The Characteristics of Youth Sports Specialization among Japanese Baseball Players

Ryuto Fuke¹*, Yoshimitsu Kohmura², Kazuhiro Aoki¹

¹Graduate School of Health and Sport Science, Juntendo University, 1-1 Hirakagakuendai, Inzai, Chiba, 270-1695, Japan; ²Faculty of Health and Sports Science, Juntendo University, 1-1 Hirakagakuendai, Inzai, Chiba, 270-1695, Japan

*Corresponding author:

Ryuto Fuke
Graduate School of Health and Sport Science, Juntendo University
1-1 Hirakagakuendai, Inzai, Chiba, 270-1695, Japan
Phone number: +81-476-98-1001
Email address: fuke0716@gmail.com

The type of manuscript: Regular Article
Number of tables: 4
Number of figures: 3
Running head: Specialization of Japanese Baseball Players
Abstract

In this study, the characteristics of the athletic careers of Japanese college baseball players were identified, and relationships between their athletic careers and levels of performance and injury were analyzed. A questionnaire survey was conducted for 589 players in teams affiliated with the All-Japan University Baseball Federation; the relationship between their background in competitive activity and levels of performance in competitive experience was analyzed with a $\chi^2$ test. In total, 541 players participated in the survey. The survey results showed that the average age at which they started playing baseball was 7.8±1.8 years, and the average age at which they specialized in baseball was 10.0±3.2 years. In terms of athletic experience and the college performance level, the $\chi^2$ test showed a significant association ($\chi^2=8.83$, Cramer’s V=0.133, $p<0.05$). Moreover, significantly more rosters specialized before 12 years of age, with experience in other sports, and significantly fewer rosters specialized after 13 years of age, with experience in other sports ($p<0.05$). Therefore, childhood sports experience may influence performance levels of college players, and Japanese baseball players tend to specialize early.

Keywords: competitive experience; Japanese baseball players; performance level
Title: 日本の野球選手における専門化の特徴について

Affiliation:

1順天堂大学大学院スポーツ健康科学研究科

2順天堂大学スポーツ健康科学部

Authors: 福家瑠都 1, 河村剛光 2, 青木和浩 1

Abstract:

本研究では、日本の大学野球選手の競技経歴の特徴を明らかにし、競技経験と競技レベル及び障害発症との関連性を分析した。全日本大学野球連盟加盟チームに所属する選手 589 名を対象にインターネットによるアンケート調査を実施した。質問項目は、野球を始めた年齢、野球以外の競技経験、各年代における野球の最高成績、使用球、障害発症、競技レベルなどとした。競技経験と各年代の競技レベル及び障害発症との関連性について x² 検定を実施した。調査への参加に同意を得た回答者は 541 名であった。調査の結果、野球を始めた平均年齢は 7.8±1.8 歳、野球に専門化した平均年齢は 10.0±3.2 歳であった。x² 検定の結果、競技経験と大学での競技レベルについて、有意な関連性が認められた（x²=8.83, Cramer’s V=0.133, p<0.05）。12 歳以前で専門化し野球以外の種目経験がある選手の群で、競技レベルが高い傾向があり、13 歳以降で専門化し野球以外の種目経験がある選手の群では、競技レベルが低い傾向があった（p<0.05）。競技経験と障害発症については、有意な関連性は認められなかった。本研究の結果から、幼少期のスポーツ経験が大学野球選手の競技レベルに影響を与える可能性があり、また日本の大学野球選手は、早期専門化の傾向にある
ことが明らかとなった。
Introduction

In recent years, the number of Japanese individuals playing in Major League Baseball (MLB) has increased, and Japan has achieved a high level of success in the World Baseball Classic, reaching the top four or higher and winning the Tokyo 2020 Olympics. In Japan, the number of children playing baseball is second only to that of soccer and swimming. Japanese college baseball players are one of the top performers in the world. High school baseball players with high performance levels can join professional baseball teams after graduation to become professional baseball players, but most top-level high school baseball players enroll in college to improve their performance and join professional baseball teams after graduation. This is illustrated by the population of baseball players in Japan, where the estimated number of high school baseball players in 2021 is 134,282 [1], and the estimated number of college baseball players is 28,902 [2].

