INTERNATIONAL JOURNAL of IJSETS SPORT, EXERCISE & TRAINING SCIENCES

e-ISSN 2149-8229 | Volume 11, Issue 1, 26–34, (2025) | Research Article

https://dergipark.org.tr/tr/pub/useeabd

The Impact of Circadian Rhythm and Running Training on The Agility and Lower Limb Performance of Pre-Adolescent Football Players

Baha Engin ÇELİKEL[1], Süreyya Yonca SEZER[2], Coşkun YILMAZ[3], Erdem TİRYAKİ[4]

Abstract

Aim: The objective of this study was to examine the impact of running training in accordance with the circadian rhythm on the agility and lower extremity muscles of football players.

Method: The subjects were divided into three groups according to the chronotype of the research: Runing group morning (10.52±0.51 years), Running group evening (11.09±0.67 years), and the control group (11.86±1.17 years). The study involved 75 volunteer football players. The subjects' age, height, body weight, functional performance tests and 505 agility tests were measured. The data obtained were analysed using SPSS 25 package programme. The significance level was set at p>0.05.

Results: According to the results obtained from the data, a significant difference was determined in the values of single-leg jump, triple jump, 6-meter single-leg jump, crossover jump, and 505 agility tests based on the ANOVA analysis (p<0.05). The greatest effect in the study was observed in the morning running group, where the single-leg jump value increased by 24.77%, the triple jump by 10.67%, and the crossover jump by 8.81%, while the 6-meter single-leg jump increased by 8.75% and the 505 agility test value decreased by 5.25%.

Conclusion: Consequently, following a 6-week running training programme synchronised with the circadian rhythm, it was determined that the performance of football players who ran in the morning was more effective. Running has a positive effect on the agility and leg strength of preadolescent football players. It is therefore recommended that this training be included in the training programmes to be implemented in terms of sportive performance.

Key words: *Agility, Football, Functional Performance Tests, Running Training.*

Submission Date : 07.02.2025 **Acceptance Date** : 20.03.2025 **Online Publication Date** : 27.03.2025

https://doi.org/10.18826/useeabd.1635425

INTRODUCTION

It has been determined that football training is important in terms of speed, agility and some anthropometric characteristics (Bayer, 1996). The game duration in football is long, the playing field is larger than in most branches, and there are continuous offensive and defensive actions throughout the match. Within the domain of football training, significant emphasis is placed on the cultivation of biomotor characteristics such as strength, speed, and endurance. The training model that will provide efficiency to the athlete is realised by considering the physical characteristics of the individual. The primary objective of the training programme applied to football players is to enhance their physical and physiological characteristics (Ateş et al., 2007). Football is characterised by high intensity, endurance, frequent sprints, coordination, rapid directional changes, the adept use of the ball, and precise in-game decisions (Agostini, 1994). Football is regarded by researchers and experts as a game, yet it is also recognised as a tool for education by various nations due to its favourable impact on the development of children and adolescents from a sociological and psychological standpoint, fostering mental and physical well-being (İnal, 2013). The importance of directing children in their developmental stage towards sporting activities cannot be overstated in terms of their physical and mental development. Football, a sport which continues to gain popularity on a daily basis, is a pastime in which a significant proportion of the global population engages. In this country, as well as in many others, it attracts a considerable following. In a sporting discipline with such widespread appeal, it is imperative to augment the infrastructure and sports schools to cater to the needs of all segments of the population. This necessitates the strategic development of athletes from an early age, with the ultimate goal of preparing them for future success (ibid.). Infrastructure and football schools have been identified as key contributors to the identification and development of talented athletes who meet the requirements of this discipline. A pivotal element in this process is the collaboration between school, family, and club. Education and training methods are of paramount importance in football (Kurban & Kaya, 2017).

