

Pitfalls of Pediatric and Adolescent Sports Specialization

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Abstract:

Engagement in athletic participation is important for the physical and emotional well-being of pediatric and adolescent youth. Yet, changing patterns of sports participation have created multiple consequences for those involved. A trend toward single sport specialization and club sports at the expense of unstructured recreational play has led to these changes. As a result, youth are subject to increased injury risk as well as compromised mental health. Furthermore, disparities in access to sports are created for many who cannot afford to play, leaving many communities without access to physical activity. This drive toward sports specialization (and privatization) has been driven by the fallacy that it will lead to subsequent athletic success at the collegiate and professional level, a notion that healthcare providers must help to dispel.

Key Concepts:

- In an effort to compete at the collegiate level and beyond, there is an increasing trend toward single-sport specialization amongst pediatric and adolescent athletes.
- Sport specialization is associated with both overuse and acute injuries as well as burnout and compromised mental health as consequences of this pattern of athletic participation.
- Significant financial barriers for sports participation exclude youth from lower socio-economic backgrounds from playing sports.
- Paradoxically, early sports specialization is rare among athletes who go on to compete in collegiate and professional sports.

Introduction

Physical activity is one pillar of a healthy lifestyle for many youth. Yet, there has been an increasing emphasis on skill-based development rather than healthy, well-rounded participation amongst pediatric and adolescent athletes. This trend has been largely driven by parents, coaches, and athletes who see sports specialization as a

means to an end, rather than an end in and of itself. The purpose of this paper is to review the epidemiology of pediatric sports participation, the physical and mental consequences of sports specialization, the financial barriers and disparities which exist in youth sports, and the impacts on collegiate/professional sports performance.

This information is critical for healthcare providers at all levels to be able to comprehensively counsel youth sports parents and athletes.

Epidemiology of Pediatric Sports Participation

Youth sports participation in the United States has shifted drastically over the past 10-15 years. School-based programming has been largely replaced by a private, profit-driven model in which skill-based development has been emphasized. Rather than engage in seasonal, multi-sport participation, sports specialization has become increasingly prevalent.¹ Sports specialization has been defined as participation in one sport at the exclusion of other sports.² This has been associated with increased injury risk, burnout, and decreased sports performance/achievement.^{3,4}

According to the Aspen Institute, this trend towards sports specialization has been ongoing for the past several years.⁵ Although COVID-19 has changed participation patterns over the past year,^{6,7} many anticipate that this trend will return as restrictions are lifted. Parents, coaches, and athletes are driving this trend with their desire for scholarship/college entrance.^{8,9} Yet, only 7% of all high school athletes will play collegiately with only 2% obtaining an NCAA scholarship.¹⁰

The implications of sports specialization on the health of the athlete, finances of the athlete/family, as well as future performance are critical to understand.

Sports Specialization and Injury Risk

Sports specialization was initially linked to injury as a proposed risk factor for overuse injury due to repetitive movements, resulting in an accumulation of micro-trauma to bone, tendon, or apophyseal or physeal cartilage.^{11,12} Early studies suggesting specialization as a contributor to overuse injury in young athletes were primarily single-sports case series. In a case-control study, injured athletes pitched significantly more months per year, games per year, innings per game, pitches per game, pitches per year, and warmup pitches before a game compared to their uninjured counterparts.¹³ Furthermore, the injured athletes pitched in more

showcases, pitched with higher velocity, were more likely to be starting pitchers, and were more likely to pitch when they had arm pain or fatigue.¹³ In a series of 481 youth baseball pitchers (age 9-14 years) followed over a 10-year period, pitching more than 100 innings per year was found to increase the risk of injury 3.5 times.¹⁴

Expanding from youth baseball pitchers, Jayanthi et al. evaluated sports specialization and injury in adolescent elite tennis players, finding the risk of reported injury was 1.5 times greater for athletes who only played tennis.¹⁵ Similarly, in a group of 546 female athletes participating in basketball, soccer, and volleyball, the relative risk of patellofemoral pain, Osgood-Schlatter disease, and Sinding-Larsen-Johansson syndrome was 1.5 times that of multisport athletes.¹⁶

As more studies have adopted Jayanthi’s scale for measuring sports specialization (Figure 1)¹⁷ and utilized it when assessing the association of specialization with sports injury, there is growing evidence that sports specialization is a risk factor for both overuse and acute injury among youth athletes. The scale categorizes athletes’ level of specialization as low, moderate, or high based on their answers to three questions about their sports participation.