To improve the performance level of youth athletes, coaches must systematically develop children as athletes; hence, physical activity at childhood is critical [3]. Fundamental motor/movement skills (FMS) are foundational movements that form the building blocks of more complex and specialized skills that are essential for participation in sports, physical activity, and recreation [4]. FMS are classified into two subgroups: object control skills required to control tools (throwing, hitting, catching, etc.) and locomotor skills required to move the body in any direction (running, jumping, walking, etc.) [5]. Additionally, it is important to develop basic motor skills and the ability to operationalize physical movements at an early age, when the brain is maturing.
and neural circuit plasticity, which is the foundation for the acquisition of complex
movements and motor skills, is high [6]. Various suggestions have been proposed to
maximize the potential of athletes during the development stage [7]. The
Developmental Model of Sports Participation (DMSP) illustrates the importance of
appropriate training that considers the developmental stages of youth. The DMSP
proposes two strategies to improve sports performance: early specialization and
multiple sports during childhood [8].

Early specialization may lead to superior performance at a younger age and is
required in some disciplines, such as gymnastics and figure skating [9]. Early
specialization is defined by the following three criteria: intensive training and
competition in organized sports for at least 8 months per year (essentially year-round),
participation in one sport that restricts participation in other sports (thus restricting
freedom of movement), and participation of children before adolescence (1st year of
junior high school or at approximately 12 years of age) [10]. However, this limits the
exposure to other sports throughout the year, resulting in a lack of motor skills that
develop through experience in multiple sports and potentially reducing motor skill
proficiency [11]. Additionally, early specialization and the amount of practice are
extensively associated with injury [12]. Moreover, early specialization may increase the
risk of overuse disorders by subjecting the musculoskeletal system to maximum training
volume and intensity and not allowing time for rest [13].

In contrast, the second approach involves encouraging participation in multiple
sports in the childhood (up to 11 years of age for girls and 13 years of age for boys) [6, 8]. Engaging in multiple sports during childhood has been found to have positive effects on muscle strength, speed, endurance, and gross motor coordination between the ages of 10 and 12 years [14]. Moreover, young athletes who have experienced three or more sports between the ages of 11 and 15 years are more likely to display a higher level of performance between the ages of 16 and 18 years [15]. In discipline-specific reports, sports that measure time and records require greater physical effort and do not require the same tactical and decision-making processes as team and racquet sports; therefore, the transfer of physical skills does not have a significant impact on the development of expertise, and even if a person specializes at a later age, they can still achieve a high level of performance [16]. However, it is not always possible to adapt to all types of sports. The peak performance is usually achieved at a later age (after maturity); therefore, this may not be applicable to sports that require peak performance before physical maturity, such as gymnastics and figure skating [8]. Therefore, research regarding adaptation to multiple sport experiences in childhood needs to be conducted from various sporting perspectives.

The stage at which baseball players specialize is currently unclear. According to a recent report, in a survey of MLB players, 44.5% of the participants specialized during childhood and adolescence, with differences among countries regarding the age at which they specialized and differing attitudes toward specialization [17]. However, regarding the impact on injury, players who specialized in baseball before 13 years of age had a higher rate of injury than those who did not [18, 19]. Additionally, among
minor leaguers, 64% of 15–18-year-old athletes played multiple sports and almost all (94%) specialized in baseball by 19 years of age, with elite athletes participating in sports from childhood, most of whom participated in multiple other sports during their junior years \[20\]. However, most of these findings have been reported for American leagues, and data for Japanese players are not available. Additionally, the age of specialization is different in each country \[21\], and views on specialization differ, i.e., there is a lack of consensus.

Baseball is a sport that requires a multitude of movements \[21-23\] and various considerations regarding the development process of players during childhood and adolescence. Additionally, there is insufficient information regarding trends in specialization and how competitive experience in childhood influences future competition. Therefore, it is important for sports science data to understand the trends of specialization in competition for athletes who have been competing for a long time and are relatively competitive. This knowledge can provide important insights for training and studying athletes in their childhood and adolescence. This study aimed to identify the characteristics and problems regarding specialization among Japanese college baseball players with long and competitive careers and relatively high competitiveness. Boys who have experienced multiple sports in their childhood have higher physical fitness gains than boys who have experienced a single sport \[14\], and players with high performance levels, such as MLB players and minor leaguers, often experience multiple sports \[17,20\]. Further, in 2022, the Junior Sports Clubs had more members in baseball (110,756) than in any other sport \[24\]. Therefore, we hypothesize that a characteristic
regarding specialization among Japanese baseball players is that players with high performance levels tend to have experience in multiple sports at childhood and early specialization. To substantiate this hypothesis, in this study, a cross-sectional anonymous survey was conducted to understand the actual situation and analyze the relevance of the current data on the athletic careers of college baseball players. The participants included in this study were college baseball players aged 19–22 years; the aim was to compare competitive performance and disability onset among players with a long history of competitive activity and a relatively high level of performance.

