

Psychological Skills and Mental Toughness Affect Aerobic Endurance and Change of Direction Speed in Adolescent Female Soccer Players?

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ORIGINAL ARTICLE

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Abstract

This study aims to examine the effects of psychological skills and mental toughness on aerobic endurance and change of direction abilities in football players. The study included 55 female athletes aged between 13 and 17. Demographic data of the athletes were collected, followed by the administration of the Sport Mental Toughness Inventory and the Psychological Skills Inventory for Sports. Afterward, a 15-minute dynamic warm-up routine was completed, followed by the Illinois Agility Test. The 20-meter shuttle run test was also administered. The two measurement sessions were conducted 48 hours apart. Statistical analyses were performed using SPSS Statistics software version 26.0. For regression graphics, the Jamovi statistical analysis program version 2.6.2.0 was utilized. Mean, standard deviation (SD), linear regression, and skewness-kurtosis values of the variables were calculated for the entire sample. There is no statistically significant relationship between the change of direction values of the football players and the mental endurance and psychological skill variables. While there is no statistically significant correlation between the endurance values of the football players and mental endurance, there is a moderately positive and statistically significant correlation between the endurance values and psychological skill. Psychological skills have a positive effect on aerobic endurance in adolescent female football players, whereas mental toughness does not appear to have an effect. Additionally, neither psychological skills nor mental toughness were found to have an effect on change of direction performance.

Keywords: Adolescent Female Football, Psychological Skills, Mental Toughness, Aerobic Endurance, Change of Direction.

Adölesan Kadın Futbolcularda Psikolojik Beceri ve Zihinsel Dayanıklılık, Aerobik Dayanıklılık ve Yön Değiştirme Hızını Etkiler mi?

Öz

Bu çalışmanın amacı, futbolcularda psikolojik beceri ve zihinsel dayanıklılığın aerobik dayanıklılık ve yön değiştirme becerileri üzerindeki etkilerini incelemektir. Çalışmaya 13-17 yaş arası 55 kadın sporcu dahil edilmiştir. Sporcuların demografik bilgileri toplandı, ardından sporda zihinsel dayanıklılık envanteri ve spor için psikolojik beceriler envanteri uygulandı, ardından 15 dakikalık dinamik ısınma egzersizleri ve Illinois testi yapıldı. 20m mekik koşusu testi yapılmıştır. İki ölçüm günü 48 saat arayla yapılmıştır. İstatistiksel analizler SPSS istatistik yazılımı versiyon 26.0 kullanılarak gerçekleştirilmiştir. Regresyon grafikleri için Jamovi versiyon 2.6.2.0 istatistiksel analiz programı kullanıldı. Değişkenlerin ortalama, standart sapma (SD) Lineer Regresyon ve Skewness-Kurtosis değerleri tüm örneklem için hesaplanmıştır. Futbolcuların yön değiştirme değerleri ile zihinsel dayanıklılık ve psikolojik beceri değişkenleri arasında istatistiksel olarak anlamlı bir ilişki yoktur. Futbolcuların dayanıklılık değerleri ile mental dayanıklılık arasında istatistiksel olarak anlamlı bir korelasyon bulunmazken, dayanıklılık değerleri ile psikolojik beceri arasında orta derecede pozitif ve istatistiksel olarak anlamlı bir korelasyon bulunmaktadır. Ergen kadın futbolcuların psikolojik becerileri aerobik dayanıklılık üzerinde pozitif bir etkiye sahipken, zihinsel dayanıklılığın aerobik dayanıklılık üzerinde bir etkisi yoktur. Psikolojik beceriler ve zihinsel dayanıklılığın yön değiştirme hızı üzerinde etkisi yoktur.

Anahtar Kelimeler: Adölesan Kadın Futbolu, Psikolojik Beceriler, Zihinsel Dayanıklılık, Aerobik Dayanıklılık, Yön Değiştirme.

Introduction

In recent years, sport sciences have focused on exploring the effects on physical, psychological and mental development in young athletes, and it has been demonstrated that in team sports such as soccer, intra-team dynamics play as important a role as individual performance (Granacher and Borde, 2017; Hernández-Mendo et al., 2019). Soccer is a sport that has gained immense global popularity and demands diverse skills including physical endurance, speed, agility, strategy, psychological toughness, and effective teamwork (Hoff et al., 2002; Sheppard and Young, 2006). In this context, not only physical skills but also psychological factors such as mental toughness, psychological skills and strategic thinking capacity are key to success for soccer players (Alvarez-Bueno et al., 2017; Valentini and Gennari, 2024).

