

## ANALYSIS OF MATCH ACTIVITIES IN HIGH SCHOOL SOCCER PLAYERS USING A MOBILE GPS AND VTR METHODS

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The purposes of this study were to obtain the match activity of high school soccer player, and to examine the measured value between GPS and VTR methods during a match play. The players' match activity ratios of total distance covered were walking 37.8%, jogging 16.6%, running 32.2%, sprinting 6.8%, back-walking 3.9% and back-running 3.1%, respectively. The total distance covered by GPS method was  $5140.7 \pm 476.6$  m, and by VTR method was  $5105.6 \pm 459.8$  m. As for the total distance covered, no significant difference was found between GPS and VTR methods. These findings gave suggestion that the distance covered by soccer player could be used with mobile GPS receiver. In the near future, more new accurate data will be got with GPS technique of new receiver in high quality.

**KEY WORDS:** GPS technique, match activity, high school soccer player, distance covered

**INTRODUCTION:** The physiological demands of soccer can be examined by making relevant observations during match play or obtaining physiological measures during real or simulated games. Distance covered is one of the essential factor determine physiological demands of soccer player. Several methods have been employed to determine the distance covered during a soccer match. But these current measurement techniques of the distance covered of soccer player during a match need a great number of time and materials and so on. So we tried to use by GPS technique for the measured soccer players' activities during a match play.

GPS was developed for military affairs by the United States Department of Defence, and originally imposed Selected Availability (SA) added to a measuring error on purpose. But SA was removed at the beginning of May 2000, furthermore, GPS is being more popular and accurate, and GPS receiver become so small. The GPS system is based on the emission of radio signals in a synchronized way by 24 satellites in orbit around the earth. GPS technique is used for spatio-temporal behavior studies of animals, crustal shortening accommodates and more. In a field of sports, GPS is used orienteering, yacht and assessment of physical activity. However in a field of ball games, so far as I know, only a few studies used GPS technique.

The purposes of this study were to obtain the match activity of high school soccer players during a match and to examine the difference of measured value between GPS and VTR methods.

**METHODS:** Twenty seven high school male soccer players (age  $16.1 \pm 0.8$  years, height  $168.4 \pm 5.8$  cm, weight  $57.1 \pm 5.6$  kg, exp. of soccer  $6.5 \pm 2.1$  years) participated in this study; eight forward players, eleven midfield players and eight defense players. Each player wore small waist bag with a mobile GPS receiver (GPS-315, MAZELLAN) and performed an exhibition match Kanazawa Soccer Festival (60min match, August 6-13) in his usual way. We had prior consultation with responsible person, referee, coach and player of the match to ask for permission to wear GPS receiver during a match. This competition was chosen because a player was prohibited to wear such as GPS receiver in regular soccer tournament by Laws of the Game issued by FIFA (Federation International de Football Association) as follows: "A player must not use equipment or wear anything which is dangerous to himself or another player (including any kind of jewellery)". The distance covered was displayed monitor on GPS receiver, and renewed every other second. Furthermore, players were observed the whole match play by video camera (SONY) and recorded videotape. Subsequently, an experienced analyst viewed the video playback on the monitor and corded the players' match

activities. Match activities were divided as following categories (Martin et al., 2001. D'Ottavio and Castagna, 2001, Withers, 1982):

- a) walking—strolling forwards and stepping sideways;
- b) jogging—slow running in which no effort was made to stride or accelerate;
- c) running—running with an elongated stride but without full effort;
- d) sprinting—running at maximum speed and full effort;
- e) back-walking—walking backwards; and
- f) back-running—running backwards.

As part of their warm-up before a match, the subjects performed straight distance of 20 m using the specific type of activity (walking, jogging, running sprinting, back-walking and back-running). The total distance covered was calculated by mean stride length of each subject.

Data was presented as mean and standard deviation. Mean values for match activities were compared using Student's paired *t*-test. Correlation coefficients were determined and tested for significance using Pearson's regression test. Significance was set at  $p < 0.05$ .

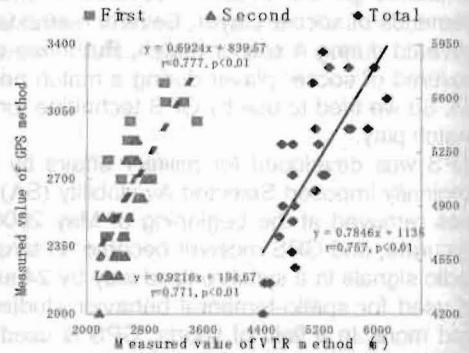
**RESULTS AND DISCUSSION:** The mean and standard deviation of overall distance covered by GPS vs. VTR methods were first half 2648.1±292.7 vs. 2621.1±328.3 m, second half 2492.6±236.8 vs. 2493.5 ± 198.1 m and total 5140.7 ± 476.6 vs. 5105.6 ± 459.8 m, respectively

**Table1 The mean and S.D. of measurements by GPS and VTR method during match (m).**

Method	First half		Second half		Total	
GPS	2648.1(292.7)	ns	2492.6(236.8)	ns	5140.7(476.6)	ns
VTR	2612.1(328.3)		2493.5(198.1)		5105.6(459.8)	

ns: not significance ( $p > 0.05$ )

(Table1). There was no significant difference between a measured value of GPS and VTR methods. The relationship obtained between the distance covered by GPS and VTR methods were shown in Figure1. It can be seen that the correlations co-efficient between the measured value of GPS and VTR methods were high (first half  $r = 0.777$ , second half  $r = 0.771$  and total  $r = 0.757$ ,  $p < 0.01$ ). So we got accurate data of distance covered during a match play using GPS method similar to VTR method. In other words, there was every possibility of using GPS for measurement of match activity. However, a measured value of GPS was tendency larger than VTR method, and this was remarkable at first half. This caused may be related to playing speed or variation, and GPS may be not able to provide accurate measured value to these activities.



