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Adolescent physical activity-related injuries in school physical education and leisure-time sports

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Abstract

Objective: The aims of this study were to investigate the prevalence of sports injuries in school physical education (PE) and leisure-time sports among 1011 15- to 16-year-old adolescents in relation to physical activity, and to examine goal orientation.

Methods: A survey was used with additional narrative descriptions.

Results: There was a higher prevalence of injuries in leisure time (645/993 = 65%) than in PE (519/998 = 52%). Two groups with high PE injury rates were identified: a) highly active (258/998 = 26%) in both school PE and leisure-time sports and b) highly inactive (180/998 = 18%) in both contexts. There were no differences between girls and boys. Task-oriented adolescents were more prone to injury.

Conclusions: The high prevalence of injuries in PE appears to have two mechanisms: renewed inadequately recovered leisure-time injuries among highly active adolescents, and injuries among fragile inactive adolescents unfamiliar with exercise. PE educators of these two groups with different injury patterns have a considerable didactic challenge. Knowledge of inadequately recovered injuries and consideration of the high volume and intensity of early sport-specific training in children and adolescents are important parameters in the design of lesson plans for PE.

Keywords

Sports injury, adolescents, physical activity, school physical education, leisure-time sports, attributional style

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Introduction

Childhood and adolescent physical activity (PA) promotes healthy growth and prevents development of chronic diseases later in life. School physical education (PE) has a

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distinct role in the acquisition and development of children's functional movement skills and physical competence.[1,2] These factors are related to the concept of physical literacy, described as '*the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life*'.[3] Physical literacy is not restricted to the development of motor skills in early childhood; rather, it is characterized by a broad variety of forms of PA and is relevant throughout life.[4] Insufficient movement skills from childhood can lead to both avoidance of PA and low ability to avoid injury in adolescence and adulthood.[5–8] Inadequate range of motion and uncoordinated muscle activation prevent proper technique, resulting in abnormal stresses on the structures of the musculoskeletal system. However, PA, especially participation in sports, also carries a risk of injury[9–12] and in the worst cases can affect growing bones and soft tissues, such as tendons, ligaments and muscles, leading to subsequent problems that become chronic if left untreated.[13]

Children are vulnerable to injuries because of their immature reflexes, undeveloped coordination and inability to recognize and evaluate risks.[14] Sports injuries are problematic for young people[15] and cause disruption to sports participation, physical discomfort, inactivity and unnecessary absence from school.[16] About 25% of children's injuries are classified as serious and many children are treated in hospital for sports-related injuries.[14] The range of injuries differs across different sports and countries.[17] Some reports indicate an injury incidence of 28 injuries/100 children/year in 9- to 12-year-olds.[18] Sports injuries of the ankle and knee are most common among adolescents,[19] but hip, shoulder, elbow, wrist and vertebrae injuries also occur.[17,20]

Sports injuries among young people mainly occur in three settings: school PE, organized sports in sports clubs and casual PA.[21] Most PE injuries are minor, but some require medical attention and cause school absence. Sports injury incidence and characteristics vary by age. The prevalence of sports injuries is higher in adolescents than in younger children, and adolescent injuries are more severe.[16,21,22] School administrators have discussed the role of PE in injuries, sometimes reducing allotted PE time to reduce injuries and avoid negative publicity. It is a challenge for physical educators to promote physical literacy and reduce injury prevalence. Students vary widely in skill sets, attitudes toward PE and use of biopsychosocial responses.[23] Physical educators must consider each of these factors when developing lesson plans for a student cohort.

There are several causes of success and failure in PA and sports and these affect not only expectations of success or failure but also emotional reactions.[24] Attribution theory is concerned with how and why people explain events. It explains the way in which we ascribe causes to outcomes, events and behaviours. Attribution theory comprises several concepts, such as goal orientation. Goal orientation can be categorized as either ego-oriented (which focuses on comparing the individual with others) or task-oriented (which focuses on improvements in personal accomplishments). An individual can be both ego-oriented and task-oriented, but most tend to be one or the other.[25]

Although spontaneous PA has decreased among children in general,[26,27] specialization and training in leisure-time sports at a young age has increased in some groups, leading to increasingly severe injuries.[28] In light of these developments, we examined the injury arenas of PE and leisure-time sports in this study. A self-report method was used and survey respondents were asked to characterize their perception of the reported injury. Minor injuries caused difficulty but did not require formal treatment, whereas major

injuries required medical interventions (including possible surgery).