Adolescent athletes are individuals who are not yet fully mature physically and psychologically, undergoing a process of continuous change and development (Kalinca and Polat, 2022). Adolescence is one of the most critical stages of an athlete's development, both physically and mentally (Komarudin et al., 2022). Athletes performance is significantly influenced by psychological resilience, their mental abilities, and how well they manage stress (Weiß et al., 2024). Especially in high-paced sports that require strategic thinking, such as soccer, a player's change of direction speed and aerobic endurance can be directly affected not only by their physical fitness, but also their ability to cope with the pressures they face during the game (Şahin et al., 2023).

Athletes who possess strong mental toughness are generally expected to perform with greater resilience and consistency across sports disciplines. Competition analysis has shown that change of direction speed is an essential performance element in soccer (Reilly et al., 2000). Soccer game analysis has shown that 31% of the purposeful movements of soccer players consist of sharp turns directly backward or sideways, and curved arc-shaped movements (Bloomfield et al., 2007; Miller et al., 2005). In soccer competitions, agility is characterized by side-to-side, back-to-back, high-intensity sprints and sharp-angled, arc-shaped, curved changes of direction (Little and Williams, 2005; Reilly et al., 2000). Research has shown that players make an average of 50 turns per game (Bloomfield et al., 2007). These data on changes of direction signify the importance of changing direction in soccer. The question of whether a connection exists between directional change ability and mental toughness in soccer remains an open topic for further exploration.

Agility is an important component of soccer play and has relationships with both physical and cognitive components (Florin, 2018), defined by a rapid whole-body movement with change of velocity or direction in response to a stimulus. Research has shown that there is a significant relationship between agility and dribbling ability, a fundamental skill in soccer, with agility

contributing 43.30% to dribbling ability (Saputra, 2019). Modern soccer is based on an aerobic-based energy system and is characterized by motoric traits and types of strength, such as acceleration at irregular intervals, sustained speed, explosive strength, and agility (Embiyaoğlu, 2020). Soccer players often show maximal or submaximal effort, with frequent short sprints of 1-7 seconds and changes of direction during the game (Bradley et al., 2010). Therefore, soccer training should focus on improving repeated sprinting abilities and agility (Köse and Atlı, 2020).

Against this background, the aim of this study was to explore the effects of psychological skills and mental toughness on aerobic endurance and change of direction ability in soccer players.

Materials and Methods

Research Design

The model of this study is the correlational survey model, which is one of the quantitative research methods. The method used to determine the existence of change between two or more variables and the degree of change, if any, is called correlational survey model (Karasar, 2011).

Research Grup

The study included 55 female athletes aged 13-17 years. In the study, measurements were taken from 55 participants, but 21 people were excluded from the study because there were inconsistencies and incorrect measurements. The athletes participating in the study were amateur athletes who had been training three times a week and participating in competitions for at least two years. The study data were obtained from the athletes who volunteered to participate in the study conducted in Ankara. The inclusion criteria were that all subjects were off-season female footballers with no history of lower extremity injury in the last 1 year. Athletes who met the study criteria were evaluated for two days. On the first day, demographic information of the athletes (age, gender, height, weight, sport age) was collected, followed by the administration of the sport mental toughness inventory and the psychological skills for sport inventory, followed by 15 minutes of dynamic warm-up exercises and the Illinois test. Two measurements were taken and the best results were analysed. On the second day, a 20 metre shuttle run test was performed. There were 48 hours between the two measurement days. Voluntary consent form and parental consent form were signed by the legal guardians of the athletes. The study was conducted in accordance with the Declaration of Helsinki.

Data Collection Tools

Anthropometric Measurements

Body heights of subjects were measured using a portable stadiometer with 0.01cm accuracy following standardized procedures (Holtain Ltd., UK). Body weights, fat percentages and body mass

indexes of subjects were measured with a Tanita bioelectrical impedance analyzer (Tanita (MC-980, Tanita Corp. Tokyo, Japan).

