

Influence of Intermittent Endurance on Individual Playing Time in Games for U-18 Soccer Players

Kentaro Chuman*, Hirotaka Jo**, Daisuke Yamada**, Shota Mishio**, Kozue Ando** and Takahiko Nishijima***

*JUBILO CO., LTD.

**Doctoral Program in Physical Education, Health and Sport Sciences, University of Tsukuba

***Institute of Health and Sport Science, University of Tsukuba
2500 Shingai, Iwata-shi, Shizuoka 438-0025 Japan
chumank@jubilo.com

[Received November 13, 2013; Accepted August 18, 2014]

The purpose of this study was to investigate the influence of intermittent endurance on individual playing time in games for U-18 soccer players. Subjects were twenty-four male soccer players (high school students) aged 16.7 ± 0.8 years. Subjects performed the Yo-Yo intermittent recovery level 2 test (Yo-Yo IR2 test) for intermittent endurance. Individual playing time in official games and factors of substitution were recorded. Subject Yo-Yo IR2 test results were 1197 ± 171 m. When subjects were divided by Yo-Yo IR2 test results (intermittent endurance), high intermittent endurance subjects showed a tendency for greater playing time (%) in soccer games; however, low intermittent endurance subjects did not. The intermittent endurance of regular players (starters) in games was significantly higher than that of non-regular players (non-starters) as substitute members and non-members on the same team. Player (MF) who had the highest intermittent endurance was not substituted by physical factors but player (MF) who had the lowest intermittent endurance was substituted many times by physical factors. From these results, it was concluded that intermittent endurance influenced the individual playing time in games for U-18 soccer players. It was suggested that intermittent endurance of young soccer players should be developed throughout the year.

Keywords: High-intensity running, Yo-Yo intermittent recovery level 2 test, Starters and non-starters, Member substitution

[Football Science Vol.11, 59-64, 2014]

1. Introduction

Soccer is a sport that requires players to engage in bursts of high-intensity running over the course of 90 minutes during a game (Bangsbo, 1994). Bangsbo et al. (1991) defines high-intensity running as 15 or more kilometers per hour. It is reported that in the English premier league, international-level players are engaged more in high-intensity running during games than non-international-level players are. This also applies to sprints, which are also considered high-intensity running (Mohr et al., 2003). Sprints run usually last for 2 seconds during games. This is the same for international-level players and non-international-level players alike. However, the number of sprints run by international-level players was 30% greater than the number run by

non-international-level players. This indicates that a requirement for professional soccer players is the ability to perform repeated high-intensity running (intermittent endurance).

The Yo-Yo intermittent recovery level 2 test (Yo-Yo IR2 test) is used in the field to evaluate the intermittent endurance of soccer players (Krustrup et al., 2006). In the Yo-Yo IR2 test, subjects repeat high-intensity running, including a change in direction, with short jogging breaks. In addition, since the aerobic and anaerobic energy systems are employed by players during the Yo-Yo IR2 test (Bangsbo et al., 2008), it is extremely close to game conditions, with the obvious exception that a ball is not used during the test. The results of Yo-Yo IR2 test reflected distance covered in high-intensity running during soccer games and showed five-minute periods of high-intensity

running to be the most frequent (Bangsbo et al., 2008; Randers et al., 2009). These results suggested that the Yo-Yo IR2 test is appropriate for the evaluation of intermittent endurance in soccer players.

On the road to becoming a professional soccer player it is first necessary for the individual to attract the attention of scouts of professional soccer club through performance in official games. According to Ueda et al. (2011), university soccer players with experience playing in official games performed better on the Yo-Yo IR2 test results than players with no experience in official games. This indicates that Yo-Yo IR2 test results reflect play in official games. Thus, it is essential for youth soccer players to achieve a high level of intermittent endurance during the preliminary stages of professional if intermittent endurance influences the individual playing time in their official games.

However, there are no studies examining the relationship between intermittent endurance and individual playing time in official games targeting youth soccer players. Clarifying this relationship would reveal the role of intermittent endurance in youth soccer players and provide important data for the planning of training content. Therefore, this study was carried out to examine the influence of intermittent endurance on individual playing time in official games for U-18 soccer players.

2. Methods

Subjects of this study were 24 soccer players (16.7±0.8 years) belonging to U-18 team in a club of the Japan Professional Football League Division 1 (J1-League). All subjects were either scouted or selected, and the level of their technical and tactical skills was similar. Subjects participated in team training after parental consent, and this study was conducted as a part of training under the supervision of club instructors. To achieve high-level intermittent endurance, team training was performed so as to maintain the high training load throughout the year.

