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# 한국 축구의 상대연령효과: 연령대별 국가대표팀 분석

스피크 재활의학과 & 퍼포먼스센터[1], 세종대학교 체육학과[2], 포항공과대학교 스포츠산업지원센터[3]

정태석[1] • 방상열[1] • 박세환[1] • 이용수[2] • 김용래[2] • 김영석[3]

# Relative Age Effects in Korean Football: Analysis of Age-Specific International Teams

**Tae-Seok Jeong[1], Sang-Yeol Bang[1], Sehwan Park[1], Young-Soo Lee[2], Yong-Rae Kim[2], Young-Seok Kim[3]**

*[1]SPIK Sports Medicine Clinic and Performance Center, Seoul, [2]Department of Sports Science, Sejong University, Seoul, [3]Korea Sport Industry Development Institute, Pohang University of Science and Technology, Pohang, Korea*

**Purpose:** This study aimed to identify relative age effects of South Korea national male football teams that participated in 38 international competitions in age-specific categories from 2000 to 2018; U-16 (n=176), U-17 (n=82), U-19 (n=198), U-20 (n=147), and U-23 (n=166).

**Methods:** Available information on birth-dates, heights, and body weights of South Korean elite male football players was collected from the official websites. Chi-square test was conducted and odds ratios were calculated with 95% confidence interval in order to examine differences of quarter distribution between expected and observed subgroups.

**Results:** The birth distributions observed in each team were significantly different than those expected in general population of the same age (U-16: $\chi^2$=59.364, $p<0.05$; U-17: $\chi^2$=36.829, $p<0.05$; U-19: $\chi^2$=51.697, $p<0.05$; U-20: $\chi^2$=39.531, $p<0.05$) except U-23 ($\chi^2$=17.759, $p=0.087$). The magnitude of birth distribution was 3.2 times higher in the first quarter compared to that in the fourth quarter and was decreased in accordance with age. In accordance with age, the distribution of “competition age group” was significantly decreased in each team (U-16, 91%; U-17, 89%; U-19, 76%; U-20, 63%; U-23, 42%; $p<0.05$) but that of “under-competition age group” was increased (U-16, 9%; U-17, 11%; U-19, 24%; U-20, 37%; U-23, 58%; $p<0.05$). There is also significant difference in distribution between both “competition” and “under-competition age group” at the same tournament category ($p<0.05$).

**Conclusion:** Conclusively, these findings indicate that Korean players who are in the early stage of development have higher “relative age effects” than those in the late stage of development. This may implicate that it is necessary to develop strategies for relatively late-mature players who have potentials in terms of skills and intelligence of football.

**Keywords:** Football, Relative age, Talent

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Correspondence: Young-Seok Kim

Korea Sport Industry Development Institute, Pohang University of Science and Technology, 77 Cheongam-ro, Nam-gu, Pohang 37673, Korea

Tel: +82-54-279-8843, Fax: +82-54-279-8852, E-mail: tessj@hanmail.net

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## Introduction

In most of international sports competitions including football, chronological age-groups are categorized in order to reduce the potential variations of physical and cognitive ability related to growth and development of players[1-5]. In 1997, the Federation Internationale de Football Association (FIFA) has also defined an available player in each category for the age-specific competition as who was born in a selection year between 1 January and 31 December[2].

Under this grouping by chronological age, players could be different in age by nearly 12 months. A year of growth and maturation could significantly contribute to different achievements and successes in the context of youth football[6]. The oldest players within each group have an advantage over the youngest in terms of intellectual, psychological, and physiological perspectives; which has been termed the "relative age effect" (RAE). For example, the over-representation of youth players born in the first quarter of the selected year (January, February, and March) has been found extensively in European football[2,6-10]. Such phenomenon implicates that early growth and development of players is an important factor in the selection of elite male youth football players[11].

