Paper : Football (Soccer)

Prediction of talent in youth soccer players: prospective study over 4-6 years

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Many recent studies have investigated talent identification in soccer players; however, no clear results have been reported due to the lack of prospective research designs. Moreover, the issue is complicated by large differences in individual biological maturation rates. The present study investigated the index of talent identification for youth soccer players in career development. Sixty-two adolescent soccer players participated in this study. They were divided into professional, collegiate, and regional players based on their performance level at 18 years of age. Height, weight, skeletal age, stepping speed, endurance, and choice reaction time (hand: HRT, foot: FRT and hand-foot-complex: CRT) were measured. CRT was significantly faster in professional players and collegiate players compared with regional players. The mean values of body weight, height, and CRT tended to be higher for professional players than collegiate players, albeit statistically insignificant. Our findings suggest that adolescent soccer players with faster CRT should be identified as potential professional players.

Keywords: Youth soccer, Talent identification, Information-processing ability, Skeletal age

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1. Introduction

Soccer is one of the most popular sports in the world with player numbers increasing annually at an explosive rate. Children now tend to start specific sports training in a specialized environment at a younger age than in previous years. The desire to be a professional soccer player is strong and future aspirations are usually relayed to the coaching staff. Coaches are, therefore, increasingly interested in identifying talented players in their clubs for development to a professional level.

Four key stages have been proposed in sourcing professional soccer players: detection, identification, selection, and development (Williams and Franks, 1998; Williams and Reilly, 2000). Sports scientists are in a position to provide support to coaches and players through the development of methods for “talent identification” and “development” of physiological performance. To this end, elite soccer players have been studied to identify key factors in their success. Reilly et al. (2000) reported that elite young soccer players show better aerobic power, fatigue tolerance, muscle power, and speed than subelite players do. Bunc and Psotta (2001) also referred to the physiological demands placed on top-level soccer players and concluded that a high level of aerobic ability was required. Moreover, anthropometric characteristics have been correlated with performance, and Franks et al. (1999) noted that this will be useful for initial talent identification. However, these studies compared late-adolescent players and adult players. Therfore, characteristics of professional soccer players in their early adolescent remain unkown.

A prospective study is necessary to clarify this issue, and few such studies have been undertaken. Jankovic et al. (1997) reported that 15- to 17-year-old players who turned professional within three years showed enhanced aerobic ability, anaerobic ability, and grip strength than those who became semiprofessional players. This result implied the existence of physiological factors separating future professional players from those destined to become non-elite and sub-elite soccer players. However, these physiological characteristics tend to develop only during late adolescence. Therefore these parameters may not be suitable for an index of talent

identification in early adolescent.

On the other hand, the relationship between reaction time and performance has been examined. Harbin et al., (1989) examined the speed of visual response in athletic performance and injury and clarified that professional football players had faster visual response times than amateur players. They concluded that response time was useful to a certain extent in determining athletic potential. Several studies examined the relationship between reaction time and sports performance levels in handball (Lidor A. et al., 1998), basketball, volleyball, water-polo (Kioumourtzoglou E. et al., 1998), and fencing (Williams LR. et al., 2000) from 1990 to 2000. Many of these studies recognize that the potential of reaction time in determining sports performance level. Moreover, several groups have cited significant improvements in reaction time from childhood to adolescence (Mullis et al., 1985; Johnson 1989). These results may suggest that the development of reaction time ceases before adolescent. From these results, we hypothesized that reaction time has some potential for use in talent identification in early adolescent.

Stepping speed improves along with the development of choice reaction time during childhood (Asami and Shibukawa, 1975; Hirose et al., 2002). In addition, it has been reported that professional soccer players have faster stepping speed than collegiate soccer players (Ogai et al., 2000). These results may imply that stepping ability has potential as a predictor of talent. However, previous studies have adapted different stepping task durations; ie, 20 seconds (Asami and Shibukawa, 1975) and 5 seconds (Ogai et al., 2000). It can be speculated that the former procedure may reflect stepping fatigue tolerance ability in addition to stepping speed. Thus this discrepancy in stepping duration may result in different outcomes. In this study, therefore, we measured stepping frequency for 20 seconds, then divided the result into stepping speed (stepping frequency per second for 0 to 6 seconds) and stepping endurance (stepping frequency per second for 7 to 20 seconds/stepping speed).

