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Futsal's Inside Human Sport Physiology : A Literatures Description

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Abstract

Futsal is played with high intensity (indoor version of football played by 5 people per team). With the dimensions of the playing field 40 x 20 m and the infinite turnover, as well as the task of defense and attack constantly, futsal players perform activities with high intensity such as sprints, acceleration, deakselation and changes in the direction of the game, creating a separate burden to the body's physiological processes involves the aerobic and anerobic metabolic systems. With the fact this game is played with high intensity then the research data found the average pulse rate (HRaverage) reached 174 times per minute, so that it can reach 90% of the maximum pulse rate (HRmaximum) for 72% of game time. This exercise also requires cardiovascular adaptation of 85-90% of the maximum pulse rate per individual. As for aerobic capacity to fulfill oxygen availability alone, the recommended VO2 max value is in the range of 50-55 ml / kg / minute is the recommended range for a minimum of professional futsal athletes. With more and more playing experience, the knowledge and training patterns practiced by futsal athletes make physical and physiological needs to support the performance of the game be fulfilled.

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INTRODUCTION

Futsal is a team sport with increasing popularity which is played all over the world by men and women, on an amateur or professional level (Barbero-Alvarez et al., 2008). This sport is a sport with high intensity, with rapid changes in direction, start moving, stopping, jumping and kicking, involving high forces involving bones and increased bone formation (Anliker et al., 2013; Barbero-Alvarez and Soto, 2008; Castagna et al., 2009; Hart et al., 2016). Futsal is played with high intensity (indoor version of football played by 5 people per team). With the regulation of the dimensions of the playing field (40 x 20 m), and unlimited player changes, as well as the constant defense and attack tasks, futsal players carry out activities with high intensity such as sprints, acceleration, deactivation and changes in the direction of the game, creating separate burdens on aerobic and anerobic metabolism (Caetano et al., 2015). A futsal match consists of 2 rounds (2x20 minutes) with between 10-15 rounds of rest. This time is the net time, because the time stops when the ball leaves the match field, so a futsal match can end 75 to 80 minutes. The game with a long duration accompanied by high intensity requires players to improve their futures performance, so regular training is needed for the sake of increasing the work of the aerobic and anaerobic metabolic systems. And although this sport is a relatively new sport, there are already many scientific publication articles available on the internet to analyze the players›anthropometry ,parameters,physiological needs and team fitness levels. The main task of trainers is to optimize athletic performance (Coutts and Aoki, 2009), the best improvement is obtained from the fruits of physical training with a recovery period sufficient to provide good adaptation before competition (Gamble, 2006; Coutts & Aoki, 2009).

The most decisive period in a futsal match is determined by high-intensity and fast running with changes in movement patterns varying, on average every 3.3 seconds (Barbero-Alvarez et al., 2008; Dogramaci et al., 2011). Professional futsal players spend about 5% and 12% of the game time on high-intensity sprints and runs (Barbero-Alvarez et al., 2008; Castagna et al., 2009). Furthermore, the ability of futsal athletes to engage in intense activities (Barbero-Alvarez et al., 2008) and neuromuscular work (Dal Pupo et al., 2014) decreases towards the end of game time, making knowledge of the importance of intermittent physical endurance to sustain high-intensity activity to undergo training sessions or matches (Castagna et al., 2009).