Illinois Change of Direction Test

Change of direction performance was assessed using a portable wireless photocell system (Witty, Microgate, Bolzano, Italy). The Illinois test requires subjects to complete a test course that has a length of 10 meters and a width of 5 meters, with three cones placed down the center on a straight line, each spaced 3.3 meters apart. The test involves a 20m slalom run between the cones and 40m straight run, with 180° turns every 10m. After the test course was set up, a two-gate photocell electronic stopwatch system with 0.01s accuracy was installed at the start and end point of the test course. Subjects made a standing start. Test course completion times were recorded in seconds. Subjects were given two attempts, with 3 minutes rest time between attempts, and their best time was put to analysis.

20m Shuttle Run Test

This multi-stage test requires subjects to run 20 meters back and forth across a marked track. Running speed was monitored at regular intervals with the help of a signaling sound system. Subjects started running at the first beep signaling the start, trying to reach the 20m marker at or before the following beep (touching the line with a single foot was acceptable). Then, they ran back to the 0m marker, trying to reach it at or before the next beep. The speed, which was slow at the beginning, gradually increased every 10 seconds. Subjects adjusted their pace so that they reached the markers at or before the next beep. Subjects missing one beep but making it to the next were cautioned. Subjects missing two beeps in a row and failing to reach the relevant marker were given a second caution, which ended the test.

Psychological Skills Scale for Sports

The “Athletic Psychological Skills Inventory” used for the purpose of this study was developed by (Erhan et al., 2015). Fit indices of the athletic Psychological Skills Inventory were as follows: χ^2/df was 2.33, RMSEA was 0.05, GFI was 0.90, AGFI was 0.90, CFI was 0.95, SRMR was 0.06, NFI was 0.90, and NNFI was 0.95. Factor loadings for each item of the inventory were as follows: factor loadings for items constituting the “Coping Skills” subscale varied between 0.58 and 0.73, between 0.56 and 0.97 for items constituting the “Openness to Learning” subscale, between 0.59 and 0.89 for items constituting the “Concentration” subscale, between 0.59 and 0.83 for items constituting the “Confidence and Motivation for Success” subscale, between 0.59 and 0.88 for items constituting the “Goal Setting and Mental Readiness” subscale, between 0.55 and 0.69 for items constituting the “Ability to Perform Well Under Pressure” subscale, and between 0.66 and 0.96 for

items constituting the “Letting Go of Worries” subscale. To check whether the Internal Consistency Coefficient, Mean and Standard Deviation Values of the scale had internal consistency reliability, Cronbach’s Alpha values were calculated for the overall scale and its subscales. The overall total value of the scale was 0.85. Cronbach’s Alpha coefficient for “Coping Skills” was 0.62, and 0.51 for “Openness to Learning”, 0.59 for “Concentration”, 0.60 for “Confidence and Motivation for Success”, 0.62 for “Goal Setting and Mental Readiness”, 0.71 for “Ability to Perform Well Under Pressure”, and 0.50 for “Letting Go of Worries”.

Sport Mental Toughness Scale

The “Sport Mental Toughness Scale” used for the purpose of this study was developed by (Seydaoğullari, 2018). Reliability coefficients were 0.82 for the Control subscale, 0.75 for the Commitment subscale, 0.74 for the Challenge subscale, 0.72 for the Disintegration subscale, and 0.86 for total SMT. Scales with a reliability coefficient of 0.70 or higher are accepted as reliable (Büyüköztürk, 2010; Tezbaşaran, 2008). No significant correlation was found between the Commitment subscale of the Sport Mental Toughness Inventory and the Control subscale of the Sport Mental Toughness Scale ($p > 0.05$). A positive significant correlation was found between all other subscales and total scores of the scales ($p < 0.01$). The highest degree of correlation between subscales was between Challenge and Confidence ($r = 0.459$; $p < 0.01$), and the lowest degree of correlation was between Challenge and Control ($r = 0.155$; $p < 0.01$).

Analysis of Data

Statistical analyses were performed using SPSS statistical software version 26.0 (SPSS, Inc., Chicago, IL). Jamovi version 2.6.2.0 statistical analysis program was used for regression graphs. Variables mean, standard deviation (SD) and Skewness-Kurtosis values were calculated for the whole sample. Linear regression analysis was performed to predict the variables. Significance level for all statistical tests was pre-set at 0.05.

