The Relationship between Chronotype and Photoperiod in Soccer Players: Seasonal Differences

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Abstract: It is understood that the difference in daily sunlight duration between summer and winter seasons in Türkiye is approximately 4 hours 51 minutes. In Türkiye, a country located on both the European and Asian continents, it is a matter of curiosity whether the difference in daily sunlight duration of almost 5 hours, specific to the seasons, can have a significant effect on chronotypes. Especially the fact that the display of sports performance varies throughout the day according to chronotypes is of significant importance in the sports science community. Therefore, in this research, the relationship between the season of birth and chronotypes of the soccer players participating in the Development Leagues affiliated with the Turkish Soccer Federation during the 2022-2023 season was examined. The population of this cross-sectional study consisted of 8,952 soccer players, while the sample size was composed of 402 soccer players with a 95% confidence level. The survey technique was used for data collection, and in this context, the "Turkish form of Morningness-Eveningness Stability Scale" was employed. Based on the findings of this study, the conclusion reached is that the season of birth does not have a significant impact on the chronotypes of soccer players in the age range of 14-19. We believe that conducting further research in this field is important for a better understanding of chronotype mechanisms. It is recommended that future studies be conducted on different sample groups and in regions with varying altitudes.

Key words: soccer, chronotype, season, light-dark cycle, photoperiod

Introduction

The regular recurrence of behavioral, physiological, and biochemical rhythms within a 24-hour time frame is defined as circadian rhythms (Foster and Kreitzman, 2005; Ishida et al., 1999), and the biological diversity of this rhythm is expressed as chronotype (Melo et al. 2019). Chronotypes are typically classified into three distinct types: morning type (M-type), evening type (E-type), and neither type (N-type) (Adan et al., 2012; Horne and Ostberg, 1976; Vitale et al., 2015). Morning types (M-types) achieve their highest levels of mental and physical

performance during the early hours of the day, while evening types (E-types) perform best during the latter part of the day. Neither types (N-types) are individuals with no clear circadian preference and are categorized within this group due to displaying intermediate characteristics (Adan et al., 2012; Montaruli et al., 2017; Taillard et al., 2004).

Chronotype is a biological rhythm that can be influenced by geographical variables such as east-west and north-south positioning (Borisenkov et al., 2012a; Natale and Di Milia., 2011) and photoperiod factors like the light-dark cycle (Arendt, 2012; Chen et al., 2016; Friborg et al., 2012). This suggests that the duration of the light-dark cycle between countries based on their geographical location and the seasons they experience could impact individuals' chronotypes. In this context, it is noteworthy that Türkiye is located in the Northern Hemisphere and experiences all four seasons distinctly.

In Türkiye, which is located in the Northern Hemisphere, the tilt of the Earth's axis and its annual movement result in the maximum duration of sunlight occurring in the summer months, while the minimum duration of sunlight is observed in the winter months [Erol, 1999]. The daily average sunlight duration in Türkiye is approximately 9 hours and 56 minutes in winter, 13 hours and 10 minutes in spring, 14 hours and 47 minutes in summer, and 11 hours and 30 minutes in autumn (Astronomical Almanac, 2022). Based on this information, it is understood that there is an approximate 4-hour and 51-minute difference in daily sunlight duration between the summer and winter seasons in Türkiye. Considering this nearly 5-hour daily difference in sunlight duration during different seasons, it is believed that it could have a significant impact on chronotypes.

In the literature, some researchers have emphasized that individuals born in the autumn and winter months, who are exposed to lower levels of daylight and higher levels of darkness, are more likely to exhibit a morning-type (M-type) chronotype. Conversely, individuals born in the spring and summer months, who are exposed to higher levels of daylight and lower levels of darkness, are more likely to have an evening-type (E-type) chronotype (Cavallera and Giudici, 2008; Borisenkov et al., 2002b). However, it should be noted that there is no consensus among researchers on this matter in the literature.