While in women›s performance, in a season of futsal competition, female players play 2 to more times a week, almost the same as men›s competition, with short periods of rest and inadequate recovery time for energy recovery, increasing muscular and physiological fatigue. Periodically, athletes from the data found to have a high incidence of infection and disease, increasing the risk of injury during the pre-season training period so that it impacts on the physical performance of the team in a match (Avloniti et al., 2007). The female futsal players move strongly in the game, resulting in considerable energy loss and high metabolic requirements of the neuromuscular system (Cyrino, Altimari, Okano, & Coelho, 2002). Cyrino et al. (2002) explain that capital to play futsal well requires the ability to execute movements quickly, jump and change direction constantly and any excess in the form of fat can affect the performance of players on the field, especially in this case female futsal players because fat is easier to accumulate in women especially in the area around the balance point such as the abdomen and pelvis, which then these non-ideal physical characteristics can affect the specific performance of futsal. Football version played in this room is included in team sports that invade teams from opposing groups, which are characterized by confrontation on the field (defending against attacking) (Garganta, 2002). The invasion referred to here is the spatial invasion of the playing field, trying to master ball mastery, ball circulation, functional viewpoints of combined anerobic and aerobic energy (Garganta, 1998) and acyclic activities (Nunes et al., 2012). By knowing the physiological sciences that work during futsal and its details, this can improve the quality of the training process and performance in competitions (Castellano & Casamichana, 2010). At present the level of professional competition in futsal is very competitive, with physiological abilities that are almost similar, making the role of science applications very important to win the game (Gomes et al., 2011), making the authors feel the publication of this paper is important. The purpose of writing this scientific paper is to make a review of the latest sources of literature related to physiological futsal to improve the performance of players on the playing field, so that their knowledge can be absorbed and applied by related parties.

METHOD

There are still many who do not yet know how physiological futsal players, especially related to publications related to this topic that are still rare discussed about futsal especially in physiology term. With a literature study of articles that

is summarized from the latest scientific articles obtained from the internet media search literature engine: Proquest, Researchgate and Google Scholar related to futsal physiology with the keyword futsal physiology search scientific papers are found related to this topic and with this writing it is expected that the parties concerned will gain important physiological scientific knowledge of futsal from a more developed futsal country so that it can optimize the potential of players especially in Indonesian professional futsal players so that minimal achievements in the futsal professional's international level achievements can be obtained for my beloved country.

RESULTS AND DISCUSSION

Characteristics of futsal physiological needs

Futsal is a sport with high intensity (Gorostiaga et al., 2009). Barbero-Alvarez et al. (2008) found an average pulse rate (HRaverage) 174 times per minute, up to 90% of the maximum pulse rate (HRmaximum) during 72% of game time. The physiological evaluation factor aspects that researchers have outlined regarding the needs throughout the game are in addition associated with heart rate (Barbero-Alvarez, Soto, Barbero-Alvarez, & Granda-Vera, 2008; Castagna et al., 2007), there are also other evaluations such as observing the concentration of lactic acid in the blood (Rampinini et al., 2007), and kinematic characteristics (Barbero-Alvarez et al., 2008). Meanwhile, when referring to the statement of Alvarez-Medina et al. (2002), this exercise requires cardiovascular adaptation of 85-90% of the maximum pulse rate per individual. As for the aerobic capacity itself, the recommended VO2 max value in the range of 50-55 ml / kg / minute is the recommended range for professional futsal athletes to have (Castagna et al., 2009) as can be seen in the summary of **Table 1** (Naser et al., 2017). It can be seen that the more trained the player, with the status held as a professional player with more playing experience, has a better VO2 max number than the players whose number of years of experience is below, with Brazilian league division I players at least 10 years experience showing results The highest VO2 max is approximately 71.5 ml / kg / minute ± 5.9 (Rodrigues et al., 2011). While the lowest data was found in the semi-professional division 3 Italian league in a 2009 study with a VO2 max of around 55.2 ml / kg / min ± 5.7 (Alvarez et al., 2009), this is likely due to the pattern and type Different training between professional and non-professional players. Professional players have regular practice time every day and are under professional contracts so they must always be in the best physical condition.