To obtain data on intermittent endurance, Yo-Yo IR2 test was conducted (**Figure 1**) in accordance with instructions contained in a manual in CD format (bangsbosport.com). Specifically, subjects repeated the 20-meter shuttle run with 10-second slow jogging for rest following a signal from the CD that gradually became faster. At the first signal, subjects started running, and reversed direction at the second signal

to return to the starting point before the third signal. Subjects rested by jogging for 10 seconds, turned around a cone set at 5 meters from the starting point, and re-started at the next signal. Measurement was ended for subjects who were late for goal signals two times, and the running distance of each subject was deemed the results of their Yo-Yo IR2 test.

To understand the results of individual playing time in official games, we calculated the ratio of the individual playing time (%) from seven official games in the final part of the season. Individual playing time was indicated by the level of intermittent endurance (Yo-Yo IR2 test results). Intermittent endurance of subjects was classified according to the evaluation standards for Yo-Yo IR2 test established by Bangsbo & Mohr (2012) into a Low group (800-960 m), a Moderate group (1000-1160 m), a Good group (1200-1360 m), and a Very good group (1400-1560 m).

Subjects were classified into 10 starters in the last official game of the season, five substitute members, and eight non-members, excluding those who could not play because of injury, and their Yo-Yo IR2 test results were indicated. Players who played in more than 50% of games as starters in the above-mentioned seven games were considered to be regular players, and the ratio of changes of four regular midfielders (MF) was calculated. We also asked coaches who changed members about the reason of changes, and classified the reasons into three factors such as a change in tactics (tactical factors), a decrease in movement (physical factors), and injury.

To examine changes in the intermittent endurance of individual players in the season, we measured 11 subjects who participated in team training and conducted measurements three times throughout the season; namely, the 2nd week from the start of the season (Start of season), the 11th week (Start of in-season), and the 46th week (End of season).

Measurements are shown as mean value ± standard deviation. One-way ANOVA without replication was used to compare Yo-Yo IR2 test results among

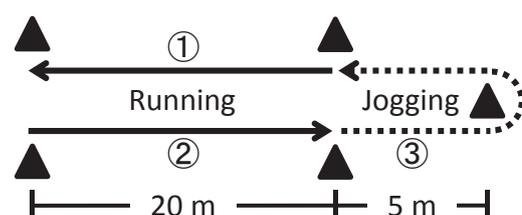


Figure 1 Yo-Yo intermittent recovery test

Starters, Substitute members, and Non-members. One-way ANOVA with replication was used to compare Yo-Yo IR2 test results in Start of season, Start of in-season, and End of season. When analysis revealed a significant difference, multiple comparison was conducted (Tukey's HSD test) as a post-hoc test. All statistical analysis was performed with SPSS 12.0J and the statistical level of significance was set at 0.05 ($\alpha = 0.05$).

3. Results and Discussion

3.1. Relationship between Ratio of Individual Playing Time in Game and Intermittent Endurance

The Yo-Yo IR2 test results at End of season were 1197 ± 171 m in all subjects. They were higher than the results obtained from Japan national team members (1019 m) and U-18 national team members (934.7 m) (JFA physical fitness project, 2005), which suggested that among Japanese soccer players the subjects of this study had higher intermittent endurance. We classified these subjects into four groups (Low, Moderate, Good, and Very good groups) using the Yo-Yo IR2 test evaluation standards established by Bangsbo & Mohr (2012) and indicated the ratio of individual playing time (%) (Figure 2). The results showed 0.0% for the Low group, 26.6% for the Moderate group, 51.1% for the Good group, and 76.0% for the Very good group. This revealed that players with a higher ratio of playing time tend to have better Yo-Yo IR2 test results. Therefore, we examined the relationship between Yo-Yo IR2 test results and selection of starters and member substitution to clarify the relationship between intermittent endurance and individual playing time.

3.2. Relationship between Selection of Starters and Intermittent Endurance

We classified subjects of this study into Starters, Substitute members, and Non-members groups, and compared their Yo-Yo IR2 test results. The results of Starters (1324 ± 130 m) were significantly higher than those of non-starters (Substitute members = 1144 ± 112 m, Non-members = 1055 ± 132 m) (Figure 3).

