Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 12, Issue 10, December 2021: 6566 – 6575

# Study on Maximum Oxygen Uptake with Respect to Different Playing Positions among Sub Junior and Junior Football Players

**A.Sivaraj *and P. Kulothungan****
*Ph.D Research Scholar, Department of physical education, Annamalai University, Chidambaram ,
**Associate Professor, Department of physical education, Annamalai University, Chidambaram

**Abstract**

The purpose of the study was to find out the variation in $VO_2$ max with respect to different playing positions among sub junior and junior football players. To achieve the purpose of the study, the playing position in football were differentiated as offensive, midfield and defensive positions. In each of the above positions 150 players were selected from various clubs of Cuddalore, Villupuram and Kallakuruchi district. Thus there were 450 players in the sub junior category and 450 players in the junior category comprised of a total of 900 football players. The age of the subjects ranged between 12 and 19 years. To assess the $VO_2$ max was measured by Cooper test formula $VO_2$ max = $\frac{d_{12} - 504.9}{44.73}$ was conducted and recorded in ml /kg/ min. The collected data were statistically analyzed by 2 x 3 factorial ANOVA of independent groups. Whenever they obtained 'F' ratio value was significant, the simple effect test was applied followed by Scheffee'S post hoc test wherever required. The results of the study showed that the junior football players were significantly better in $VO_2$ max as compared to sub junior football players. The sub junior midfield players have shown significantly better $VO_2$ max as compared sub junior offensive and defensive players. Similarly junior midfield players have shown significantly better $VO_2$ max as compared junior offensive and defensive players.

**Key Words*:*** $VO_2$ max, Sub Junior, Junior Offensive, Midfield, Defensive, Football Players

## Introduction

Football is one of the most popular sports in the world. There is still uncertainty and debate surrounding its physiological requirements because its emphasis is on skills to the neglect of fitness, conservative training methods and the difficulty of studying the sport scientifically. The frequently found value for the total distance covered in a game is about 10 km, and an above-average, though not outstanding, maximum oxygen uptake of 60 ml/kg/min suggests a moderate overall aerobic demand. A comparison of top teams and players with less able participants indicates that the components of anaerobic fitness speed, power, strength and the capacity of the lactic acid system may differentiate between the two groups.

Modern football style requires physical fitness or physical fitness and $VO_2$ max in particular. A talented soccer player may not be able to play a good and satisfying game if he is physically unfit and cannot maintain his physical fitness continuously [**Hornby et al., 2008**]. The style of modern football is also increasingly demanding the ability to play the ball in high skills. These soccer characteristics involve the speed of pressure from the opposing player when a player is controlling the ball. The high pressure on the player who space to freely play the ball. In such conditions, players are required to have the ability to escape from the control of opponents, protect the ball so that it remains in control, and collectively arrange attacks through fast passes and directed in the condition of the ball remains in the mastery of the team (ball possession) [**Elferink-Gemser et al., 2012**]. The game of football is a sport that is prerequisite with skills. Even so, the functional movement patterns in the game of football which are known as "ball technique" skills can be divided into eight, namely: 1) kicking; 2) stop the ball (ball control); 3) carrying the ball (dribbling), 4) heading (heading); 5)feinting; 6) seize the ball (tackling); 7) throw-in; and 8) goal keeper [**Curry , 2019**]. Therefore, in football, high $VO_2$ max and skills are needed to compete at the international level. Because, if you only have the skills or skills in managing a good ball, but do not have a high $VO_2$ max, then these players will not be able to compete at international and professional levels.