Figure 1. Jayanthi’s three-point scale to assess level of sports specialization.

1. *Can you pick a main sport?*
2. *Did you quit other sports to focus on a main sport?*
3. *Do you train in a sport for > 8 months in a year?*

	Low Specialization	Moderate Specialization	High Specialization
# “Yes” answers	1	2	3

In a case-control study of athletes 7-18 years of age (822 injured athletes and 368 uninjured athletes) first utilizing Jayanthi's specialization measure, sports-specialized training was found to be a risk for injury independent of athlete age or hours of training per week (odds ratio [OR], 1.27; 95% CI, 1.07-1.52; $P < .01$) as well as serious overuse injury (OR, 1.36; 95% CI, 1.08-1.72; $P < .01$), which authors defined as an injury for which a physician recommended ≥ 1 month of rest from sports.¹⁷ Bell et al. surveyed 302 high school athletes for injury history and assessed their level of specialization using Jayanthi's scale, finding that athletes who were highly specialized were more likely to report an overuse knee or hip injury.¹⁸ Authors identified participation in a single sport for more than 8 months out of the year as an important factor in the increased injury risk seen in the highly specialized athletes.¹⁸

In a larger scale survey of 2011 high school athletes, highly specialized athletes were more likely to report a previous injury of any kind and more likely to report an overuse injury in the previous year compared with athletes in the low specialization group.¹⁹ In this series, playing a single sport more than 8 months of the year was associated with increased reports of an upper extremity and lower extremity overuse injury within the previous year.¹⁹ Further evaluation of the data by gender found that high and moderate specialization was associated with increased reports of overuse injury in female athletes compared to low specialization while high specialization was not associated with increased overuse injury in males.²⁰ Similar associations between specialization and history of injury were reported in a series of 1588 female high school volleyball players with more injury reports in the highly and moderately specialized athletes compared to those with low levels of specialization.²¹ As research into the effects of sports specialization on injury continue, further investigation into gender differences in health and injury risk should be evaluated.

While there is abundant evidence for an association of sports specialization and overuse injury, there is growing evidence that specialization may play a role in acute

injury as well. Biese et al. reported an increase in acute injuries among highly specialized female high school athletes over the course of a single academic year compared to female athletes with low specialization.²⁰ Again, gender differences were apparent in this cohort, as this association between high specialization and acute injury was not seen among male high school athletes.²⁰ In a survey of 761 youth soccer players (age 12-18 years), highly specialized athletes were more likely to report a history of both overuse and acute knee injuries.²² When looking just at injuries resulting from soccer, highly specialized youth soccer players were nearly five and a half times more likely to report a history of overuse knee injury.²²

Much of the literature on sports specialization and injury is derived from retrospective or survey studies. In a large prospective study of 1544 high school athletes, sports specialization was assessed while athletic exposures and injuries were recorded.²³ In this series, 13.4% of the athletes were classified as highly specialized, 27.1% as moderately specialized and 59.5% had low levels of specialization.²³ Over a single academic year, 15.2% of athletes sustained a lower extremity injury, most commonly to the ankle (34.4%) or knee (25%).²³ Similar to the survey and retrospective studies, this prospective study found that athletes classified as having high and moderate specialization were more likely to sustain a lower extremity injury compared to the low specialization group.²³

Sports Specialization and Mental Health

Sports specialization does not just affect the physical health of young athletes but there seems to be a strong impact on mental health as well; however, evidence for a connection between specialization and mental health is less abundant. Malina outlines concerns of extreme regulation of schedules creating an over reliance on parents and coaches in addition to social isolation and burnout as potential risks of sports specialization.¹² Early cessation of sports participation has been associated with early sports specialization, either due to injury or athlete burnout.²⁴⁻²⁸

Sports-related injury, which is associated with sports specialization, effects the mental health of young athletes. A prospective study followed 2073 female high school volleyball players through an interscholastic volleyball season, tracking athletic exposures and recording any injuries that were reported during the season.²⁹ The athletes completed the Pediatric Quality of Life (QOL) survey and reported average nightly sleep at the start and the end of the season. Girls who were injured during the season demonstrated a greater decrease in total QOL, physical function, school function, and psychosocial function domains of survey compared with uninjured athletes.²⁹ The greatest decrease in total QOL was seen among athletes who sustained a season-ending injury compared with those who were able to return to play during the season.²⁹