[1] **Corresponding Author:** Fırat University, Sports Sciences Faculty, Recreation Department, Türkiye, Bahaecelikel23@gmail.com
[2] Munzur University, Sports Sciences Faculty, Recreation Department, Türkiye, sureyyayoncasezer@munzur.edu.tr
[3] Gümüşhane University, Kelkit Aydın Doğanvocational High School, Sport Management Programme, Türkiye, Coşkun.yilmaz@gumushane.edu.tr
[4] Gümüşhane Provincial Directorate of National Education, Türkiye, erdemtiryaki99@gmail.com

Football is a sport that requires a structured educational and training process. During this period, it is imperative that footballers receive training in the physical, tactical, technical and psycho-social aspects, and that they acquire these skills (Konter, 2004). The significant potential for growth exhibited by the young population in our country underscores the imperative for the establishment of robust infrastructure and the undertaking of rigorous research studies. Consequently, it is imperative that football training programmes for children and adolescents are scientifically designed and implemented (Eniseler, 2009). Specifically, fundamental biomotor characteristics encompass an individual's physical strength, aptitude, and multifaceted attributes. These characteristics encompass the capacity to execute movements with regard to strength, speed, endurance, mobility and coordination. It is acknowledged that these characteristics may be subject to variation in accordance with the adaptability and efficiency of the organism. While these characteristics are intrinsic to all humans, they can be cultivated through various exercises (Karaca, 2012). It is an established fact that anthropometric characteristics have a significant impact on the performance of athletes. However, the impact of anthropometry on biomotor characteristics remains a subject of considerable debate (Şentürk, 2006). In the developmental stage from childhood to adolescence (specifically between the ages of 8 and 13), the child's motor abilities undergo a period of rapid and significant growth. This developmental phase can be enhanced through the implementation of exercises and sporting activities (Muratlı, 2003). The period between the ages of 7 and 14 is the most significant in terms of performance development. In this age range, children rapidly acquire new movement forms and readily assimilate additional ones. Consequently, physical performance attains a level of distinction that is readily discernible at this age. Significant advancements in speed, aerobic endurance, and agility are observed during this period (Muratlı, 2003).

The development of biomotor characteristics in the period serves as a crucial support for the present study. The present study was conducted to determine the effect of morning and evening training on the lower extremity muscles of football players.

METHOD

Research model

In this study, a parallel two-group pre-test–post-test randomized controlled trial was conducted according to CONSORT guidelines (Moher et al, 2001). All participants and their parents were given detailed information about before the study, and written informed consent was obtained in accordance with the ethical principles described in the Declaration of Helsinki. Help was received from a 3rd-level athleticism coach for planning and implementing running exercises to be used in the project. The study was designed according to the rules of the Declaration of Helsinki (World Medical Association, 2013).

Population and sample

The aim of this study was to investigate the effects of morning and evening running training on lower extremity strength and agility performance in 10–12-year-old male soccer players who had been training regularly for at least 2 years. A power analysis was performed via the G. Power 3.1 program to determine the sample size of the study, and the d value was found to be 1.12 (α=0.05, 1-β=0.95, $\eta 2p$ = 0.8). As a result of the analysis, it was decided to include at least 20 participants for each group in the study. However, in order to circumvent potential complications, each group comprised 23 participants. The studies were divided into 3 groups: Running at morning group (RMG), Running at evening group (REG) and a control (CG) group.

Data collection tools

Chronotype

The HS-MEQ was used to assess the chronotype of each participant. On the basis of the scores obtained, individuals were classified into one of five chronotype categories: definite evening type (DET) (16--30), moderate evening type (MET) (31-41), no type (NT) (42--58), moderate morning type (MMT) (59--69) and definite morning type (DMT) (70--86) (Horne and Ostberg, 1976). As grouping athletes by chronotype results in significant diurnal variation and better performance data can be obtained when training and testing sessions are circadian in nature, the study grouped athletes by chronotype (Kusumoto et al., 2021). In our study, participants were grouped into 'moderate and definite morning type' (MRG, n=25), 'no type' (CON, n=25) and 'moderate and definite evening type' (ERG, n=25) according to their responses to the questionnaire assessing morning/evening status. Participants who answered 'no type' were included in the control group (Roveda et al., 2020). The reason why extreme chronotypes were not found in the samples in this study was that such chronotypes were not included in the study.