The incipient conspicuousness of early matured players might attract more attention from coaches and parents which consequentially increases youth players' motivation in line with their perceived competence[2,12]. As a result, early-matured players are more likely to be detected as talented athletes and then to be recruited for top elite levels of youth football through their early-career. Those youth players could be provided with a high quality of coaching, better instruction, more experience and sufficient time to play. Those result in their strengthened confidence and self-esteem[5,13-17]. The RAE may lead to a higher perception of competence, self-efficacy, motivation and other cognitive aspects that, in turn, have an impact on the quality of learning and on the player's level of performance[18]. Those impacts of the RAE in youth football players have demonstrated both physical and cognitive advantages in the recent research regarding youth academy levels in several nations such as the United States, Brazil and European countries[6-8,10,12,14,19-21]. However, there is little research on the RAE on national teams that participating in age-specific international tournaments such as the World Cup and Olympic Games. This study aimed to determine the RAE of Korean elite male players who participated in the highest level of age-specific international competitions from 2000 to 2018.

## Methods

### 1. Participants

The study comprised the South Korean elite male football players (n=769) who competed in one of the following tournaments: eight of Asian Football Confederation (AFC) U-16 Championships, four of FIFA U-17 World Cups, nine of AFC U-19 Championships, seven of FIFA U-20 World Cups, five of Asian Games (AG), and five of Olympic Games (OG) from 2000 to 2018. Subgroups of players were categorized into U-16 (n=176), U-17 (n=82), U-19 (n=198), U-20 (n=147) and U-23 (n=166) according to the regulation of each competition (Table 1).

### 2. Procedure

Available information on the South Korean elite male football players was collected from the official websites of FIFA, the AFC, and the Korea Football Association (KFA). Players who

Table 1. Age-specific international competitions included in the study

| Group | U-16 (n=176) | U-17 (n=82) | U-19 (n=198) | U-20 (n=147) | U-23 (n=166)* |
|---|---|---|---|---|---|
| Tournament | 8 AFC Championship (2002, 2004, 2006, 2008, 2012, 2014, 2016, 2018) | 4 FIFA WC (2003, 2007, 2009, 2015) | 9 AFC Championship (2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018) | 7 FIFA WC (2003, 2005, 2007, 2009, 2011, 2013, 2017) | 5 AG (2002, 2006, 2010, 2014, 2018), 5 OG (2000, 2004, 2008, 2012, 2016) |

AFC: Asian Football Confederation, FIFA: Federation Internationale de Football Association, WC: World Cup, AG: Asian Games, OG: Olympic Games.
*In U-23 subgroup, players who were over-competition age (i.e., wild card) were excluded.
All data were sourced from www.kfa.or.kr, www.fifa.com, and www.the-afc.com.

were over competition-age in the U-23 category (termed "wild card") were excluded from the data. The data included date of birth (day, month, and year), height and weight of each player. The cutoff date of the selected year for each tournament organized by FIFA and the AFC was the 1st of January. The players born between the 1st of January and 31st of December in the specific birth-year were allocated in "competition age group" but those born in before the specific birth-year were defined as "under-competition age group." The birth month of each player was categorized into four birth quarters (Q); each quarter was defined as Q1 (January to March), Q2 (April to June), Q3 (July to September), and Q4 (October to December), respectively.

### 3. Statistical analysis

The relationship between birth-date and the number of players was examined by simple linear regression analysis. Chi-square ($\chi^2$) tests were performed to compare differences between the observed and expected birth-date distributions across the four quarters. Odds ratio (OR) with a 95% confidence interval (CI) was calculated in order to compare the magnitude of quarterly distribution; for instance, Q1 against Q4, Q2 against Q4, and Q3 against Q4. An equal distribution ratio of births across all months and quarters assumed for all analyses in the study (8.33% per month and 25% per quarter, respectively). As the various sub-group analyses were conducted, it was difficult to take into account potential variations in monthly birth rates that might occur during 19 years. The one-way analysis of variance (ANOVA) was used to analyze the distribution of "competition age group" and "under-competition age group" in accordance with an age-specific category, respectively. In addition, independent t-test was conducted to compare the distribution of "competition age group" and "under-competition age group" players within the same age-specific sub-group. The height and body weight of players were compared by ANOVA according to age-specific subgroups, respectively. All statistical analysis was conducted using SPSS ver. 17.0 (SPSS Inc., Chicago, IL, USA). Statistical significance was set at $p<0.05$.