Burnout is defined as “a series of psychological, physiologic, and hormonal changes that result in decreased sports performance.”³⁰ Manifestations of burnout include chronic pain, elevated resting heart rate, decreased sports performance, and personality changes. Young athletes may also show a lack of enthusiasm to practice or play their sport, fatigue, and difficulty completing tasks.^{24,28,30}

Specific studies looking at the mental health impact of sports specialization have primarily focused on collegiate athletes. In a study comparing former NCAA Division I collegiate athletes to noncollegiate athletes, collegiate athletes scored lower on Patient-Reported Outcomes Measurement Information System (PROMIS) measures of physical function, depression, fatigue, sleep disturbances, and pain interference.³¹ When comparing graduated college athletes to current college athletes, Weigand et al. found two times higher rates of depression among current collegiate athletes (16.77% vs. 8.02%).³² Similarly, Yang et al. reported a 21% rate of depression among NCAA Division I collegiate athletes, with highest rates seen in freshman and female athletes.³³

More recent studies have investigated the effect of sports specialization on youth athletes. A cohort of 52 youth soccer athletes, 13-18 years of age, was followed

prospectively over a 4-month long soccer season.³⁴ Athletes reported daily training load and recorded their sleep duration, stress, mood, fatigue, soreness, and sleep quality on a scale of -3 (worst) to +3 (best). Investigators found that despite similar sleep duration each night, specialized athletes had worse fatigue, mood, and sleep quality as well as more soreness when compared to the nonspecialized athletes.³⁴

Financial Implications and Disparities of Sports Specialization

Any discussion in regards to youth sports specialization is incomplete without an understanding of the financial underpinnings of this trend. According to a TD Ameritrade survey, youth sports are a \$15 billion industry with greater than 60% of parents paying between \$1,200 to \$6,000 per year for sports involvement.³⁵ The degree of financial capital necessary to access sports has created a barrier to participation for many families. Nearly double the number of children in homes with annual incomes greater than \$100,000 participate in sports as opposed to those with less than \$25,000.⁵ This disparity holds true amongst racial/ethnic lines with children of color participating to a lesser degree than their white counterparts.⁵

With a decreasing emphasis on affordable community/recreational programming (which have been limited due to COVID-19), a further consequence of sport specialization has been limited opportunities for physical activity within these socio-economic groups who cannot afford the multitude of costs associated with the “pay-to-play” model.³⁶ From a public health standpoint, the benefits of sports participation both for physical and mental health are not questioned, and have been particularly amplified due to COVID-19.³⁷ As a result, a detrimental youth sporting system has been created due to the finances intertwined within it—one group of youth who pay to play (and become injured/burned out) and a second group who have opportunities for physical activity taken away from them due to lack of financial resources.

This discrepancy has been demonstrated in the literature. Post et al. demonstrated that higher household incomes

as well as advanced degrees obtained by parents were associated with club sport participation.³⁸ Jayanthi et al. demonstrated that higher socio-economic status was associated with sports specialization (and overuse injuries).³⁹ Furthermore, Hyde et al. found that white males had higher levels of sports participation.⁴⁰ In addition, Fabricant et al. demonstrated that government/lack of insurance was associated with lower physical activity levels.⁴¹ Clearly, large scale interventions at the national, regional, and local levels are necessary in order to improve more equitable youth sports participation in order to promote physical activity, in general, among children/adolescents.

Long-Term Implications of Sports Specialization

Although the data is clear about the deleterious effects of sports specialization from the perspective of injury risk, mental health, and access disparities, many athletes, coaches, and parents are still insistent on specializing due to preconceived notions of future athletic success. A critical review of the literature demonstrates otherwise, and it is important for healthcare providers to understand as they counsel patients and families.