Lower extremity strength tests

Dominant and nondominant foot measurements were taken for functional performance tests (FPTs), which were used to determine the subjects' lower extremity strength. Prior to each test, the subjects were instructed on how to perform the measurement. Three trials were performed for each test prior to the actual measurements. After the trial repetitions, the participant was subjected to 3 main tests, and the success criterion in the test was determined as the subject landing on one leg with full stabilization and staying there for three seconds. The subjects rested for 30 seconds between trials. Arm movement was allowed during the movement, and no restrictions were imposed (Munro & Herrington, 2011). For all the trials, a 30 cm strip was drawn on the ground as a starting point, a 6 m long and 15 cm wide strip was placed vertically on the ground from the center of this strip, and all the measurements were taken on this platform.

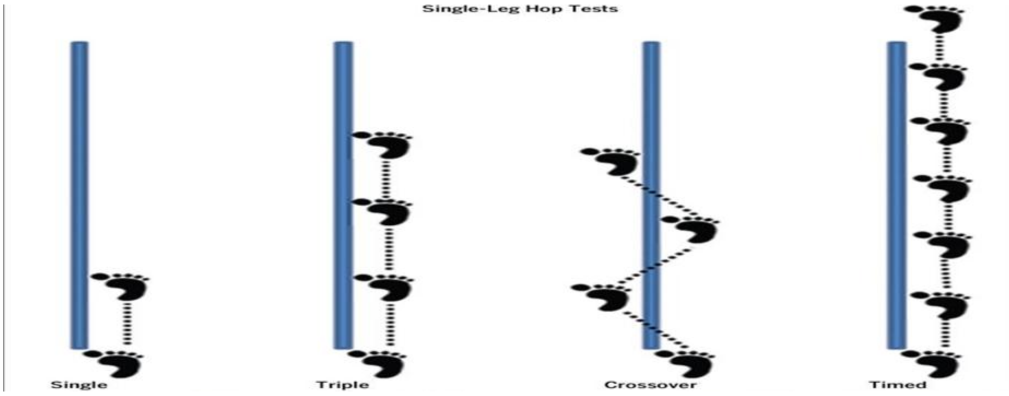

Figure 1. Application of Functional Performance Tests (Schmitt et al., 2012)

Single Leg Hop for Distance (SL)

In the SL test, subjects start standing on one leg at the marked starting line and, when ready, jump horizontally and as far as they can jump so that they fall on the same leg; the result is determined by the successful attempt between the starting line and the subject's heel and recorded in cm (Yılmaz & Kabadayı, 2020).

Triple jump for distance (THD)

In the THD test, the subject began by standing on one leg at the start line and, when ready, jumped horizontally as long as he could three times in succession without stopping. The distance between the starting line and the heel height of the subject's fall was recorded in cm (Yılmaz & Kabadayı, 2020).

Single Leg 6 m. Timed Hop Test (6mt THT)

The subject stands on one foot at the start line and finishes the 6-meter track in the fastest possible time. The test began at the start line and ended when the subject's heel touched the first point at which the subject crossed the finish line. All the subjects were tested three times, with a rest period of 2 minutes between each test. The test was timed in seconds using a standard stopwatch. The best time from the three trials was recorded in seconds. The use of arm movements during movement was allowed, and no restrictions were imposed (Schmitt et al., 2012).

Crossover Hop for Distance (CHD)

The subject stands on one foot at the starting line and performs 3 jumps forward, and the distance jumped is recorded in cm. The first jump starts diagonally opposite the foot used and continues laterally to the side of the fall. For each test, the subjects were given three repetitions. The criterion for success in the test was that the subject landed with full stabilization on the leg and remained standing for three seconds.

The best jump distance was recorded in cm. The subjects were given a 30 second rest interval between each trial (Schmitt et al., 2012).