Because there are limitations to VO2max for accurately monitoring adaptation of exercise to team sports (Milanez et al., 2011; Tomlin and Wenger, 2001), this measurement must be followed by other evaluations such as increased body temperature, circulating catecholamine levels and lactate metabolism that is can increase oxygen uptake in sports / exercise with an intensity that makes it close to VO2max (Hughson et al., 2001). The close association of the use of type 2 muscle fibers which increases when undergoing activities with high intensity, on the other hand increases the energy lost due to high demand for oxygen (Dupont et al., 2010). The VO2max value of each athlete is different when viewed from the position of the game. Although in general futsal players indicate numbers above 70-75% (Castagna, D'Ottavio, Vera, & Alvarez, 2009; Makaje et al., 2012; Rodrigues et al., 2011), the position of the goalkeeper is in the range of 60-70% from VO2max, wing and pivot at a percentage of 81-100% and defender 71-90% (Arins & Silva, 2007). It can be concluded that the goalkeeper's position requires the lowest VO2max when compared to other positions (Baroni & Leal, 2010). The level of speed of the game that is high enough to undergo a futsal competition is impossible if it is not supported by the power of a capable body aerobic system (Alvarez-Medina et al., 2002), especially needed for the recovery process during repeated sprints during futsal (Nunes et al. ., 2012). Although aerobic capacity is an important variable in futsal, this sport also requires high physical needs, indicating a high anaerobic capacity, which is an equally important variable (Nunes et al., 2012). One of the decisive actions obtained from the path of the anaerobic system to overcome the resistance of other teams, occurs in action attempts at matches that do not last more than 5 seconds and are carried out at high speed and decisive intensity (Álvarez-Medina et al., 2002). Barbero-Alvarez et al. (2008) demonstrated that futsal athletes ran around 8.9% (4-6 km) the amount of distance with sprints, this high physical need was obtained from exhausting futsal competitions and short recovery distances, thus requiring a good energy balance between aerobics and anaerobic can be obtained with practice. Good precision in the choice of training patterns used is a major aspect that can modify the metabolic response of trained athletes (Buchheit and Laursen, 2013).

Players can travel run constantly an average distance of 4300 m during the game (Barbero-Alvarez et al., 2008) which is similar to basketball (McInnes, Carlson, Jones, & McKenna, 1995) and handball (Perš, Bon, Kova□i□ , Sibila, & De□man, 2002). The distance traveled by pro-

Table 1. Average and standard deviations of anthropometric, playing experience and physiological variables of professional and semi-professional futsal players summarized from several countries (Naser et al., 2017).

References	Total Players	Age (year)	Height (cm)	Body mass (kg)	Experience class/ level	VO2max (ml/kg/ min)	Heart rate max (beat/ minute)
Barbero-Alvarez et al. (2007)	8	22.5 ± 1.7	177.8 ± 8.7	75.3 ± 7.3	Professional players	64.6 ± 5.2	
Barbero-Alvarez et al. (2008)	10	25.6 ± 2.5	175.8 ± 6	73.8 ± 5.7	Spanyol's Professional players 5 years of experience		174 ± 7
Alvarez et al. (2009)	11	22.8 ± 1.5	178 ± 7.4	75.3 ± 6.3	Second-division spanish players 5 years experience	62.8 ± 5.3	191 ± 8
Alvarez et al. (2009)	13	24.6 ± 2.7	175 ± 4.2	69.8 ± 6.6	Semi-professional Italian third division players 5 years playing experience	55.2 ± 5.7	198 ± 13
Castagna et al. (2009)	8	22.4	177	75.4	Second division Spanish league players	64.8	191
Gorostiaga et al. (2009)	25	25.2 ± 3.2	180 ± 5.7	76.6 ± 5.8	Professional outdoor Spanis first division players		
Gorostiaga et al. (2009)	15	26.2 ± 4.1	176 ± 7.6	76.9 ± 10	Professional indoor Spanish second division players		
Castagna et al. (2010)	18	20.6 ± 3.1	175 ± 7.9	71.6 ± 8.5	Spanish professional second division players	65.1 ± 6.2	193 ± 8
Dogramaci et al. (2011)	8	25.5 ± 3.8	176 ± 7	74.8 ± 4.7	Australia national team players		
Milanez et al. (2011)	9	22.8 ± 2.2	174.3 ± 6	70.6 ± 6.4	Brazilian league first division players		
Milanovic et al. (2011)	40		176.2 ± 6.8	70.3 ± 5.33	Professional Croatian league players Experience at least 3 years	59.6 ± 2.5	190.4 ± 6.4
Rodrigues et al. (2011)	14	22.5 ± 3.1	172.8 ± 5.5	70 ± 6.3	Brazilian first division players Experience at least 10 years	71.5 ± 5.9	199.8 ± 8.5
Pedro et al. (2013)	9	22.6 ± 4.2	174.3 ± 6	70.6 ± 6.4	Brazilian first division players Experience range 5-10 years	63.7 ± 4.1	189 ± 7
Pedro et al. (2013)	11	17.2 ± 0.8	175 ± 4	70.4 ± 6.5	Semi professional Brazilian league players Experience range 5-10 years	62.1 ± 4.4	204 ± 11

