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Youth Single-Sport Specialization in Professional Baseball Players

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Investigation performed at the Rothman Orthopaedic Institute, Thomas Jefferson University Hospital, Philadelphia, Pennsylvania, USA

Background: An increasing number of youth baseball athletes are specializing in playing baseball at younger ages.

Purpose: The purpose of our study was to describe the age and prevalence of single-sport specialization in a cohort of current professional baseball athletes. In addition, we sought to understand the trends surrounding single-sport specialization in professional baseball players raised within and outside the United States (US).

Study Design: Cross-sectional study; Level of evidence, 3.

Methods: A survey was distributed to male professional baseball athletes via individual team athletic trainers. Athletes were asked if and at what age they had chosen to specialize in playing baseball at the exclusion of other sports, and data were then collected pertaining to this decision. We analyzed the rate and age of specialization, the reasons for specialization, and the athlete's perception of injuries related to specialization.

Results: A total of 1673 professional baseball athletes completed the survey, representing 26 of the 30 Major League Baseball (MLB) organizations. Less than half (44.5%) of professional athletes specialized in playing a single sport during their childhood/adolescence. Those who reported specializing in their youth did so at a mean age of 14.09 ± 2.79 years. MLB players who grew up outside the US specialized at a significantly earlier age than MLB players native to the US (12.30 ± 3.07 vs 14.89 ± 2.24 years, respectively; $P < .001$). Additionally, MLB players raised in the US recalled a significantly higher incidence of sustaining an injury attributed to specializing in baseball than MLB athletes raised outside the US (27.7% vs 20.6%, respectively; $P = .05$).

Conclusion: This study challenges the current trends toward early youth sport specialization, finding that the majority of professional baseball athletes studied did not specialize as youth and that those who did specialize did so at a mean age of 14 years. With the potential cumulative effects of pitching and overhead throwing on an athlete's arm, the trend identified in this study toward earlier specialization within baseball is concerning.

Keywords: sport specialization; youth; single; baseball; injury

Single-sport specialization has commanded increased scrutiny in recent years, although no specific universal definition has been agreed upon. Nonetheless, the current literature focuses on a number of common themes that are well encapsulated by the definition advanced by Jayanthi^{15,16}: "intensive, year-round (8+ months/year) training and competition in a single sport to the exclusion of all other organized sports." There is a sense in the orthopaedic community that many athletes and families believe that single-sport specialization enhances athletic performance and increases the likelihood of participation at an

elite level, including potentially lucrative rewards in the form of collegiate scholarships and professional contracts.

On the contrary, a substantial and growing body of literature suggests that early specialization may not be necessary for advancement in one's sport and that such specialization subjects youth athletes to an increased risk of both injuries and burnout.^{2,16} The dismaying trends of early specialization have prompted the American Academy of Pediatrics, National Athletic Trainers' Association, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, and World Health Organization to produce position statements cautioning athletes, parents, coaches, trainers, and physicians on the potential risks of early single-sport specialization.^{1,14,17} Additionally, data from the National Collegiate Athletic Association (NCAA) suggest that only a small percentage

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of youth athletes seeking to attain elite status will ultimately reach the collegiate level, with only 3.3% to 6.8% of high school athletes in men's basketball, women's basketball, football, baseball, and men's soccer playing their sport in college.²³ Similarly, the NCAA reports that the percentage of high school athletes who ultimately play their sport professionally is only 0.03% to 0.5%.⁶ Furthermore, the general public often overestimates the financial benefits of sports participation. In 2008, the average collegiate athletic scholarship was US\$10,000, which does not account for the total cost associated with attending college for most 4-year colleges and universities.²⁶ Nonetheless, this concerning trend toward early single-sport specialization continues.

Despite the increasing number of sports available to youth athletes in the United States (US), baseball, often referred to as the "national pastime," remains popular. The National Federation of State High School Associations reports that baseball is the third most popular sport among high schools by the number of schools with programs and is played by 490,105 high school athletes annually.²⁴ The Sports & Fitness Industry Association estimated that 6.7 million American youth aged 6 to 17 years played baseball in 2014.³⁰ In addition to its popularity in the US, the sport of baseball also enjoys tremendous popularity in other countries, with many athletes who currently play professionally in Major League Baseball (MLB) hailing from countries outside the US.