505 Agility test: This test consists of measuring the time taken to complete the last 5 m of a 15 m track. The time within the first 10 m from the start of the test is not included in the test score. When the next 5 m distance is passed for the first time, the recording begins and stops when the same distance is returned (Nimphiu et al., 2016).

Measurement of height and weight: A Seca 769 electronic height measuring device (Seca Anonim Şirketi, Hamburg, Germany) was used. The device measures height with an accuracy of 0.1 cm and body weight with an accuracy of 0.01 kg. Body weight was measured in kilograms (kg) without shoes and wearing shorts and a T-shirt to avoid influencing the participants' weight. Height was measured in centimeters (cm) without shoes, with the body weight evenly distributed on both feet.

Running training

It was performed between 08:00 and 10:00 for morning running and between 18:00 and 20:00 for evening running (Bessot et al., 2014). The exercise intensity of each child in the running group was determined as the 50% heart rate (HR) according to the Karvonen formula (target pulse: (220-age-basal pulse) × intensity) + basal pulse) (Goldberg et al., 1988). HR was determined via a telemetric heart rate monitor (PolarM400, Finland) during the first week of running training. Environmental conditions are known to influence the degree of airway epithelial disruption during high-intensity exercise (Boukelia et al., 2017). Therefore, all the participants performed continuous running exercise on a football field in Centre / Elazığ /Turkey (altitude: 1067 m). It was performed for 50 minutes (including 10 min warm-up and cool-down), 3 days a week, for 8 weeks at the set target heart rate. Each session was supervised by trainers. Running included approximately 10 minutes of warm-up and cool-down with static stretching and light exercises of the relevant muscle groups. The coaches were responsible for monitoring the athletes' running technique and speed, ensuring safety and providing motivation. Both groups were provided sufficient water to avoid dehydration (Maresh et al., 2006).

Data analysis

The statistical software programme SPSS 25.0 was utilised for the analysis of the data obtained in the study. The variables were evaluated using the Kolmogorov-Smirnov test, following the establishment of the prerequisites of normality and homogeneity of variances. Upon examination of the normal distribution curves, deviations from normality were observed within the range of ±1.5. The researcher accepted that the data showed normal distribution and normal distribution tests were applied. The variables were expressed using mean ± standard deviation values. In the analysis of more than two groups, the one-way analysis of variance (ANOVA) test was applied by calculating the difference values (Post-Pre=Difference). The graphical representation of the findings was facilitated by the GraphPad Prism 10 programme.

RESULTS

In this section of the study, the obtained results are presented in tables and figures.

Table 1. Characteristics of participants.

Group	RMG (n:23)		REG (n:23)		CG (n:23)	
	X	S.D.	X	S.D.	X	S.D.
Age	10,52	0,51	11,09	0,67	11,86	1,17
Heigh	145,78	6,76	147,35	8,29	148,27	7,85
Weight	35,57	6,96	37,17	6,23	53,50	69,80

Table 1 summarizes the age, height, and weight characteristics of participants in three different groups (RMG, REG, and CG). When examining the groups, it is observed that the CG group has the highest average age (11.86 ± 1.17). Although the height averages are similar, the CG group has a slightly higher value. In terms of weight data, the CG group's average (53.50 ± 69.80) was found to be higher than the others.

Table 2. Groups' responses to the training

		RMG		%	REG		%	CG		%
		X	S.D.		X	S.D		X	S.D	
6mt THT	Pre	2,74	0,43	-8,75	2,74	0,55	-1,82	2,6	0,32	-3,46
	Post	2,5	0,46		2,69	0,55		2,51	0,32	
Agility	Pre	3,43	0,35	-5,25	3,27	0,38	-2,45	3,19	0,21	2,50
	Post	3,25	0,32		3,19	0,33		3,27	0,26	
SL	Pre	78,27	7,57	24,77	91,52	26,76	6,27	109,23	18,52	4,04
	Post	97,66	20,11		97,26	24,91		113,64	15,01	
CHD	Pre	289,09	63	8,81	295,22	71,92	5,54	344,73	49,5	0,96
	Post	314,57	61,83		311,57	73		348,05	50,07	
THD	Pre	307,35	54,92	10,67	319,83	68,74	-0,10	363,95	48,39	1,09
	Post	340,13	50,55		319,48	69,35		367,91	48,7	