The lack of specialization amongst collegiate athletes has been well established. Rugg et al. in a survey of over 1500 former NCAA athletes found that less than one-fifth of NCAA athletes surveyed specialized before age 15 years, and neither scholarship attainment nor time-loss injury rate was affected by early specialization.⁴² This was further demonstrated by Swindell et al. who (in a survey of collegiate athletes) found that nearly 95% of athletes had played another organized sport (other than their current primary sport) before college and nearly half had played multiple sports up until age 16 with a mean age of specialization of 14.9 years.⁴³ Furthermore, Post et al. demonstrated that the vast majority of NCAA athletes they studied were not highly specialized throughout high school.⁴⁴

The data in regards to potential future impact on professional performance is also critical, particularly as this is used to drive specialization. Rugg et al.

examined 7 years of National Basketball Association (NBA) first round draft picks and found that those who played multiple sports participated in more games, had fewer major injuries, and had longer careers than single sport athletes.⁴⁵ A similar trend has been shown in Major League Baseball (MLB). Confino et al. examined 8 years of MLB first and second draft picks.⁴⁶ Of the 746 athletes in the study, 68% were single-sport athletes and 32% were multi-sport athletes. The multi-sport high school athletes played in more major league games and had lower rates of both upper and lower extremity injuries while playing professionally.⁴⁶ Furthermore, Buckley et al. surveyed nearly 1700 professional baseball athletes and only 44.5% played a single sport during childhood/adolescence.⁴⁷ This trend continues in the National Football League (NFL) as well. In a study by Steinl et al. examining 9 years of first round NFL draft picks, 88% of the athletes were multisport athletes in high school although no difference in injury risk was found.⁴⁸

When looking at other sports, this pattern holds as well. Black et al. examined 91 male professional and collegiate hockey players and found that early sport specialization was not common in elite hockey players, with a mean age of specialization of approximately 14 years.⁴⁹ In fact, Sheppard et al. examined hip/groin dysfunction in collegiate hockey players and found that those players who specialized before high school had more hip/groin pain, dysfunction during activities, and lower current hip- and groin-related quality of life compared to non-specialized players.⁵⁰

Clearly, the power of this data demonstrates that professional success is not only more likely to occur from a performance standpoint through multisport specialization but also decreases the potential injury risk (which is intimately intertwined with performance). Continued reemphasis of available data in regards to performance and injury comparisons between specialized and non-specialized athletes in the high school, collegiate, and professional ranks is important to reverse the current trend toward specialization.^{51,52}

Summary

Pediatric and adolescent sports specialization has multiple consequences for the physical and emotional well-being of youth. A multi-pronged approach based in evidence is necessary to combat this trend and allow for youth of all backgrounds to be healthy and active. A critical understanding of the literature is a powerful tool for healthcare providers.

Additional Links

- The Aspen Institute Project Play
<https://www.aspenprojectplay.org/>
- STOP (Sports Trauma and Overuse Prevention)
<https://www.stopsportsinjuries.org/>

