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Narrative Review

The Public Health Consequences of Sport Specialization

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Sport specialization was thought to affect a relatively small number of elite athletes, but it is now a common practice in youth sport culture. Recent research in the field of sport specialization has led to a better understanding of the influence this issue is having on youth (ie, younger than 19 years of age) today. This review focuses on sport specialization from a public health perspective to elucidate the effect that this practice is having within the United States. The specific goals of this review are to describe (1) the prevalence of sport specialization and the factors that may affect the decision to specialize, (2) the costs of youth sport-related injuries in the context of sport specialization, (3) the financial costs that sport specialization has for families, and (4) how sport specialization may be affecting physical literacy.

Sport specialization is most commonly defined as year-round participation in a single sport, often to the exclusion of other sports.[1] Research into sport specialization has expanded exponentially over the past few years. A recent PubMed search using the search term *sport specialization* revealed that approximately 195 articles were published in the last 6 years alone (2012–2018). This is equivalent to the number of articles published during the preceding 57 years (1954–2011, n = 199). Youth sports have changed dramatically since 1954 and perhaps most dramatically in the past 20 years, with the emergence of club sports and the decline of the physical education curriculum in schools.

Physical activity in children is advantageous because (1) activity improves their immediate overall health, (2) there seems to be a biological carryover into adulthood, with active children having better cardiovascular and bone health as adults, and (3) there seems to be a behavioral carryover into adulthood whereby active children are more likely to be active adults.[2] As a result, participation in sports is likely associated with positive long-term health implications in children[3] and a reduced disease burden associated with physical inactivity–related diseases.[3] In addition, many well-documented positive outcomes of sport participation exist beyond physical activity. These improvements include, among others, better self-esteem, discipline, and academic performance; learning about goal setting and teamwork; and less participation in risky behavior.[4–8]

Children participate in sports for a variety of reasons. The primary reason most often cited by children themselves is because it is "fun."[9] Although this list is not exhaustive, other factors associated with sport participation include becoming more skilled at their sport, being part of a team, and learning leadership skills.[9] Some children may elect to intensify and specialize their participation, which may include involvement in more competitive leagues or in more specialized training sessions. These athletes may believe specializing in a sport will lead to increased chances of making their high school team and securing a college scholarship or professional contract related to athletic performance.[10,11]

Several statistics associated with youth sport participation demonstrate significant public health consequences that may be a result of sport specialization. For example, up to 70% of children will drop out of sport by the time they are 13 years of age[12] and girls drop out of sports at a rate twice that of boys.[13] By 12th grade, boys are much more likely to participate in organized sport compared with girls.[14] The primary reason for dropping out of sport most often cited by children themselves is that it is no longer fun.[9] Dropout and burnout at an early age have been partially attributed to sport specialization and intensive training.[15] Specialization may also serve as a barrier to exploring sport by limiting late entrance into the sport. This may be particularly problematic for children who mature later in adolescence or children who wish to explore different sport options. Youths may be interested in a sport but may find that the environment is not conducive to novice learners.

We need a better understanding of how sport specialization is affecting our children as they navigate the youth sports experience. The purpose of this narrative review is to discuss the role that sport specialization is playing in children's health and wellbeing and how it applies to the larger realm of public health. In this article, we will focus on (1) the prevalence of sport specialization and the factors

that may affect the decision to specialize, (2) the costs of youth sport-related injuries in the context of sport specialization, (3) the financial effect that sport specialization has on families, and (4) how sport specialization may be affecting physical literacy.