Because players switch extremely quickly between offense and defense in modern soccer games, intermittent endurance for repeated high-intensity

running is essential (Bangsbo, 1994). Mohr et al. (2003) reported that professional soccer players at higher competition levels showed more high-intensity running during games. Considering the positive correlation between high-intensity running during soccer games and Yo-Yo IR2 test results (Randers et al., 2009), it is thought that players with excellent Yo-Yo IR2 test results have high potential to become starters because of greater high-intensity running during games.

Soccer rules limit the number of player substitutions during official games. The regulations used for the purpose of this study stipulate that no more than five players may be changed during a game. According to these regulations, at least six players are required to play throughout the game, which means that teams require at least six players

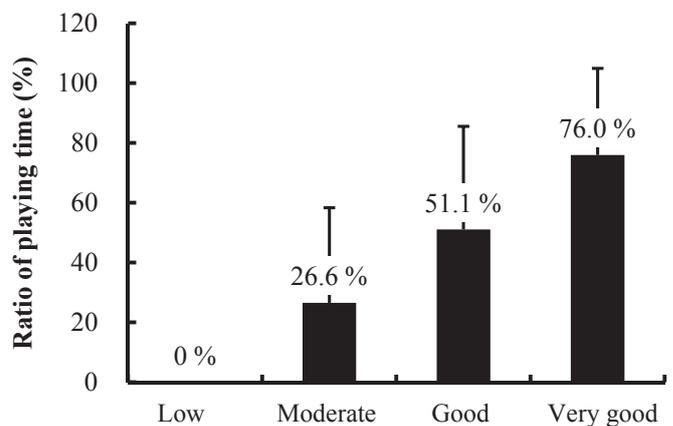


Figure 2 Relationship between Yo-Yo IR2 test results and ratio of individual playing time in soccer games

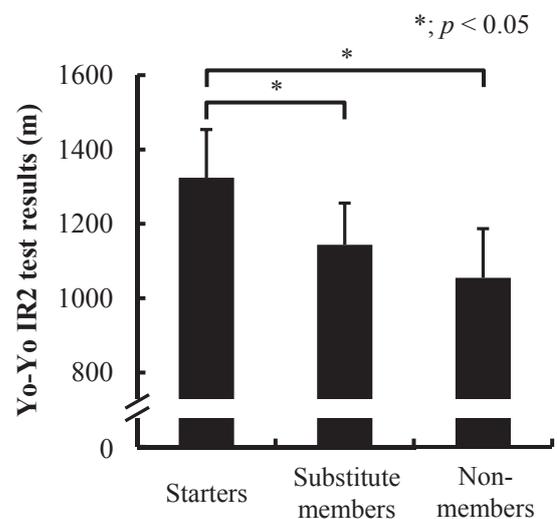


Figure 3 Yo-Yo IR2 test results in starters, substitute members and non-members

who can repeat high-intensity running over the 90-minute duration of the game. If a player with lower intermittent endurance who cannot perform high-intensity running throughout the game period is selected as a starter, it is highly likely that the coach will put a substitute member into the game to ensure the team's ability to maintain the required intensity of movement. If the coach is required to change members due to such physical factors, he uses up the number of substitutions allowed in the game, which makes it more difficult to make later changes for tactical reasons. Using players with high intermittent endurance as starters increases the possibility of securing the number of substitute players allowed for tactical changes.

According to the above, players with higher intermittent endurance have a greater chance of being selected as starters, which explains why individuals in this study with excellent Yo-Yo IR2 test results were also starters. However, we did not question coaches about their criteria for the selection of starters. In future studies, it will be necessary to ask coaches about the factors employed in selecting starters and to multilaterally examine the relationship between the selection of starters and intermittent endurance.

Table 1 Descriptive statistics

Item	Ave.	S.D.
Height (cm)	172.3	4.8
Body mass (kg)	64.8	6.4
Yo-Yo IR2 test (m)	1197	171

3.3. Relationship between Member Substitution and Intermittent Endurance

Table 2 shows the Yo-Yo IR2 test results of four regular players (MF), substitution ratio and factors. Among these four regular players, Player A (Yo-Yo IR2 test result = 1440 m) played for 90 minutes in all 7 games in this study. Meanwhile, Player D (Yo-Yo IR2 test result = 1040 m), who had the lowest Yo-Yo IR2 test result, was substituted in all five games, three of which (60%) were due to physical factors, the highest among these four players. Member substitution because of physical factors is often seen in players with lower intermittent endurance while it is seen less in players with higher intermittent endurance.