Identifying sporting talent in adolescents has been considered difficult due to the large individual differences in biological maturation measurements such as skeletal age (Malina et al., 2000; Cacciari et al., 2001). The development of physical and physiological measurements for predicting talent, therefore, should take the biological maturation of an adolescent player into consideration (Baxter-Jones, 1995; Malina et al., 2000).

The aim of the present study was to define characteristics in professional soccer players that were advanced during adolescence with regard to maturational, anthropometric, physiological, and psychophysiological features using a prospective study.

2. Methods

2.1. Subjects

The study enrolled 80 Japanese male adolescent soccer players. Nine players were eliminated by injury and nine goalkeepers were also excluded. The final group comprised 62 healthy field players (age range: 11-year-olds, n=3; 12-year-olds, n=27; 13-year-olds, n=14; 14-year-olds, n=18), with a mean age of 13.4±1.0 years (range 11.8–14.9 years). They were members of an under (U)-15 team in the Japanese professional soccer league (J League) during the 2000 and 2001 seasons.

Subjects were divided into three groups; namely, professional, collegiate and regional. The professional group included eight players who passed selection as 18-year-olds and who were employed as professional soccer player in division 1 (J1: 7 players) and division 2 (J2: 1 player) teams. The collegiate group included 21 players who passed the selection at 14 years of age and advanced their careers; however, these were not professional soccer players as 18-year-olds. The regional group included 33 players who failed the selection at 14 years of age, and were not professional player as 18-year-olds (**Figure 1**). Information on subject career was obtained by questionnaire and interview. All measurements were compared between groups.

All players participated in the same training program during their term with the U-15 team. Professional and collegiate players participated in the same program in a U-18 team. The U-15 team had five training days (2 hour sessions) per week, includin one or two match days. The U-18 team had six training days (2.5- to 3-hour sessions), including one or two match days.

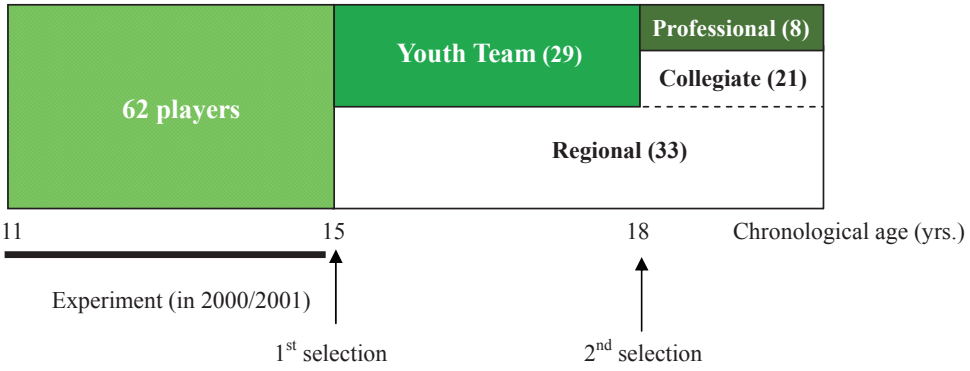

Figure 1 Experimental design.

Twenty-nine of sixty-two adolescent soccer players advanced their careers to the youth teams. Of youth team players, eight became professional soccer players.

2.2. Measurements

Body height, weight, and skeletal age

Body height and weight were measured prior to training. Height was measured by stadiometer (YL-65S, Yagami Co., Nagoya, Japan) to the nearest 0.1 cm, and body weight was measured to the nearest 0.1 kg using a body fat monitor (TBF-551, Tanita Co., Tokyo, Japan). Skeletal age was estimated from X-rays of the left hand and wrist using the radius-ulna-short bone (RUS) score according to the method of Tanner–Whitehouse (TW) (Tanner et. al., 1983). The RUS score was measured by a skilled orthopedic surgeon and researcher.

Previous studies reported that the RUS score in Japanese children increased more rapidly during maturation at pubertal age than in children from European countries (Britain, Belgium) and other Asian countries (southern China, and northern India), attaining adult scores one or two years earlier (Ashizawa et al., 1996). Therefore, standardized conversion tables were used when calculating the skeletal age of our Japanese subjects using the method of Murata (Murata et al., 1993). The biological maturation of each individual was evaluated as the maturation difference (skeletal age - chronological age).