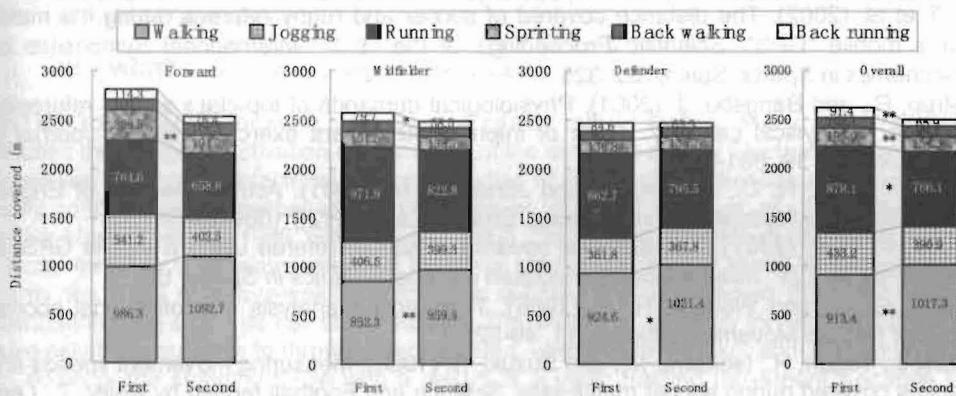
**Figure1 The correlation between measured value of GPS and VTR method. (Left degree matches first and second half, and right matches total.)**

In previous studies reported as for elite adult soccer players, the distance covered of every five minutes was 480-640 m (Reilly and Thomas, 1976, Withers, 1982, Bangsbo, 1994, Ekblom, 1991, Ohashi, 1991). In our study, the distance covered of every five minutes by GPS and VTR methods were first half 441.3 m and 435.4 m, second half 415.3 m and 415.6 m and total 428.3 m and 425.5 m, respectively. This difference was caused by difference of players' physiological level and/or skill level. Furthermore, Drust et al. (1988) reported that in the maximum speed distance covered by players reduced by approximately 50% caused by following factor that heat combined with high relative humidity (>70%). In this reason thought may effected by players performance.

The match activities of each position and overall players by VTR method were shown in Figure2. Defense players covered the shortest distances (Defender<Midfielder<Forwards) during a match. Similarly, as for GPS method, defense players covered the shortest distances (Defender<Forward<Midfielder) during a match, but no significant differences

among three positions. This tendency was similar to previous studies (Reilly and Thomas, 1976, Withers et al., 1982, Bangsbo, 1994).

The mean and standard deviation (ratio of total distance covered) of overall match activities were walking  $1930.6 \pm 320.8$  m (37.8%), jogging  $824.1 \pm 273.6$  m (16.1%), running  $1644.2 \pm 439.3$  m (32.3%), sprinting  $348.2 \pm 152.1$  m (6.8%), back-walking  $201.1 \pm 87.0$  m (3.9%) and back-running  $157.3 \pm 78.8$  m (3.1%), respectively. In positional roles, only sprinting of forward players during first half and total were significant higher ( $p < 0.01$ ) than other players. Discussed for each match activity, the increase between first and second half of walking ( $p < 0.01$ ), the decreases of running ( $p < 0.05$ ), sprinting ( $p < 0.01$ ) and back-running ( $p < 0.01$ ) were significant. These findings were similar for some previous studies (Drust, Reilly). This finding suggested our studies players can't keep up high performance level even 60min match, so they need physiological level for keep up running around 60-90min.



**Figure 2** The mean distance covered each type of match activity by forward, midfielder, defender and overall during first and second half.

\*:  $p < 0.05$ . \*\*:  $p < 0.01$

As for GPS method, the mean and standard deviation of distance covered by forward players during the first and second half amounted to  $2750.0 \pm 350.0$  m and  $2475.0 \pm 249.2$  m, and overall was  $2648.1 \pm 292.6$  m and  $2492.5 \pm 236.8$  m, respectively. These decreases of distance covered between first and second half (10.0% and 5.9%) were significant ( $p < 0.05$  and  $p < 0.01$ ). Furthermore, there were no significant difference but the decrease of distance covered between first and second half was found by almost players. As for VTR method, the mean and standard deviation of overall distance covered during the first and second half amounted to  $2612.1 \pm 328.3$  m and  $2493.5 \pm 198.1$  m, respectively. The decrease of distance covered between first and second half (4.5%) were significant ( $p < 0.05$ ).

Discussed for walking, Reilly and Thomas (1967) reported 24.8% for English First Division players; Withers et al. (1982) reported 26.3% for Australian professional soccer players, in our studies value (37.8%) was larger than those studies. For high intensity exercise (running and sprinting), Reilly and Thomas (1976) reported 17.9%, Withers (1982) reported 18.8% and in present study was 22.9%. Our studies subjects developed a tendency to move greater ratios of walking and high intensity exercise than previous studies, but these tendencies may be caused by difference in absolute value.

**CONCLUSION:** Total distance covered performed by high school male soccer players was 65%-85% smaller than previous studies as for elite adult players. However, the ratio of high intensity exercise and walking were higher than previous studies. The measurement of distance covered between GPS and VTR methods were approved significant high correlation. In present study, we provide only the measurement of the distance covered of soccer player by GPS technique. But in the near future, we firmly believe that GPS could be measure new

accurate match activities by soccer player, referee and any other sports because of technological advances and be make the best use of it.

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