**Materials and Methods**

**Subjects**

The study included 589 male college baseball players from 14 teams in the All-Japan University Baseball Federation. The teams included in the study were those that would qualify for the Japan National Collegiate Baseball Championship by winning the league championship or those at the same performance level, along with teams with highest performance levels among the youth generation of players aspiring to become professional baseball players. Players on the teams were asked to respond to an anonymous Internet-based questionnaire regarding their athletic background, injury, athletic performance, and the balls used. In Japan, school-age baseball players are allowed to choose the type of ball (rubber ball, hard ball, etc.) they use. Therefore, in the “ball used” section of the questionnaire, the respondents were asked to indicate the type of ball they used in elementary and junior high school. The recruitment method for the study participants was explained in detail to the coach of the college baseball teams via email or explanatory documents, including the purpose of the study. The URL of the response page was sent to the coach of the teams who gave their consent, and their
cooperation was requested to guide the players to respond to the questionnaire.  

Regarding consent to respond to the survey, we provided the research participants with information about the details of the study on the Internet-based response page and in the participation guide, included a question on the response page to confirm their willingness to consent, and obtained their consent to respond. Participation in the study was limited to players on the teams that provided consent; however, players were free to respond to the survey and were not disadvantaged if they did not participate. Additionally, student coaches, managers, and other non-players were not included in the study. This study was approved by the Ethics Review Board of the Graduate School of Sports and Health Science, Juntendo University (Ethical Recognition: 2021-3).

**Procedures**

Participants completed an Internet-based questionnaire designed for the study. Questionnaire items were discussed with the co-researchers, and the main questions consisted of the following four items: (a) the age at which they started playing baseball; (b) baseball competitive career, including elementary school (6–12 years), junior high school (12–15 years), high school (15–18 years), and college (18–22 years) (type of ball, highest achievement, and performance level such as roster, position, practice days, and practice time); (c) injury; and (d) athletic career other than baseball (events played, duration, and practice days). For the type of ball, the respondents were asked to select from the three following types of balls: hard ball, rubber ball, and others, which are mainly used in elementary and junior high schools in Japan. The performance level was defined by competitive results (participation in national tournaments or higher, participation in regional tournaments or higher, best 8 or higher in prefectural
tournaments, and best 8 or lower in prefectural tournaments) for high school and by roster (on the bench) and non-roster (off the bench) for university. Additionally, we used the Croci, Nicknair, and Goetschius definition of injury as a disability that would prevent a player from playing for more than two weeks. Data that were considered traumatic injuries were removed from the collected response data. Regarding the definition of specialization, we referred to "training throughout the year (8 months or more)," "quitting other sports to focus on one sport," and "choosing one major sport" for the age of specialization. We analyzed the age at which the only athletic sport played was baseball. For participants who engaged in a sport other than baseball, the age at which they specialized in baseball was defined based on question (d), "Regarding the period of time spent playing other than baseball (duration of participation),," and the age at which they started playing baseball. The survey in this study attempted to minimize recall bias by limiting disability to disabilities that would prevent them from playing for more than two weeks. Recall bias was also minimized by limiting the non-baseball event experience to games played for more than one year.

Statistical Analyses
The response data were summarized in terms of frequency and percentage (%) and mean and standard deviation. In the analysis, we divided the respondents into three groups according to their competitive experience: "Specialization before 12 years of age (childhood) with baseball experience only," "specialization before 12 years of age (childhood) with experience in other sports," and "specialization after 13 years of age (adolescence) with experience in other sports," referring to previous studies. One
participant who specialized after 13 years of age in only baseball was excluded from the
analysis. Moreover, $\chi^2$ tests were conducted to determine the association between
competitive experience and performance levels in each competitive experience group
along with competitive experience and injury. When the $\chi^2$ test results showed a
significant association, residual analysis was used. Furthermore, we analyzed
differences between the groups for each competitive experience, the age they started
playing baseball and the hours of practice per week during elementary, junior high, and
high school years. A Kolmogorov-Smirnov test did not indicate that the data are
consistent with a normal distribution ($p<0.05$). Therefore, the Kruskal-Wallis test and
Mann-Whitney U-test were employed. Mann-Whitney U-test was used to test the
significance of post-hoc differences using the Bonferroni correction to adjust for
multiple comparisons. Statistical significance was set a priori at $p<0.05$. All analyses
were performed using the SPSS statistical software (Ver 29, IBM).