PREVALENCE OF SPORT SPECIALIZATION

Until recently, relatively basic questions regarding the effects of sport specialization could not be answered, such as "What percentage of children are considered highly specialized?" Over the past several years, studies have provided evidence to help determine the scope of this issue. Most of this research coincides with the advent of different sport-specialization scales that attempt to classify individuals into categories of specialization.[16] One of the most commonly used scales uses answers to 3 binary (*yes/no*) questions to classify participants as low, moderate, or highly specialized athletes.[16] Jayanthi et al[16] were the first to indicate the prevalence of specialization, with 28.1% of adolescents classified as highly specialized within a cohort of patients ranging from 7 to 18 years of age who reported to a hospital sports medicine clinic for injury evaluation. Multiple authors have reported the prevalence of highly specialized athletes at approximately 30% for club sport participants.[17,18] For the purposes of this review, *clubs* are in reference to the United States and are often private, fee-for-participation sports leagues that have a range of competition levels. However, other investigators using more population-based measurements observed that the prevalence of highly specialized athletes might be lower.[17–21] For example, the smallest prevalence value for highly specialized athletes was 13.4%. This value was noted in a large prospective cohort study with more than 1500 participants in a variety of settings (suburban versus rural, large and small schools, multiple sports).[20] This value might better represent a more accurate estimate of the overall prevalence; however, many factors can affect these numbers.

Several factors affect the prevalence of sport specialization. These include sport selection, age, sex, and school location and size. Girls have different sport-participation patterns compared with boys.[2] For example, girls are more likely to be classified as highly specialized than boys.[2] In addition, girls are more likely to participate in high competition volumes and play on a club sports teams when compared with their male counterparts.[17] These factors can increase the susceptibility to musculoskeletal overuse injuries. High school size and school location affect sport participation and specialization characteristics. Students at large high schools are more likely to be classified as highly specialized compared with athletes at small high schools.[21] The roster size for a varsity basketball team is similar between large and small high schools. However, larger schools will potentially have more athletes trying out for these roster spots, thus putting more pressure on the individual to specialize in order to make a team. In addition, athletes who live in suburban settings are more likely to be classified as highly specialized compared with athletes in rural settings, which may be attributable to school size.[22]

Specialization prevalence peaks around age 14, which is the age at which many children enter high school, but the phenomenon often begins much earlier.[18] Recent research has identified that up to 25% of 12-year-olds competing in club sport events were classified as highly specialized.[18] Specialization before puberty is believed to be more problematic because it may coincide with maturation and skeletal growth, which might increase the risk of injury, especially when compounded with repetitive, high-volume activity. Informed by this concern over the timing of sport specialization, the American Academy of Pediatrics has issued a position statement, based on expert opinion, which recommends delaying sport specialization until 15 to 16 years of age.[15] However, contemporary, high-quality prospective researchers have observed that specialization increases the risk of sustaining overuse injuries in high school athletes even after controlling for age.[20] Therefore, age-based recommendations may need to be revisited as more high-quality scientific evidence becomes available to inform these recommendations.

Sport selection also affects specialization prevalence.[18] Individual sports, such as tennis, figure skating, and gymnastics, have been associated with high levels of early specialization.[19] Despite some well-known exceptions, such as Roger Federer,[23] success in these sports seems to require early specialization because peak performance occurs before puberty. Recent data demonstrated that specialization is now ubiquitous across most youth sports, including team sports where peak performance occurs after puberty.[18] For example, soccer, volleyball, ice hockey, basketball, softball, and lacrosse have the greatest prevalences of highly specialized athletes in team sports.[17,18] Experts[15] agree that early sports specialization is not likely necessary for success in these team sports.

THE ECONOMIC BURDEN OF SPORTS-RELATED INJURIES

The costs associated with youth sports injuries in the United States are thought to be substantial, albeit difficult to measure. The costs specifically related to injuries attributable to youth sport specialization are even less well understood. Myriad factors contribute to the research gaps in these areas; they include the complex mix of public and private payers in the American health care system, as well as the lack of a single injury-reporting platform that could be used to aggregate national data. Despite these difficulties, several groups using different methods have attempted to capture the economic costs associated with youth sports-related injuries.