However, both medical providers and the lay press have expressed growing concerns that youth baseball athletes are subjected to increasing pressures toward early specialization with an attendant increased risk of injuries.^{10,11,21,22} This is especially true for the pitching position, in which the potential for overuse injuries is well documented.^{6,7,9,12,13,25} The cumulative effects of overhead throwing by the youth athlete may have a substantial impact on immature anatomy, generating adaptive changes that have been well described in overhead throwers.^{3,5,20,28} These adaptive changes may be asymptomatic and may include an alteration in total arc of motion, increase in external rotation, decrease in internal rotation at the shoulder, and humeral retroversion as well

as such abnormalities as proximal humeral epiphysiolysis ("Little League shoulder").^{3,5,20,28,29} Sport medicine providers are increasingly learning that the effects of repetitive throwing by the youth athlete can have an important impact on the athlete's future health and throwing career.

The purpose of this study was to further investigate the phenomenon of single-sport specialization, specifically within baseball, by describing the age and prevalence of single-sport specialization in professional baseball athletes. Additionally, we sought to further understand this topic by comparing specialization trends and characteristics between MLB athletes raised in the US and those raised outside the US. We hypothesized that the majority of professional baseball athletes would have been multisport athletes during their childhood and would not have specialized at a very young age to play only baseball. We sought to (1) determine the prevalence of single-sport specialization in professional baseball athletes, (2) identify the age of specialization of current MLB athletes, (3) examine the reasons and perceptions about specialization from these professional athletes, (4) determine whether athletes associated any past injuries with the decision to specialize, and (5) identify any differences in the single-sport specialization patterns of professional baseball players born in the US as compared with those raised outside the US.

METHODS

Over a 1-year period from 2015 to 2016, there were 3090 surveys collected from current high school, collegiate, and professional athletes who had their orthopaedic care provided by athletic trainers and physicians from a large subspecialty orthopaedic practice, a population that has been previously reported on by Buckley et al.⁴ This study is a subgroup analysis of the survey data for all professional baseball players from this original cohort, examining the topic of single-sport specialization. In this study, we present survey results from a total of 1673 professional baseball athletes. Institutional review board approval and exempt status were obtained for this study.

The surveys were collected in a digital format from the professional athletes via an online survey tool

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Ethical approval for this study was waived by the Thomas Jefferson University Institutional Review Board (FWA No. 00002109).

TABLE 1
Level and Position of All Players^a

	n (%)
Level	
Rookie	336 (20.7)
A	578 (35.6)
AA	224 (13.8)
AAA	166 (10.2)
MLB	320 (19.7)
Total	1624
Position	
Pitcher	902 (55.4)
Starting pitcher	413
Relief pitcher	482
Infield	333 (20.4)
Outfield	249 (15.3)
Catcher	145 (8.9)
Total	1629

^aMLB, Major League Baseball.

(SurveyGizmo.com), and athletes' responses were voluntary. The surveys were distributed by their team certified athletic trainers via a mobile electronic device or laptop computer at the discretion of the organization. Professional athletes surveyed were members of multiple MLB organizations and represented both active MLB and Minor League Baseball (MiLB) players. In total, 26 of the current 30 MLB organizations and 1673 professional baseball athletes participated in this survey, and their participation was coordinated via the MLB Commissioner's Office. Survey questions asked details pertaining to characteristic information, current sport commitment, history of specialization, and perspectives on specialization.⁴ Each player's highest level of baseball (A vs AA vs AAA vs MLB) was reported by the player at the time of the survey and was not adjusted for any roster changes after this time.

The data collected were retrospective in nature and analyzed for statistical results. Categorical data (all yes/no questions) were analyzed using chi-square analysis. Continuous data were analyzed using 1-way analysis of variance, the Kruskal-Wallis test, and the Mann-Whitney test. Statistical significance was set at $P < .05$ for all data. Some individual questions were left blank by respondents, and so the percentages presented represent the number of responses divided by the total number of respondents for that individual question.