Aim

The aim of the study was to investigate and compare the prevalence of self-reported sports injuries in both school PE and in leisure-time sports activities among 15- to 16-year-old students. Our research questions were as follows:

Are adolescents more likely to be injured in school PE or in leisure-time sports activities?
Are active adolescents more likely to be injured than non-active adolescents?
Do ego-orientation and task-orientation differentially affect injury rates in adolescents?

Methods

The study was conducted in agreement with the Swedish Law of Research Ethics, SFS 2003:460, which follows the ethical principles of the 2008 Declaration of Helsinki. Approval was also obtained from universities in each participating country: from Sweden in 2007, New Zealand in 2009, Germany in 2010 and the USA in 2011. In the USA, approval was also obtained from the Assessment, Accountability and Evaluation Committee of the School Board of Polk County. Written and verbal information was given to participants to explain the purpose of the study. It was emphasized that confidentiality would be maintained and participation was voluntary. Written consent was obtained from participants in all countries and all data were kept strictly confidential to make it impossible to identify individuals.

Design and sample

The study design was cross-sectional. Data were obtained using a questionnaire completed by adolescents aged 15 to 16 years old from four countries: Sweden, Germany, New Zealand and the USA. Students completed the questionnaires anonymously during school classes. Students in the United States sample were from a sports medicine academy located in a large (2000-student) underprivileged high school. The academy teaches students interested in health care for active people and who are planning to train as physicians, physical therapists or athletic trainers.

Measures

The survey comprised questions on demographics, self-reported PA, attribution style, goal orientation, pain perception in daily life and/or in the context of PA, sports injuries in PE and in leisure-time sports, attitudes toward PA and self-rated skills. To ensure that participants understood the questions, the questionnaire was translated by professional linguists and then piloted in each country with students of the same age as the participants. To investigate goal orientation and attributional style, the Task and Ego Orientations in Sport Questionnaire (TEOSQ) was used,[29] and scores were calculated for task-orientation (minimum 7 and maximum 35) and ego-orientation (minimum 6 and maximum 30). For statistical analysis, the PA responses were dichotomized. Participation in school PE was also dichotomized. The prevalence of injuries in school PE and in leisure time was assessed by two questions. The narrative part of the questionnaire allowed participants to provide a written description of their injuries, if the injuries happened in PE or in leisure time, where the injuries were located, treatment and recurrent pain from the injuries.

Statistical analysis

Statistical analyses were performed using the statistical package IBM SPSS Statistics

for Windows, version 23.0 (IBM Corp., Armonk, NY, USA). Attribution style, goal orientation, self-reported PA and prevalence of sports injuries were examined in the data analysis. Descriptive proportions and means were presented for PA levels and prevalence of sports injuries. The chi-square test was used to determine the significance of differences in the categorical, nominal and ordinal data when comparing the adolescent groups. All variables included in the chi-square tests were dichotomized by the median value. Student's t-test was used to compare the task- and ego-orientation scores. The significance level was set at $p < 0.05$.