fessional players is even further with the numbers 5000 m and 4500 m for amateur players (Makaje, Ruangthai, Arkarapanthu, & Yoopat, 2012). From year to year the data shows that players can travel farther from 108 m / min (Molina, 1992) and 113 m / min (Oliveira, 1999) to 117 m / min (Barbero-Alvarez et al., 2008) as can be seen in **Table 2**. This distance is traveled at a higher speed than soccer (Bangsbo, 1993; Reilly, 1994) and other sports (Alexander & Boreskie, 1989; McInnes et al., 1995). Of course, like football, futsal players travel different distances based on their playing position.

Specifically the goalkeeper traveled the distance in a match at 700 m, 3,500 m pivot, 4,500 m central defender and 7,000 m winger (Burns, 2003). Similar results were found in energy loss figures found in the wing and pivot positions of

Table 2. The distance that futsal players can take in the first, second and overall round of the match and its intensity from several different studies

References	First half covered (m)	Second half (m)	Total distance (m)	Intensity (m/mnt)
Hernandez (2001)			6535.3	
Barbero-Alvarez et al. (2008)	2496.1 ± 1024.9	2595.7 ± 932	4313.2± 2138.6	117.3 ± 11.6
Castagna et al. (2009)				121 ± 8.2
Dogramaci et al. (2011)			4277± 1030	139.8
Makaje et al. (2012)			5087± 1104	
De Oliveira Bueno et al. (2014)	1710.6 ± 888.3	1635.9 ± 1089.2	3133.2± 2248.5	94.1 ± 14.1

Table 3. Variable age, height, and weight of futsal players from publications in several different countries.

Nationality	Age (year)	Height (cm)	Body mass (kg)	References
Spain	25.6 ± 2.5	175.0 ± 6.0	73.8± 5.7	Barbero-Alvarez et al. (2008)
Spain	26.2 ± 4.1	176.7 ± 7.6	76.9± 10.0	Gorostiaga et al. (2009)
Brazil	23.9 ± 5.4	176.4 ± 5.8	74.5± 8.1	Baroni & Leal Junior (2010)
Australia	25.5 ± 3.8	176.0 ± 7.0	74.8± 4.7	Dogramaci et al. (2011)
Brazil	22.5 ± 3.1	172.8 ± 5.5	70.0± 6.3	Rodrigues et al. (2011)
Thailand	24.2 ± 5.0	174.0 ± 3.0	66.9± 4.5	Makaje et al. (2012)
Brazil	26.0 ± 4.0	175.0 ± 6.0	73.0± 7.8	De Oliveira Bueno et al. (2014)
New Caledonia	25.5 ± 3.8	170.0 ± 7.0	70.7± 8.6	Charlot et al. (2016)

Table 4. Characteristics of anthropometric comparisons between goalkeepers and other players in the control group (D. Berdejo, R Moore and W. Lauphemier, 2015)

Control group	n	Age (years) (tahun)	Height (cm)	Body mass (kg)	BMI (kg/m2)
All players	12	23.91 ± .97	179.05± 3.53	75.64 ±4.58	23.59 ±0.91
The oldest		29	185	90	26.29
The youngest		18	173	72	21.13
Range		11	12	18	5.16
Outfields	10	24.00 ±3.39	177.11± 4.18	72.21 ±4.28	23.02 ±1.75
The oldest		29	185	80	25.70
The youngest		18	173	72	21.13
Range		11	12	8	4.57
Goalkeeper	2	23.66 ±1.53	185.00± 0.00	87.50 ±3.53	25.56 ±1.02
The oldest		25	185	90	26.29
The youngest		22	185	85	24.84
Range		3	0	5	1.45