Member substitutions in soccer games are usually due to injury, tactical or physical factors. According to Carling et al. (2010), most member substitutions in the France League Division 1 clubs were due to tactical factors while member substitutions of midfielders were due to physical factors. High-intensity running during games tends to decrease toward the end. In particular, high-intensity running in the last 15 minutes of games decreased to approximately 50% of the amount in first 15 minutes of games (Bangsbo & Mohr, 2012). Considering the correlation between high-intensity running in the last 15 minutes of games and Yo-Yo IR1 test results (Bangsbo & Mohr, 2012), it is easy to assume that high-intensity running in an end game by players with lower intermittent endurance decreases remarkably as well. Distance covered for midfielder is the greatest of all positions (Bradley et al., 2009); therefore, members are substituted to maintain the required intensity of movement for the team.

Considering the above, it is highly likely that players with higher intermittent endurance will

Table 2 Factors of member substitution of four regular players (MF)

Player (MF)	Yo-Yo IR2 test	Factors of substitution			
		(Total)	Tactical	Physical	Injury
A	1440 m	0%	0%	0%	0%
B	1160 m	40%	20%	20%	0%
C	1160 m	50%	33%	17%	0%
D	1040 m	100%	40%	60%	0%

experience fewer member substitutions due to physical factors; therefore, the regular players (MF) with fewer substitutions had better Yo-Yo IR2 test results. Although we asked coaches their reasons for member substitutions, we did not measure individual subject performance related to intermittent endurance in games, which prevents the objective evaluation of the relationship between member substitutions and intermittent endurance. In future studies, it is necessary to measure individual player performance to multilaterally examine factors associated with member substitutions.

3.4. Changes in Intermittent Endurance during the Season

Yo-Yo IR2 test results for the subjects in this study were 869 ± 120 m at Start of season, 1124 ± 138 m at Start of in-season, 1276 ± 155 m at End of season. Comparison of their Yo-Yo IR2 test results during the measurement period showed a significant difference between Start of season and Start of in-season, and between Start of in-season and End of season (Figure 4).

Bangsbo et al. (2008) reported that Yo-Yo IR2 test results obtained from professional soccer players increased from the start of pre-season preparation period to the start of in-season; however, they decreased from the start of in-season to the end of season. Professional soccer players training throughout the in-season is managed to recover from fatigue between official games. However,

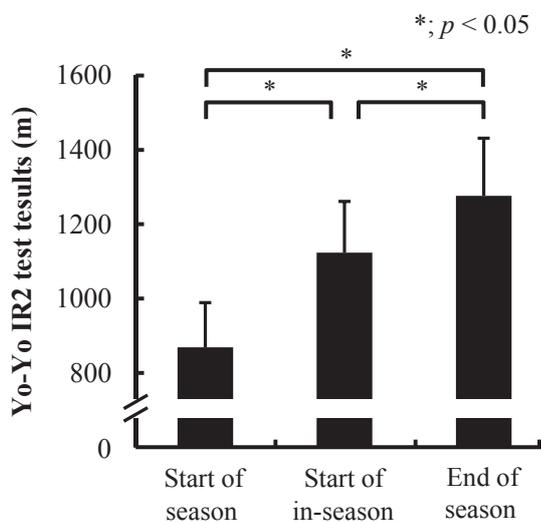


Figure 4 Seasonal changes in Yo-Yo IR2 test results for U-18 soccer players

as is described above, intermittent endurance is a major requirement, making it necessary to provide young players with training to increase intermittent endurance throughout the season while giving due consideration to reducing fatigue. U-18 soccer players in this study succeeded in improving their intermittent endurance through the season.

Among professional soccer players, Yo-Yo IR2 test results for international level players were superior to results for non-international level players, and domestic league Division 1 player results were superior to Division 2 player results (Krustrup et al., 2006). Yo-Yo IR2 test results for players on upper grade teams in Danish Premier League were better than players on middle grade teams, and better for middle grade teams than lower grade teams (Randers et al., 2009). It is, therefore, desirable to increase the intermittent endurance of youth soccer players throughout the year and allow them to attain higher-level intermittent endurance to play in higher level categories and get more outstanding achievement.

4. Conclusion

In conclusion, it is thought that U-18 soccer players with higher intermittent endurance have the chance selected as starters with less member substitutions and are highly possible to become higher ratio of individual playing time in official soccer games.