Results

Table 1 provides a summary of the survey questions used and the categorization of the responses. In total, 1109 students were invited to participate in the study and 1011 completed the questionnaire. In Sweden, 598 students from 21 schools completed the questionnaire; 75 students declined participation. In Germany, 279 students from two schools participated; 12 additional students were invited but declined to participate. Of New Zealand students, 62 from one school participated and 4 students declined. There were 80 students in the required age range in the United States academy. All the American students gave their consent, but 8 did not obtain parental consent and were unable to participate. The survey response rate ranged from 97.1% to 100% (missing responses on some items are reflected in the totals of 993 and 981 shown here). The final sample consisted of 1011 adolescents aged 15 to 16 years. A total of 645 (65%) students ($n = 993*0.65$) reported injury from participation in leisure-time sports. The most common injury locations were the knee (8% of injuries), foot (5%), arm (4%), hand (3%) and head (2%). Injury in school PE was reported by 519 (52%) adolescents ($n = 981*0.52$). The most common school PE injuries reported had the same location as the injuries reported from leisure-time activities, but with a lower prevalence: knee (4%), foot (3%), hand (2%), head (1.5%) and arm (1%). A correlation was found between leisure-time injury and PE injury (Pearson 0.236; $p < 0.001$). In the narrative answers, students reported that previous injuries from leisure-time sports recurred in PE. A total of 24% of adolescents ($n = 993*0.24$) reported that they had received major injuries from leisure-time sports. These injuries required some medical attention and the students had recurrent pain from the injuries. Of participants, 12% ($n = 998*0.12$) reported major injuries from PE in school that needed medical treatment. No significant differences in injury prevalence were found between boys and girls, or between leisure-time sports and PE.

A total of 66% of adolescents ($n = 993*0.66$) reported PA in leisure time twice a week or more. The remaining 34% reported activity less than once a week. Adolescents who reported PA at least twice a week in leisure time reported a higher prevalence of injuries than more inactive adolescents (73% vs. 51%; $p < 0.001$. There was a stepwise increase in the prevalence of sports injuries in relation to activity frequency, with the highest prevalence among those who exercised four or more times a week (Table 2). A remarkable difference in prevalence was noted between adolescents participating in PA three times a week and those participating four times or more.

A total of 258 students (26%) were highly active in both school PE and leisure-time sports and 180 (18%) were highly inactive in both contexts. A comparison of active and inactive adolescents showed no significant difference in the prevalence of injuries in PE. Inactive

Table 1. Survey variables, response options and dichotomization for between-group comparisons.

Variable	Response options in questions	Dichotomized
Gender	2 options	1. Boy
Question: Are you?	Boy/Girl	2. Girl
PA in leisure time	7 options	1. PA Often (6–7)
Question: How often do you exercise or train during your leisure time for a period of at **least half an hour** and get **out of breath or sweaty**?	1. Never 2. A few times a year 3. A few times a month 4. Regularly, once a week 5. Regularly, twice a week 6. Regularly, three times a week 7. Regularly, four or more times a week	2. PA Seldom/Never (1–5)
Participation in school PE	4 options	1. High participation (1)
Question: How often do you miss a sports lesson at school?	1. Never, I am almost always there 2. A few times a year 3. A few times a month 4. Always, I hardly ever take part	2. Low participation (2–4)
Injury in school PE	3 options	1. No injury (1)
Question: Have you ever injured yourself in a sport and health education lesson at school?	1. No, nothing serious 2. Yes, only a simple sprain or dislocation	2. Some injury (2–3)
Write freely: Specify the type of injury/ injuries, situation in which it happened, describe any medical treatment needed and describe any recurrent pain.	3. Yes, it was necessary to go to the doctor/ hospital	
Injury in leisure-time PA	3 options	1. No injury (1)
Question: Have you ever injured yourself playing sports out of school (leisure time)?	1. No, nothing serious 2. Yes, only a simple sprain or dislocation	2. Some injury (2–3)
Write freely: Specify the type of injury/ injuries, situation in which it happened, describe any medical treatment needed and describe any recurrent pain.	3. Yes, it was necessary to go to the doctor/ hospital	

PA, physical activity; PE, physical education.

adolescents reported injuries in PE to the same extent as active adolescents (55% vs. 52%). Adolescents who were active in leisure-time sports participated more frequently in PE than those who were inactive in leisure-time sports (86% vs. 66%; $p < 0.001$. A total of 18% ($n = 998*0.18$) reported that they participated very seldom in PE. This group of adolescents reported injuries in PE to about the same extent as those who always participated in PE (56% vs. 50%) even though their risk exposure was lower (Figure 1)

Approximately 70% (28/40) of students who reported knee injuries in PE stated that the injury originally occurred in leisure-time

Table 2. Prevalence of sport injuries in leisure time and in school physical education (PE) in relation to leisure time-physical activity frequency in 15 to 16-year-old adolescents (%).