Nearly 10 000 sports injury hospitalizations occur in the United States each year, resulting in annual charges of $113 million to $133 million. Approximately 90% of these hospitalizations are in patients 10 to 18 years of age, and boys are 6 times more likely to be admitted compared with girls. The most common diagnoses were fractures, ligament sprains, and dislocations.[24] Similar trends can be observed for sport-related emergency department visits.[25] Approximately 430 000 visits occured annually, which cost an estimated $447 million per year. Males constituted nearly 90% of patients; the most frequent injuries were contusions, sprains and strains, and fractures. The average hospital cost was $22 703. Finally, Knowles et al[26] investigated the medical costs, human-capital costs (medical + loss of future earnings), and comprehensive costs (medical + loss of

Table 1. Medical Economic Effects of Sports in Which High Levels of Specialization Are Common[a]

Sport	MD or ED, Visits	Direct Medical Costs, $ Millions	Total Costs, $ Billions
Baseball	25 075	50.9	0.82
Basketball	164 746	264.2	3.81
Soccer	88 009	152.9	2.20
Softball	27 093	43.5	0.55
Volleyball	31 532	48.8	0.64
Total	336 455	560.3	8.02

Abbreviations: ED, emergency department; MD, medical doctor.

[a] Data are from the National Electronic Injury Surveillance System of the US Consumers Product Safety Commission (2016, ages 14–18 years).

future earnings + reduced quality-of-life costs) of injuries sustained by high school athletes. They studied athletes from the 12 most common high school sports and estimated $9.9 million in medical costs, $44.7 million in human capital costs, and $144.6 million in comprehensive costs. The average medical cost per injury was $709.

Another source of data that can be used to quantify the costs associated with sports and recreational injuries is the National Electronic Injury Surveillance System of the United States Consumers Product Safety Commission.[27] Sports injuries sustained by male and female athletes aged 14 to 18 that occurred in team sports with high rates of specialization (ie, baseball, basketball, soccer, softball, volleyball; figure skating, gymnastics, and tennis were not included in these data) were substantial. During 2016 alone, an estimated 336 000 physician and or emergency department visits took place, with direct costs of more than $560 million and total costs (direct and indirect) of more than $8 billion (Table 1).

A significant limitation to using these estimates to quantify the costs associated with sport specialization is that reported injuries are most likely acute in nature rather than overuse or chronic. Sport specialization has been associated primarily with overuse injuries,[1] but the link with acute injuries is unclear.[28] Athletes with overuse injuries will be less likely to present to emergency departments for evaluation. In addition, overuse injuries are underreported and difficult to capture via surveillance networks.[29]

The next logical step to quantify the costs associated with sport specialization is to estimate the economic burden of injuries that may be at least partially attributable to sport specialization each year. We have extrapolated estimates of the direct medical costs associated with injuries attributable to sport specialization (Table 2). We estimate that the United States spends $0.8 billion to $5.2 billion per year on these injuries collectively, a figure that is similar to the costs associated with acute sport-related musculoskeletal trauma such as ankle sprains[30] and anterior cruciate ligament tears.[31] It should be noted that these are crude estimates with many limitations. For example, the cost of acute injuries tends to be greater than the cost of overuse injuries, and these estimates do not account for specific injuries or sex differences. Health care costs have outpaced inflation, meaning that we may be underestimating the cost of injuries attributable to sport specialization. Moreover, in an overall cost-benefit analysis, the benefits of youth sports would be included (eg, the reduced costs of obesity, pediatric hypertension), whereas these calculations did not account for these benefits. However, sports medicine providers need to be aware of the potential sizeable economic implications associated with sport-related injuries and specialization.

Another limitation of research in this area is the lack of high-quality injury surveillance in younger cohorts of athletes. The challenges associated with measuring the phenomena of injuries and sport specialization in this population are numerous. They include (1) a lack of medical providers who can identify injuries for youth leagues and therefore (2) recording of injury and exposure information would probably have to rely on volunteer nonmedical personnel (eg, parents); (3) the large number of youth leagues (clubs, travel teams, different age groups); (4) the interest of youth leagues in collecting this information; and (5) the cost of capturing this information and how that may affect costs to participants. Future researchers in sport specialization and injury should prioritize this cohort of younger athletes, which has largely been overlooked to date.

