chronotype" [3], which is divided into three different types: morning (M-type), evening (E-type), and neither (N-type) [4,5]. The N-type are individuals without a clear circadian preference and are categorized in this group because they show intermediate characteristics. M-type individuals go to bed and get up early and reach peak mental and physical performance in the early hours of the day. The E-type are individuals who get up later and reach their best performance in the second half of the day [6,7]. In this context, the duration of exposure to daylight, i.e. the duration of sleep and wakefulness, is one of the most important fac-

tors affecting the circadian system [1,8]. Melatonin hormone levels, which are one of the best indicators of sleep onset and affect the behavior and physiology of individuals [9], differ between chronotypes. This situation causes M-type and E-type individuals to differ from each other in terms of 24-hour sleep-wake timing and mental-physical activation [8]. In this context, the sleep and activity timing preferred by individuals depending on their chronotypes affects their behavior, lifestyle, cognitive function, athletic performance, and personality traits [10–15]. However, chronotypes are influenced by many genetic, environmental, and sociocultural factors [6,16–18], with one of the most important factors being age.

Chronotypes change with age. For example, the evening chronotype in youth is likely to be changed by the morning chronotype type in older adulthood [7]. Especially during adolescence, a progressive change towards the E-type starts at about 12-13 years of age [19] and stops at about 14 years of age, followed by a slow change back towards the M-type after 18 years of age [20,21]. However, during the period between 14 and 18 years of age, the tendency towards E-type often means a mismatch with social and community schedules, such as the time of school lessons, the time of training, the opening and closing times of places to eat, drink, and play, which can lead to impairment in terms of cognitive, motor, learning, and social activities and sleep in adolescents [22–24].

Soccer is one of the world's most popular sports practiced during adolescence, especially by boys, and is a team sport with a fascinating role and wide influence [25]. In this age group, training and soccer matches usually take place in the afternoon or evening after school [14]. Therefore, we think that both the tendency towards E-type between the ages of 14 to 18 years and the incompatibility between social community programs will have negative effects on sleep quality, chronotypes, and psychophysiological performance levels of soccer players.

Furthermore, soccer, which has become an indispensable part of social life, provides an opportunity to satisfy basic human impulses such as competition, ambition, struggle, and the desire to win [26]. Therefore, coaches, athletes, and sports scientists agree that psychological characteristics are also necessary in addition to technical, tactical, and physical skills to show the best sports performance [27]. Mental toughness, which is considered one of these psychological characteristics and has been researched extensively recently, is of great importance for coaches and athletes, especially during competition periods [28,29]. Mental toughness is defined as the natural or developed psychological power that enables athletes to cope with their mental needs better than their competitors in competition, training, and other conditions; specifically, to be more task-oriented, self-confident, and controlled under pressure than their competitors and to maintain these abilities [29,30]. In the literature, it has been emphasized in many studies that mental and emotional activities can be affected by circadian rhythm [31–33] and it has been stated that fluctuations can be seen in critical abilities such as mental focus in sports during the day due to the variability of circadian rhythm [34]. Therefore, it is thought that there may be a relation between athletes' chronotypes and mental endurance. Identifying chronotypes with lower levels of mental toughness will enable athletes to take earlier precautions in this regard and provide a strategic advantage when making training plans.

To our knowledge, no research has explored the relations among chronotype, sleep quality, and mental toughness, which are of great importance in sports performance and have been examined in relation to each other. Therefore, the purpose of this study was to examine the relationship between features that are of great importance in sports performance in soccer players, such as chronotype, sleep quality, and mental toughness.

Material and Methods

Population and Sample

The study population consisted of soccer players playing in the Development Leagues (U14, U15, U17 and U19; U19 Elite A League, U19 Elite B League, U17 Elite A League, U17 Elite B League) affiliated with the Turkish Football Federation (TFF) in the 2022-2023 season. Since the total number of athletes playing in these leagues is not published on the TFF official website, the population was calculated by multiplying the total number of teams in the Development League by the total number of players within each team (n=24). In this context, in the review made on the TFF official website, there were 54 teams in the U14 Development League, 72 teams in the U15 Development league, 64 teams in the U16 Development league, 49 teams in the U17 Regional Development league, and 53 teams in the U19 Regional Development league. It was determined that there were 373 teams in total, including 22 teams in the U19 Elite A League, 18 teams in the U19 Elite B League, 21 teams in the U17 Elite A League, and 20 teams in the U17 Elite B League. When the number of teams in a development league (373) was multiplied by the total number of players within each team (n=24), it was determined that there were 8,952 athletes in total. The population for this study consisted of 8,952 athletes. The sample size was determined using the estimated sample size table [35], which is used when the population is known, and it was found that at least 370 athletes should be included in the study, with a 95% confidence level.