Frequency of physical activity	Prevalence of injuries in leisure time (n = 993)	Prevalence of injuries in school PE (n = 981)
Never (n = 49)	37	53
A few times a year (n = 59)	49	46
A few times a month (n = 107)	49	54
Regularly, once a week (n = 127)	59	57
Regularly, twice a week (n = 203)	68	52
Regularly, three times a week (n = 190)	68	51
Regularly, four or more times a week (n = 258)	81	52
p-value	**0.001**	0.902

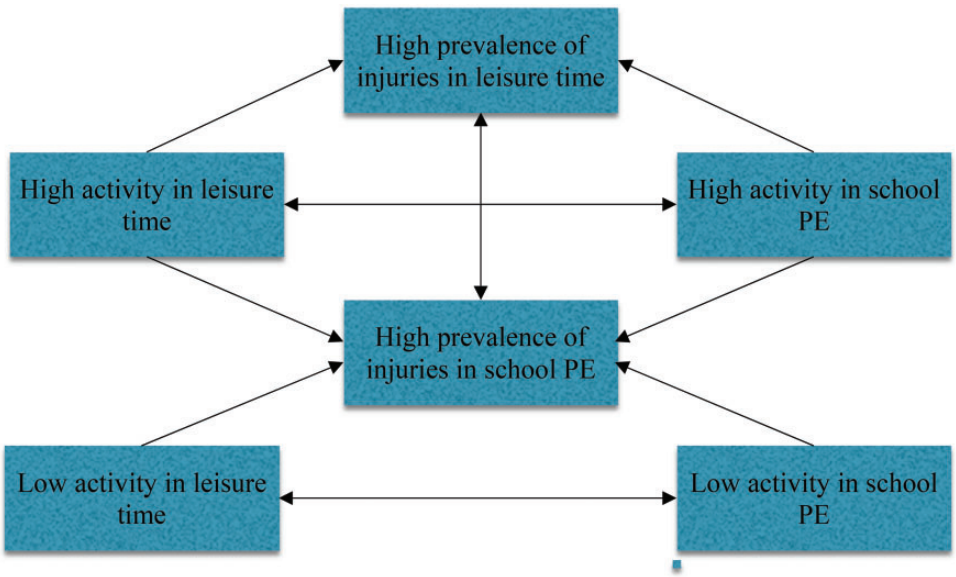

Figure 1. Relationships between physical activity in leisure time, activity in school physical education and prevalence of leisure-time and school physical education injuries.
PE, physical education.

sport. Sixteen students (50%) who reported foot injuries in PE stated these had originally occurred in leisure-time sport.

Students who were highly physically active in leisure time had higher scores than inactive students for both task-involved goal orientation (mean 28.0; standard deviation [SD] 4.4 vs. 23.3; SD 5.7; $p < 0.001$) and ego-involved goal orientation (18.6; SD 5.2 vs. 15.9; SD 5.3; $p < 0.001$). Thus, when ego- and task-orientation scores were merged, active students had higher scores than inactive students (46.5; SD 8.0 vs. 39.1; SD 9.8; $p < 0.001$). Adolescents who reported injuries in leisure time had higher scores than those without injuries (44.8; SD 9.9 vs. 42.8; SD 8.9; $p = 0.003$). There was no difference in injury prevalence in relation to ego-involved orientation between active

Table 3. Leisure-time physical activity, school physical education, prevalence of leisure-time and school physical education (PE) injuries and task- and ego-orientation in adolescents in Sweden, New Zealand, United States and Germany (%).

