**SPORMETRE**
The Journal of Physical Education and Sport Sciences
Beden Eğitimi ve Spor Bilimleri Dergisi

**DOI: 10.33689/spormetre.1255170**

Geliş Tarihi (Received): 22.02.2023 Kabul Tarihi (Accepted): 11.07.2023 Online Yayın Tarihi (Published): 30.09.2023

# INVESTIGATION OF THE RELATIONSHIP OF COGNITIVE PERFORMANCE, VISUAL REACTION TIME AND AGILITY PARAMETERS ON FOOTBALL PLAYERS*

**Okan Demir[1†], Fatih Kıyıcı[2]**
[1] Gümüşhane University, Şiran Mustafa Beyaz Vocational School GÜMÜŞHANE
[2]Atatürk University, Faculty of Sport Sciences, ERZURUM

**Abstract:** The research aims to examine the relationship between cognitive performance, visual reaction time and agility parameters on football players. Twenty- five football players with an average age of 18-20 years (18.16 ± 0.68), who have been active for at least five years and who are in the Turkish U19 Super League participated in the study from the Turkish U19 Super League participated. Body composition (BODPOD), agility (Illinois test), visual reaction time (Witty Sem Microgate) and cognitive performance (Stroop Test) of the football players were measured. SPSS v23 was used in the analysis of the data and the significance level was taken as $p<0.05$. The relationship between normally distributed data was examined with the Pearson Correlation Coefficient. According to the analysis of the data a significant positive correlation was found between cognitive performance and visual reaction time on football players. When the relationship between cognitive performance and agility parameter was examined, no significant relationship was found between the two concepts. There was a significant correlation and a negative correlation between visual reaction time and agility parameters. As a result, when height, body mass index and body fat ratio values increase on football players, visual reaction time increases and performance decreases. Likewise, when the body fat ratio increases, agility time increases and performance decreases.

**Anahtar Kelimeler:** Football, Cognitive Performance, Agility, Reaction, Training

# FUTBOLCULARDA BİLİŞSEL PERFORMANS, GÖRSEL REAKSİYON ZAMANI VE ÇEVİKLİK PARAMETRELERİ İLİŞKİSİNİN İNCELENMESİ

**Öz:** Araştırmanın amacı, futbolcularda bilişsel performans, görsel reaksiyon zamanı ve çeviklik ile parametreleri arasındaki ilişkinin incelenmesidir. Araştırmaya 18-20 (18,16 ± 0,68) yaş ortalamasına sahip, en az beş yıldır aktif futbolcu olan, Türkiye U19 Süper liginde yer alan 25 futbolcu katılmıştır. Futbolcuların vücut kompozisyonu (BODPOD), çeviklik (Illinois testi), görsel reaksiyon zamanı (Witty Sem Microgate) ve bilişsel performansları (Stroop Testi) ölçülmüştür. Verilerin analizinde SPSS v23 kullanılmış ve anlamlılık düzeyi $p<0.05$ olarak alınmıştır. Normal dağılım gösteren veriler arasındaki ilişki Pearson Korelasyon Katsayısı ile incelenmiştir. Elde edilen verilerin analiz sonuçlarına göre futbolcularda, bilişsel performans ile görsel reaksiyon zamanı arasında anlamlı bir ilişki ve arasında pozitif yönlü bir korelasyon saptanmıştır. ($p<0.05$). Bilişsel performansın çeviklik parametresi ile ilişkisi incelendiğinde iki kavram arasında anlamlı bir ilişki bulunamamıştır. ($p>0.05$) Görsel reaksiyon zamanı ve çeviklik parametrelerinin arasındaki anlamlı düzeyde ilişki ve ve negatif yönlü bir korelasyon saptanmıştır. ($p<0.05$) Ayrıca görsel reaksiyon zamanı test değeri ile boy uzunluğu, beden kitle indeksi, vücut yağ oranı arasında ve çeviklik test değeri- vücut yağ oranı arasında anlamlı düzeyde pozitif yönlü ilişki elde edilmiştir. Boy uzunluğu, beden kitle indeksi ve vücut yağ oranı değerleri arttığında görsel reaksiyon test skoru (süresi) artmakta, reaksiyon zamanı performansı düşmektedir. Paralel olarak vücut yağ oranı arttığında çeviklik test değeri artmakta ve çeviklik performansı düşmektedir.