RESULTS

The demographic information of the professional athlete cohort is presented in Tables 1 and 2. Of the 1673 professional baseball athletes, 1621 responded to the questionnaire with a breakdown of 1106 athletes who were born in the US and 515 athletes who were born outside of the US, and the remaining 52 athletes did not respond to this question. The breakdown of position players versus pitchers and highest level of professional baseball participation was also recorded. The values presented in Table 1

TABLE 2
Characteristics of All Players^a

	Value
No. of responses	1673
Age, y	23.60 ± 8.63
Quit other sports to focus on 1 sport, n (%)	717/1613 (44.5)
Age at which player quit other sports, y	14.09 ± 2.79
Trained in sport at age of specialization, mo/y	8.21 ± 3.51
Competed in sport at age of specialization, mo/y	7.30 ± 2.80
Sustained an injury that player attributed to specializing in 1 sport, n (%)	181/703 (25.7)

^aValues are presented as mean ± SD unless otherwise indicated. Percentages are presented based on the number of responses for each individual question.

represent the number of athletes who responded to each question rather than the total number of surveys collected.

The overall characteristics of the entire study cohort of baseball athletes are shown in Table 2. Overall, 44.5% of professional athletes specialized in playing a single sport during their childhood/adolescence. Those who reported specializing in their youth did so at a mean age of 14.09 ± 2.79 years. Of those athletes who did specialize, 25.7% felt that they sustained an injury attributed to specializing in 1 sport. At the age of specialization, those athletes were, on average, training in their sport 8.21 months per year and competing in their sport 7.30 months per year.

Table 3 presents survey responses of non-US-born and US-born MLB players. MLB athletes raised in the US began participating in competitive sports at a statistically earlier age than MLB athletes who grew up outside the country (5.91 ± 2.16 vs 8.93 ± 3.77 years, respectively; $P < .001$). There were no differences in the percentage that specialized between US-raised and non-US-raised players (44.7% vs 44.5%, respectively; $P = .829$). However, of those who did specialize, non-US-raised players specialized approximately 2 years earlier than those MLB athletes raised in the US (12.30 ± 3.07 vs 14.89 ± 2.24 years, respectively).

MLB athletes raised in the US trained for their baseball season for approximately 2 additional months throughout the year than athletes from non-US countries (8.91 ± 3.09 vs 6.68 ± 3.87 mo/y, respectively; $P < .001$) (Table 4). Additionally, MLB athletes from the US were more likely to report sustaining an injury that they attributed to specializing in 1 sport (27.7% vs 20.6%, respectively; $P = .05$). A significantly lower percentage of US-raised MLB athletes believed that specializing in 1 sport helped an athlete play the sport at a higher level (49.1% vs 88.8%, respectively; $P < .001$). Additionally, over half of non-US-born MLB players would want their children to specialize in 1 sport; however, less than 10% of US-born MLB players want their children to specialize (55.4% vs 7.1%, respectively; $P < .001$).

When asked the main reason for specialization, 34.5% of MLB athletes said that they did so because of their love/enjoyment of the sport. The full list of reasons for

TABLE 3
Survey Responses for Single-Sport
Specialization Questions^a

	All Players	Non-US	US	P
No. of responses	1673	515	1106	
Age, y	23.60 ± 8.63	21.37 ± 3.41	24.57 ± 10.05	<.001
Age at which player first started to participate in competitive sports, y	6.85 ± 3.10	8.93 ± 3.77	5.91 ± 2.16	<.001
Quit other sports during childhood/adolescence to play only baseball, n (%)	717 (44.5)	225 (44.1)	489 (44.5)	.829
Age at which player quit other sports to focus on baseball, y	14.09 ± 2.79	12.30 ± 3.07	14.89 ± 2.24	<.001

^aValues are presented as mean ± SD unless otherwise indicated. Bolded values indicate a statistically significant difference. Percentages are presented based on the number of responses for each individual question.

specialization is included in Table 5. Of the US-born athletes who specialized in our cohort, the top 3 states that they lived in at the time of specialization were California, Florida, and Texas (Figure 1).