$VO_2$ max is the body's ability to consume oxygen maximally during activity and training [**Hoff et al., 2002**]. The maximum volume of oxygen that can be consumed during continuous and gradually increasing intensive exercise mainly uses the aerobic process. It is calculated in ml/kg/min using specific laboratory tests or field tests [**Taylor, 2016**]. The maximum amount of oxygen that can be consumed during intense physical activity until fatigue finally occurs [**Hoff, 2005**]. Many theories and literature explain the needs of $VO_2$ max a football player. The average oxygen uptake for international soccer teams ranges from 55 to 68 ml/kg/min [**Slimani et al., 2018**], 48–62 ml/kg/min [**Wells et al., 2012**]. Professional 56.5 ml/kg/min; Amateur 55.7 /kg/min [**Helgerud et al., 2001**], $VO_2$ max football players aged 22-28 years are for men 54 ml/kg/min - 64 ml/kg/min and girls 50 ml/kg/min - 60 ml/kg/min. While **Taylor (2016)** states in football, the best players can reach $VO_2$ max levels of 65-70 ml/kg/min, depending on their age, level of individual performance and position on the pitch. A $VO_2$ max of 60-62 ml/kg/min is already considered to be a decent reserve for a footballer and more so for players aged 16-17 years [**Watulingas et al., 2013**].

Generally football players are divided into four categories regarding playing position. There are goalkeepers, defenders, midfielders and attackers, and each has its own characteristics. Attackers appear to be the fastest players in the team. The greatest overall distances appear to be covered by midfield players who act as links between defense and attack **(Rienzi et al., 2000)**. In a football game defenders perform more backward movement than attackers. Furthermore, different football related activities (tackling, heading and passing) provide an extra physiological stress to the player **(Bangsbo et al., 2006)** with different playing positions having to perform specific activities. Positional differences have been the subject of interest of sport scientists for years (**Al-Hazzaa et al., 2001)**. The physical

fitness of a player however can be a decisive determinant of success during competition **(Sporis et al., 2009)**. Thus the present study was undertaken to study on maximum oxygen uptake with respect to different playing position among sub junior and junior football players.

**Methodology**

The purpose of this study was to find out the significant difference in $VO_2$ max between sub-juniors and juniors offensive, midfield and defensive football players. To achieve the purpose of the study nine hundred 900 football players were selected from various football clubs of Cuddalore, Villupuram and Kallakurichi district, Tamil Nadu and India' The clubs that were selected for the study have been conducting tournaments in the game of football for both sub-juniors and juniors players.

The 900 players comprised of 450 sub-juniors and 450 juniors which encompass 150 players from offensive, mid field and defensive playing positions. All the players were in the age category between 12 to 19 years.

The data collected on $VO_2$ max was measured by Cooper test formula $VO_2$ max = $\frac{d_{12} - 504.9}{44.73}$ for offensive, midfield and defensive sub-junior and junior football players were statistically analyzed by using 2 x 3 factorial ANOVA (categories x playing positions) Whenever, the obtained 'F' ratio value for interaction effect was found to be significant, the simple effect test was applied and follow up test. In all cases, the .05 level of confidence was fixed to test the level of significance which was considered as appropriate.

**Result of study**

**Table – 1.1**

**MEAN AND STANDARD DEVIATION OF VO2 MAX AMONG CATEGORIES (SUB-JUNIOR & JUNIOR) AND DIFFERENT PLAYING POSITIONS (OFFENSIVE, MIDFIELD, DEFENSIVE FOOTBALL PLAYERS)**

| Categories / Positions | | Offensive | Midfield | Defensive | Combined |
|---|---|---|---|---|---|
| **Sub-Junior** | Mean | 45.68 | 47.28 | 43.74 | 45.57 |
| | SD | 4.78 | 3.89 | 2.54 | |
| **Junior** | Mean | 50.61 | 54.31 | 48.72 | 51.21 |
| | SD | 2.88 | 3.21 | 3.21 | |
| **Combined** | Mean | 48.14 | 50.80 | 46.23 | 48.39 |

Table – 1.1 indicated that the mean and standard deviation of VO2 max of offensive sub junior and offensive junior football players were 45.68 ± 4.78 and 50.61 ± 2.88 with a combined mean value of 48.14. The midfield sub junior and midfield junior football players mean and standard deviation values on $VO_2$ max were 47.28 ± 3.89 and 54.31 ± 3.21 with a combined mean value of 50.80. The defensive sub-junior and defensive junior football players mean and standard deviation values on $VO_2$ max were 43.74 ± 2.54 and 48.72 ± 3.21 with combined mean value of 46.23. The combined mean values on $VO_2$ max of sub junior offensive, midfield and defensive football players was 45.57. The combined mean value on $VO_2$ max of junior offensive, midfield and defensive football players was 51.21.