**Key Words:** Futbol, Bilişsel Performans, Çeviklik, Reaksiyon, Antrenman

* *Bu araştırma yüksek lisans tezinden üretilmiştir.*

† *Sorumlu Yazar: Okan Demir, Öğr. Gör., E-mail: okandr61@gmail.com*

## INTRODUCTION

In our age, as in every field, football is in a rapid development and change process. When this process is managed correctly and systematically, sportive and economic success is achieved (Demir, 2017).

In addition to being an organism in which physiological activities are performed, the human body also keeps many different parameters of the society in which it lives. After the 19th century, the human body has transformed from a structure that observes and perceives the outside to a concept that is observed and studied scientifically (Boynukalın and Dogan, 2020). As in every subject where competition is at a high level, performance appears as the main success criterion in football. The main purpose of the camp programs and the tests during the preparation period in football is to maximize this performance and to protect the health of the athlete. In order to achieve this efficiency, physical fitness parameters such as strength, endurance, balance, coordination and speed must be integrated with technical and tactical knowledge (Deloitte, 2015). At every point of the world where there are living spaces; football is everywhere, from a metropolitan city to a small village. (TFF, 2021). Football has a "Hybrid" concept among sports branches. The reason why it is named so is that the game contains many random and intermittent movements. Every 4-5 seconds during the game, the movements change constantly. An adult player runs nearly a total distance of 10-14 km for 90 minutes in this action (Kirkendall, 2020). Due to the high-effort nature of the game, both players and coaches aim to bring a top performance that will be reflected on the field (Kızılet, 2010).

In order to be successful, models that will increase efficiency effectively should be applied to the development of the athlete and the results should be monitored (Coutinho et al, 2016). The evolutionary structure of the game, being open to continuous development and change, enables the performance to be affected by many physical characteristics (Strength, power, speed, endurance) and multi-faceted factors that it participates in cognitive values such as technical-tactical capacity (Vaeyens et al.,2007). Players must maintain good physical condition during a competitive competition and develop this in order to remain competitive. This development allows to increase performance and achieves maximum efficiency in the process (Periashami, 2015).

Visual reaction time in football; as a result of the evaluation of his/her responses to intense stimuli encountered muscularly, auditory and visually. Also it is an important criterion for success. The fact that the area where football is played is larger than many sports branches and that it is played by helping teammates based on sudden decisions causes visual reactions time to be more important for this sport than for other branches (Aksoy, 2012).

Agility is a combination of speed, balance, strength and coordination abilities. An important part of the distance run during the match is the agility-based change of direction runs for the purpose of controlling the ball (Little & Williams, 2006). High-quality agility skills reduce the risk of injury, increase performance, and contribute to visual reaction in group games (Svensson & Drust, 2005).

Cognitive Performance is the efficient fulfillment of mental processes such as perception, learning, understanding, reasoning, intuition and awareness (APA, 2021). Cognitive development has great importance in sports, as it is in all fields of life. It is known that not only physical conditions but also cognitive performance emerges as an important factor for success in the efficiency of athletes (Bitbrain, 2021).

Including the mental and cognitive performance of the football players during the health control allows a healthier evaluation. In addition, both the coach and the players should be updated about stress, anxiety and fear. Mental functions for players and technical teams in football are very important and their importance is increasing gradually (Coban, 2021). In our research, we holistically combined cognitive and cycomotor skills together to measure the impact of the survey. It is thought that the data obtained as a result of these measurements will be a support for training planning, talent selection and tests for athlete health.

## METHODS

### Research Model

The research was created by using the relational survey model, one of the quantitative research methods. Model; it was designed to determine the relationships (positive/negative) of cognitive performance, agility and visual reaction time parameters. For this research, necessary permissions were obtained from the Ethics Committee of Ataturk University Faculty of Sports Sciences (18.11.2021 and E-70400699-000-2100316611). In addition, our work was supported by the Scientific Research Project Coordinator of Ataturk University with the project code SYL-2022-10202.