References

1. Pasulka J, Jayanthi N, McCann A, Dugas LR, LaBella C. Specialization patterns across various youth sports and relationship to injury risk. *Phys Sportsmed*. 2017 Sep;45(3):344-352. doi: 10.1080/00913847.2017.1313077. Epub 2017 Apr 10. PMID: 28351225.
2. Jayanthi NA, Pinkham C, Durazo-Arivu R, Dugas L, Luke A. The risks of sports specialization and rapid growth in young athletes. *Clin J Sports Med* 2011;21:157
3. Lansdown DA, Rugg CM, Feeley BT, Pandya NK. Single Sport Specialization in the Skeletally Immature Athlete: Current Concepts. *J Am Acad Orthop Surg*. 2020 Sep 1;28(17):e752-e758. doi: 10.5435/JAAOS-D-19-00888. PMID: 32520903.
4. Popkin CA, Bayomy AF, Ahmad CS. Early sport specialization. *J Am Acad Orthop Surg*. 2019 Nov 15;27(22):e995-e1000. doi: 10.5435/JAAOS-D-18-00187. PMID: 31157759.
5. The Aspen Institute. State of Play 2019. Accessed online February 8th, 2020 at https://www.aspeninstitute.org/wp-content/uploads/2019/10/2019_SOP_National_Final.pdf.
6. Ng K, Cooper J, McHale F, Clifford J, Woods C. Barriers and facilitators to changes in adolescent physical activity during COVID-19. *BMJ Open Sport Exerc Med* 2020; 6(1):e000919. doi: 10.1136/bmjsem-2020-000919.
7. McGuine TA, Biese KM, Petrovska L, Hetzel SJ, Reardon C, Kliethermes S, Bell DR, Brooks A, Watson AM. Mental health, physical activity, and quality of life of US adolescent athletes during COVID-19-related school closures and sport cancellations: a study of 13000 athletes. *J Athl Train* 2020 Dec doi: 10.4085/1062-6050-0478.20. Epub ahead of print.
8. Padaki AS, Ahmad CS, Hodgins JL, Kovacevic D, Lynch TS, Popkin CA. Quantifying parental influence on youth athlete specialization: a survey of athletes' parents. *Orthop J Sports Med*. 2017 Sep 21;5(9):2325967117729147. doi: 10.1177/2325967117729147. PMID: 28975135; PMCID: PMC5613852.
9. Padaki AS, Popkin CA, Hodgins JL, Kovacevic D, Lynch TS, Ahmad CS. Factors that drive youth specialization. *Sports Health*. 2017 Nov/Dec;9(6):532-536. doi: 10.1177/1941738117734149. Epub 2017 Oct 12. PMID: 29023194; PMCID: PMC5665117.
10. NCAA. Estimated probability of competing in college athletics. Accessed online February 8th, 2021 at <https://www.ncaa.org/about/resources/research/estimated-probability-competing-college-athletics>
11. DiFiori, John P MD. Overuse Injury of the Physis: A “Growing” Problem, *Clin J Sport Med*. 2019 Sept;20(5):336-337. doi: 10.1097/JSM.0b013e3181ebb55d
12. Malina RM. Early sport specialization: roots, effectiveness, risks. *Curr Sports Med Rep*. 2010 Nov-Dec;9(6):364-71. doi: 10.1249/JSR.0b013e3181fe3166. PMID: 21068571.
13. Olsen SJ 2nd, Fleisig GS, Dun S, Loftice J, Andrews JR. Risk factors for shoulder and elbow injuries in adolescent baseball pitchers. *Am J Sports Med*. 2006 Jun;34(6):905-12. doi: 10.1177/0363546505284188. Epub 2006 Feb 1. PMID: 16452269.
14. Fleisig GS, Andrews JR, Cutter GR, Weber A, Loftice J, McMichael C, Hassell N, Lyman S. Risk of serious injury for young baseball pitchers: a 10-year prospective study. *Am J Sports Med*. 2011 Feb;39(2):253-7. doi: 10.1177/0363546510384224. Epub 2010 Nov 23. PMID: 21098816.
15. Jayanthi N, Dechert A, Durazo R, et al. Training and sports specialization risks in junior elite tennis players. *J Med Sci Tennis*. 2011;16(1):14-20.
16. Hall R, Barber Foss K, Hewett TE, Myer GD. Sport specialization's association with an increased risk of developing anterior knee pain in adolescent female athletes. *J Sport Rehabil*. 2015;24(1):31-35. doi:10.1123/jsr.2013-0101.
17. Jayanthi NA, LaBella CR, Fischer D, Pasulka J, Dugas LR. Sports-specialized intensive training and the risk of