Results

A total of 589 players responded to the survey, of which 541 (91.9%) (aged 19–
22 years, mean age 19.5±1.2 years) provided consent for the survey. The mean age at
which they began playing baseball was 7.8±1.8 years (n=539), the mean age at which
they specialized in baseball was 10.0±3.2 years (n=535), and 44.0% (n=238) of the total
respondents had baseball experience only. Moreover, 56.0% (n=303) of the total
respondents had experience in a discipline other than baseball. Of these, 71.0% (n=215)
had experienced only one non-baseball sports, 23.4% (n=71) had experienced two, and
5.6% (n=17) had experienced three sports. The weekly baseball practice time for all
participants was 17.5±9.5 h (n=529) in elementary school, 22.9±6.4 h (n=532) in junior high school, and 33.4±7.9 h (n=533) in high school. Regarding the balls used, most elementary schools used rubber balls; however, junior high schools tended to divide between rubber balls and hard balls, a characteristic of Japanese baseball culture. Table 1 shows the specialization characteristics of college baseball players by competitive experience and the pitch they use.

Considering the age at which the players started playing baseball, the results of
the Kruskal-Wallis test showed a significant difference for each athletic experience (H value: 9.97, \( p < 0.05 \)). Moreover, Table 2 shows a cross-tabulation of competitive experience and high school performance level, for which the \( \chi^2 \) test results showed no significant association. Table 3 shows a cross-tabulation of competitive experience and performance level in college, and the results of the \( \chi^2 \) test demonstrated a significant association (\( \chi^2 = 8.83 \), Cramer’s V = 0.133, \( p < 0.05 \)). Additionally, residual analysis showed that the number of responses from rosters was markedly greater than expected for the group that specialized before 12 years of age with experience in other sports, and significantly less than expected (\( p < 0.05 \)) for the group that specialized after 13 years of age with experience in other sports. Fig. 1 shows college performance levels and competitive experiences by age of specialization. Participants who specialized before 12 years of age had more rosters, while those who specialized after 13 years had fewer rosters.
Table 4 shows a cross-tabulation of the competitive experience and onset of injury in college, for which the $\chi^2$ test results showed no significant association. Fig. 2 and Fig. 3 show box-and-whisker plots consisting of the minimum, first quartile (25th % value), mean, median, third quartile (75th % value), and maximum values of the hours of baseball practice per week for each competitive experience. The Kruskal-Wallis test showed significant difference in hours of baseball practice per week considering competitive experience in elementary (H value: 8.31, $p<0.05$) and junior high school (H value: 8.44, $p<0.05$). The results of the multiple comparison test showed that in elementary school, the group that specialized before 12 years of age with experience in other sports showed considerably more practice time than the group that specialized after 13 years of age with experience in other sports ($p<0.05$). In junior high school, the group that specialized before 12 years of age with experience in other sports showed considerably more practice time than the group that specialized before 12 years of age with baseball experience only ($p<0.05$).

Discussion

In this study population, the average age of beginning to play baseball was 7.8 years. Contrastingly, Buckley et al. [17] reported that the average age of beginning to play baseball for MLB players in the United States was 5.9 years, and the average age
of beginning to play baseball for MLB players outside the United States was 8.9 years; therefore, Japanese college baseball players began playing baseball later than MLB players from the United States. The age at which the study participants specialized was 10.0 years. In contrast, the age at which MLB players from the United States specialized in baseball was 14.9 years, and the age at which players from outside the United States specialized in baseball was 12.3 years, indicating that Japanese college baseball players specialize in baseball at an earlier age than MLB players. As a reason for differences in the age of specialization, Buckley et al. [17] found that the socioeconomic environment in which the players grow up influences their attitudes toward specialization and sporting experiences. Furthermore, Ginsburg et al. [20] reported that North American minor leaguers from warmer climates specialize earlier because they have shorter off-seasons in which they can play other sports and, therefore, spend more time training in their primary sports. Hence, it is possible that Japan's climate and time spent practicing baseball will accelerate specialization.