Ethics of Research

In compliance with ethical guidelines, this study was approved by the Gazi University Ethics Committee with the decision numbered 18 and dated 12.11.2024.

Findings

Table 1

Descriptive Statistics of Mental Toughness, Psychological Skill, Change of Direction and Endurance Variables in Soccer Players.

	N	X	Std. Deviation	Skewness	Kurtosis
MT	34	3.85	0.481	-0.193	0.232

PS	3.65	0.536	0.503	0.307
Endurance	40.14	2.660	0.477	-0.302
Change of Direction	18.75	0.737	-0.462	-0.301

MT: Mental Toughness. PS: Psychological Skill

Table 1 shows that the mental toughness levels of soccer players are high, while there is higher diversity in terms of psychological skills. Although endurance levels were generally high, some soccer players were found to have lower endurance levels. Their change of direction ability was found to be average. These data indicate that the physical and mental skills of soccer players are generally at a good level, with some individual differences.

Table 2

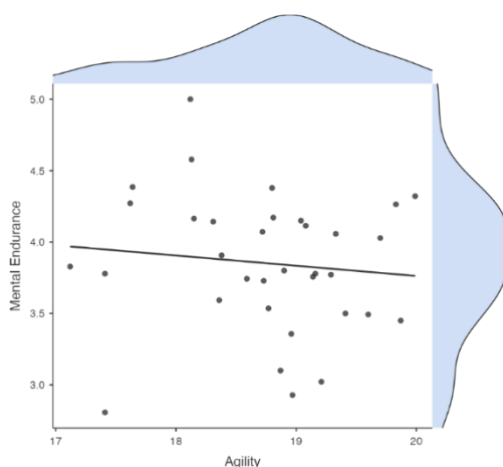
Regression Analysis Results on the Effect of Mental Toughness and Psychological Skill on Change of Direction in Soccer Players.

	B	Std. Error	B	T	P	Partial	Part
(Constant)	19.510	1.083		18.013	0.000		
MT	-0.041	0.377	-0.027	-0.109	0.914	-0.020	-0.019
PS	-0.165	0.338	-0.120	-0.489	0.628	-0.087	-0.087

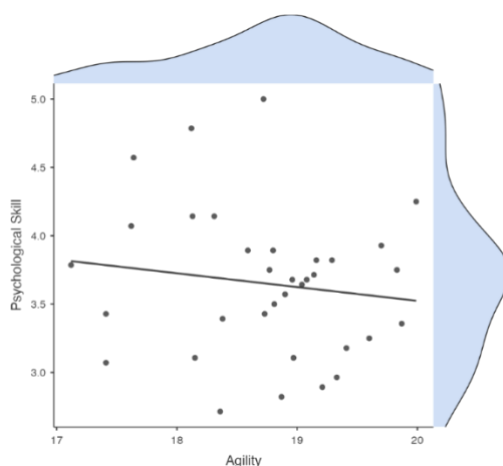
R: .140 R²=.020 F (2-31) = .310 p: .735

MT: Mental Toughness. PS: Psychological Skill

Table 2 shows that there is no low degree of negative and statistically significant correlation between change of direction values and mental toughness and psychological skill variables of the soccer players ($R = .140$ $R^2 = .020$ $F(2-31) = .310$ $p = .735$). When t-test results on the significance of regression coefficients are analyzed, it is seen that mental toughness does not have a statistically significant effect on change of direction ($t = -0.109$, $p < 0.05$), and that psychological skill has no statistically significant effect on change of direction ($t = -0.489$, $p < 0.05$).



Graphic 1. Change of Direction and Mental Toughness (Endurance) Linear Regression Curve.



Graphic 2. Change of Direction and Psychological Skill Linear Regression Curve.