### Research Universe and Sample Group

The universe of the study is football players who have been interested in football for at least more than five years. The sample group was determined on a voluntary basis. Sample group consists of 25 players (two goalkeepers, eight defenders, eleven midfielders and four strikers) who are actively competing in the 2021-2022 season in the Turkish U-19 Super League (during the testing process) constitute the player.

### Data Collection Tools

All measurements were made at Ataturk University Sports Sciences Application and Research Center. For the athletes, in order of test, agility, visual reaction test, and finally Stroop test were applied. The test order for the athletes was planned as the Illinois test, which measures agility, then the Witty Sem reaction time test, where reaction time data will be obtained, and finally the Stroop test, where cognitive performance test scores will be measured. Test times a period of approximately one week was envisaged. Players were tested on consecutive days risk of a reduction in test performances by introducing a new test system is avoided.

Warm up protocol: Before the measurements, a standard warm-up procedure was applied; starting to work with a 5-minute warm-up run at a light tempo, this period at the end, it is aimed to accelerate blood flow to the muscles with dynamic stretching. 2 minutes after dynamic stretching time, in-foot pass, ball passing, not exceeding 3 minutes in total Basic movements such as bouncing the ball were performed. A standard general warm-up and a special warm-up for the knee joint and muscles.

The body composition of the football players was analyzed with the BODPOD, which can measure in the confidence interval of 0.3%-1.1% (Fields et al., 2000). Illinois Agility Test is a standard agility test used to evaluate both the training and performance of talented athletes (Raya, 2013). he Illinois Test is 5 m wide, 10 m long, and a straight line with 3.3 m intervals in the center section. The test track, consisting of three cones arranged on a training field with a grass surface. The test consisted of 40 m straight, 20 m between cones, with 180 º turns every 10 m. slalom run.

The Witty Sem reaction time protocol was used to measure the coordination capacity and reaction time of athletes. In the visual reaction measurement, the athletes were asked to catch the green color among the randomly lit colors on eight lamps fixed on a panel of the Witty-Sem reaction test device, and the test was terminated by determining the value obtained as a result of fifteen correct catches. As a result of two trials, the best measurement was evaluated (Microgate, 2021).

The Stroop test basically consists of three processes: selective attention, reading and color expression, and it was also used to measure and develop characteristics such as the speed of information processing and the ability to react to confusion caused by distractors in the environment (Macleod, 1990).

The tasks were used in the digital content of this test. These tasks consist of 2 types of trials: neutral (the text XXX written in green, blue and red), incompatible (the text on the screen and the background color are different). One block of the test consists of 96 trials and 2 types of stimuli (48 incompatible and 48 neutral) and these trials were randomly presented to the athletes. Players were informed to press the corresponding key on the keyboard with the actual color of the word displayed on the screen, as quickly as possible and with minimum error. Participants marked the ink color of the text presented to them from the options specified with the right and left arrow keys. The total time given to the non-conforming factors was accepted as the criterion without considering the error rates.

**Data Analysis**

SPSS23 package program was used for the analysis of the data. As a result of the analysis performed to determine the normality of the distribution in the data, the Skewness-Kurtosis test values were between-1.5 and +1.5, and the distribution was considered to be normal (Tabachnick and Fidell, 2013). In addition, the distribution is considered to be normal when the test values obtained as a result of the Shapiro-Wilk test, which is used when the sample groups are less than 30, are above the specified scale ($p>0.05$) (McKillup, 2012).

When the data obtained in the normality analysis were examined, it was determined that the test results had a normal distribution, and the relationship between the parameters was examined by the Pearson Correlation Coefficient method. P values of $<0.05$ were considered significant at the 95% confidence interval (Gogoi, 2020)

## RESULTS

At Table 1 the descriptive statistics of players which are reflect their anthropometric measurements and body composition has shown.