## Results

The quarterly distributions of birth-date by subgroups such as U-16, U-17, U-19, U-20, and U-23 were displayed in Fig. 1. Approximately 44% of U-16, 45% of U-17, 42% of U-19, 44% of U-20 and 33% of U-23 players were born in the first quarter (Q1) of the year. In contrast, birth distributions of players born in the last quarter (Q4) were 11% of U-16, 12% of U-17, 12% of U-19, 12% of U-20, and 16% of U-23, respectively. These findings suggested that there was a prominent RAE in each age-specific Korea national team with a greater distribution of early birth-date than that of late birth-date of players.

The distribution of players were significantly decreased according to birth month in all age-specific groups (U-16: $\beta=-0.879$, $p<0.05$; U-17: $\beta=-0.762$, $p<0.05$; U-19: $\beta=-0.752$, $p<0.05$; U-20: $\beta=-0.751$, $p<0.05$; U-23: $\beta=-0.591$, $p<0.05$; entire cohort: $\beta=-0.903$, $p<0.05$) (Table 2, Fig. 2). The birth distributions observed in each subgroup were significantly different than those expected (U-16: $\chi^2=59.364$, $p<0.05$; U-17: $\chi^2=36.829$, $p<0.05$; U-19: $\chi^2=51.697$, $p<0.05$; U-20: $\chi^2=39.531$, $p<0.05$), except U-23 ($\chi^2=17.759$, p=0.087). The median birth-month was April for U-16, 17, 19 and 20, and June for U-23 (Table 2).

The magnitude of birth distribution was displayed in Table 3 with odds-ratio and 95% CI. The odds-ratios decreased magnitude along with a decrease of relative age difference in each subgroup (U-16, 4.0–1.5; U-17, 3.8–0.8; U-19, 3.5–1.7; U-20, 3.7–1.7, U-23, 2.1–1.7). In comparison between subgroups, a higher magnitude

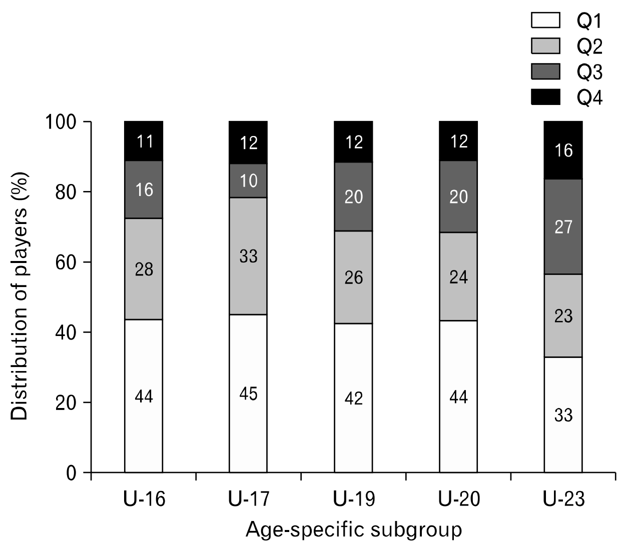


Fig. 1. Quarterly distribution of birth-date by each age-specific subgroup. Q1: January to March, Q2: April to June, Q3: July to September, Q4: October to December.

of birth distribution in the first quarter compared to that in the fourth quarter was obtained in a younger age-specific category (Table 3).