**Table – 1.2**
**TWO FACTOR ANOVA FOR VO2 MAX OF CATEGORIES (SUB JUNIOR & JUNIOR) AND DIFFERENT PLAYING POSITIONS (OFFENSIVE, MIDFIELD AND DEFENSIVE FOOTBALL PLAYERS)**

| Source of Variance | Sum of squares | Df | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Factor A (Categories) | 7170.64 | 1 | 7170.64 | 585.01* |
| Factor B (Playing Positions) | 3151.08 | 2 | 1575.54 | 128.54* |
| Factor A & B (Interaction) | 216.23 | 2 | 108.11 | 8.82* |
| Residual | 10957.86 | 894 | 12.25 | |

**Significant at .05 level of confidence.*
*(The required table value for significant at .05 level of confidence with df of 1 to 894 and 2 to 894 are 3.84 & 3.00 respectively).*

Table –1.2 showed that the obtained 'F' ratio value on $VO_2$ max was 585.01 for factor-A irrespective of different categories namely sub-junior and junior football players which was greater than the table value of 3.84 with df 1 and 894 required for significance at .05 level of confidence. The result showed that there was significant difference on $VO_2$ max sub junior and juniors irrespective of different playing positions of football players on $VO_2$ max.

The obtained 'F' ratio on $VO_2$ max was 128.54 for factor-B of different playing positions namely offensive, midfield and defensive football players irrespective of categories sub junior and junior football players which were greater than the table value of 3.00 with df 2 and 894 required for significance at .05 level of confidence. The results showed that there was significant difference on $VO_2$ max among three different playing positions such as offensive, midfield and defensive football players irrespective of categories namely sub junior and junior.

The obtained 'F' ratio on $VO_2$ max was 8.82 for the interaction [A×B factor - (categories × different playing positions) and it was also greater than the table value of 3.00 with df 2 and 894 required for significance at .05 level of confidence. Since, the obtained 'F' ratio for the interaction effect was found to be significant, the simple effect test was applied as a follow up test and it is presented in table – 1.3.

**Table– 1.3**
**SIMPLE EFFECT FOR CATEGORIES (SUB JUNIOR & JUNIOR) AND DIFFERENT PLAYING POSITIONS (OFFENSIVE, MIDFIELD AND DEFENSIVE FOOTBALL PLAYERS) ON VO2 MAX**

| Source of variance | SJ | J | Sum of squares | Df | Mean Squares | F- ratio |
|---|---|---|---|---|---|---|
| Categories and Offensive | 45.68 | 50.61 | 1822.86 | 1 | 1822.86 | 148.80* |
| Categories and Midfield | 47.28 | 54.31 | 3706.56 | 1 | 3706.56 | 302.57* |

| | | | | | | |
|---|---|---|---|---|---|---|
| Categories and Defensive | 43.74 | 48.72 | 1860.03 | 1 | 1860.03 | 151.83* |
| Error | | | 10957.86 | 894 | 12.25 | |

**Significant at .05 level of confidence.*

*(The table value required for significance at .05 level of confidence with df 1 and 894 was 3.84 respectively).*

Table – 1.3 showed that the obtained 'F' ratio on $VO_2$ max between sub junior and junior players of offensive, midfield and defensive football players were 148.80, 302.57 and 151.83 respectively. The results showed that there was significant difference on $VO_2$ max between sub junior and junior of offensive, midfield and defensive football players, since the obtained 'F' ratio values is greater than the table value of 3.84 with df 1 and 894 required for significant at .05 level of confidence.

**Table– 1.4**

**SIMPLE EFFECT SCORES FOR DIFFERENT PLAYING POSITIONS (OFFENSIVE, MIDFIELD AND DEFENSIVE FOOTBALL PLAYERS) OF CATEGORIES FOR (SUB JUNIOR & JUNIOR) ON $VO_2$ MAX**

| Source of Variance | Mean | | | Sum of Squares | Df | Mean Squares | F-ratio |
|---|---|---|---|---|---|---|---|
| | Offensive | Midfield | Defensive | | | | |
| **Position and Sub Junior** | 45.68 | 47.28 | 43.74 | 942.76 | 2 | 471.38 | 38.48* |
| **Position and Junior** | 50.61 | 54.31 | 48.72 | 2425.51 | 2 | 1212.75 | 99.00* |
| **Error** | | | | 10957.86 | 894 | 12.25 | |