Choice reaction time, stepping speed and stepping endurance.

Choice reaction time, stepping speed and stepping endurance were measured by Talent-Diagnose-System (TDS, Werthner Sports Consulting, KEG). TDS consisted of an interface, personal computer including a monitor, and plate for tapping or stepping (**Figure 2**). These tapping plates were connected to the computer through the TDS interface. Signals generated from tapping and stepping plates were digitized through the TDS interface and computed reaction time. Visual stimuli were displayed on the monitor, which was positioned on a table 70 cm above ground level.

To identify the choice reaction time, subjects stood in front of the plates so that they could react as quickly as possible. Bilateral hands and feet were represented by squares. Dots appeared on each square randomly. Subjects were instructed to tap or step on each plate following the appearance of the dots. One trial included 32 repetitive stimuli. Reaction time was divided into HRT (Hand Reaction Time), FRT (Foot Reaction Time), and CRT (Complex Reaction Time).

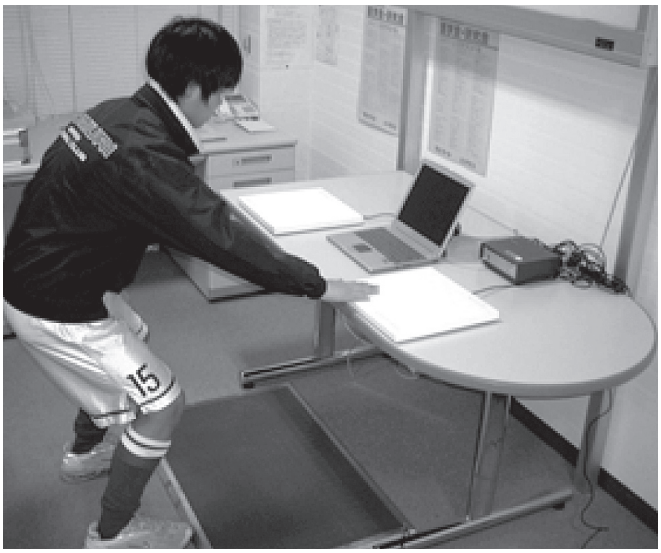

Figure 2 Experimental set up.

Talent-diagnose-system (TDS) includes display (PC), TDS interface and tapping plate for hand and foot.

CRT represented the time between the appearance of the dot and the tapping/stepping of the hand and foot simultaneously.

Stepping ability was also measured by TDS. Subjects stepped on the stepping plate for 20 seconds, and the measure was divided into stepping speed and stepping endurance.

The choice reaction time, stepping speed, and stepping endurance of two measurement trials were averaged and used for statistical analysis. Subjects trained in the protocol of this method before the measurement to eliminate the influence of practice.

All measurements were taken once during March and April in 2000 and 2001. This study complied with the requirements for human experimentation of the Faculty of Sport Sciences, Waseda University. The subjects and their parents were fully informed about the procedures and the purpose of this study. Written informed consent was obtained from all participants and their parents.

2.3. Statistical methods

All data were expressed as mean ± SD. Differences in all measurements among groups in performance level were evaluated by one-factorial ANOVA and Scheffé least significant difference test. *P* values less than 0.05 denoted the presence of a statistically significant difference.

3. Results

The mean values of each measurement are presented in **Table 1**. Skeletal age of the subjects was generally ahead of chronological age (**Figure 3**). There were no significant differences between groups in chronological age, skeletal age, or skeletal age–chronological age difference.

Comparison of anthropometric characteristics revealed that professional players were taller than other players; however, this difference was not statistically significant. This tendency was also found in body weight.

There were no significant differences between groups in stepping speed (F=1.339, p=0.272) and stepping endurance (F=0.545, p=0.583).

In this study, only choice reaction time showed significant group differences, with a significant difference in CRT (F=5.726, p<0.01). Professional players (p<0.05) and collegiate players (p<0.05) showed significantly faster CRT than regional players (**Figure 4**). HRT (F=1.044, p=0.359) and FRT (F=1.452, p=0.243) showed the same trend as CRT, but the differences were not statistically significant (**Figure. 4**).