After receiving approval from the Graduate Education Institute Ethics Committee, Çanakkale Onekiz Mart University (approval number: 09/24), 370 soccer players playing in the Development League between the ages of 14-19 were recruited using convenience sampling via mobile phone. Participants' consent (or assent and parental consent for individuals who were 17 years of age or younger) was obtained from all participants.

Demographic and sport-related information of the participants is presented in Table 1.

Table 1. Demographic information of the participants

Variables		n	%
Age (year)	14.00	154	41.6
	15.00	74	20.0
	16.00	55	14.9
	17.00	47	12.7
	18.00	23	6.2
	19.00	17	4.6
League	U 14	108	29.2
	U 15	46	12.4
	U 16	75	20.3
	U 17 (regional)	9	2.4
	U 19 (regional)	19	5.1
	U 17 (elite)	58	15.7
	U 19 (elite)	55	14.9
Training time	06:00-12:00	12	3.2
	12:00-18:00	144	38.9
	18:00-00:00	214	57.8
Time of going to school	Before midday	264	71.4
	Afternoon	24	6.5
	Distance education	82	22.2

Note: n = number of participants; % = percentage of total participants

Data Collection Tools

This cross-sectional research was conducted using the survey technique, one of the quantitative research methods. A form prepared by the researchers was used to determine the demographic characteristics of the participants (age, league they play in, training time, and school time). All questionnaires were presented in a random order.

In order to determine the mental toughness levels of the participants, we used the Mental Toughness Scale developed by Madrigal et al. [36] adapted to Turkish by verifying its validity and reliability by Erdoğan [37]. This single-dimensional scale is a five-point Likert-type scale. The Cronbach's alpha internal consistency coefficient of this scale is .87 and the test-retest reliability coefficient is .79. The corrected item-total score correlations of the scale range between .48 and .76.

To determine the chronotypes of the participants, we used the Turkish form of the Morningness-Eveningness Stability Scale (MESSi), developed by Randler et al. [38] and adapted to the Turkish language by Demirhan et al. [16]. The Turkish form of MESSi consists of three sub-dimensions: morning affect (M-Type), eveningness (E-type), and distinctness (N-Type). The scale is a five-point Likert type. This scale consists of 15 items and the factor loadings of the items vary between 0.44 and 0.85.

In order to determine the sleep behaviors of the participants, we used the Athlete Sleep Behavior Questionnaire-Turkish Version developed by Driller et al. [39] and adapted to Turkish by Darendeli et al. [40], with high validity and reliability. The scale consists of four sub-dimensions: sport-related factors, sleep quality factors, habitual sleep efficiency factors, and sleep disturbance, and is a five-point Likert-type scale. The factor loadings of this scale, which consists of 17 items in total, vary between 0.418 and 0.825.

Data Acquisition Process

Within the scope of this research, data were collected electronically between 01.11.2023 and 03.11.2023. A Google Form was created from the questions in the data collection tools and the form link was sent to the mobile phone numbers of the research participants. The data obtained within the scope of this research were uploaded to the Excel sheet (Microsoft 365) and numerical values were assigned to the verbal data. The research data, which was made suitable for analysis, was transferred to the IBM statistical program (SPSS version 26.0, Armonk, NY) for analysis.

Statistical Analysis

In this study, multivariate linear regression analysis was conducted using the IBM Statistics (SPSS version 26.0, Armonk, NY) package program. To ensure the validity of the analysis, careful examination was made to ascertain the fulfillment of assumptions underlying multivariate linear regression. The assumptions of the analysis were normality, homoscedasticity, and multicollinearity. The normality assumption was verified using visual and statistical techniques such as histograms, Q-Q plots, and the skewness and kurtosis test to assess the relation between independent and target variables. The homoscedasticity assumption was employed to evaluate the homogenous distribution of the variance of error terms, determining the quality and accuracy of the regression model. Multicollinearity was examined using techniques such as Variance Inflation Factor to identify the presence of high correlations among independent variables. The results indicated that the assumptions of multivariate linear regression analysis were successfully met, ensuring the reliability of the outcomes of the analysis. The statistical significance level was set at $p<.05$.

Results

The effects of chronotype variables on Mental Toughness and Sleep Behaviors variables are presented in Table 2 below.