***** *Significant at .05 level of confidence.*

*The table value required for significance at .05 level of confidence with df 2 and 894 were 3.00respectively.*

Table – 1. 4 revealed that the obtained 'F' ratio on $VO_2$ max was 38.48 for players under the playing positions sub junior of offensive, midfield and defensive football players and it was higher than the table value of 3.00 for significance at .05 level of confidence for df 2 and 894. The results showed that there was significant difference on $VO_2$ max among the players of offensive, midfield and defensive football players sub junior. Similarly, the obtained 'F' ratio on $VO_2$ max was 99.00 among the players under the three playing positions junior of offensive, midfield and defensive it was higher than the table value of 3.00 for df 2 and 894, required for significance at .05 level of confidence. The results showed that there was significant difference among junior football players of three different playing positions of offensive, midfield and defensive.

**Table-1.5**

**SCHEFFE'S TEST FOR THE DIFFERENCE ON MEAN VALUES OF VO2 MAX AMONG CATEGORIES (SUB JUNIOR AND JUNIOR) DIFFERENT PLAYING POSITIONS (FORWARD, MIDFIELDER AND DEFENDER FOOTBALL PLAYERS)**

| Categories | DIFFERENT PLAYING POSITIONS | | | | |
|---|---|---|---|---|---|
| | **Offensive** | **Midfield** | **Defensive** | **MD** | **C.I** |
| **Sub Junior** | 45.68 | 47.28 | | 1.60* | 0.98 |
| | 45.68 | | 43.74 | 1.94* | 0.98 |
| | | 47.28 | 43.74 | 3.54* | 0.98 |
| **Junior** | 50.61 | 54.31 | | 3.70* | 0.98 |
| | 50.61 | | 48.72 | 1.89* | 0.98 |
| | | 54.31 | 48.72 | 5.59* | 0.98 |

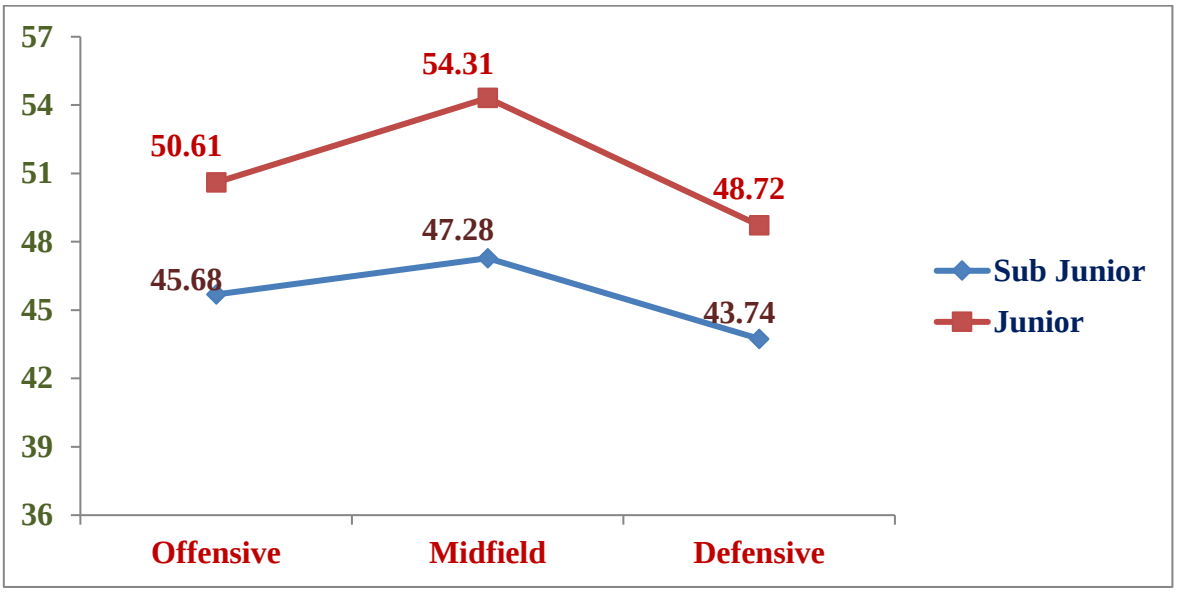
** Significant at .05 level of confidence*