In terms of the performance level, there was no significant difference in competitive experience in high school (Table 2); however, in college, athletes who specialized before 12 years of age with experience in other sports had remarkably higher performance levels than athletes who specialized after 13 years of age with experience in other sports (Table 3). Moreover, participants who played sports other than baseball in their childhood had performance levels comparable to those of participants who played only baseball. The results also suggest that a later age of specialization may affect performance levels in college. These characteristics are similar to those of early specialization [9, 26]. With regard to specialization at an early age, it
was concluded that for athletes to be the best at a particular skill or sport, they need to improve their skills from an early age to develop their strengths and reduce their weaknesses [27]. Additionally, team sports require complex movements, tactics, and decision-making and, thus, require early specialization and specialized practice.

Therefore, early specialization results in a higher level of performance in college. Although early specialization may increase the amount and duration of practice in a particular sport, which may have a positive impact on performance, it may increase the risk of injury due to repetitive tasks [28].

It has been reported that pitchers who received specialized training at an early age have a higher incidence of shoulder and elbow injuries [19] and players who specialize before 13 years of age have a higher incidence of arm injuries than those who did not [18]. According to previous studies on college baseball players, early specialization affects injury history due to deteriorated throwing arm function [25].

Furthermore, Little League players with high specialization have been reported to have poorer throwing arm health [29]. One reason for the higher rate of injury onset in early specialization is that the risk of injury increases as practice time increases [30]. However, there was no association between competitive experience and the incidence of injury in college (Table 4). Moreover, in elementary and junior high school, the group that specialized before 12 years of age with experience in other sports had higher practice time than the other group (Fig. 2, Fig. 3). Previous studies reported that athletes who only played baseball had higher incidence of injury compared to athletes involved in sports other than baseball [19]. Further, with increasing practice hours per week, the risk of developing injury increases [12]. One possible reason for the lack of association
between the onset of injury in college and each competitive experience in this study could be the influence of more practice time in the group that specialized before 12 years of age with experience in other sports; they were able to practice baseball along with other disciplines. Multiple sports can improve athletic performance and reduce the risk of developing disabilities compared to single-sport experiences. However, increased practice may lead to the onset of disabilities. In contrast, a previous study defined early high training volume as at least 28 h per week in a specialized sport by the age of 14 years and reported that exceeding this time increases the risk of injury [12]. Moreover, players who quit baseball may experience more injuries. Based on these findings, it is necessary to investigate the relationship between competitive experience and injury onset in the future.

In Japan, there is a tendency toward early specialization; however, players have been able to increase their level of performance without obstacles that prevent them from playing for long periods. In addition to early specialization, Japanese college baseball players may have experienced multiple sports at an early age, which may have affected their levels of performance in college. It has been reported that spending a long time playing sports during childhood and experiencing multiple sports has a positive effect on strength and coordination before 12 years of age [14], and playing a variety of sports is necessary to develop physical fitness [31]. Success in sports such as running, jumping, kicking, and throwing requires the development of basic skills [27], and it is important to experience multiple disciplines to develop motor skills at an early age [31]. Unlike timed sports, such as track and field or swimming, baseball requires skills specific to the sport, such as coordinated play and strategy. Therefore, if players do not
specialize and practice from an early age, they may not be proficient in college.

Experiences during the developmental period (0–12 years of age) contribute positively and functionally to the subsequent acquisition of a specialty [32], and sport experiences during this period have a marked influence on future sports specialization. Similarly, in this study, childhood sports experience affected the level of performance in college, and if early specialization reduces the risk of injury onset, childhood sports experience may be a viable option in college.

This study had few limitations. The players in this study were college students and not professional baseball players. Additionally, players who dropped out of baseball were not included in this study. Research on players who drop out of baseball could affect early specialization and injuries. Second, this was a retrospective study in which participants responded based on their memories; thus, there might be recall bias. Furthermore, the data regarding the onset of injury are not the result of a physician's diagnosis; therefore, the data are not sufficiently reliable. Based on these issues, it is necessary to further expand our knowledge through research on athletic careers.