- injury in young athletes: a clinical case-control study. *Am J Sports Med.* 2015;43(4):794-801. doi:10.1177/0363546514567298.
18. Bell DR, Post EG, Trigsted SM, Hetzel S, McGuine TA, Brooks MA. Prevalence of Sport Specialization in High School Athletics: A 1-Year Observational Study. *Am J Sports Med.* 2016;44(6):1469-1474. doi:10.1177/0363546516629943.
19. Post EG, Trigsted SM, Riekens JW, et al. The Association of Sport Specialization and Training Volume With Injury History in Youth Athletes. *Am J Sports Med.* 2017;45(6):1405-1412. doi:10.1177/0363546517690848.
20. Biese KM, Post EG, Schaefer DA 2nd, et al. Evaluation of adolescent sport specialization and injury mechanism by sex: A secondary analysis. *J Sci Med Sport.* 2020;23(8):721-725. doi:10.1016/j.jsams.2020.01.012.
21. Biese KM, McGuine TA, Kliethermes SA, et al. Sport specialization and sport participation opportunities and their association with injury history in female high school volleyball athletes. *Phys Ther Sport.* 2020;45:86-92. doi:10.1016/j.ptsp.2020.06.005,
22. Bell, D. R., Lang, P. J., Valovich McLeod, T. C., McCaffrey, K. A., Zaslow, T. L., & McKay, S. D. Sport Specialization Is Associated with Injury History in Youth Soccer Athletes. *Athletic Training & Sports Health Care.* 2018;10(6):241-246. doi:10.3928/19425864-20180813-0.
23. McGuine TA, Post EG, Hetzel SJ, Brooks MA, Trigsted S, Bell DR. A Prospective Study on the Effect of Sport Specialization on Lower Extremity Injury Rates in High School Athletes. *Am J Sports Med.* 2017;45(12):2706-2712. doi:10.1177/0363546517710213.
24. Budgett R. Fatigue and underperformance in athletes: the overtraining syndrome. *Br J Sports Med.* 1998;32(2):107-110. doi:10.1136/bjism.32.2.107.
25. Gould D, Udry E, Tuffey S, et al. Burnout in competitive junior tennis players: pt. 1. a quantitative psychological assessment. *Sport Psychol* 1996;10: 322-40.
26. Smucny M, Parikh SN, Pandya NK. Consequences of single sport specialization in the pediatric and adolescent athlete. *Orthop Clin North Am.* 2015;46(2):249-258. doi:10.1016/j.ocl.2014.11.004.
27. Myer GD, Jayanthi N, Difiori JP, et al. Sport Specialization, Part I: Does Early Sports Specialization Increase Negative Outcomes and Reduce the Opportunity for Success in Young Athletes? *Sports Health.* 2015;7(5):437-442. doi:10.1177/1941738115598747.
28. Brenner JS; American Academy of Pediatrics Council on Sports Medicine and Fitness. Overuse injuries, overtraining, and burnout in child and adolescent athletes. *Pediatrics.* 2007;119(6):1242-1245. doi:10.1542/peds.2007-0887.
29. Watson A, Biese K, Kliethermes SA, et al. Impact of in-season injury on quality of life and sleep duration in female youth volleyball athletes: a prospective study of 2073 players [published online ahead of print, 2021 Feb 24]. *Br J Sports Med.* 2021;bjsports-2020-103331. doi:10.1136/bjsports-2020-103331.
30. Small E. Chronic musculoskeletal pain in young athletes. *Pediatr Clin North Am.* 2002;49(3):655-vii. doi:10.1016/s0031-3955(02)00008-1.
31. Simon JE, Docherty CL. Current health-related quality of life is lower in former Division I collegiate athletes than in non-collegiate athletes. *Am J Sports Med.* 2014;42(2):423-429. doi:10.1177/0363546513510393.
32. Weigand S, Cohen J, Merenstein D. Susceptibility for depression in current and retired student athletes. *Sports Health.* 2013;5(3):263-266. doi:10.1177/1941738113480464.
33. Yang J, Peek-Asa C, Corlette JD, Cheng G, Foster DT, Albright J. Prevalence of and risk factors associated with symptoms of depression in competitive collegiate student athletes. *Clin J Sport Med.* 2007;17(6):481-487. doi:10.1097/JSM.0b013e31815aed6b.
34. Watson A, Brickson S. Relationships Between Sport Specialization, Sleep, and Subjective Well-Being in Female Adolescent Athletes. *Clin J Sport Med.* 2019;29(5):384-390. doi:10.1097/JSM.0000000000000631.
35. TD Ameritrade. Investor survey: parent perspectives on the cost of competitive youth sports. Accessed online February 8th, 2021 at https://s1.q4cdn.com/959385532/files/doc_downloads/research/Sports-Parents-Survey-Report_2016.pdf.
36. Bridging the Gap. Sports participation in secondary schools: resources available and inequalities in participation: a BTG research brief. Accessed July 2019 at <http://www.bridgingthegapresearch.org>.
37. Shahidi SH, Stewart Williams J, Hassani F. Physical activity during COVID-19 quarantine. *Acta Paediatr.* 2020 Oct;109(10):2147-2148. doi: 10.1111/apa.15420. Epub 2020 Jul 3. PMID: 32557827; PMCID: PMC7323361.
38. Post EG, Green NE, Schaefer DA, Trigsted SM, Brooks MA, McGuine TA, Watson AM, Bell DR. Socioeconomic status of parents with children participating on youth club sport teams. *Phys Ther Sport* 2018; 32:126-132. doi: 10.1016/j.ptsp.2018.05.014. Epub 2018 May 17.