THE FINANCIAL COSTS OF YOUTH SPORT SPECIALIZATION

Whereas sport-related injury due to sport specialization is very well known, the financial costs associated with participation are often underappreciated. The landscape of

Table 2. Extrapolated Estimates of the Direct Medical Costs Associated With Injuries Attributable to Sport Specialization

Population, Millions[a]	Prevalence of Specialization, %[b]	Highly Specialized, No.[c]	% Injured[d]	Injuries in Highly Specialized Athletes, No.[e]	Cost Per Injury, $ Range[f]	Range of Total Direct Medical Costs Associated With Specialization[g]
45	13.4	6 030 000	21	1 266 300	640–1095	810 432 000–1 386 598 500
60	13.4	8 040 000	21	1 688 400	640–1095	1 080 576 000–1 848 798 000
45	38	17 100 000	21	3 591 300	640–1095	2 298 432 000–3 932 473 500
60	38	22 800 000	21	4 788 000	640–1095	2 064 320 000–5 242 860 000

[a] Estimates of population that participate in youth sports (5–18 years of age).
[b] Minimum and maximum estimates of the prevalence of highly specialized athletes.
[c] First column × second column.
[d] Percentage of highly specialized athletes who are injured during a season.[20]
[e] Third column × fourth column.
[f] Estimated average cost per musculoskeletal injury (95% confidence interval) adjusted for inflation.
[g] Estimated total costs of injuries in highly specialized athletes.

youth sports participation has drastically changed over the past 20 years. The emphasis has shifted from school-based programming centered on fitness, teamwork, and participation to, in some cases, private programming centered on skill development, individual success, and profit. This change has come at the expense of the physical and emotional health of the young athlete.[32] According to the Centers for Disease Control and Prevention, only 7.9% of middle schools and 2.1% of high schools provide daily physical education (or its equivalent) during the school year.[3] As schools cut or reduce physical education, parents will often seek a replacement in order for their children to be physically active. Club sports organizations see this need and offer an opportunity for participation. Unfortunately, this competitive environment creates opportunities for misplaced financial gain: private entities that profit from club sports participation while promoting an increased chance of scholarship, professional status, or both. Yet, very few high school athletes will obtain a scholarship because of their athletic performance.

According to the National Collegiate Athletic Association (NCAA),[33] the percentage of college athletes who will turn professional is 9.5% for baseball, 1.2% for men's basketball, 0.9% for women's basketball, 1.6% for football, and 1.4% for men's soccer. Only 2% of high school athletes will obtain a scholarship, and the average scholarship amount in 2015 was $14 270 for men and $15 162 for women.[34] In fact, there are only 6 NCAA sports in which a full scholarship can even be obtained (football; men's and women's basketball; and women's gymnastics, volleyball, and tennis). Most NCAA sports have more roster spots than scholarships. For example, the average size of an NCAA soccer team is 28 to 29 players, whereas coaches can award the equivalent of only 9.9 scholarships.

Parents, coaches, and youth have engaged in a business transaction in which the return on investment is slim (only 2% of high school athletes receive a scholarship), and the reward that one obtains may be dwarfed by the money spent in an effort to obtain it. The following questions naturally come to the forefront: How much money overall is generated by these club sport entities? How much does each family spend? What does this dollar amount mean for access to sport participation?

Youth sports have become a $15.3 billion industry.[34] According to a 2016 survey by TD Ameritrade, 63% of parents will pay from $1200 to $6000 per year, with nearly 20% paying upward of $12 000 per year.[35] These costs do not include medical expenses, which come with the known increase in injury risk from participation on teams that promote intensive, high-volume training and skill development.[32] As a result, only a select few families will win the "jackpot" of youth sports: having a child who avoids serious injury while obtaining a scholarship amount that exceeds money paid to club sport entities on a yearly basis.