around 350 kcalori, 250 kcalori defender and 110 kcalori keeper (Arins & Silva, 2007). This may be due to the fact that the pivots are the players who are usually first replaced in high intensity matches (Soares & Tourinho Filho, 2006). Other data found that Brazilian players reduced their distance from 97.9 m / min to 90.3 m / min in the second half (De Oliveira Bueno et al., 2014). When looking at the average speed figure is 117-121 m / min, or in other words it can travel 10 m in every 2 seconds (Do□ ramaci, Watsford, & Murphy, 2011). Futsal players can do 1 sprint every 79 seconds, when they have to change their movement patterns every 3.3 seconds in a match (Da Costa, Palma, Pedrosa, & Pierucci, 2012; Castagna et al., 2009; Do□ ramaci & Watsford, 2006) . Another fact was found that the players could travel more distance by walking or standing in the second round compared to the first round (30% and 28%) (De Oliveira Bueno et al., 2014). Elite level futsal players increase low intensity action and reduce high intensity action in the second half, made possible by the influence of tactics and experience of the players to secure the outcome

of the match (guarding the tempo) (Do□ramaci, Watsford, & Murphy, 2011). The more experienced a player will be to be able to bring calm and ingenuity in the reading of the game due to the habit of observing the opponent's game patterns.

No less important performance indicators are related to player agility (Milanovi□, Sporiš, Trajkovi□, & Fiorentini, 2011), which have an impact on futsal performance in making changes to the movements that are continuously present in the game. The more experienced players or older players usually get around the lack of agility with strategy and intelligence (able to read the direction of the game) so there is no need to run a lot (Serrano, Santos, Sampaio, & Leite, 2013). One other aspect that is no less important that is needed to support the performance of futsal is muscle power. Muscle strength in the game of futsal is needed to make fast movements such as jumping, kicking, dribbling, looking for gaps and to free yourself from escorting opponents (Castagna, D'ottavio, Vera, & Alvarez, 2008; Castagna & Alvarez, 2010; Witvrouw, Danneels, Asselman, D'have, & Cambier, 2003; Achour Junior, 1996). Therefore it is essential to increase physical capacity during the pre-competition period and maintain it during the competition period which will be filled with official matches and technical / tactical training.

The last physiological characteristic of futsal players is related to the product of anaerobic metabolism, namely lactic acid. Statistically providing an explanation that futsal players are often above the lactic threshold in a match (Barbero-Alvarez et al., 2008; Karahan, 2012) and blood lactic acid concentration ranges from 5.3-5.5 mmol / L (Castagna et al., 2009; Makaje et al., 2012). It is a high recommendation given to elite level futsal players to be able to cover longer distances in one match by applying an improved training program from aerobic and anaerobic systems, especially sprint resistance (Do□ramaci et al., 2011; Spencer et al., 2004 ; Young, McDowell, & Scarlett, 2001). This anaerobic function then becomes the physiological characteristic that distinguishes futsal athletes from soccer players due to the discovery of anaerobic threshold in futsal players higher than soccer athletes (Junior, Pinto, Souza, Magini, & Martins, 2006) .

Characteristics of physical needs of futsal players

From the research data describing the importance of the physical aspects of winning a match, teams with better physical conditions show better ability to apply the results of training compared to teams with physical conditions below it (Gheorghe & Ion, 2011), and have a tendency in ease of winning games. Futsal players generally have the physical character of a mesomorphic body shape (Bangsbo, 1994; Bissas, Cooke, Paradisis, & Liefeith, 1996; Queiroga, Ferreira, & Romanzini, 2013). Players aged 16-19 years are mostly mesomorphic while younger players underneath have ecto-mesomorphic body shapes (Generosi, Baroni, Junior, & Cardoso, 2010), a characteristic which is then investigated not related to their performance (Queiroga, Ferreira, Pereira, & Kokubun, 2008), with an average found to have qualified muscle mass and ideal body weight (Bangsbo 1994; Bissas, Cooke, Paradisis, & Liefeith, 1996; Queiroga et al., 2013).