This study aimed to identify the characteristics of specialization among Japanese college baseball players. The results showed that half of the college baseball players had experience in disciplines other than baseball, and the average age of specialization was 10.0 years. Early specialization was identified as a feature of Japanese baseball players, where baseball is actively played from childhood, increasing the level of performance and reducing the risk of injury.
Acknowledgments
We would like to thank Editage (www.editage.com) for their English language editing.

Conflict of Interests
The authors declare that they have no conflict of interest.

Author Contributions
RF, YK, and KA designed the study. RF and YK performed the questionnaire and analyzed the data. RF, YK, and KA interpreted and discussed the results. RF drafted the manuscript. YK and KA edited and revised the manuscript. RF, YK and KA approved and submitted the final version of the manuscript.

References


Table 1. Characteristics of the specialization of Japanese college baseball players.

Table 2. Relationship between competitive experience and performance levels in high school.

Table 3. Relationship between competitive experience and performance levels in college.

Table 4. Relationship between competitive experience and onset of injury in college.

Fig. 1. Performance levels by age considering specialization in baseball.

Fig. 2. Comparison of practice time between the competitive experience groups in elementary school.

Fig. 3. Comparison of practice time between the competitive experience groups in junior high school.
Figure 1

Number of samples (n=498)

Ages (years)

- Not on the roster - Experience in other sports
- Not on the roster - Baseball only
- Roster - Experience in other sports
- Roster - Baseball only
Figure 2

Hours of baseball practice per week in elementary school

Baseball only  Specialization before 12 years of age  Specialization after 13 years of age

*: p < 0.05
Figure 3

Hours of baseball practice per week in Junior high school

- Baseball only
- Specialization before 12 years of age
- Specialization after 13 years of age

*: p<0.05
Table 1. Characteristics of the specialization of Japanese college baseball players

<table>
<thead>
<tr>
<th>Characteristics of specialization</th>
<th>Baseball only</th>
<th>Specialization before 12 years of age</th>
<th>Specialization after 13 years of age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of commencing baseball years, mean ± SD (n)</td>
<td>7.5 ± 1.5 (237)</td>
<td>7.8 ± 1.7 (158)</td>
<td>8.1 ± 2.1 (140)</td>
</tr>
<tr>
<td>Specialization age, years, mean ± SD (n)</td>
<td>7.5 ± 1.5 (237)</td>
<td>10.0 ± 1.6 (158)</td>
<td>14.3 ± 1.6 (140)</td>
</tr>
<tr>
<td>Ball used</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elementary school</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber ball, n (%)</td>
<td>197 (83.3)</td>
<td>134 (85.4)</td>
<td>108 (82.4)</td>
</tr>
<tr>
<td>Hard ball, n (%)</td>
<td>20 (8.5)</td>
<td>13 (8.3)</td>
<td>10 (7.6)</td>
</tr>
<tr>
<td>Other, n (%)</td>
<td>18 (7.7)</td>
<td>10 (6.4)</td>
<td>13 (9.9)</td>
</tr>
<tr>
<td>Junior high school</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber ball, n (%)</td>
<td>112 (47.7)</td>
<td>76 (48.1)</td>
<td>50 (36.5)</td>
</tr>
<tr>
<td>Hard ball, n (%)</td>
<td>116 (49.4)</td>
<td>76 (48.1)</td>
<td>80 (58.4)</td>
</tr>
<tr>
<td>Other, n (%)</td>
<td>7 (3.0)</td>
<td>6 (3.8)</td>
<td>7 (5.1)</td>
</tr>
<tr>
<td>Hours of baseball practice per week</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean ± SD (n)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------</td>
<td>---------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td><strong>Elementary school,</strong></td>
<td>17.0 ± 7.0 (234)</td>
<td>18.1 ± 7.4 (157)</td>
<td>15.8 ± 7.3 (129)</td>
</tr>
<tr>
<td><strong>Junior high school,</strong></td>
<td>22.3 ± 6.1 (234)</td>
<td>24.3 ± 7.1 (156)</td>
<td>22.4 ± 6.2 (135)</td>
</tr>
<tr>
<td><strong>High school,</strong></td>
<td>33.9 ± 7.8 (232)</td>
<td>33.5 ± 7.8 (157)</td>
<td>32.9 ± 8.2 (137)</td>
</tr>
</tbody>
</table>

The results for each category are shown in aggregate.