Yet, even with an understanding of the economic implications, families who have the means to "pay to play" might continue to fill the pockets of these private entities. The underreported aspect of these economic costs is the barrier to sports participation that they create for families who either lack the money for their children to join these club teams or do not live in areas where these teams are accessible. Therefore, the current youth sports climate has created a barrier to participation for minority youth, those of lower socioeconomic status (SES), and disabled youth. In some instances, youth sports have become accessible only to the elite, unfortunately mirroring the inequalities in other areas of our society.

A 2-tiered sports culture has arisen in which middle- and upper-class families have access to multiple options for sports participation, whereas families who are challenged financially have access to limited or no offerings for sports participation as school-based programs are de-emphasized and recreational and community options become scarce. A recent quote by a parent (who chose to remain anonymous) at a club sporting event captures the idea: "Youth sports seems to discriminate against minority and poor participants via high fees, travel requirements, and scheduling." According to the Aspen Institute, only 34.6% of children between the ages of 6 and 12 in families making under $25 000 per year participated in team sports, whereas in families with incomes greater than $100 000 per year, the sports participation rate nearly doubled (68.4%).[36] Furthermore, the Robert Wood Johnson Foundation reported that only 25% of middle and high school students from lower income areas participated in youth sports due to fees, transportation challenges, and equipment costs.[37] This disparity of means is further exemplified by data suggesting that those who obtain college athletic scholarships are more likely to be of a higher SES than the average student and are less likely to be first-generation college students.[38]

Recent researchers who focused on the relationship between sport specialization and SES seemed to support the observation that a 2-tiered system exists in contemporary American youth sports.[39,40] Post et al[40] found that parents of children who participated in club sports spent approximately $1500 per year on those activities. Most parents reported having a total household income greater than $100 000 and having a bachelor's degree. Parents in the highest income ranges were more likely to have a child who was classified as highly specialized in a single sport. Jayanthi et al[39] expanded on these findings by dividing a large sample of respondents into high and low SES groups. The high SES group was more likely to spend more hours per week playing organized sports, to train more than 8 months per year in their primary sport, and to report a serious overuse injury compared with the low SES group.

Adults have created an environment that will have vast implications for the long-term health of our youth. In this 2-tiered system, 1 group is characterized in many ways by a highly specialized cohort that requires underwriting of significant economic costs and that also leads to overuse injury and burnout. This is juxtaposed with the second group, which may be less specialized, cannot afford the costs to play, has fewer opportunities to participate in physical activity, and may be at risk for long-term sedentary-lifestyle diseases.[41] All individuals who are dedicated to improving the culture of youth sports—whether it be health care providers, coaches, or parents—must work to create a culture in which economics do not drive access and health.

PHYSICAL LITERACY AND SPORT SAMPLING

Sport participation provides a major avenue for children to optimize their motor development and learn the fundamental movement skills (eg, running, balancing,