Table 2. Multivariate linear regression analysis of test results of the effect of chronotype variables on Mental Toughness and Sleep Behaviors variables

DV	IV	Coefficients						Model Summary			ANOVA			
		B	Std.E	Beta	t	p	Pr	R	R^2	Adj. R^2	F	Reg. df	Res. df	p
	C	2.803	.238		11.780	.000								
	M-Type	.213	.051	.233	4.214	.000**	.215							
	E-type	-.015	.119	.019	.080	.075	.080							
MT	N-Type	.076	.257	.286	.186	.177	.186	.353	.125	.118	17.390	3	366	.000
	C	2.797	.287		9.748	.000								
	M-Type	-.031	.061	-.030	-.515	.607	-.027							
	E-type	.098	.041	.128	2.382	.018*	.124							
SBSRF	N-Type	-.067	.055	-.068	-1.207	.228	-.063	.160	.025	.017	3.188	3	366	.024
	C	3.853	.236		16.360	.000								
	M-Type	-.272	.050	-.301	-5.446	.000**	-.274							
	E-type	-.033	.034	-.050	-.977	.329	-.051							
SBSQ	N-Type	-.099	.045	-.117	-2.179	.030*	-.113	356	.127	.120	17.726	3	366	.000
	C	3.232	.293		11.043	.000								
	M-Type	-.256	.062	-.235	-4.117	.000**	-.210							
	E-type	-.006	.042	-.007	-.136	.892	-.007							
SBHSE	N-Type	-.072	.056	-.070	-1.273	.204	-.066	269	072	.065	9.500	3	366	.000
	C	1.373	.237		5.782	.000								
	M-Type	-.052	.050	-.060	-1.023	.307	-.053							
	E-type	.016	.034	.025	.459	.647	.024							
SBSD	N-Type	-.042	.046	-.052	-.912	.363	-.048	.101	.010	.002	1.252	3	366	.291

*$p<0.05$; **$p<0.01$; IV: Independent variables; DV: Dependent variables; C: Constant; MT: Mental Toughness; SBSRF: Sleep Behavior (sport-related factors); SBSQ: Sleep Behavior (sleep quality); SBHSE: Sleep Behavior (habitual sleep efficiency); SBSD: Sleep Behavior (sleep disturbance); Reg. df: Regression df; Res. Df: Residual df; Pr: Partial; Std.E: Standard Error

In Table 2, the chronotypes of the participants explain 11% of the changes in Mental Toughness (Adj. R2= 0.118). While M-Type has a significant positive relation with Mental Toughness (β= 0.23, t (36) = t 4.21, p<.001, Pr2= 0.04), no significant relation was found for other types. Furthermore, a one-unit change in M-Type leads to a 0.213 change in Mental Toughness. A significant relation was found between E-Type and Sleep Behavior (sport-related factors) (β= 0.12, t (36) = t 2.38, p<0.005, Pr2= 0.01), but E-Type can explain only 0.01% (Adj. R2= 0.017) of the changes in Sleep Behavior (sport-related factors). No significant relation was found between M-Type and N-Type and Sleep Behavior (sport-related factors). A negative significant relation was found between Sleep Behavior (sleep quality) and M-Type (β=-0.30, t (36) = t -5.44, p<0.001, Pr2=-0.54) and N-Type (β=-0.11, t (36) = t -2.17, p<0.005, Pr2=-0.22). M-Type and N-Type explained only 12% of the changes in Sleep Behavior (Adj. R2=0.120). Moreover, there is a negative and significant relation between M-Type and Sleep Behavior (habitual sleep efficiency) (β=-0.235, t (36) = t-4.11, p<0.001, Pr2=-0.42). M-Type explains 0.06% (Adj. R2=0.065) of the changes in Sleep Behavior (habitual sleep efficiency). No significant relation was found between E-Type and N-Type variables and Sleep Behavior (habitual sleep efficiency). Finally, no statistically significant relation was found between M-Type, E-Type, and N-Type variables and Sleep Behavior (sleep disturbance) variables.

Discussion

The results of this research, which was carried out to determine whether there is a relation between chronotype and factors known to have a great effect on sportive performance such as sleep quality and mental toughness, were remarkable. As a result of this research, it has been determined that there is a positive and statistically significant relation between M-Type and Mental Toughness. In terms of sleep behaviors, a statistically significant relation was found between E-Type and Sleep Behavior (sport-related factors), between M-Type and N-Type and Sleep Behavior (sleep quality), and between M-Type and Sleep Behavior (habitual sleep efficiency). Although the findings were statistically significant, the chronotypes of the participants explained 11% of the changes in Mental Toughness. Although this rate is quite low, it shows that chronotype may have an effect on mental toughness in athletes. Since there is no research in the literature directly examining athletes' chronotypes and mental endurance, these findings are very important.

Mental toughness is often associated with an athlete's ability to focus, avoid failure, cope with pressure, mental flexibility, and maintain resilience in the face of challenging situations [41]. On the other hand, the fact that M-Type individuals go to bed early and get up early, their cognitive and physical performance is higher in the morning [42,43], adrenaline hormone is secreted more in the morning [44], and normal body temperature is reached 1-3 hours earlier than other chronotypes. A study [42] suggests that these may be important parameters affecting mental toughness. Therefore, conducting research on these parameters will provide important contributions to the literature.