Table 3

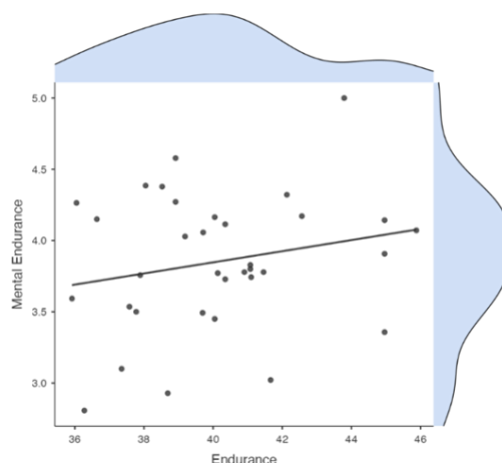
Regression Analysis Results on the Effect of Mental Toughness and Psychological Skill on Endurance in Soccer Players.

	B	Std. Error	B	T	p	Partial	Part
(Constant)	33.791	3.567		9.473	0.000		
MT	-0.761	1.242	-0.138	-0.613	0.544	-0.109	-0.099
PS	2.541	1.114	0.512	2.282	0.030	0.379	0.370

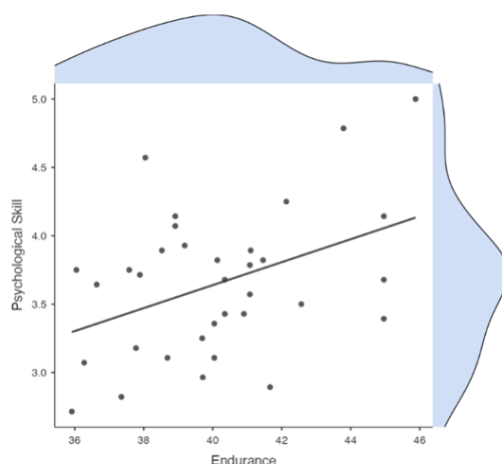
R: .429 R²=.184 F₍₂₋₃₁₎=3.490 p= .043

MT: Mental Toughness. PS: Psychological Skill

Table 3 shows that there is no low degree of negative and statistically significant correlation between the soccer players' endurance values and mental toughness, while there is a moderate degree of positive and statistically significant correlation between endurance values and psychological skill (R: .429 R²=.184 F₍₂₋₃₁₎=3.490 p= .043). When t-test results on the significance of regression coefficients are analyzed, it is seen that mental toughness does not have a statistically significant effect on endurance (t=-0.613. p<0.05), while psychological skill has a statistically significant effect on endurance (t= 2.282. p<0.05). The regression model explains 18% of the change in endurance (R²=.184). A 1-unit increase in psychological skill increases endurance by 2.541.



Graphic 3. Endurance and Mental Toughness (Endurance) Linear Regression Curve.



Graphic 4. Endurance and Psychological Skill Linear Regression Curve.

Discussion

The findings of our research on the effect of psychological skills on aerobic endurance in female soccer players are supported by previous research. (Güvendi et al., 2018; İslam, 2022; İslam et al., 2021; Konter, 2021) concluded that the psychological skills of female soccer players and their attitudes towards soccer had a positive effect on their athletic mental toughness (Yıldız, 2021). The explanatory power of the regression models (R^2) was found to be relatively low (e.g., $R^2 = 0.020$ for change of direction and $R^2 = 0.184$ for endurance). Although such values indicate that the model lacks strong predictive capacity, as noted in the limitations section, the inability to include a larger sample size is primarily due to the limited number of female football players compared to their male counterparts, both in Türkiye and globally. Despite the low R^2 values, the current findings serve as a preliminary framework that may inform and guide future studies. It is anticipated that the

implementation of a similar model with a larger and more diverse sample population will yield stronger and more generalizable results.

In a study on elite sprinters, (Znazen et al., 2017) found that mental skills were predictive variables of power performances, while endurance performances were associated with various mental skill components. (Arthur et al., 2017) found that psychological skill affected endurance indirectly. Exploring the effects of psychological skill, (Lange-Smith et al., 2024) determined that psychological skill was effective in increasing athletic performance, i.e., aerobic endurance in athletes.

In the literature, studies examining psychological skills and competencies have demonstrated that high aerobic fitness can enhance recovery during high-intensity intermittent exercises specific to soccer performance and training. Moreover, psychological factors such as self-efficacy and motivation may influence this recovery capacity (Impellizzeri et al., 2005). In another study, the combined use of multiple cognitive strategies was found to be more effective than a single strategy for motor skill development in elite soccer players, and such approaches were shown to facilitate improvements in soccer-specific domains such as mental toughness, team cohesion, and technical skill execution (Slimani et al., 2016). Furthermore, a 10-week soccer training program led to significant changes in total mood disturbance and running intensity during the lactate minimum test (Miranda et al., 2013). These findings collectively support the current study by highlighting the influence of psychological competencies on aerobic capacity.