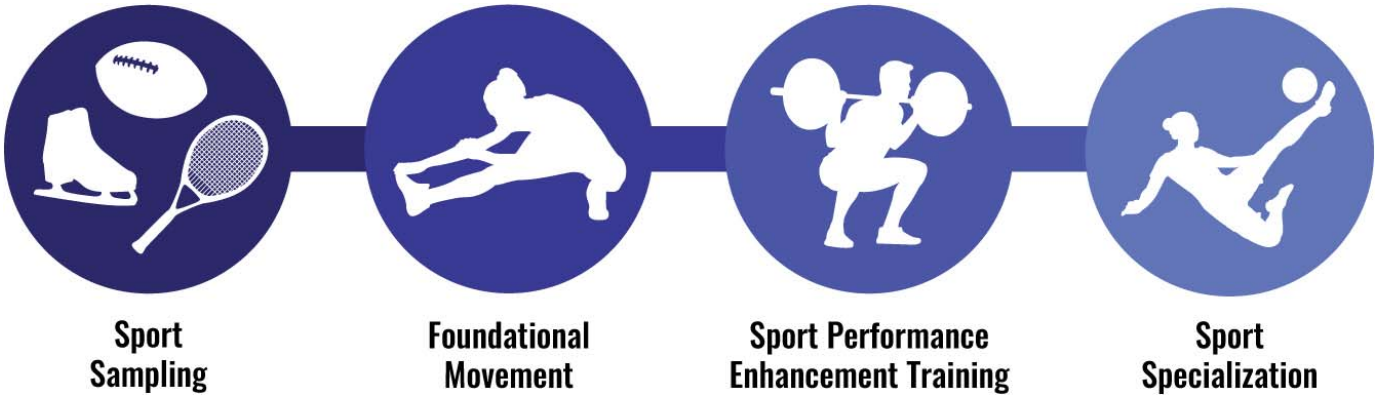

Figure 1. Sport sampling contributes to the development of physical literacy and promotes an active lifestyle.

throwing, kicking) needed to participate in future physical activities. Participation in sports should, in theory, simultaneously build children's confidence in their own abilities to be active and motivate them to participate further. Unfortunately, the declining numbers of youth sport participation suggest that current practices are failing to achieve these desired outcomes.

Physical literacy is a growing concept internationally that can be defined as the ability, confidence, and desire needed for people to be active throughout their lifetime. Using this definition, physical literacy is essentially a goal of youth sport participation.[42] The ability to be active, or competency in fundamental movement skills, is positively associated with increased activity participation and inversely associated with weight status in children.[43] Fundamental movement skills include the essential movements incorporated into most sports and types of physical activity, such as running, hopping, jumping, balancing, striking an object, kicking, catching, and throwing. These movements are considered essential because failure to be competent likely impairs an individual's ability to be successful when performing the associated sport. For example, if a child lacks competency in catching and throwing, the child's sport performance will be limited in sports requiring these skills, such as basketball, baseball or softball, and lacrosse.

Impaired, or immature, movement competency may limit a child's ability to participate in sports and may predispose the child to musculoskeletal injury. A major risk factor for musculoskeletal injury is *poor neuromuscular control*, or insufficient control of the body during movement.[44,45] Poor balance and execution of specific movements during physical activity, such as landing with limited bending at the knees and hips, are currently considered risk factors for injury. However, these same deficits were identified decades ago as children learned fundamental movement skills. Therefore, insufficient mastery of basic movement control may be partially responsible for musculoskeletal injuries. Unfortunately, many adolescents lack physical movement competency, which likely predisposes them to musculoskeletal injury and hinders future physical activity participation.[46]

Sport sampling, or sport diversification, involves children trying out a variety of sports and physical activities and has been emphasized in the literature as critical for appropriate motor and social skill development, future athletic success, lifelong physical activity, and reduced injury risk.[47–51] Sport sampling can have a major influence on all aspects of physical literacy; it is associated with lower rates of burnout in sport and creates opportunities for children to develop a variety of fundamental motor skills while evaluating activities for their own enjoyment.[50] A variety of fundamental motor skills is essential for a child to feel confident and have the necessary abilities to transfer to sport performance. Recent data demonstrated that children who sampled, or explored, different types of sports or physical activities throughout childhood also possessed improved neuromuscular control compared with their peers with low exposure to sport or activity sampling.[52] These findings highlight the strong need for children to be exposed to a variety of sports with different movement patterns in order to optimize neuromuscular control, reduce the risk of injury, and, in theory, promote physical activity participation. Consequently, sport sampling is a major contributor to the development of physical literacy and promoting an active lifestyle (Figure 1).[53]

RECOMMENDATIONS

We identify 4 areas of contemporary youth sport culture needing improvement to address the negative trends we have discussed in this article. Although funding might be required for some of these ideas, most do not necessitate funding. They simply require a local champion to advocate for their implementation.