**Table 1.** Average ($\bar{x}$) and Standard Deviation (SD) Values of Anthropometric Measurements and Body Compositions of Footballers

| Anthropometric Measurements / Body Composition | n | Min. | Max. | $\bar{X}$ | SS |
|---|---|---|---|---|---|
| **Age (Year)** | 25 | 17.00 | 20.00 | 18.16 | 0.68 |
| **Height (cm)** | 25 | 171.00 | 195.00 | 178.52 | 5.47 |
| **Weight (kg)** | 25 | 57.90 | 81.70 | 70.58 | 7.45 |
| **Body Fat Ratio (%)** | 25 | 3.10 | 17.70 | 8.25 | 3.06 |
| **Body Mass Index (kg/m2)** | 25 | 18.80 | 26.70 | 22.13 | 1.89 |

***p<0.05**

The mean age of the football players participating in the study was 18.16±0.68, the average height was 178.52±5.47 cm, the average body weight was 70.58±7.45 kg, the body fat ratio was 8.25±3.06%, and the Body Mass Index was 22. It was found to be 13±1.89 kg/m2 (Table 1).

**Table 2.** Agility, visual reaction and cognitive performance Mean (x̄) and Standard Deviation (SD) values of the football players (sec)

| Position (N) | Agility (sec) x̄ ±SS | Visual Reaction (sec) x̄ ±SS | Cognitive Performance (sec) x̄ ±SS |
|---|---|---|---|
| **Goalkeeper (8)** | 15.81±0.33 | 20.74±2.65 | 78.64±3.91 |
| **Defense (32)** | 15.74±0.27 | 17.33±3.23 | 72.83±7.38 |
| **Midfield (44)** | 15.56±0.29 | 17.39±1.93 | 76.77±5.75 |
| **Striker (16)** | 15.53±0.38 | 21.46±0.85 | 74.22±9.93 |

The frequency distribution, agility, visual reaction time and cognitive performance mean (x̄) and standard deviation (SD) values of the football players participating in the study were given at Table 2.

**Table 3.** Correlation of agility and physical characteristics in football players

| | | Height | Weight | Body Mass Index | Body Fat Ratio |
|---|---|---|---|---|---|
| **Weight** | **r** | **,635**** | | | |
| | **p** | **,000** | | | |
| **Body Mass Index** | **r** | ,114 | **,786**** | | |
| | **p** | ,293 | **,000** | | |
| **Body Fat Ratio** | **r** | -,141 | **,402*** | **,649**** | |
| | **p** | ,250 | **,023** | **,000** | |
| **Agility Test Value** | **r** | **-,245*** | -,018 | ,180 | **,391*** |
| | **p** | **,119** | ,465 | ,195 | **,027** |

***p<0.05**

Considering the relationship between agility and physical characteristics in football players, no significant relationship was found between height, weight and body mass index and agility. A significant (p<0.05) and positive correlation (r =.391) was found between body fat ratio and agility. This indicates that as the body fat ratio increases, the agility period increases.

**Table 4.** Correlation of visual reaction and physical characteristics in football players

| | | Height | Weight | Body Mass Index | Body Fat Ratio |
|---|---|---|---|---|---|
| **Weight** | **r** | **,635**** | | | |
| | **p** | **,000** | | | |
| **Body Mass Index** | **r** | ,114 | **,786**** | | |
| | **p** | ,293 | **,000** | | |
| **Body Fat Ratio** | **r** | -,141 | **,402*** | **,649**** | |
| | **p** | ,250 | **,023** | **,000** | |
| **Reaction Time Test Value** | **r** | **-.364*** | ,054 | **,361*** | **,361*** |
| | **p** | **,037** | ,398 | **,038** | **,038** |

***p<0.05**

It is seen that there is a significant relationship between the visual reaction time of football players and their height, body mass index and body fat ratio (p<0.05). In addition, a negative

correlation between visual reaction time and height (r=-.364); there is a positive correlation between body mass index (r=.361) and body fat ratio (r=.361) (Table 4).

**Table 5.** Correlation of cognitive performance and physical characteristics in football players

| | | Height | Weight | Body Mass Index | Body Fat Ratio |
|---|---|---|---|---|---|
| **Weight** | **r** | **,635**** | | | |
| | **p** | **,000** | | | |
| **Body Mass Index** | **r** | ,114 | **,786**** | | |
| | **p** | ,293 | **,000** | | |
| **Body Fat Ratio** | **r** | -,141 | **,402*** | **,649**** | |
| | **p** | ,250 | **,023** | **,000** | |
| **Cognitive Performance** | **r** | -.284 | -,151 | ,038 | ,170 |
| **Test Value** | **p** | ,084 | ,236 | ,429 | ,208 |

***p<0.05**

No significant relationship was found between cognitive performance and height, weight, body mass index and body fat ratio (Table 5).