Table – 4.35 showed that the mean difference between sub junior offensive and sub junior midfield players, sub junior offensive and sub junior defensive players, sub junior midfield and sub junior defensive players were 1.60, 1.94 and 3.54 respectively on $VO_2$ max of sub junior of different playing positions which are greater than the confidence interval value of 0.98 at .05 level of confidence. Junior offensive and junior midfield players, junior offensive and junior defensive players, junior midfield and junior defensive players were 3.70, 1.89 and 5.59 respectively on $VO_2$ max of junior of different playing positions which are greater than the confidence interval value of 0.98 at .05 level of confidence.

The results of the study showed that the junior players had significant difference on $VO_2$ max as compared to sub junior players. The sub junior midfield players had significantly better in $VO_2$ max as compared to sub junior offensive and defensive players. The results also revealed that the difference in $VO_2$ max is significantly more for sub junior offensive players as compared to sub junior defensive players. Similarly, junior midfield players had significantly better results in $VO_2$ max as compared to junior offensive and defensive players. The result also revealed that the difference in $VO_2$ max was significantly more for junior offensive players as compared to junior defensive players. The data on $VO_2$ max was graphically represented in figure – 1.A

**Figure – 1.A**

**Graphical Representation of Mean Value on $VO_2$ max between Sub Junior and Junior Football Players of Different Playing Positions (Offensive, Midfield, Defensive Players)**




**Discussion of study**

The results of the study showed that the junior players had significant difference on $VO_2$ max when compared to sub junior players. The sub junior midfield players had significantly better results in $VO_2$ max when compared to sub junior offensive and defensive players. The result also revealed that the difference in $VO_2$ max is significantly more for sub junior offensive players as compared to sub junior defensive players. Similarly, junior midfielder players had significantly better results in $VO_2$ max as compared to junior offensive and defensive players. The result also revealed that the difference in $VO_2$ max was significantly more for junior offensive players as compared to junior defensive players. There are many studies in support of findings of the present study. **Slimani et al., (2019)** have proved that there was significant difference found on $VO_2$ max among different age groups of under-12, under-14, under-17, and under-20 male soccer players. Cardiovascular fitness is one of the most important aspects of physical fitness conditioning in soccer **[Stolen et al., 2005]**. In this context, well-developed aerobic fitness helps the soccer players to maintain repetitive high-intensity actions within a soccer match, accelerate the recovery process, and maintain their physical condition at a good level until the end of the match. Soccer players' aerobic fitness has been established by measuring maximal oxygen consumption ($VO_2$ max) during a continuous graded exercise test, using either a cycle ergometer or a treadmill in the laboratory or a multistage shuttle-run test as a field test. The VO2max values reported extend from 59.2 to 66.6 ml/kg/min and from 57.8 to 61.7 ml/kg/min for elite and amateur male soccer players, respectively, in different playing positions and age groups. A previous investigation reported that aerobic performance was different between playing levels, with a higher peak $VO_2$ max in elite league teams players (63.2 ± 4.5 ml·kg-1·min-1) than in the first division teams players (61.7 ± 5.1 ml·kg-1·min-1) **[Arnason et al., 2004].** Thus, compared to the sub-elite group, the elite players had higher aerobic power **[Reilly et al.,**

**2000]. Canhadas et al. (2010)** indicated that $VO_2$ max increased significantly with age: 10 years < 11 years < 12 years < 13 years. Accordingly, another study showed that the selected and non-selected soccer players' 14-year-old team had lower $VO_2$ max than older soccer players (U-15, U-16, and U-17) **[Gil et al., 2007]**. Thus, youth soccer players (U-16 and U-18) had higher $VO_2$ max than U-23 and university players [**Aziz et al., 2008**]. In contrast, other studies reported that there was no significant difference in the values of $VO_2$ max between U-14, U-15, and U-16 soccer players **[Vanderford et al., 2004]** or between pubescent and post-pubescent players **[Cunha et al., 2011].**