	Sweden n = 598	New Zealand n = 62	United States n = 72	Germany n = 279
Physically active in leisure time	67	74	67	60
Active in school PE	81	89	74	86
Prevalence of injures in leisure time	66	68	39	70
Prevalence of injuries in school PE	57	32	36	51
Prevalence of major injuries in leisure time	23	29	12	30
Prevalence of major injuries in school PE	13	5	11	14
Proportion with high scores in task orientation	57	65	51	37
Proportion with high scores in ego orientation	64	40	42	44

and inactive adolescents, but there was a higher prevalence of sports injuries in leisure-time sports among adolescents with high scores for task-involved orientation than adolescents with low scores (56% vs. 44%; $p < 0.001$). Sweden and Germany had a similar prevalence of injury in school PE: 57% and 51%, respectively (Table 3). The low number of student participants in New Zealand and the USA made further comparisons difficult.

Discussion

Adolescents aged 15 to 16 years were chosen as participants, as they may have experienced injuries in school PE and/or leisure-time sports, and are capable of describing the events. In our study, the reported injury prevalence among adolescents was in accordance with results from other studies[14,18] for both leisure time and PE injuries. The PE injury rate has led some countries to discuss whether this school subject is too risky for children.

There was a strong association between participation in sports and PE. There was also a strong correlation between injuries in leisure time and injuries in PE. Adolescents who reported PA more than three times a week were much more likely to be injured than inactive students, which reflects their greater PA exposure. These findings are not surprising, as greater activity in each setting is associated with greater exposure time to injury. However, there was also a strong similarity between injury prevalence in the most active and the least active adolescents in PE, which is of note. Adolescents with the most PE exposure time had a similar injury prevalence to those with the least exposure time.

One in four adolescents reported recurrent trouble and pain with old or recurrent injuries, mostly in the knee and foot. Most injuries were several years old and had happened in childhood or early puberty. Two-thirds of adolescents reported some type of injury from participation in leisure-time sports and half of adolescents reported injuries from school PE. In order of prevalence, injuries were located in the knee, foot, arm, hand and head. The same pattern was observed for both PE and leisure-time injuries. The questionnaire narratives indicated that previous injuries recurred in both PE and leisure time. The most serious injuries, which required medical attention, occurred twice as often in leisure-time sports activities (24%) as in PE (12%).

Rational training of children in leisure-time sports activities is sometimes adapted from adult training in terms of both frequency and capacity, but children may not

have the strength, complex motor skills or biopsychosocial skills needed for some intense activities. As more young people participate in sports activities with rational training, there has been an increase in acute and overuse injuries in the early years.[8,30] We found a stepwise increase in injury prevalence when the number of activity periods per week increased; individuals who exercised four or more times per week showed the highest injury prevalence. Active adolescents participate in sports all year round and may exercise with several teams. Adolescents who exercised four times or more per week may have a large volume of activity, which has been associated with greater injury risk.[8,17,28,30] However, we asked participants how often they were active for at least half an hour, which is only half of the recommended moderate-to-vigorous PA (MVPA), allowing a generous margin between normal training and overtraining. According to World Health Organization guidelines, children and youth should accumulate at least 60 minutes of MVPA daily,[26] which is more than the amount of activity we assessed in the survey. It should also be recognized that even if PA results in injury, the risk of severe injury is minimal compared with the clear benefits of PA.[31]

The adolescents' narratives showed a clear connection between injuries in leisure time and in school PE. This connection could indicate that 'old' leisure-time injuries reappear in school PE. This may be the case for soccer students, who reported that knee and ankle injuries first occurred in their leisure-time sports and reappeared in PE. It has been argued that too many students are injured in school PE.[21] The incidence of injuries increased by 150% per year in the USA between 1997 and 2007.[32] In some countries, the legitimacy of PE has been discussed and the risk of injuries used as an argument to justify the small amount of time allocated to PE in the school schedule. More than half of the adolescents (52%) reported some kind of injury from school PE. Other studies have shown that PE accounts for a substantial proportion of all injuries in children and adolescents[21] and suggest that efforts should be made to decrease the rate of PE injuries. However, it may be difficult to reduce the prevalence of injuries in PE if children and adolescents bring to sessions inadequately recovered injuries from leisure time. This suggests that an emphasis on rehabilitation and recovery of early sports injuries would have substantial effects on reducing PE injuries. Recurrent injuries cause problems and have both short-term and long-term effects on PA.