**Table 6.** The relationship between cognitive performance, agility and visual reaction in football players

| | | Agility Test Value | Reaction Time Test Value |
|---|---|---|---|
| **Reaction Time Test Value** | **r** | **-,405*** | |
| | **p** | ,044 | |
| **Cognitive Test Value** | **r** | -,177 | **,492*** |
| | **p** | ,396 | ,012 |

***p<0.05**

A significant correlation was found between cognitive performance and visual reaction time, and a positive correlation was also found between the parameters ($p<0.05$), (Table 6). It is observed that there is a significant negative correlation between visual reaction time and agility parameters ($p<0.05$), (Table 6). When the cognitive performance and agility parameters were examined, no significant relationship was found ($p>0.05$), (Table 6).

## DISCUSSION

In this part of the research, the relationship between agility, visual reaction time and cognitive performance was discussed with similar studies in the literature. The relationship between visual reaction and cognitive performance: in the literature (Reinal et al., 2019, Colakoglu et al., 1993), it has been determined that visual reaction time is effective on cognitive performance items. The findings of our study also support these studies. In this context, it can be thought that the reaction time of the player whose cognitive performance increases will be shortened and therefore the reaction performance will also increase. It is thought that this meaningful relationship between cognitive performance and visual reaction will have a positive effect if the players who are asked to act more quickly add to the training programs that improve their cognitive ability. Colakoglu et al. (1993) investigated the effect of concentration activities on the reaction time of these individuals. As a result of the research, it was determined that the athletes in the group in which these activities were applied showed three times more improvement than those in the other group. He stated that mental training should be used to ensure optimum efficiency regarding reaction time. It is estimated that the short-term reaction time will enable the players to gain an advantage against their opponents, and this will have a positive impact on the team performance.

The development of performance in the game depending on cognitive processes emphasizes the importance of cognitive performance. It is mentioned in the literature that the inclusion of trainings that contribute cognitively in the planning and that complex training that includes this (Chang et al., 2021) will make a positive contribution. In addition, since the players with good visual reaction efficiency will be at a good level in terms of cognitive performance, it can be thought that these players will decide faster and provide more efficient performance in dynamic games such as football.

In a study that supports the data obtained in the research, it was determined that the reaction time of elite athletes was shorter than the players with lower levels and the reaction was faster (Moelhi, 2006). In another study, when the results of the study (Vestberg et al, 2012) that the elite athletes playing in the upper leagues show better cognitive characteristics compared to the football players competing in the lower leagues, it can be said that the positive relationship between the reaction time and cognitive performance we obtained as a result of our research is more clearly revealed.

The relationship between agility and cognitive performance: In our study, no significant correlation was found between agility and cognitive performance. Lennemann et al. (2013) examined the relationship between these parameters in his study titled the effect of agility training on psychological and cognitive performance, and found that agility training contributed to cognitive and psychological performance at a higher rate than physical activities. Despite this finding, the results obtained from the participants in our study differ from the results of this study. In addition, in the literature in this sense; Spiteri et al. (2015) investigated how agility performance at different speeds made a difference in neuromuscular strategy, and as a result, no significant difference was found between cognitive concepts and agility ability. Spiteri et al. (2015) seems to be compatible with the result we obtained in our study. As the reason for this difference between studies in the literature, it can be thought that agility ability is more related to motoric features such as strength and speed, which are other elements of physical fitness, rather than a reaction that occurs as a result of cognitive decision making.

In another study investigating the relationship between agility and cognitive factors, Scanlan et al. (2013) in his study investigating the effects of physical and cognitive factors on the agility characteristics of male basketball players, concluded that the reactive agility feature is mostly affected by the cognitive features (reaction time and decision-making time). In addition, it was determined in the study that morphological features were in a low-level significant relationship with linear speed and direction change characteristics, that is, reactive agility. Although these data contain results that some cognitive elements are related to reactive agility, it is included in the content of the same study that this is limited to reactive agility and some morphological features. In addition, it is clear that there are different constructs and game structures between the sports branch in the study and the football included in this study. From another point of view, it is estimated that the different morphological characteristics of the players, the differentiation of game perceptions and, as mentioned before, the agility ability develops with motor skills and physical characteristics rather than cognitive processes as the reason for the different results.