Fig. 3 shows that the distribution of "competition age group" significantly decreased ($p<0.05$) but "under competition age group" significantly increased in accordance with age ($p<0.05$). In each age-specific category, there were significant differences in the distribution between "competition age group" and "under-competition age group" (U-16: 91% vs. 9%, $p<0.05$; U-17: 89% vs. 11%, $p<0.05$; U-19: 76% vs. 24%, $p<0.05$; U-20:

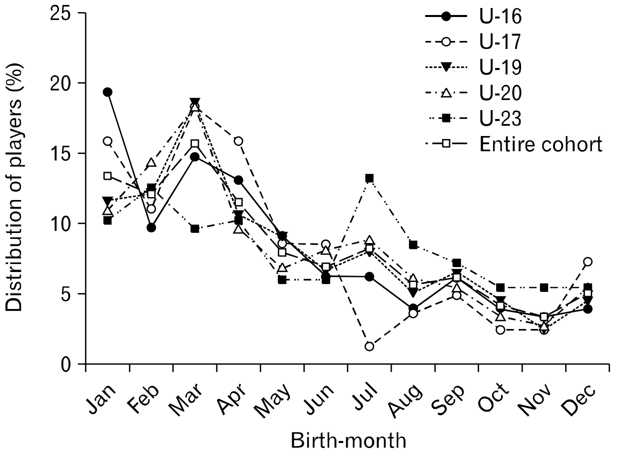


Fig. 2. Birth-month distribution of players by age-specific subgroups. Distribution of each subgroup was significantly different in accordance with month ($p<0.05$).

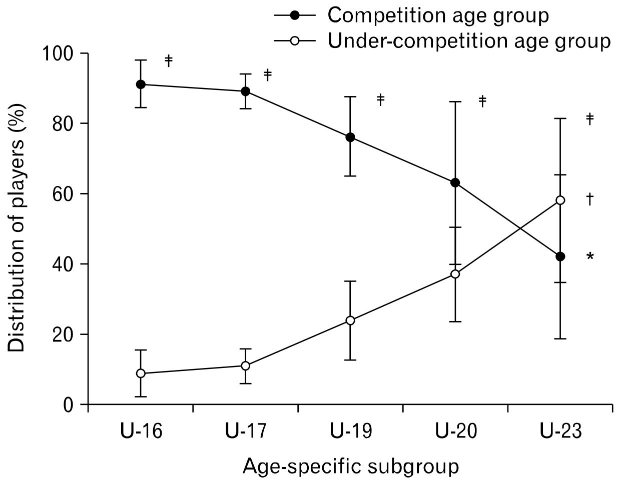


Fig. 3. Distribution of "competition age group" and "under-competition age group" significantly decreased (*) and increased (†) in accordance with age, respectively. In each age-specific subgroup, there were significant differences in the distribution between both groups (‡).

Table 2. Comparison of differences between the observed and expected birth-date distributions across the four quarters

| Group | Number | Median birth month | $\chi^2$ | p-value | Regression coefficient | |
|---|---|---|---|---|---|---|
| | | | | | $\beta$ | p-value |
| U-16 | 176 | April | 59.364 | 0.000 | −0.879 | 0.000 |
| U-17 | 82 | April | 36.829 | 0.000 | −0.762 | 0.000 |
| U-19 | 198 | April | 51.697 | 0.000 | −0.752 | 0.000 |
| U-20 | 147 | April | 39.531 | 0.000 | −0.751 | 0.000 |
| U-23 | 166 | June | 17.759 | 0.087 | −0.591 | 0.000 |
| Entire cohort | 769 | April | 156.841 | 0.000 | −0.903 | 0.000 |

$\chi^2$: chi-square test.

Table 3. The magnitude of quarterly distribution of players in each age-specific subgroup

| Group | Number | Q1/Q4 | Q2/Q4 | Q3/Q4 |
|---|---|---|---|---|
| U-16 | 176 | 4.0 (1.7−9.5) | 2.5 (1.0−6.2) | 1.5 (0.6−4.0) |
| U-17 | 82 | 3.8 (1.6−8.7) | 2.8 (1.2−6.5) | 0.8 (0.3−2.3) |
| U-19 | 198 | 3.5 (1.5−8.2) | 2.2 (0.9−5.2) | 1.7 (0.7−4.1) |
| U-20 | 147 | 3.7 (1.6−8.5) | 2.1 (0.9−5.0) | 1.7 (0.7−4.1) |
| U-23 | 166 | 2.1 (0.9−4.7) | 1.5 (0.6−3.5) | 1.7 (0.7−3.9) |
| Entire cohort | 769 | 3.2 (1.4−7.3) | 2.1 (0.9−4.9) | 1.5 (0.6−3.8) |

Values are presented as odds ratio (95% confidence interval).
Q1: January to March, Q2: April to June, Q3: July to September, Q4: October to December.