Reference

- Bangsbo, J. (1994). The physiology of soccer with special reference to intense intermittent exercise. *Acta Physiologica Scandinavica*, 151, Suppl. 619: 1-156.
- Bangsbo, J., Nørregaard, L. & Thorsø, F. (1991). Activity profile of competition soccer. *Canadian Journal of Sport Sciences*, 16(2): 110-116.
- Bangsbo, J., Iaia, F.M. & Krustrup, P. (2008). The Yo-Yo intermittent recovery test: a useful tool for evaluation of physical performance in intermittent sports. *Sports Medicine*, 38(1): 37-51.
- Bangsbo, J. & Mohr, M. (2012). Fitness testing in football – Fitness training in soccer II (pp. 35-58). Bagsværd: Stormtryk.
- Bradley P.S., Sheldon W., Wooster B., Olsen P., Boanas P. & Krustrup P. (2009). High-intensity running in English FA Premier League soccer matches. *Journal of Sports Sciences*, 27(2): 159-168.
- Carling, C., Espiè, V., Le Gall, F., Bloomfield, J. & Jullien, H. (2010). Work-rate of substitutes in elite soccer: a preliminary study. *Journal of Science and Medicine in Sport*, 13(2): 253-255.
- JFA physical fitness project (2005). Evaluation of physical performance 2006. Tokyo: JAPAN FOOTBALL ASSOCIATION. (in Japanese)

- Krustrup, P., Mohr, M., Nybo, L., Jensen, M.J., Nielsen, J.J. & Bangsbo, J. (2006). The Yo-Yo IR2 test: physiological response, reliability, and application to elite soccer. *Medicine & Science in Sports & Exercise*, 38(9): 1666-1673.
- Mohr, M., Krustrup, P. & Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. *Journal of Sports Sciences*, 21(7): 519-528.
- Randers, M.B., Jensen, J.M., Bangsbo, J. & Krustrup, P. (2009). Match performance and Yo-Yo IR2 test performance of players from successful and unsuccessful professional soccer teams. In T. Reilly & F. Korkusuz (eds), *Science and Football VI* (pp.345-349). New York: Routledge.
- Ueda, S., Yamanaka, A., Yoshikawa, T., Katsura, Y., Usui, T., Orita, K. & Fujimoto, S. (2011). Differences in physiological characterization between Yo-Yo intermittent recovery test level 1 and level 2 in Japanese college soccer players. *Journal of Sport and Health Science*, 9: 33-38.



Name:
Kentaro Chuman

Affiliation:
JUBILO CO., LTD.

Address:
2500 Shingai, Iwata-shi, Shizuoka 438-0025 Japan

Brief Biographical History:

2003-2005 Master's Program in Health and Physical Education, University of Tsukuba
2009-2012 Doctoral Program in Physical Education, Health and Sport Sciences, University of Tsukuba
2004-2010 Physical coach, Jubilo Iwata Youth Academy
2011- Scout & Physical adviser, Jubilo Iwata

Main Works:

- Chuman, K., Takahashi, S. & Nishijima, T. (2004) Dynamic characteristics of muscle in preadolescent boys. *Human Performance Measurement 1*: 30-35.
- Chuman, K., Takahashi, S., Nakano, T. & Nishijima, T. (2005) Dynamic causal structure analysis of condition fluctuation factors in a soccer player. *Football Science 2*: 1-7.
- Chuman, K., Hoshikawa, Y. & Iida, T. (2009) Yo-Yo intermittent recovery level 2 test in pubescent soccer players with relation to maturity category. *Football Science 6*: 1-6.
- Chuman, K., Hoshikawa, Y., Iida, T. & Nishijima, T. (2011) Relationships between Yo-Yo intermittent recovery tests and development of aerobic and anaerobic fitness in U-13 and U-17 soccer players. *International Journal of Sport and Health Science 9*: 91-97.
- Chuman, K., Hoshikawa, Y., Iida, T. & Nishijima, T. (2011) Yo-Yo intermittent recovery level 2 test performance and leg muscle growth in a six-month period among pubescent soccer players at different stages of maturity. *International Journal of Sport and Health Science 9*: 105-112.
- Chuman, K., Hoshikawa, Y., Iida, T. & Nishijima, T. (2013) Relationship between sprint ability and maturity in elite and sub-elite pubescent male soccer players. *Football Science 10*: 10-17.
- Chuman K., Ikoma T., Hoshikawa Y., Iida T., Nishijima T. (2013) Yo-Yo intermittent recovery level 2 test in young soccer players from U-13 to U-18. *Science and Football VII*: 101-106.
- Chuman, K., Hoshikawa, Y., Iida, T. & Nishijima, T. (2013) Quasi-simplex structure among physical ability factors with relation to sprint speed in pubescent male soccer players. *Football Science 10*: 57-64.

Membership in Learned Societies:

- Japanese Society of Science and Football
-