Studies conducted in Japan have indicated that the birth month does not have any effect on the chronotype of individuals aged 18-30 (Takao et al., 2009). However, a relationship between birth month and chronotype was observed in children aged 2-12 years (Harada et al., 2011). Additionally, it has been reported that the birth month has a significant impact on the chronotype of Italian adolescents (Tonetti et al., 2011). Similar results have been obtained in studies conducted on Italian, Spanish (Natale et al., 2009), and Canadian (Mongrain et al., 2006) adults. These studies found a prevalence of evening chronotypes among individuals born in the spring and summer months (Borisenkov et al., 2012b). However, considering Türkiye's geographical location and the differences in seasonal day-night durations, there have been no studies investigating inter-individual differences in chronotypes.

Therefore, it is of interest to explore the outcomes of such research conducted in Türkiye, which spans both the European and Asian continents.

Moreover, the fact that individuals' physical performances vary throughout the day based on their chronotypes is both important and thought-provoking for determining how Turkish athletes are affected by this. Soccer, one of the world's most popular sports, especially among adolescent boys (Roveda et al., 2020), is also highly popular in Türkiye. In this context, the aim of this study was to examine the relationship between the season of birth and the chronotypes of soccer players participating in the Development Leagues affiliated with the Turkish Soccer Federation (TFF) during the 2022-2023 season.

Material and Methods

Research Design

This study was conducted in accordance with the Helsinki Declaration and was approved by the Scientific Research and Publication Ethics Committee of İnönü University, with decision letter number 2023/5138, dated 14.11.2023. A cross-sectional research design was employed, and quantitative research methods were utilized with the survey technique.

Population and Sample

The population of this study consists of 8,952 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 to the TFF in the 2022-2023 season. Since the total number of players playing in these leagues is not specified on the official website of the TFF, it was calculated by multiplying the total number of teams in the Development League by the total number of players (24) of each team. In this context, it was determined that there are 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, 53 teams in the U19 Regional Development League; 22 teams in the U19 Elite A League, 18 teams in the U19 Elite B League, 21 teams in the U17 Elite A League, 20 teams in the U17 Elite B League, totalling 373 teams. When the number of teams in the development league (373) is multiplied by the total number of players of each team (24), it is determined that there are 8.952 athletes in total. Since the number of athletes constituting the population is clearly known, the sample size was determined by using the estimated sample size table (Adam, 2020) used in cases where the population is known. Accordingly, it was understood that the sample size should be 370 athletes with 95% confidence level. In sample selection, convenience sampling technique, one of the non-random sampling techniques, was used. In this context, a total of 402 male soccer players between the ages of 14-19 playing in TFF affiliated Development Leagues were included in the study. A voluntary consent form was obtained from the participants aged 18 years and over, and both

the voluntary consent form and the parental consent form were signed by all participants under the age of 18. The demographic information of the participants is given in Table 1.

Table 1. Demographic information of the participants

Variable		Frequency (f)	Percent (%)
Age (year)	14	162	40.3
	15	80	19.9
	16	58	14.4
	17	56	13.9
	18	26	6.5
	19	20	5.0
Season of birth*	Spring	102	25.4
	Summer	111	27.6
	Autumn	72	17.9
	Winter	117	29.1
Sports experience (year)	1-3	59	14.7
	4-6	125	31.1
	7-9	142	35.3
	+10	76	18.9
Positions played	Goalkeeper	39	9.7
	Defender	124	30.8
	Midfielder	141	35.1
	Forward	98	24.4
League	U 14	114	28.4
	U 15	48	11.9
	U 16	82	20.4
	U 17 (regional)	12	3.0
	U 19 (regional)	22	5.5
	U 17 (elite)	61	15.2
	U 19 (elite)	63	15.7
Training time	06:00-12:00	13	3.2
	12:00-18:00	157	39.1
	18:00-00:00	232	57.7
Time period for going to school	Before midday	285	70.9
	Afternoon	26	6.5
	Distance education	91	22.6
Desired time of competition	09:00-12:00	68	16.9
	12:00-15:00	70	17.4
	15:00-18:00	264	65.7

Note. Winter: (December, January, February); spring: (march, april, may); Summer: (June, July, August); Autumn: (September, October, November).