Pitching Results

The data pertaining to pitchers and their survey responses are presented in Table 6. Most MLB pitchers started restricting their pitching schedule based on pitch count limits and throwing off-speed pitches by their 14th birthday. Non-US-born players started focusing on only pitching (rather than fielding positions) at a significantly earlier age than US-born players (14.28 ± 2.87 vs 16.89 ± 1.82 years, respectively; $P < .001$). However, US-born players started throwing off-speed pitches (ie, curveball, slider) at a statistically younger but not clinically different age (13.41 ± 2.22 vs 13.85 ± 2.63 years, respectively; $P < .001$).

MLB pitchers were asked to give their own guidelines pertaining to pitch count limits for a Little League baseball player pitching in a single game, with usual rest, for 3 hypothetical ages. Their responses are presented in Table 7. US-born players had significantly higher pitch count cut-offs for each Little League age group than MLB pitchers born outside the US. However, regardless of country of origin, all MLB pitchers recommended a pitch count number below the MLB/USA Baseball Pitch Smart guidelines.¹⁹

TABLE 4
Survey Responses Comparing US-Raised
and Non-US-Raised Players^a

	All Players	Non-US	US	P
Trained for main baseball season (fitness, skills training, weight training, etc), mo/y	8.21 ± 3.51	6.68 ± 3.87	8.91 ± 3.09	<.001
Competed in baseball games (ie, school team, winter ball, AFL, instructional league, etc), mo/y	7.30 ± 2.80	5.78 ± 3.30	7.97 ± 2.25	<.001
Sustained an injury that player attributed to specializing in 1 sport, n (%)	181 (25.7)	45 (20.6)	134 (27.7)	.05
Glad that player focused on only 1 sport at age of specialization, n (%)	626 (88.8)	205 (93.6)	419 (86.6)	.006
Thought that specializing in 1 sport helps to play sport at a higher level, n (%)	979 (61.6)	446 (88.8)	532 (49.1)	<.001
Wanted children to specialize in only 1 sport during their adolescent years, n (%)	357 (22.4)	278 (55.4)	78 (7.1)	<.001

^aValues are presented as mean ± SD unless otherwise indicated. Bolded values indicate a statistically significant difference. Percentages are presented based on the number of responses for each individual question. AFL, Arizona Fall League.

Table 8 presents specialization results filtered for baseball position. There was no significant difference between the percentage of athletes that specialized or the age of specialization when comparing pitchers, infielders, outfielders, and catchers. Additionally, there was no significant difference between starting and relief pitchers with respect to the percentage that specialized and the age of specialization.

DISCUSSION

The current study investigates the topic of youth single-sport specialization among 1673 professional baseball players from 26 of the 30 MLB organizations. To our knowledge, this is the largest study, to date, examining the topic of single-sport specialization in baseball. There is a sense in the medical community that many current youth athletes and families perceive that early sport specialization is required for advancement to higher levels of competition

and ultimately will improve their chances of obtaining elite status in their sport. In contrast to this perception, our findings confirmed our hypothesis that the majority of current professional baseball athletes did not specialize in only 1 sport at a young age. Of the current professional baseball athletes who did specialize (44.5% of the study population), they did so at a mean age of 14 years. This suggests that

early single-sport specialization may not be necessary for advancement to the professional level of baseball.

Injury occurrence in sports is certainly multifactorial, but it has been suggested that early single-sport specialization may be an important injury factor in the youth athlete. Notably, we found that 25.7% of current MLB athletes recalled sustaining an injury that they attributed to single-sport specialization. This may suggest that early specialization can be a potential factor in the occurrence of early sport-related injuries in baseball. Importantly, these data reflect each surveyed athlete's ability to recall any injury that interrupted sport participation and required specific treatment, but it was not a prospective or documented account of the injury occurrence. Further prospective studies regarding the relationship between early sport specialization and injury occurrence are warranted.