Baseball only: Specialization before 12 years of age with baseball experience only; Specialization before 12 years of age: specialization before 12 years of age with experience in other sports; Specialization after 13 years of age; specialization after 13 years of age with experience in other sports
Table 2. Relationship between competitive experience and performance levels in high school

<table>
<thead>
<tr>
<th>Competitive experience</th>
<th>National tournament</th>
<th>Regional tournament</th>
<th>Best 8 or higher</th>
<th>Best 8 or lower</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseball only, n (%)</td>
<td>42 (18.0)</td>
<td>51 (21.8)</td>
<td>89 (38.0)</td>
<td>52 (22.2)</td>
<td>234 (100.0)</td>
</tr>
<tr>
<td>Specialization before 12 years of age, n (%)</td>
<td>25 (16.1)</td>
<td>29 (18.7)</td>
<td>62 (40.0)</td>
<td>39 (25.2)</td>
<td>155 (100.0)</td>
</tr>
<tr>
<td>Specialization after 13 years of age, n (%)</td>
<td>18 (13.0)</td>
<td>32 (23.2)</td>
<td>40 (29.0)</td>
<td>48 (34.8)</td>
<td>138 (100.0)</td>
</tr>
<tr>
<td>Total, n (%)</td>
<td>85 (16.1)</td>
<td>112 (21.2)</td>
<td>191 (36.4)</td>
<td>139 (26.3)</td>
<td>527 (100.0)</td>
</tr>
</tbody>
</table>

Chi-square value = 10.15, Cramer’s V=0.098, ns

Baseball only: Specialization before 12 years of age with baseball experience only; Specialization before 12 years of age: specialization before 12 years of age with experience in other sports; Specialization after 13 years of age: specialization after 13 years of age with experience in other sports; National tournament: participation in national or higher level tournament; Regional tournament: participation in regional or higher level tournament; Best 8 or higher: best 8 or higher in prefectural tournament; Best 8 or lower: best 8 or lower in prefectural tournament.
Table 3. Relationship between competitive experience and performance levels in college

<table>
<thead>
<tr>
<th>Competitive experience</th>
<th>Roster (on the bench)</th>
<th>Non-roster (off the bench)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td>Baseball only, n (%)</td>
<td>77 (34.5)</td>
<td>146 (65.5)</td>
<td>223 (100.0)</td>
</tr>
<tr>
<td>Specialization before 12 years of age, n (%)</td>
<td>59 (39.6)*</td>
<td>90 (60.4)†</td>
<td>149 (100.0)</td>
</tr>
<tr>
<td>Specialization after 13 years of age, n (%)</td>
<td>29 (23.0)†</td>
<td>97 (77.0)*</td>
<td>126 (100.0)</td>
</tr>
<tr>
<td>Total, n (%)</td>
<td>165 (33.1)</td>
<td>333 (66.9)</td>
<td>498 (100.0)</td>
</tr>
</tbody>
</table>

Chi-square value = 8.83, Cramer’s V=0.133, p<0.05

*: significantly more (p<0.05) †: Significantly less (p<0.05)

Baseball only: Specialization before 12 years of age with baseball experience only; Specialization before 12 years of age: specialization before 12 years of age with experience in other sports; Specialization after 13 years of age: specialization after 13 years of age with experience in other sports.
Table 4. Relationship between competitive experience and onset of injury in college

<table>
<thead>
<tr>
<th>Competitive experience</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseball only, n (%)</td>
<td>70 (29.7)</td>
<td>166 (70.3)</td>
<td>236 (100.0)</td>
</tr>
<tr>
<td>Specialization before 12 years of age, n (%)</td>
<td>59 (37.3)</td>
<td>99 (62.7)</td>
<td>158 (100.0)</td>
</tr>
<tr>
<td>Specialization after 13 years of age, n (%)</td>
<td>50 (35.7)</td>
<td>90 (64.3)</td>
<td>140 (100.0)</td>
</tr>
<tr>
<td>Total, n (%)</td>
<td>179 (33.5)</td>
<td>355 (66.5)</td>
<td>534 (100.0)</td>
</tr>
</tbody>
</table>

Chi-square value = 2.92, Cramer’s V=0.074, ns

Baseball only: Specialization before 12 years of age with baseball experience only; Specialization before 12 years of age: specialization before 12 years of age with experience in other sports; Specialization after 13 years of age: specialization after 13 years of age with experience in other sports.