Advocate for Policy and Rule Changes

Parents and coaches must be educated about the current sports culture to concretely affect change. This burden of education falls on anyone who interacts with these families, including sports medicine clinicians. However, for change to occur, these conversations must include a variety of stakeholders, those from outside as well as inside the medical community. We have provided suggestions to improve the consistency of messaging between persons of influence for key stakeholder groups in the youth sport experience (Figure 2). The heart of these recommendations is to encourage children to participate in a variety of sports and to remove policies that penalize children wishing to do so (eg, if you do not play in the fall, you cannot play in the spring). These punitive policies are beneficial to the financial wellbeing of the organization but can have negative effects on children. All teams and organizations

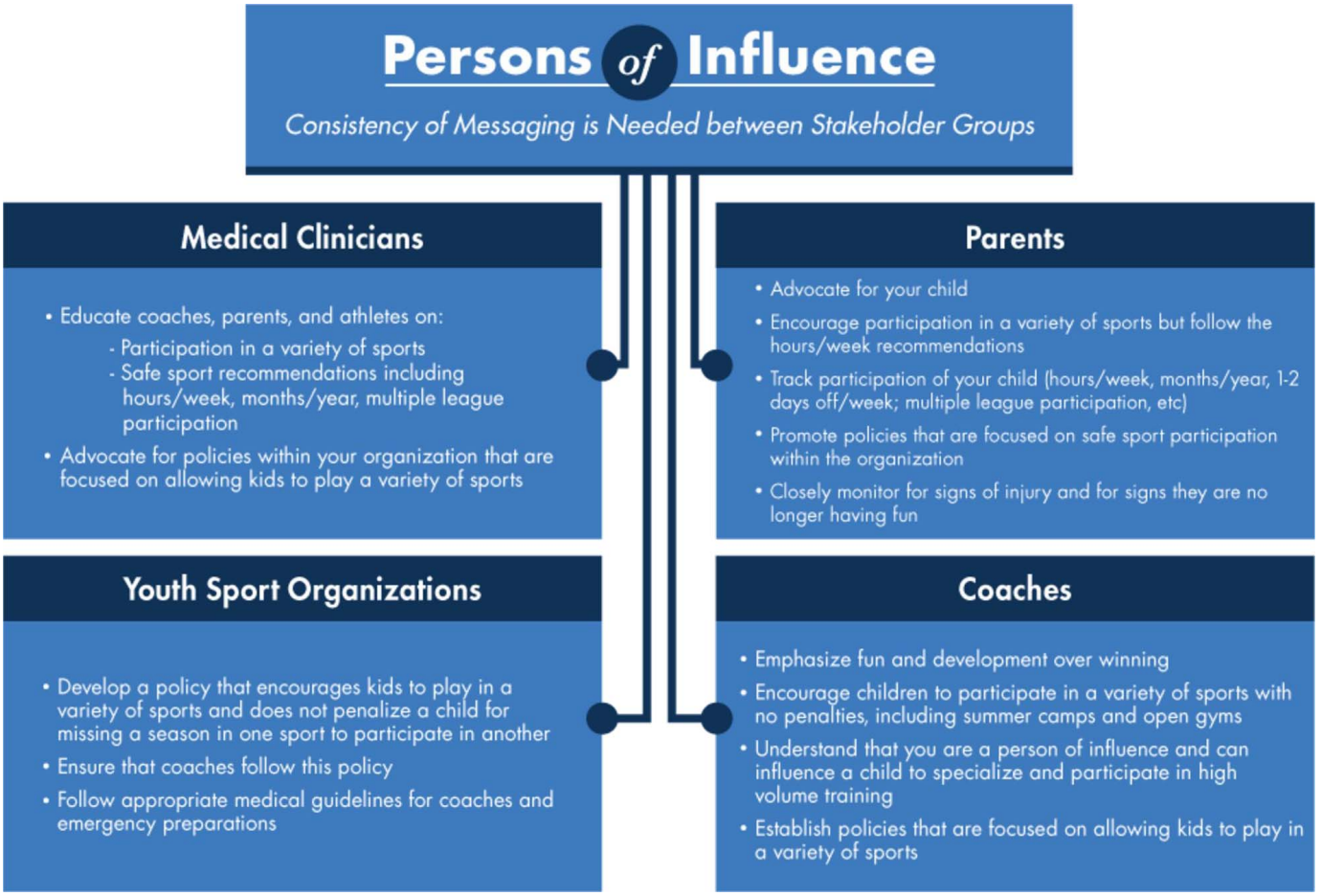

Figure 2. Suggestions for enhancing messaging between persons of influence and key stakeholders to benefit the youth sport experience.

should promote teamwork, participation, and fitness above skill development and individual success. To facilitate this focus, policies of high school, clubs, communities, and professional organizations should encourage cooperation between teams and organizations for the benefit of participants.

Participate in Injury-Prevention Programs, Follow and Disseminate Safe Sport Recommendations

Evidence-based safe-sport recommendations exist in order to provide parents, coaches, and athletes with guidelines to reduce injury risk. Yet, recent data demonstrated that 80% of these individuals had no knowledge of these recommendations.[10,54,55] Examples of recent and clinically useful guidelines include encouraging sport sampling during childhood, not specializing in a single sport until late adolescence (excluding gymnastics and figure skating), and not playing in multiple leagues at the same time.[51] Other clinically useful guidelines are time based and include limiting participation by the number of hours per week and months per year.[16,18] A child should not participate in organized sport more hours per week than the child's age (eg, a 12-year-old athlete should not participate in more than 12 hours per week of organized sport). In addition, children should not play a single sport more than 8 months per year and should have 1 to 2 days per week off from organized training and competition.[18,56] The hours-per-week and months-per-year recommendations need to be investigated further; however, these metrics serve to start conversations among parents, coaches, and athletes. If a child decides to specialize, participation in an injury-prevention program may improve performance as well as mitigate injury risk.[57] Parents should monitor their athlete to ensure proper training-load management via these evidence-based recommendations.