Data collection tools

In determining the chronotypes of the participants, the "Turkish form of MESS" scale, developed by Randler et al. (2016) called "Morningness-Eveningness Stability Scale (MESS)" and adapted to the Turkish language by Demirhan et al. (2019), was used. The Turkish form of MESS consists of three sub-dimensions: morning affect (MA), eveningness (EV), and distinctness (DI). The scale is five-point Likert type. Additionally, a form prepared by the researchers was used to collect demographic information of the participants (Table 1).

Data collection process

The data of this research were collected electronically between 11.11 and 11.11. by sending the form link to the mobile phone numbers of the participants with demographic information and Chronotype determination scale questions prepared via Google Form. The data collected in the research were uploaded to the Excel program (Microsoft 365) and then made suitable for analysis by assigning numerical values to the verbal data. Finally, the research data were transferred to IBM statistical program (SPSS Version 26.0, Armonk, NY) for analysis.

Statistical analysis

The data were analysed in IBM Statistics (SPSS version 26.0, Armonk, NY) package programme. Normality distribution of the data was tested by Kolmogorov-Smirnov and homogeneity was tested by Levene's test. Kruskal Wallis-H test and chi-square ($\chi 2$) were used for group comparison. Statistical significance level was accepted as $p<.05$. In addition, the demographic characteristics of the participants were given as frequency (f) and percentage (%) using descriptive statistics.

Results

Table 2. Kruskal-Wallis H Test results between participants' season of birth and Chronotype types

Subdimensions	Seasons	n	MR	χ^2	p
ME	Spring	102	198.94	1.012	0.798
	Summer	111	209.27		
	Autumn	72	204.32		
	Winter	117	194.63		
EV	Spring	102	202.95	2.330	0.507
	Summer	111	187.83		
	Autumn	72	206.93		
	Winter	117	209.86		
DI	Spring	102	196.90	1.610	0.657
	Summer	111	208.39		
	Autumn	72	210.76		
	Winter	117	193.28		

Note. $p<0.05$; ME: M-type; EV: E-type; DI: N-type; MR: Mean Rank; $\chi 2$: chi-square

When the difference between the season in which the participants were born and their chronotype scores is analysed in Table 2, it is understood that the seasons in which the participants were born do not have an effect on the chronotype subdimensions.

Discussion

The findings of this study, which was conducted to examine the relationship between the season of birth and chronotypes of soccer players playing in Soccer Development Leagues in the 2022-2023 season, were striking. In our research, it was determined that there was no statistically significant relationship between the season of birth and chronotypes of soccer players aged 14-19 years ($p<0.05$). Although there are studies in the literature reporting that the chronotype of an

individual can be affected by the season of birth (Harada et al., 2011; Tonetti et al., 2011; Natele et al., 2009; Mongrain et al., 2006; Santos et al., 2020), it should be kept in mind that seasonal changes are not the only factor affecting chronotype.

Epidemiological studies, particularly in humans, have reported an association between increased daylight hours and evening preferences (Natale et al., 1999; Tonetti et al., 2011; Vollmer et al., 2012b). However, it cannot be said that there is a consensus among researchers on this matter. In this context, while some studies have reported no significant relationship (Huang et al., 2015; Touchette et al., 2008), others have suggested an inverse effect (Didikoglu et al., 2019; Tegowska et al., 2006). Therefore, it is believed that the emergence of these different results may be attributed to the roles played by other factors that can influence chronotype.