Visual reaction and agility relationship: Regarding the relationship between reaction time and agility, Moradi and Esmaelizadeh (2015) found a significant relationship between reaction time and agility in their study on reaction time, agility and speed in children. In the study of Çomuk and Erdem (2010), the relationship between the reaction time and agility of triple spin performances of female figure skating athletes was investigated. As a result of the study, it was

determined that the reaction time and agility values of the athletes were significantly better when compared to the athletes in the control group. In the study, when the relationship between reaction time and agility was examined, a negative relationship was found between them. In our study, a significant correlation was found between reaction time and agility parameter, in parallel with this study, and a negative correlation was found between the two parameters. The data obtained in this sense overlap with previous studies in the literature (Çömük and Erdem, 2010, Moradi and Esmaelizadeh., 2015).

As a result, it is thought that football players who improve themselves cognitively will have a better and more efficient visual reaction time, take action in a shorter time than other players, and this will reflect positively on the performance of the player and team.

Another issue to be emphasized in the conclusion part of the study is the health of athletes. It is believed that requesting cognitive performance evaluations by authorized federations at the beginning of the season health checks will have a positive impact on the mental health of the players and their future quality of life.

## SUGGESTIONS

Measurement methods such as the Flanker Test, which reveals errors in different aspects, can be used in cognitive performance measurements. The relationship between the mental capacity of the players, such as balance and coordination, and the motor skills, which seem closer, with cognitive performance can be investigated. It is thought that determining the effect between error rates and reaction times in cognitive performance measurements with control and experimental groups will provide more sensitive results in cognitive performance measurements. It is thought that cognitive performance and studies on cerebral oxygen saturation in the brain will make a positive contribution to both athlete health and to see the effects of loading in training on the brain.

## LIMITATIONS

The reason why there was not a significant difference between the positions of the players and these parameters or the analysis for the relationship was not carried out because the number of goalkeepers was low and the player distribution frequency was not identical. In addition to the Stroop test scores of the players, the error degrees were also obtained. Error scores obtained during the test were not taken into consideration.

The total test score was taken into consideration in order to evaluate the time of the protocols applied for reaction time and agility parameters as the obtained score, to ensure that no margin of error was left during the test, and to ensure the compatibility of the cognitive performance test with the other tests.

## REFERENCES

Aksoy, Y. (2012). *Comparison of Sprint Reaction Time and Anaerobic Strength of Young Football, Volleyball and Wrestlers* (Doctoral dissertation, Master Thesis, 36).

Apa. (2021). Dictionary of American Physicological Association. https://dictionary.apa.org/ Accessed: 17.11.2021.

Bitbrain. (2021). https://www.bitbrain.com/blog/peak-brain-performance Accessed: 17.11.2021.

Boynukalın, A.R., & Dogan, N. (2020). Uniformed body and cyborg art. Ordu University Social Sciences Institute *Journal of Social Sciences Research, 10*(3), 881-893.

Colakoglu, M., Tiryaki, S., & Moralı, S. (1993). Effect of concentration studies on reaction time. *Hacettepe University Journal of Sport Sciences, 4*, 32-47.

Coutinho, P., Mesquita, I., & Fonseca, A. M. (2016). Talent development in sport: A critical review of pathways to expert performance. *International journal of sports science & coaching*, *11*(2), 279-293.

Çömük, N., & Erden, Z. (2010). The relationship of triple jump performance with agility and reaction time in figure skating. *Journal of Physiotherapy and Rehabilitation*, *21*(2), 75-80.

Deloitte. (2015). *Deloitte Annual Review of Football Finance 2015*. Manchester: Deloitte LLP. Pallant, Jullie.

Demir, M. (2018). The role of the media in the process of industrialization of football. *International Paris Congress on Social Sciences*, 1, April 2018, Paris France.

Fields, D. A., Hunter, G. R., & Goran, M. I. (2000). Validation of the BOD POD with hydrostatic weighing: Influence of body clothingin. *International journal of obesity*, *24*(2), 200-205.