Having different chronotypes leads to different results in daily life. In particular, since sociable hours and the endogenous circadian rhythm in the E-type do not match, people gain more unstable sleep habits, their sleep duration shortens, and accordingly, situations such as decreased daytime cognitive function and fatigue bring about mental and physical problems [45]. The fact that 96.7% of the participants in our study trained in the afternoon and at the same time 71.4% went to school before noon (Table 1) suggests a mismatch between chronotype and social time. The endogenous circadian rhythm and social clock time did not match potentially because M-Type athletes train in the afternoon/evening and E-Type athletes go to school before noon. This may have affected the sleep behaviors of athletes.

It is noteworthy that the differences between the chronotypes of the participants and their sleep behaviors show statistically significant differences in some sub-dimensions. However, it is quite low that E-Type predicts 0.01% of the effect of sport-related factors, and M-Type and N-Type predict 0.12% of the effect of sleep quality. Furthermore, the fact that M-Type can predict 0.06% of the effect of habitual sleep efficiency is also a very low rate. Therefore, it is thought that there are other factors affecting the sleep behaviors of our research group. In order to make this issue more understandable, it is recommended that studies be carried out to consider other issues that may be effective with chronotypes.

It is clear that circadian rhythm plays a major role in regulating the sleep-wake cycle. When the sleep-wake cycle is disrupted continuously or recurrently, circadian rhythm-related sleep disorders occur [46]. Studies have shown that individuals with E-Type have worse sleep quality than individuals with M-Type [47,48]. Since individuals with E-Type are exposed to artificial light at night more than individuals with M-Type, melatonin production is impaired, and melatonin-related sleep duration and sleep quality change [48]. Melatonin is a hormone secreted from the pineal gland in the brain and its secretion increases in the dark. Melatonin regulates many systems in the body with circadian rhythm [49]. In addition to melatonin, hormones such as leptin, ghrelin, glucagon, insulin, adiponectin, cortisol, and corticosterone are directly related to sleep quality and duration, sleep-wake cycle, and regulation of circadian rhythm

[50]. Disruption of circadian rhythm causes sleep disorders and thus a decrease in sleep quality [47,48]. The findings of our study also showed that chronotypes may have a statistical effect on sleep behaviors, albeit at a low rate. However, in order to understand this issue more clearly, it is recommended that research be conducted with mixed models in which in-depth interviews and biochemistry tests are applied in addition to scales.

Study Limitations

The limitations of the research are the study sample including only soccer players in the Development Leagues affiliated with the Turkish Football Federation, encompassing only players aged 14 to 19 years, and including only male soccer players. Therefore, it is recommended that researchers plan their future studies by considering these factors.

Conclusions

In conclusion, it has been observed that athletes with the chronotype of M-Type exhibit higher levels of mental toughness compared to those with E-Type and N-Type. Furthermore, it has been deduced that athletes have poor sleep quality habits. It has been determined that athletes with E-Type are influenced by sport-related factors, while athletes with M-Type are affected by habitual sleep efficiency factors. Furthermore, it has been found that athletes with M-Type and N-Type are influenced by factors leading to inefficient sleep. These findings are of significant importance in identifying key factors that affect athletes' performance. Understanding how individual characteristics such as chronotype and sleep habits influence athletes' mental toughness and performance is a fundamental step in developing training programs and performance-enhancement strategies. Specifically, it was found that athletes with an M-Type chronotype have an advantage in terms of mental toughness, highlighting the need to consider this in training and preparation for competitions. Additionally, given the impact on sleep quality, optimizing athletes' sleep habits and schedules can be a crucial strategy to enhance overall performance. Therefore, the analysis of individual characteristics of athletes and sleep habits plays a vital role in advancing research in sports science and maximizing athletes' potential.

Practical implications

The results of this study can be taken into consideration by coaches, health professionals, and researchers who want to improve the performance of athletes. Athletes can use these findings to optimize their performance by understanding their sleep behaviors and chronotypes. Healthcare professionals can evaluate the information in this research to improve athletes' sleep quality and support their performance. Researchers can benefit from the results of this study to better understand the factors affecting the mental endurance of athletes and develop new strategies.

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Institutional Review Board Statement: The study adhered to the principles of the Declaration of Helsinki and received approval from the Graduate Education Institute Ethics Committee, Çanakkale Onekiz Mart University, Türkiye (Approval number: 09/24).

Informed consent statement: The participants and their legal guardians were informed about the research protocol in detail and gave their written informed consent to participate in the study.

Data availability statement: The data presented in this study are available on request from the corresponding author.

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