Among the factors that influence chronotype, age (Montaruli et al., 2017; Crowley et al., 2014; Koscec-Bjelajac et al., 2014; Adam, 2020; Adan et al., 2012), gender (Adan and Natale, 2002; Adam et al., 2012), genetic factors (Landolt and Dijk, 2017; Kalmbach et al., 2017), latitude and altitude of the location (Borisenkov et al., 2012a; Masal et al., 2015), and lifestyle (Martin et al., 2012; Vollmer et al., 2012a) play significant roles. The absence of a relationship between the participants' chronotypes and the season of their birth suggests that some of these factors may have influenced the participants.

The fact that 70.9% of our study's participants go to school in the morning and 96.8% engage in afternoon training (Table 1) highlights that they are required to be active in both parts of the day. Therefore, we believe that our research group is influenced by their social program hours and adapts to them.

Furthermore, this research has demonstrated that the approximately 5-hour difference in daylight and darkness between seasons may not have a significant enough effect to influence chronotype. In fact, in the literature, Höller et al. (2021) emphasized that for there to be a relationship between daylight duration, chronotype, and seasonal differences, winters should be long and dark, while summers should have 24-hour daylight. However, even during the summer months, which are the period with the longest daylight hours in Türkiye, the daily average is only 14 hours and 47 minutes (Astronomical Almanac, 2022). Therefore, the lack of a relationship between the season of birth and chronotype in our study may be associated with not being exposed to sufficiently long daylight. To draw a definitive conclusion on this matter, it is recommended that further research be conducted with different sample groups.

Finally, we believe it is necessary to emphasize the following point in this research. If the participants in the study had the opportunity to determine the competition time themselves, 65.7% of them stated a preference for participating in competitions between 15:00 and 18:00 in the afternoon. This preference may indicate a tendency towards an E-type among the participants. Furthermore, the compatibility of this finding with similar studies in the literature is noteworthy.

In the literature, many relevant studies have reported that professional and amateur athletes exhibit maximum athletic performance around 16:30-19:00 in the afternoon (Aloui et al., 2017; Chtourou et al., 2012; Di Cagno et al., 2013; Lok et at., 2020; Silveira et al., 2020; Yarrouk et al., 2012). This increase in athletic performance is attributed to the synchronization of physiological, psychological, and metabolic rhythms (Bellastella et al., 2019; Kantermann et al., 2012). In this context, it can be said that the most suitable time of day to achieve maximum efficiency in any physical exercise is between 15:00 and 19:00.

Conclusion

This research contributed to explaining the relationship between chronotype and seasonal differences. Based on the findings of this study, the conclusion reached is that the season of birth does not have a decisive effect on the chronotypes of soccer players aged 14-19. We believe that further research in this field is crucial to gain a better understanding of chronotype mechanisms. It is recommended that future studies be conducted on different sample groups and in regions with varying altitudes.

Conflict of Interest

The researchers affirm that there were no financial or commercial ties that might be seen as creating a conflict of interest during the research's conduct.

Author Contributions

Conceptualization, İ. İ., R.I.M., Ö.E., M.J., and E.P.; methodology, İ. İ., R.I.M., Ö.E., M.J., and E.P.; software, İ. İ., R.I.M., Ö.E., M.J., and E.P.; validation, İ. İ., R.I.M., Ö.E., M.J., and E.P.; formal analysis, İ. İ., R.I.M., Ö.E., M.J., and E.P.; investigation, İ. İ., R.I.M., Ö.E., M.J., and E.P.; resources, İ. İ., R.I.M., Ö.E., M.J., and E.P.; data curation, İ. İ., R.I.M., Ö.E., M.J., and E.P.; writing—original draft preparation, İ. İ., R.I.M., Ö.E., M.J., and E.P.; writing—review and editing, İ. İ., R.I.M., Ö.E., M.J., and E.P.; visualization, İ. İ., R.I.M., Ö.E., M.J., and E.P.; supervision, İ. İ., R.I.M., Ö.E., M.J., and E.P.; project administration, İ. İ., R.I.M., Ö.E., M.J., and E.P.; funding acquisition, İ. İ., R.I.M., Ö.E., M.J., and E.P.. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

The corresponding author will freely make the raw data used to support this article's conclusions available.

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