Gogoi, P. (2020). Application of SPSS programme in the field of social science research. *International Journal of Recent Technology and Engineering*, *8*(5), 2424-2427.

Guizani, S. M., Bouzaouach, I., Tenenbaum, G., & Kheder, A. B. (2006). Simple and choice reaction times under varying levels of physical load in high skilled fencers. *Journal of Sports Medicine and physical fitness*, *46*(2), 344.

Kızılet, A., Atılan, O., & Erdemir, İ. (2010). The effect of the different strength training on Quickness and jumping abilities of basketball Players between 12 and 14 age group. *Atabesbd*, *12*(2), 44-57.

Kirkendall, D. T. (2020). Evolution of soccer as a research topic. *Progress in Cardiovascular Diseases*, *63*(6), 723-729.

Kul, Seval. (2022) Statistical Data Analysis on Spss, http://www.p005.net/pdegerinedir Access Date: 26.01.2022.

Lennemann, L. M., Sidrow, K. M., Johnson, E. M., Harrison, C. R., Vojta, C. N., & Walker, T. B. (2013). The influence of agility training on physiological and cognitive performance. *The Journal of Strength & Conditioning Research*, *27*(12), 3300-3309.

Little, T., & Williams, A. G. (2005). Specificity of acceleration, maximum speed, and agility in professional soccer players. *The Journal of Strength & Conditioning Research*, *19*(1), 76-78.

MacLeod, C. M. (1991). Half a century of research on the Stroop effect: an integrative review. *Psychological bulletin*, *109*(2), 163.

Magill, R.A. (1998). *Motor Learning Concepts and Applications*, 5th edition. Boston, USA: McGraw-Hill, p 19.

McKillup, S. (2011). *Statistics explained: An introductory guide for life scientists*. Cambridge University Press.

Microgate Industrial. (2021). https://training.microgate.it/en/products/wittysem/reactivity-and-coordination-test. Access Date: 15.12.2021.

Moradi, A., & Esmaeilzadeh, S. (2015). Association between reaction time, speed and agility in schoolboys. *Sport Sciences for Health*, *11*, 251-256.

Morehouse, L.E., & Miller, A.T. (1976). *Physiology of Exercise*. St. Louis, USA: C.V. Mosby Company.

Periasamy, S., Farenia, R., & Tedjokusumo, P. (2015). Profile of Physical Fitness of Young Football Players at SDN Cibeusi. *Althea Medical Journal*, *2*(2), 226-230.

Reigal, R. E., Barrero, S., Martín, I., Morales-Sánchez, V., Juárez-Ruiz de Mier, R., & Hernández-Mendo, A. (2019). Relationships between reaction time, selective attention, physical activity, and physical fitness in children. *Frontiers in psychology*, *10*, 2278.

Scanlan, A., Humphries, B., Tucker, P. S., & Dalbo, V. (2014). The influence of physical and cognitive factors on reactive agility performance in men basketball players. *Journal of sports sciences*, *32*(4), 367-374.

Sheppard, J. M., Young, W. B., Doyle, T. L. A., Sheppard, T. A., & Newton, R. U. (2006). An evaluation of a new test of reactive agility and its relationship to sprint speed and change of direction speed. *Journal of science and medicine in sport*, *9*(4), 342-349.

Spiteri, T., Newton, R. U., Binetti, M., Hart, N. H., Sheppard, J. M., & Nimphius, S. (2015). Mechanical determinants of faster change of direction and agility performance in female basketball athletes. *The Journal of Strength & Conditioning Research*, *29*(8), 2205-2214.

Svensson, M., & Drust, B. (2005). Testing soccer players. *Journal of sports sciences*, *23*(6), 601-618.

Turkish Football Federation. (2021). https://www.tff.org/Resources//2021-2022-Oyun-Kural-Kitabi.pdf Access Date: 03.11.2021.

Vaeyens, R., Lenoir, M., Williams, A. M., & Philippaerts, R. M. (2008). Talent identification and development programmes in sport: current models and future directions. *Sports medicine*, *38*, 703-714.

Vestberg, T., Gustafson, R., Maurex, L., Ingvar, M., & Petrovic, P. (2012). Executive functions predict the success of top-soccer players. *PloS one*, *7*(4), e34731.