Table 4. Mean height and body weight of players in accordance with birth-quarter

| Group | Total | Q1 | Q2 | Q3 | Q4 |
|---|---|---|---|---|---|
| U-16 | | | | | |
| Height (m) | 1.78±0.06 | 1.78±0.05 | 1.78±0.06 | 1.78±0.05 | 1.78±0.06 |
| Body weight (kg) | 68.4±6.1 | 68.6±5.5 | 68.5±7.2 | 67.4±5.5 | 68.8±6.3 |
| U-17 | | | | | |
| Height (m) | 1.79±0.06 | 1.78±0.06 | 1.79±0.06 | 1.80±0.05 | 1.81±0.06 |
| Body weight (kg) | 68.4±6.1 | 68.3±7.3 | 69.8±7.0 | 70.1±5.1 | 69.7±7.4 |
| U-19 | | | | | |
| Height (m) | 1.80±0.06* | 1.80±0.06 | 1.81±0.06 | 1.80±0.06 | 1.80±0.07 |
| Body weight (kg) | 71.8±6.6*,† | 71.6±6.8 | 72.7±6.3 | 71.6±5.9 | 71.0±8.1 |
| U-20 | | | | | |
| Height (m) | 1.81±0.07* | 1.81±0.07 | 1.82±0.07 | 1.81±0.06 | 1.81±0.08 |
| Body weight (kg) | 72.7±6.9*,† | 72.2±6.6 | 74.3±7.3 | 71.8±5.6 | 72.6±9.2 |
| U-23 | | | | | |
| Height (m) | 1.81±0.06* | 1.80±0.05 | 1.82±0.07 | 1.80±0.05 | 1.83±0.06 |
| Body weight (kg) | 73.7±6.3*,† | 72.9±5.4 | 75.1±7.5 | 72.4±5.9 | 75.4±6.2 |

Values are presented as mean±standard deviation.
Q1: January to March, Q2: April to June, Q3: July to September, Q4: October to December.
*,†Significantly different from U-16 and U-17 subgroup, respectively ($p<0.05$).

64% vs. 37%, $p<0.05$; U-23: 42% vs. 58%) (Fig. 3).

In terms of players' body size, mean height of U-16 subgroup (1.78±0.06 m) was significantly smaller than the other subcategories (U-17, 1.79±0.06 m; U-19, 1.80±0.06 m; U-20, 1.81±0.07 m; U-23, 1.81±0.06 m). Mean body weight of U-16 subcategory (68.4±6.1 kg) was not different from that of U-17 (68.4±6.1 kg; $p>0.05$). On the other hand, mean body weights of both subcategories were significantly different from those of the others (U19, 71.8±6.6 kg; U-20, 72.7±6.9 kg; U-23, 73.7±6.3 kg; $p<0.05$). In analysis within each subcategory, there were no differences in height and body weight between each quarter ($p>0.05$) (Table 4).

## Discussion

This study examined a RAE in Korean elite football through analysis of age-specific international teams since 2000. The results indicate that considerable RAE exists in the highest level of age-specific categories under development of football. The magnitude of RAE is markedly higher in the early stage than the late stage of development of football.

The RAE is used to describe that a player born early in the selected period has a higher participation rate than a player born late.The rationale for various academic interests in the RAE has been to identify early-year favoritism and to tackle the phenomena[3,14]. As such selection has been based on physical and psychological maturity of players, the relatively older players are more easily identified as talented players. FIFA's regulation on specific age-grouping (i.e., from 1st January to 31st December in a selected year) was introduced in order to secure the development of youth players in line with fair competition and to provide the same opportunities for each player[2]. There are, however, still unintended consequences such as the RAE[14,19,22].