Furthermore, it has been shown that outfielders (i.e., forward players, midfielders, and defenders) had higher values of $VO_2$ max and peak $O_2$ uptake than goalkeepers **[Aziz et al., 2008]**. The same authors showed that defenders and midfielders had a slightly higher mean $VO_2$ max than forward players. Accordingly, in another study the Croatian midfielders had superior values of $VO_2$ max compared with attackers and defenders, because midfielders have to cover more distance during a game **[Sporis et al., 2009]**. In contrast, it has been shown that forwards had the higher mean $VO_2$ max values compared with midfielders, defenders, and goalkeepers **[Gil et al., 2007]**. It has been also shown that the $VO_2$ max of midfielders and forwards was superior to that of the goalkeepers **[Lago- Pennas et al., 2014].** While other studies showed that $VO_2$ max did not differ significantly among players of different field positions **[Nilsson and Cardinale (2015)],** midfielders seemed to have the biggest intermittent endurance capacity, especially in the younger age categories (U-9–U-15) [**Deprez et al., 2014].** This contradiction could be explained by the fact that the non-professional forwards had higher mean $VO_2$ max values compared with non-professional young midfielders and defenders, but when the players approached the professional level, positional differences also existed, with higher values of $VO_2$ max in elite young midfielders compared with elite attackers and defenders.

## Conclusion

The present study results show comparing the two groups in $VO_2$ max junior offensive, midfield and defensive football players were better than sub junior offensive, midfield and defensive football players. The results also revealed that the difference in $VO_2$ max was significantly more for sub junior offensive players as compared to sub junior defensive players. In junior, the $VO_2$ max of midfield players was better than offensive and defensive players. In sub junior, the $VO_2$ max of midfield players was better than offensive and defensive players. The results also revealed that the difference in $VO_2$ max was significantly more for junior offensive players as compared to junior defensive players.

## Reference

[1] Al-Hazzaa HM, Alumuzaini KS, Al-Rafaee A, Sulaiman MA, Dafterdar MY. Al-Ghamedi A, Khuraiji KN. Aerobic and Anaerobic Power Characteristics of Saudi Elite Soccer Players. *The Journal of Sports Medicine Physical Fitness*, 2001; 41: 54–61.

*[2]* Arnason A, Sigurdsson SB, Gudmundsson A, Holme I, Engebretsen L, Bahr R. Physical Fitness, Injuries and Team Performance in Soccer, *Medicine and Science in Sports Exercise,* 2004; 36 (2):278-285.

[3] Aziz AR, Mukherjee S, Chia MY, Teh KC. Validity of the Running Repeated Sprint Ability Test among Playing Positions and Level of Competitiveness in Trained Soccer Players. *International Journal of Sports Medicine,* 2008; 29 (10):833-838.

[4] Bangsbo J, Mohr M, Krustrup P. Physical and Metabolic Demands of Training and Match-Play in the Elite Football Player. *Journal of Sports Science*s, 2006; 24(7): 665-674.

[5] Canhadas IL, Silva RLP, Chaves CR, Portes LA. Anthropometric and Physical Fitness Characteristics of Young Male Soccer Players. *Rev Bras Cineantropom Desempenho Hum,* 2010; 12(4): 239-245.

[6] Cunha G, Lorenzi T, Sapata K, Lopes AL, Gaya AC, Oliveira A. Effect of Biological Maturation on Maximal Oxygen Uptake and Ventilatory Thresholds in Soccer Players: An Allometric Approach. *Journal of Sports Sciences,* 2011; 29(10):1029-1039.

[7] Curry. G., The Making of Modern Soccer: A Product of Multiple Interdependencies. *Soccer and Society*, 2019; 20 (7): 1014 – 1024.

[8] Deprez D, Fransen J, Boone J, Lenoir M, Philippaerts R, Vaeyens R. Characteristics of High-Level Youth Soccer Players: Variation by Playing Position. *Journal of Sports Sciences,* 2015; 33 (3): 243 -254.