4. Discussion

In this study, possible measurements for the prediction of talent were examined in adolescent soccer players with respect to their maturational, anthropometric, physiological, and psycho-physiological status. Results showed that professional and collegiate players had significantly faster CRTs than regional players, and professional players in turn had faster CRTs than collegiate players. However, there were no significant differences in other physiological factors between groups. Stepping speed is a simple repetitive movement. In contrast, choice reaction time such as CRT involves cognition and decision-making speed and may reflect the information-processing ability of the central nervous system (Fontani et al., 1999). Consequently, our findings suggest that information-processing ability is more important than the simple measures of stepping speed and endurance when evaluating talent in adolescent players.

Simple reaction times and performance level have been discussed previously in soccer-ability evaluations. Helsen and Starks (1999) reported that semiprofessional players showed no enhanced visual information processing ability compared to student players. Williams (2000) supported this result and also commented that the performance levels in soccer are not dependent on the hardware of cognition. However, other studies have supported a relationship between reaction time and performance in soccer players (Montes-Mico et al., 2000; Ando et al., 2001).

It is possible that task modality differences may underlie these controversial results in previous studies. In this study, we adapted the choice reaction task rather than the simple reaction task, requiring a higher level of attention and central information-processing ability such as cognition and decision making (Fontani et al.,1999). Thus the soccer players had to react quickly and accurately to various visual stimuli such as the movement of the ball and other players, which is a closer reflection of performance on the soccer field than simple reaction tasks. Therefore, it will be speculated that the hardware of

Table 1 Summary of results.

Measurements		Professional (n=8)	Collegiate (n=21)	Regional (n=33)	ANOVA (F value)
Chronological age (CA)		13.5±1.2	13.4±0.8	13.3±1.0	0.049
Skeletal age (SA)	yrs.	14.1±1.2	13.9±1.2	13.9±1.1	0.139
SA-CA		0.7±1.0	0.5±0.8	0.5±0.8	0.180
Height	cm	164.8±6.7	162.7±7.5	161.0±8.0	0.883
Weight	kg	56.9±9.6	51.8±7.6	50.8±8.3	1.721
CRT		576.6±69.8	608.1±82.9	682.8±111.3	5.726**
HRT	msec	497.5±75.9	500.8±62.6	524.6±66.5	1.044
FRT		576.8±61.4	584.3±60.8	612.0±73.3	1.452
STF	rep./sec	10.9±1.0	11.2±0.8	11.6±1.2	1.339
STE	%	83.1±4.9	84.6±7.4	82.7±6.1	0.545

**p<0.01

Data are mean ± SD.
CRT: hand-foot-complex reaction time, HRT: hand reaction time, FRT: foot reaction time, STF: stepping speed (rep. means repetition), STE: stepping endurance

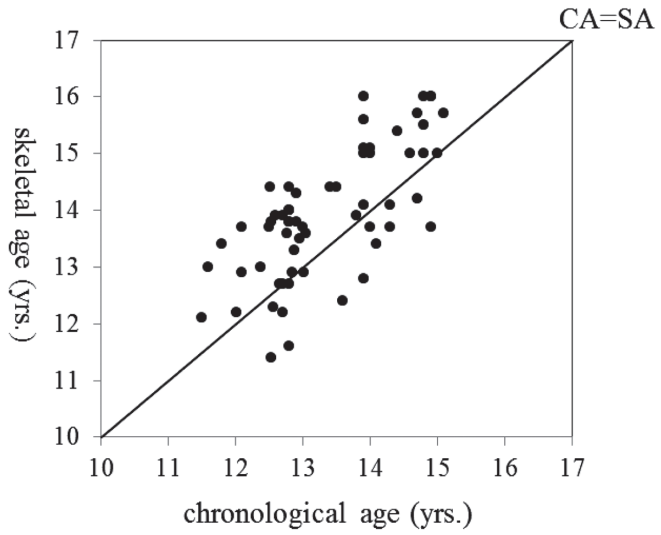

Figure 3 Scatter plot of a skeletal age and chronological age of subjects.

In many subjects, skeletal age was in advance of chronological age, implying early maturation. The diagonal line (CA=SA) indicates that skeletal age is equal to the chronological age.