This study confirmed that the RAE exists in the highest level of age-specific football teams in South Korean male football. Such findings support previous research that RAE is closely associated with success in youth and performance of players[7,15,23]. We found that birth distribution of players was remarkably high at the beginning of the birth-year. Birth distribution of players observed in each team was concentrated in early birth-year compared to the expected equal birth distribution (8.33% per month). Those findings agree with previous studies what demonstrated the birth distribution and RAE of players on football teams[24,25]. Moreover, the coefficient values of the regression analysis support this finding. The slope of the birth distribution gradually becomes smoother in accordance with age. This result supports that the RAE is much less evident in senior teams compared to junior teams[4,19,22,24,25].

This study identified a biased quarterly birth distribution of age-specific Korean elite football players. The relatively older players born in the first quarter (Q1) of the selected year were highly represented in age-specific national teams in comparison with the relatively younger players who especially born in Q4. Those findings support recent researches regarding quarterly birth distribution of elite youth football players[2-4,7,8,10,22,26]. Those findings suggest that relatively younger players were more vulnerable to be neglected by selection bias such as the RAE. The impact of the RAE is, however, diluted as youth players reach upper age groups[4,27]. This study also provides evidence that the magnitude of differences in birth distribution tends to be decreased in accordance with age. In addition, dilution of RAE was also observed in changes of the distribution of “competition age group” and “under-competition age group.” The proportion of “competition age group” was decreased from 91% in U-16 to 42% in U-23 subgroup. In contrast, the distribution of “under-competition age group” was increased from 9% in U-16 to 58% in U-23 subgroup. In the late stages of development, the other aspects such as skills, techniques and tactical intelligence might be more emphasized in determining performance of players in match-paly[28,29] than physical and psychological maturity dominated by RAE.

The present study found that the body sizes such as height and body weight of players were not significantly different across quarters in each age-specific subgroup. Although recent studies have reported the positive correlation between RAE and physique[30], our findings suggest that body size of players would not be considered as a factor to recruit players for the highest level of competitions. As recent studies have suggested a positive relationship between performance and RAE[28], physical performance of players might be one of the key indices on selection of the players rather than body sizes of players such as stature and body mass. Recent research indicated that most players are little differences in their physical maturity between older and younger players by age 17[6]. The Korean football players participated in this study showed similar patterns to a previous result on stature of players but body mass of players reached plateau by age 19.

Williams[6] argued that the RAE could result in negative consequences in both relatively younger and older players. That is, relatively younger players tend to be dropping-out but relatively older players seem to be lacking of practice due to the preferential treatment. Vincent and Glamser[12] argued that the long-term consequence of the RAE could result in deterioration of qualities in competitive sports. Thus, implementing systematic approaches targeting relatively young players must be considered to reduce the RAE by keeping physically and psychologically lagging players until they have matured and to prevent drop-out of young players[10,15]. In terms of practical perspectives, rotating calendar cut-off dates[15,22], changing the scope of the age bandwidth[9], grouping by physique[29], and other measures could be considered to reduce the unintended consequences of the RAE. Therefore, coaches ought to be urged to assess youth players on their potential and bolstered to understand their abilities[3,6,9]. A higher chronological age does not necessarily guarantee team success and players' performance[4]. It means that practical strategies for talent identification should be established in order to avoid exclusion of such late-mature football players during their development stage.

Conclusively, in the highest levels of Korean players who participated in the age-specific international competitions since 2000, there are higher RAEs in the early stage than the late stage of development of football. This may implicate that it is necessary to develop practical strategies for relatively late-mature players who have potentials in terms of skills and intelligence of football.

## Conflict of Interest

No potential conflict of interest relevant to this article was reported.

## ORCID

Tae-Seok Jeong https://orcid.org/0000-0002-3387-9125
Sang-Yeol Bang https://orcid.org/0000-0002-6834-0226
Sehwan Park https://orcid.org/0000-0001-6800-7960
Young-Soo Lee https://orcid.org/0000-0003-2275-2660
Yong-Rae Kim https://orcid.org/0000-0003-4720-7247
Young-Seok Kim https://orcid.org/0000-0002-9400-2204

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