[9] Elferink-Gemser MT., B. C. H, Huijgen., M. Coelho-E-Silva., K. A. P. M, Lemmink., & C. Visscher. The Changing Characteristics of Talented Soccer Players A Decade of Work in Groningen. *Journal of Sports Sciences*, 2012; 30(15): 1581–1591.

[10] Gil SM, Gil, Ruiz F, Irazusta A, Irazusta J. Physiological and Anthropometric Characteristics of Young Soccer Players According to Their Playing Position: Relevance for the Selection Process. *Journal of Strength and Conditioning Research,* 2007; 21: 438- 445.

[11] Helgerud JAN., L. C, Engen., U. Wisloff., & J. A. N, Hoff. Aerobic Endurance Training Improves Soccer Performance. *Medicine and Science in Sports and Exercise*, 2001; 33(11): 1925–1931.

[12] Hoff J., Wisloff U., L. C, Engen., O. J, Kemi., & J. Helgerud. Soccer Specific Aerobic Endurance Training. *British Journal of Sports Medicine*, 2002; 36 (3): 218–221.

[13] Hoff J. Training and Testing Physical Capacities for Elite Soccer Players. *Journal of Sports Sciences,* 2005; 23 (6): 573 – 582.

[14] Hornby. H. Uppies & Downies. The Extraordinary Football Games of Britain. Swindon: English Heritage, 2008.

[15] Lago-Penas C, Rey E, Casais L, Gomez-Lopez M. Relationship between Performance Characteristics and the Selection Process in Youth Soccer Players. *Journal of Human Kinetics*, 2014; 40 (1):189-199.

[16] Nilsson J, Cardinale D. Aerobic and Anaerobic Test Performance among Elite Male Football Players in Different Team Positions. *Lase Journal of Sport Science,* 2015; 6(2):73-92.

[17] Reilly T, Williams AM, Nevill A, Franks A. A Multidisciplinary Approach to Talent Identification in Soccer. *Journal of Sports Sciences,* 2000; 18 (9): 695-702.

**[18]** Rienzi E, Drust B, Reilly T, Carter JEL, Martin A. Investigation of Anthropometric and Work-Rate Profiles of Elite South American International Soccer Players. *Journal of Sports Medicine and Physical Fitness*, 2000; 40 (2): 162-169.

[19] Slimani M, Znazen H, Bragazzi NL, Zguira MS, Tod D., The Effect of Mental Fatigue on Cognitive and Aerobic Performance in Adolescent Active Endurance Athletes: Insights from a Randomized Counterbalanced, Cross-Over Trial**,** *Journal of Clinical Medicine*, 2018; 7 (12): 1- 10.

[20] Slimani M., H. Znazen., B. Miarka., & N. L, Bragazzi. Maximum Oxygen Uptake of Male Soccer Players According to Their Competitive Level Playing Position and Age Group: Implication from A Network Meta-Analysis by. 2019; 66: 233–245.

[21] Sporis G, Jukic I, Ostojic SM, Milanovic D. Fitness Profiling in Soccer Physical and Physiologic Characteristics of Elite Players. *Journal of Strength and Conditioning Research*, 2009; 23(7):1947-1953.

[22] Stolen TK, Chamari C, Castagna C, Wisloff U, Physiology of Soccer: An update, *Sports Medicine*, 2005; 35 (6): 501–536.

[23] Taylor, J. J. Youth Football. www.FIFA.com, 257. 2016.

[24] Vanderford LM, Meyers MC, Skelly WA, Stewart CC, Hamilton KL. Physiological and Sport-Specific Skill Response of Olympic Youth Soccer Athletes. *Journal of Strength and Conditioning Research*, 2004; 18(2):334-342.

[25] Watulingas, I., Rampengan, J. J. V., & Polii, H. Pengaruh Latihan Fisik Aerobic Terhadap Vo2 Max Pada Mahasiswa Pria Dengan Berat Badan Lebih (Overweight). Journal e-Biomedik , 2013;1 (2): 1064–1068.

[26] Wells M., A. M, Edwards., E. M, Winter., M. L, Fysh., & B. Drust. Sport-Specific Fitness Testing Differentiates Professional from Amateur Soccer Players Where VO2max and VO2 Kinetics Do Not. Journal of Sports Medicine and Physical Fitness, 2012; 52(3): 245–254.