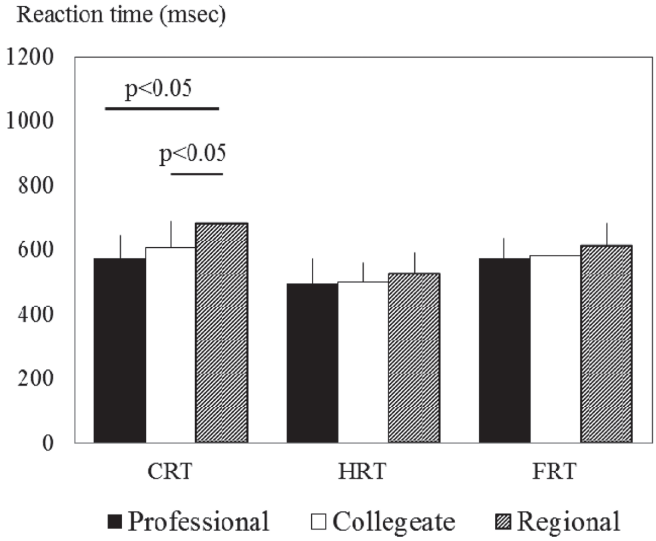

Figure 4 Comparison of choice reaction times among professional, collegiate and regional players.

Professional and collegiate players have significantly faster CRT than regional players.
Data are mean ± SD.
CRT: hand-foot-complex reaction time, HRT: hand reaction time, FRT: foot reaction time.

visual reaction may not influence performance to a significant extent, but that visual software such as information-processing ability in the central nervous system may have a correlative effect on the level of soccer player performance.

Since previous studies have been retrospective, the above findings may support only part of our results. However, an empirical prospective study into reaction ability as a characteristic of professional soccer players has never been conducted. In this regard alone, our findings are noteworthy and add new insights for talent identification in soccer.

In this study, we identified possible predictors of talent in professional soccer players. However, our findings have certain limitations. First, our findings were obtained solely from one team. Thus further research using a greater number of participants and teams is needed to generalize our findings. Second, it was not clear why players with faster CRT passed the youth selection to become professional players. Sixty-two players in this study were selected as elite soccer players based on good skills and tactics as well as the appropriate physical and physiological characteristics in early adolescence. Although all players participated in the same training program from 12 to 14 years of age, only 29 players with faster CRT advanced to the youth team and only eight players became professional players. We speculated that the "information-processing ability" and "whole-body coordination" reflected by the CRT values enhanced the effectiveness of the training period. Finally, while the professional players had faster CRTs than the collegiate players, this trend was not statistically significant. This result may indicate the difficulty in predicting long-term success in adolescent soccer players based solely on speed in CRT measurements. In addition to the advancement in CRT, professional players generally had greater body weight and height than collegiate players. These results may imply the multifactorial nature of talent identification. From these results, we conclude that information-processing ability is a fundamental factor for the career advancement of adolescent soccer players. While other physiological factors are also required, especially anthropometric characteristics, in becoming a professional player, these generally develop during late adolescence. On the other hand, information-processing ability is thought to develop completely in early adolescence (Mullis et al., 1985; Johnson, 1989). We, therefore, propose CRT as a predictive measure for the identification of talent in adolescent soccer players.

Contrary to our hypothesis, we could not obtain clear differences in skeletal age between groups. We hypothesized from recent studies (Cacciari et al., 1999; Malina et al., 2000) that those who became professional soccer player might have matured earlier and, therefore, have had faster reaction times than late-maturing players. However, our results did not support this hypothesis. Initially, we thought that the subjects in this study were biased for biological maturation, meaning that late-maturing players had already been eliminated by selection in early adolescence. The findings that skeletal ages were ahead of chronological ages may support this speculation. However, it has been reported that choice reaction time develops in preadolescents aged 10 to 12 years (Hirose, 2004), and subjects in this study ranged from 12 to 14 years old. Therefore, reaction time may not show remarkable development during this age range and, therefore, have no correlation with biological maturation. Further research using an expanded age range and longitudinal studies is needed to clarify the relationship between development of information-processing ability and biological maturation.

In conclusion, our study suggested that adolescent soccer players with faster choice reaction time such as CRT had the potential to advance their career in late adolescence and become professional soccer players. Based on these findings, evaluating this ability during mid-adolescence might enable coaches to identify players with higher potential to play soccer at a professional level. Moreover, it is suggested that in addition to speed and endurance coaches should train players to develop their information-processing ability. This is particularly important in early adolescence, when central information-processing ability develops significantly.

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