Increase Opportunities for Low-Income and Disadvantaged Students

Team sports often have associated costs, which can include not only the registration fee but travel, uniforms, and equipment. The average cost of sport participation was approximately $302.[58] However, more than half of all children received free or reduced-price lunch,[59] and 1 in 5 lower-income parents reported that cost forced them to cut back on their children's sport participation.[58] Local communities and nonprofit organizations should strive to increase funding for children who come from low-income or disadvantaged backgrounds to participate in organized sporting activity. In addition, cities, municipalities, and high schools should require fee waivers for low-income children if private clubs use public facilities.

Reinvest in School-Based Physical Education

School districts need to reinvest in school-based physical education and extracurricular sports to provide daily recreational activity and promote the acquisition of physical literacy. There is strong evidence that school-based physical education increases physical activity and fitness among children.[60] Yet, most physical education lessons do not meet the Centers for Disease Control and Prevention recommendation that 50% of a student's lesson time should involve moderate-to-vigorous physical activity. One option would be for all states to adopt resolutions to improve physical education and activity levels in schools.[61] Alternatively, parents could assist with grants to expand physical education offerings.

CONCLUSIONS

Many positive aspects to sport participation should be rightly emphasized. However, novel research demonstrated that the practice of sport specialization is now pervasive in most sports and communities and is affected by factors such as age, sex, school size and relative location, and sport selection. Whereas sport participation has a positive effect on overall health and wellbeing, sport specialization may have a negative economic effect in terms of health care spending via injuries and costs to families. This also seems to be creating different tiers of participation in which cost is a barrier to access. Finally, physical literacy seems to be negatively affected by early sport-skill acquisition because children have limited opportunities to explore different movement patterns. Dissemination and implementation of recommendations are needed to educate youth-sport stakeholders about best practices. Research into sport specialization and youth sports injuries is relatively new, and recommendations will need to be evaluated as more high-quality data emerge.

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