**p<0,05; One Way ANOVA Test*

Upon analysis of Table 2, it was determined that the morning run group exhibited the most significant alterations. A decline of 8.75% was observed in the 6-metre timed single-foot jump, while a 5.25% decrease was noted in the agility test. Conversely, there was a 24.77% increase in single step jump, 8.81% increase in cross jump test and 10.67% increase in triple jump test.

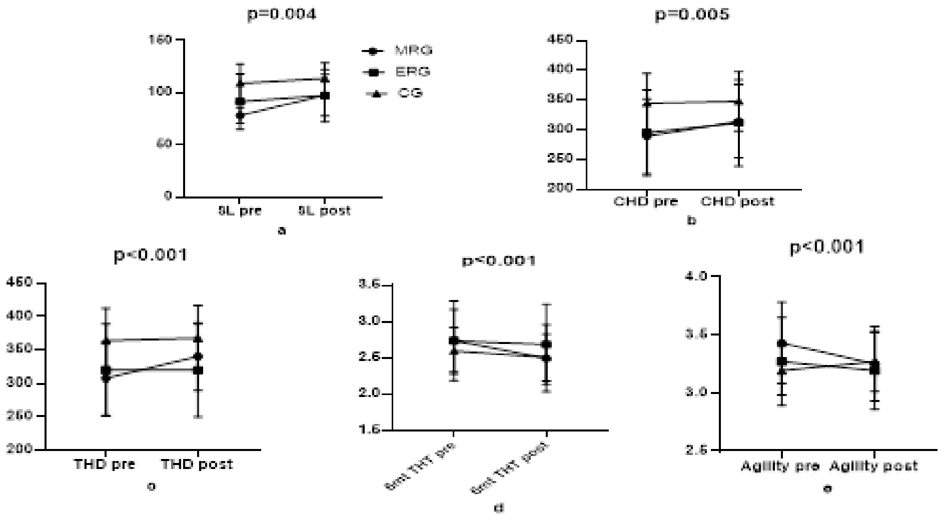

Figure 2. Comparison of the difference values of the lower extremity strength tests (dominant) a) Single leg (SL), b)Crossover (CHD), c) Triple leg hop for distance (THD) d)6 m timed-hop test (6 m THT), e) Agility.

Figure 2 presents a comparative analysis of the difference values in lower extremity strength tests performed with the dominant leg.

DISCUSSION

The objective of this study was to examine the impact of a 6-week exercise regime on the lower extremity musculature of football players. The investigation revealed that the morning running group exhibited an 8.75% decline in the 6-metre single foot jump measurement between the baseline assessments and the follow-up evaluations following a 6-week intervention. The findings of this study indicated that the 6-week training programme had a favourable impact on the 6-metre single foot jump test of the morning running group. Kurt et al., (2021) reported that there was a statistically significant difference in the 6 m single foot jump test in the study titled Investigation of the effect of strength exercises applied after anterior cruciate ligament surgery on the lower extremities in female athletes. Abrams et al., (2014) examined traditional jump tests in their study and determined that 6 m timed and single leg crossover jump tests were the best predictors for return to the field. The study further noted that 70% of the results fell within normal limits during the initial 6 months, with this figure remaining below 90% across the majority of categories within the subsequent 12 months. In the context of the agility assessment of football players, it was observed that there was a 5.25% decrease between the measurements taken 6 weeks before and after the morning run group. In a subsequent study, Şengür