Further questioning of professional baseball players, including both MLB and MiLB players, revealed a number of valuable attitudes and perceptions regarding sport specialization in baseball. US-born professional baseball players reported beginning organized sports earlier than non-US-born baseball players. However, non-US-born players reported specializing in baseball at an earlier age. Despite specializing later, US-born baseball players who

TABLE 5
Reasons for Single-Sport Specialization

	%
Love/enjoyment of the sport	34.5
Professional opportunities	15.8
Was the sport that player was best at	12.5
Collegiate scholarship	12.1
To be the best	9.6
Time/schedule conflicts	6.0
To improve in the sport	4.8
Other: write in (required)	2.1
Advice of coach	1.3
Advice of parent	1.0
Unsure	0.4

State	%
California	19.29
Florida	12.79
Texas	12.79
Georgia	7.13
New York	3.77
North Carolina	3.56
Arizona	3.14
Illinois	2.94
New Jersey	2.73
Tennessee	2.73
Virginia	2.73
Maryland	2.31
Ohio	2.1
Washington	2.1
Alabama	1.89
Pennsylvania	1.47
South Carolina	1.47

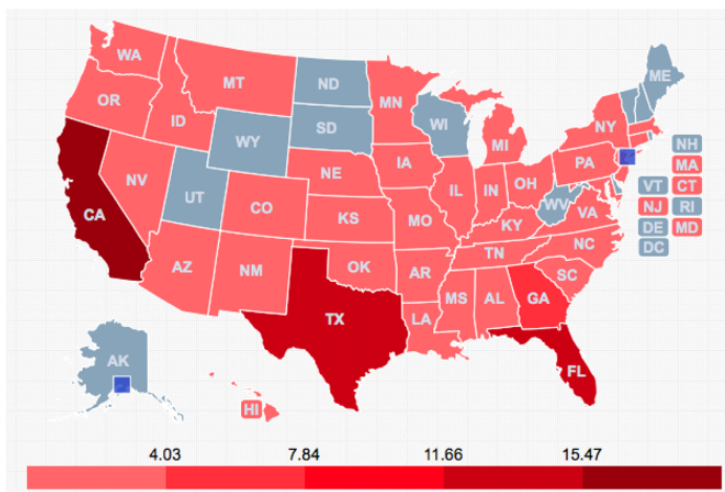


Figure 1. Heat map showing the geographic breakdown within the United States of the state of residence at the time of specialization for Major League Baseball athletes.

trained for more months per year were more likely to report an injury that they causally related to specialization and were less likely to attribute their current success to specialization compared with non-US-born athletes. With regard to injuries, it is critical to emphasize that the data collected in this study reflect the ability of each athlete to recall an injury that interrupted their participation and required treatment but may have been remote depending on the age of that particular athlete. In contrast to US-born baseball players, non-US-born athletes were more likely to want their own child to specialize. Additionally, they were more likely to agree that “early specialization was beneficial.” The socioeconomic environment a player was raised in may play a role in the opportunities available to the athlete as well as the attitudes that those athletes espouse regarding the potential rewards of sport specialization.¹⁸

Despite the commonly perceived pressures from parents and coaches as well as the allure of scholarships and professional contracts, the most commonly cited reason in our study for specialization among MLB players was love of the sport. This is contrary to the idea that coach/parental

pressure is the primary driver of specialization.²⁷ However, it remains necessary to balance supporting and encouraging youth athletes with participating in a way that is healthy and minimizes the risk of injuries and burnout. Education is key for athletes, parents, coaches, trainers, and even fellow physicians; early specialization may not be necessary for success, even at the professional level, and has been identified as an independent risk factor for injuries.¹⁵

Within the US, warm-weather states such as California, Texas, and Florida were the most represented regions for baseball players at the time of specialization. This highlights the role of geographic location and weather on the phenomenon of sport participation and specialization.⁸ This is likely a greater factor in predominantly outdoor sports such as baseball, golf, or football. It likely has a lesser impact on sports such as gymnastics, basketball, swimming, or skating, which may be indoor regardless of the season. Research by Erickson et al⁸ supports this idea and showed that MLB athletes who pitched in competitive youth baseball in warm-weather areas underwent medial ulnar collateral ligament reconstruction more frequently and earlier in their career than pitchers who played in cold-weather areas.