In a study published in 2014 futsal players have an average height of 177 cm and a body weight of 70-77 kg (Trabelsi, Aouichaoui, Richalet, & Tabka, 2014), 10-12% percentage of body fat (Gorostiaga et al., 2009; Rodrigues et al., 2011; Trabelsi et al., 2014), and flexibility of 30-40 cm (Bertolla, Baroni, Leal Junior, & Oltramari, 2007; Cyrino, Altimari, Okano, & de Faria Coelho, 2002), while other studies present results that are not much different as can be seen in **Table 3**. Data obtained from several countries in different parts of the world such as Spain (Europe), Australia and Brazil (South America) show almost similar anthropometric data.

Futsal players with characteristics like this can jump vertically up to 40-50 cm and horizontally 220-240 cm (Cyrino et al., 2002; Fachineto, Ribeiro, Lezonier, & Mazieiro, 2008; Gorostiaga et al., 2009). When viewed based on the position of the goalkeeper games generally have the highest height, body fat percentage and muscle mass, on the other hand the players who occupy the position of wing posture the shortest (Avelar et al., 2008; Queiroga et al., 2013) and Similar results expressed by D. Berdejo-del-Fresno, R. Moore, and MW Laupheimer in their publication entitled "VO2max Changes in English Futsal Players after a 6-Week Period of Specific Small-Sided Games Training" in 2015 also can be seen in table 4 which was carried out in the experimental and control groups of elite British professional players. The experimental group consisted of 12 elite level futsal players with 10.4 ± 1.2 years of playing experience with the top 2 teams competing in the FA (The Football Association) Futsal National League. While the control group consisted of 12 elite level players who played in the same competition with 10.5 ± 1.6 years playing experience. The results showed that the goalkeeper was the highest and heaviest player compared to the overall player, with BMI in the healthy category of all players.

From **Table 4.** other data obtained from Avelar and colleagues (2008) concluded that the

keepers have a height of 182.4 cm, body weight 81.1 kg, 24.3 kg / m2 BMI, 73.4 kg muscle mass and 9.2% body fat percentage, defender has a height of 170.5, body weight 68.8 kg, 23.7 kg / m2 BMI, 62.5 kg muscle mass and 9.1% body fat percentage, winger 175.9 cm, 76.3 kg, 24.6 kg / m2 BMI, 69 kg muscle mass and 9.9% body fat percentage, pivots have 178.6 cm, 77.7 kg, 24.4 kg / m2 BMI, 70 kg muscle mass and 9.9% percentage of body fat. In female futsal players a high percentage of body fat is proven to have a negative impact on dribbling ability (Kooshaki, Nikbakht, & Habibi, 2014), and is most likely to affect other variables such as vertical and horizontal jumps.

Considering the age factor of physical development that is still ongoing in children ages 9-10 and 13-14 years which is different so that the anthropometric and physiological characteristics are also different (Ré, Teixeira, Massa, & Böhme, 2003) which then stable start to be similar in age group 16-19 years (Dias et al., 2007). Then the players in the 20-year age group are not too different in character from the adult age above it so they can start participating at senior futsal level (Barbieri, Barbieri, Queiroga, Santana, & Kokubun, 2012). Understanding the anthropometry profile becomes important for coaches in organizing and evaluating the training process that suits the players needs (Giusti et al., 2012). Especially for young players after we know from the description above the physical characteristics that are ideal for futsal players in general and also based on position, from an early age the coaches can give responsibilities by playing players and training them specifically for the technical-futsal needs in these positions. No less important is the regulation of the role of nutrition for the development of physical development in young futsal players

CONCLUSION

Futsal game is a game that requires a fair amount of energy constantly from both aerobic and anaerobic metabolism systems, due to the need for rapid movement throughout futsal games such as jumping, dribbling, shooting, etc. To support the performance of futsal in physiological terms, the futsal trainers must understand the physiological profile of each player in order to be able to monitor the process and progress of their training individually.

Bearing in mind the physiological profile of futsal players who have to travel long distances in a high-intensity match, training programs can be applied to improve aerobic and aerobic system functions such as sprint resistance training. But the training pattern must also adjust to the conditions of the players such as the example after undergoing difficult parties in the competition, the reduction of the high intensity of training can help the recovery process of the players. Equally important, besides training for physical endurance, training related to technical abilities and neuromuscular coordination are important physiological variables to maintain the performance of futsal athletes.

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