There are also other studies exploring different sports branches that are similar to and support the findings of our research. A study conducted by (Nabilpour et al., 2023) on psychological skill and aerobic endurance in taekwondo athletes found that there was a relationship between psychological factors and the advantages of good aerobic abilities. (Madera et al., 2021) conducted a study on psychological skill and anaerobic performance and found that psychological skill had an effect on anaerobic and aerobic performance among the participants. In a study on endurance performances, (McCormick et al., 2015) reported that psychological skill training would positively affect the performance of an endurance athlete.

These findings suggest that individual effects as well the performance of female soccer players are shaped by factors such as self-confidence, motivation, social influences and athletic mental toughness, and that in scientific terms, this can be explained by a combination of these elements coming together to enable players to achieve maximum efficiency during the game. It is also noted that social and psychological aspects significantly contribute to optimizing the performance outcomes of female soccer players. In this context, we believe that the positive correlation between mental

toughness and psychological skill helps female soccer players to achieve enhanced efficiency and success on the field.

A further outcome of our research revealed that mental toughness showed no significant influence on aerobic capacity, and this aligns with previous study results. This finding is supported by previous research. A study on Anaerobic Endurance and Mental Toughness Levels of Faculty of Sports Sciences Students found no relationship between mental toughness and anaerobic-aerobic endurance data (Tokat and Iğdır, 2022). The study reported that there was no difference between mental toughness and anaerobic endurance data for all participants, both by gender and ignoring gender. This may indicate that mental toughness and anaerobic endurance are based on different physiological and psychological mechanisms. Furthermore, the lack of difference in the results even when ignoring gender may indicate that mental toughness and anaerobic endurance develop similarly between genders, i.e., are not affected by gender.

Crust and Clough (2005) explored the relationship between mental toughness and physical endurance and found that the results were inconsistent with the belief that mental toughness is positively associated with physical endurance (Jones, 2020). This finding may indicate that physical endurance and mental toughness do not always develop in parallel or that intra-individual variability has a complicating effect on the relationship between mental toughness and physical endurance.

Latif et al. (2022) examined the relationship between cardiovascular (aerobic) endurance and mental toughness in 218 football players aged 13 to 17 years, before and after a 10-week athlete's training. They found that there was no relationship between cardiovascular (aerobic) endurance and mental toughness before and after training. These results suggest that understanding the relationship between physical endurance and mental toughness requires considering many factors and that individuals may attain physical endurance and mental toughness in different ways.

Conclusion

Our research found that in adolescent female soccer players, psychological skills positively affect aerobic endurance, whereas mental toughness has no effect on aerobic endurance. In addition, both psychological skills and mental toughness have no effect on change of direction speed.

This result can be explained by the fact that psychological skills such as motivation, self-confidence and stress management can positively affect aerobic endurance. Mental toughness, on the other hand, may not have a direct effect on aerobic endurance as mental toughness is considered to be associated rather with the ability to perform under pressure and decision-making abilities.

Psychological skills and mental toughness having no effect on change of direction speed may be due to the fact that these abilities are rather associated with physical competencies and types of training.

Limitations

This study is limited to female football players participating in amateur-level competitions in the province of Ankara. The sample consists of female athletes between the ages of 13 and 17 who are engaged in amateur sports. Due to the relatively low participation rates of female football players in Türkiye, the study was confined to athletes from a single team based in Ankara. Furthermore, given the social and economic constraints commonly observed in amateur sports clubs, the research had to be completed within a limited timeframe. Consequently, rest intervals between tests could not exceed 48 hours. These factors are acknowledged as limitations of the present study.

Ethics Committee Approval Information

Ethics committee: Gazi University Ethics Committee

Date of ethics approval document: 12.11.2024

Approval document number: 18

Author Contributions Statement

All authors contributed equally to the research.

Conflict of Interest Statement

The authors declare that there is no conflict of interest related to this research.

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