TABLE 6
Survey Responses for Pitching-Specific Questions^a

	All Players	Non-US	US	<i>P</i>
Age at which player started adjusting pitching schedule based on pitch count limits, y	13.82 ± 3.30	14.60 ± 3.04	13.78 ± 3.32	.149
Age at which player started throwing off-speed pitches (ie, curveball, slider), y	13.56 ± 2.36	13.85 ± 2.63	13.41 ± 2.22	<.001
Age at which player focused primarily on pitching rather than a fielding position, y	16.13 ± 2.47	14.28 ± 2.87	16.89 ± 1.82	<.001

^aValues are presented as mean ± SD. Bolded values indicate a statistically significant difference.

Limitations

There are several limitations of this study. This includes the cross-sectional nature of the study, which assesses different groups of athletes at different ages in their athletic careers. Next, it is possible that several aspects of the survey may have been misinterpreted by an individual athlete, including the definition of “sport specialization” and the age of “childhood/adolescence,” but the completion of all surveys was facilitated by certified athletic trainers to limit this possibility. Every effort was made to ensure accurate and complete survey completion, but nonetheless, there were many surveys that were only partially completed. Additionally, this survey was not translated into languages other than English and Spanish. This may have affected our ability to capture athletes from Europe or Asia who speak other languages. We do not have access to exact numbers, but we believe that there are roughly 7500 MLB and MiLB athletes across 30 teams. Of this, approximately 1200 athletes are part of the 40-man active roster, and 6300 are athletes in MiLB. Thus, although our study represents a large number of professional baseball athletes, we may be sampling only a fraction of the overall athletes. Furthermore, all athletes were subject to recall bias, as they were

TABLE 7
Pitchers' Responses for Little League Pitch Count Limits^a

	Athlete Responses				Pitch Smart Recommendations (Daily Maximum Pitches/Game)
	All Players	Non-US	US	<i>P</i>	
For 10-year-old players	47.03 ± 17.86	31.98 ± 15.67	52.53 ± 15.31	<.001	75
For 13-year-old players	61.39 ± 19.21	43.47 ± 19.57	67.84 ± 14.43	<.001	95
For 16-year-old players	77.93 ± 21.01	58.11 ± 23.47	85.47 ± 13.95	<.001	95

^aValues are presented as mean ± SD. Bolded values indicate a statistically significant difference.

TABLE 8
Differences in Specialization Based on Player Position^a

Position	Specialized, n (%)	P	Age of Specialization, Mean ± SD, y	P
Pitcher	391/887 (44.1)	.122	14.82 ± 2.33	.279
Starting pitcher	182/409 (44.5)	.8389	15.01 ± 1.81	.2154
Relief pitcher	209/478 (43.7)		14.66 ± 2.68	
Infield	158/330 (47.9)		14.81 ± 2.40	
Outfield	94/244 (38.5)		15.26 ± 2.10	
Catcher	69/144 (47.9)		14.61 ± 1.96	

^aAnalysis of variance: $F_{3,701} = 1.28$; $P = .279$. P values listed for “pitcher” compare the results of all 4 positions (pitcher, infield, outfield, and catcher). The P values listed next to “starting pitcher” reflect the comparison between only starting and relief pitchers.

asked to remember potentially remote events, decisions, and injuries. Conclusions on injury data reflected each surveyed athlete’s ability to recall an injury and their perception of whether factors associated with sport specialization contributed to the injury. Additionally, specific details pertaining to injuries or medical confirmation of injuries were not possible through this survey study, as it is not a prospective account of injury occurrence. However, we feel that the athletes’ perceptions of injuries in relation to sport specialization are important findings in the realm of sport specialization. Lastly, it was necessary to translate the survey for non-English speakers, with the further possibility of question misinterpretation. The translation, however, was performed by MLB, which has decades of experience in translating for its non-English-speaking players.

CONCLUSION

This study challenges the current trends toward early youth sport specialization, finding that the majority of professional baseball athletes studied did not specialize as youths and that those who did specialize did so at a mean age of 14 years. Further research is necessary so that we can continue to educate parents, coaches, trainers, medical caregivers, and athletes on early youth sport specialization and thereby provide the safest environment for healthy athletes to participate in sports at all ages and all levels. We hope that a more robust understanding of this phenomenon will ultimately serve to better counsel patients and their parents, coaches, trainers, and physicians to mitigate the injuries and burnout that may result from early single-sport specialization within baseball.

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