39. Jayanthi NA, Holt DB Jr, LaBella CR, Dugas LR. Socioeconomic factors for sports specialization and injury in youth athletes. *Sports Health* 2018;10:303-310. doi: 10.1177/1941738118778510. Epub 2018 May 31.
40. Hyde ET, Omura JD, Fulton JE, Lee SM, Piercy KL, Carlson SA. Disparities in youth sports participation in the U.S., 2017-2018. *Am J Prev Med* 2020;59:e207-e210. doi: 10.1016/j.amepre.2020.05.011.
41. Fabricant PD, McLaren SH, Suryavanshi JR, Nwachukwu BU, Dodwell ER. Association between government health insurance status and physical activity in American youth. *J Pediatr Orthop* 2019;39:e552-e557. doi: 10.1097/BPO.0000000000001329.
42. Rugg CM, Coughlan MJ, Li JN, Hame SL, Feeley BT. Early Sport specialization among former national collegiate athletic association athletes: trends, scholarship attainment, injury, and attrition. *Am J Sports Med.* 2021 Mar;49(4):1049-1058. doi: 10.1177/0363546520988727. PMID: 33719607.
43. Swindell HW, Marcille ML, Trofa DP, Paulino FE, Desai NN, Lynch TS, Ahmad CS, Popkin CA. An analysis of sports specialization in NCAA Division I collegiate athletics. *Orthop J Sports Med.* 2019 Jan 28;7(1):2325967118821179. doi: 10.1177/2325967118821179. PMID: 30729145; PMCID: PMC6350152.
44. Post EG, Thein-Nissenbaum JM, Stiffler MR, Brooks MA, Bell DR, Sanfilippo JL, Trigsted SM, Heiderscheid BC, McGuine TA. High school sport specialization patterns of current Division I athletes. *Sports Health.* 2017 Mar/Apr;9(2):148-153. doi: 10.1177/1941738116675455. Epub 2016 Nov 3. PMID: 27807260; PMCID: PMC5349389.
45. Rugg C, Kadoor A, Feeley BT, Pandya NK. The effects of playing multiple high school sports on National Basketball Association players' propensity for injury and athletic performance. *Am J Sports Med.* 2018 Feb;46(2):402-408. doi: 10.1177/0363546517738736. Epub 2017 Nov 14. PMID: 29135275.
46. Confino J, Irvine JN, O'Connor M, Ahmad CS, Lynch TS. Early sports specialization is associated with upper extremity injuries in throwers and fewer games played in Major League Baseball. *Orthop J Sports Med.* 2019 Jul 26;7(7):2325967119861101. doi: 10.1177/2325967119861101. PMID: 31384622; PMCID: PMC6661792.
47. Buckley PS, Ciccotti MC, Bishop M, Kane P, Selverian S, Exume D, D'Angelo J, Emper W, Freedman KB, Hammoud S, Cohen SB, Ciccotti MG. Youth single-sport specialization in professional baseball players. *Orthop J Sports Med.* 2020 Mar 20;8(3):2325967120907875. doi: 10.1177/2325967120907875. PMID: 32232067; PMCID: PMC7092410.
48. Steidl GK, Padaki AS, Irvine JN, Popkin CA, Ahmad CS, Lynch TS. The prevalence of high school multi-sport participation in elite national football league athletes. *Phys Sportsmed.* 2020 Dec 6:1-4. doi: 10.1080/00913847.2020.1856632. Epub ahead of print. PMID: 33238784.
49. Black S, Black K, Dhawan A, Onks C, Seidenberg P, Silvis M. Pediatric sports specialization in elite ice hockey players. *Sports Health.* 2019 Jan/Feb;11(1):64-68. doi: 10.1177/1941738118800446. Epub 2018 Oct 5. PMID: 30289744; PMCID: PMC6299349.
50. Sheppard M, Nicknair J, Goetschius J. Early sport specialization and subjective hip and groin dysfunction in collegiate ice hockey athletes. *J Athl Train.* 2020 Mar;55(3):232-237. doi: 10.4085/1062-6050-0375-19. Epub 2020 Feb 7. PMID: 32031885; PMCID: PMC7093925.
51. Buckley PS, Bishop M, Kane P, Ciccotti MC, Selverian S, Exume D, Emper W, Freedman KB, Hammoud S, Cohen SB, Ciccotti MG. Early single-sport specialization: A survey of 3090 high school, collegiate, and professional athletes. *Orthop J Sports Med.* 2017 Jul 28;5(7):2325967117703944. doi: 10.1177/2325967117703944. PMID: 28812031; PMCID: PMC5536378.
52. DiFiori JP, Quittiquit C, Gray A, Kimlin EJ, Baker R. Early single sport specialization in a high-achieving US athlete population: comparing National Collegiate Athletic Association student-athletes and undergraduate Students. *J Athl Train.* 2019 Oct;54(10):1050-1054. doi: 10.4085/1062-6050-431-18. PMID: 31633415; PMCID: PMC6805068.