(2018) utilised the Illinois agility test to evaluate the agility performance of 33 football players. The present study sought to analyse the agility performance of football players by comparing the pre-test and post-test values in the absence and presence of vibration training. The findings indicated a statistically significant enhancement in the agility performance of the football players. In a similar vein, Chin et al., (2016) reported that vibration training significantly improved agility, speed, and power performance in male volleyball players. A similar finding was reported in a study conducted on 21 male college football players, where it was found that acute vibration exercises improved speed and agility performance. In a separate study, Meylan & Malatesta (2009) reported a decrease in agility test time of -9.6% after eight weeks of plyometric training in a group of 14 boys with a mean age of 13.3 years (Jeffrey et al., 2013). In addition, a separate study involving 19 individuals reported that a 8-week whole body vibration training programme led to significant improvements in agility performance (Bayram, 2015). A 24.77% increase in the single step jump test of football players was determined between the measurements taken 6 weeks before and after the morning running group. In a separate study, forward and multidirectional single leg jump tests were applied to footballers, revealing very low level asymmetries and balanced strength development between dominant and non-dominant legs in the subject group. In this context, it was evaluated that the risk of injury was low in the pre-season measurements of football players (Akyuz, 2022). Sobido et al. (2017) determined that the training performed in the study increased statistically in the single step jump test. In a related study, Cankurtaran (2022) examined the impact of both static and dynamic core training on the performance responses of female taekwondo athletes in her master's thesis. The findings revealed a statistically significant difference in single step jump values between the dynamic and static core training groups. In the study by Reid et al. (2007), the affected side distance measured single step jump test of subjects with ACL surgery was 127.4 cm for the affected leg, while the second measurement was 129 cm. In a subsequent study, Kızılet (2011) examined the effect of coordination and plyometric exercises on running economy and other biomotor characteristics in young female football players. The study found that there was an improvement in single foot jump value. The findings indicated an 8.81% increase in the mean value of the single-foot jump test, as measured across the 6-week period following the incorporation of morning running sessions into the subjects' training regimens. The findings further demonstrated that the training programme led to a notable enhancement in the cross jump performance of 11-year-old footballers. Conversely, Bračič et al., (2022) reported that no statistically significant difference was observed in the cross jump test in a study conducted on elite football players at different league levels. Bračič et al. (2010) discovered greater asymmetries in runners, as measured by unilateral vertical countermovement jumps from each leg, which were associated with slower sprint starts. Hoffman (2007) demonstrated that asymmetries of approximately 10 per cent in power resulted in diminished change of direction velocity. In addition, Young & Farrow (2006) asserted that change of direction speed encompasses the ability to accelerate and decelerate quickly, as well as change of direction, which is a component of agility. It was further emphasised that leg strength constitutes a pivotal component of both linear acceleration and change of direction speed. The findings of the study revealed a 10.67% increase in the three-step jump test of football players following the training intervention. In a subsequent study by Reid et al., (2007), the affected side distance-measured three-step jump test of subjects with ACL surgery yielded a result of 363 cm for the affected leg, with a second measurement of 372 cm. For the contralateral side, the initial measurement was recorded at 440 cm, while the subsequent measurement registered at 452 cm. The cross jump test yielded a measurement of 328 cm for the affected side, with a second measurement of 331 cm. The unaffected side demonstrated a measurement of 387 cm, with a second measurement of 399 cm. In the study by Gözel (2023), the impact of a basic tennis training programme on motor skills in children aged 10-12 years was examined. The study found a statistically significant difference in three-step jump measurements.

CONCLUSION

As a result; It is seen that morning running affects the performance of football players as a result of 6 weeks of training. In line with the data obtained, we think that morning running affects the performance of athletes positively and that it will be important to include it in training programs to be implemented in terms of sports performance.

Etical Approval and Permission Information

Ethics Committee: Gümüşhane University Scientific Research and Publication Ethics Committee
Protocol/Number E-95674917-108.99-248173

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CITATION

Çelikel, B.E., Sezer, S.Y., Yılmaz, C., & Tiryaki, E. (2025). The Impact of Circadian Rhythm and Running Training on The Agility and Lower Limb Performance of Pre-Adolescent Football Players. *International Journal of Sport Exercise and Training Sciences - IJSETS, 11*(1), 26-34. https://doi.org/10.18826/useeabd.1635425