Students active in leisure-time sports were also very active in school PE, and were exposed to many more occasions in which they could get hurt than inactive students. Therefore, it was interesting to find that adolescents with low PE participation levels reported PE injuries to the same extent as active students (55% and 52%, respectively). The high prevalence of injuries in inactive adolescents may stem from unfamiliarity with exercise and poor motor skills[33] because these adolescents are inactive and untrained, which other studies have shown to be risk factors.[30,34–36] In addition to low PA levels, poor bone and tissue quality and poor muscle strength,[37] these children also perceive PE as risky because of poor motor control.[30,38] The perception of low physical competency levels is itself a risk factor. Half-hearted movements or hesitant entry into situations involving body contact increase the risk of injuries. Poor motor skills and low physical capacity levels lead to negative psychological outcomes and increased risk of injury.[33] School PE should be educational and involve training in fundamental and complex motor skills to increase physical literacy and physical self-efficacy,[39] which could prevent injuries.

The didactic dilemma for PE is substantial. PE teachers must be skilled to teach functional motor skills to increase physical literacy among children and adolescents. Pupils interacting in the PE setting have a wide range of functional movement skills, interest and motivation for PE, goal orientation and fitness levels. Individualization in teaching plans is essential to avoid high rates of injury. Whereas inactive students are at risk of injuries in PE because of unfamiliarity with exercise, low self-efficacy, poor skills and low fitness, active students are more prone to renew old injuries or to acquire new ones, as a high activity level increases the risk of injury.[40] There is increased polarization between fit and unfit children and adolescents,[41] and it is more challenging than ever to pedagogically handle students' different fitness levels and proneness to injury in school PE. An increasing number of young people are diagnosed with exercise deficit disorders comparable to the 'active couch potato' classification in adults.[42] If adolescents are physically active in leisure time, it does not mean that their functional movement skills are automatically excellent in all situations. Their movement skills may be very specialized for one or two sports, which increases the risk of injury in a different context. Attention to improved motor skills, proper technique and correction of maladaptive movement patterns are important in both active and inactive adolescents. Strengthening and improving flexibility is likely to be necessary in inactive individuals to allow proper motion. Reduction of compensatory movement patterns stemming from previous injury would be helpful in highly active individuals.

We found no significant differences in self-reported injuries between boys and girls in either leisure-time sports or school PE. Some studies indicate that boys are more prone to injuries,[27] whereas others have shown the opposite pattern.[43] Boys seem to engage in more risk taking than girls in childhood play[27] and in sports participation in adolescence.[44] Knee injuries were common in leisure-time sports; the highest prevalence among both girls and boys occurred in soccer, a finding demonstrated by other studies.[45]

Successful sports performance requires psychological qualities as well as physical fitness and motor skills. It has been suggested that some athletes are prone to injury because of their psychological disposition.[46] This may reflect attributional style. A sports injury is an unexpected event and is likely to activate attributional processes and explanatory behaviour. In our study, the association between high task-orientation scores and high prevalence of sports injuries may indicate that these adolescents were highly motivated toward their activity, more willing to take a risk and likely to adopt challenges, especially in a mastery climate.[47] To achieve self-determined goals, task-oriented adolescents may exert themselves beyond their abilities and therefore get hurt. In this study, ego-involved orientation did not seem to affect injury prevalence in either high- or low-scoring adolescents.

Strengths and limitations

The study design was cross-sectional, which limits conclusions about causality. PA was assessed using self-reports and not objectively measured, which is a limitation. We chose to ask adolescents about the amount of engagement in weekly sports activities that lasted for more than 30 minutes. The aim was to include a wide variety of sports activities. An alternative exposure variable would have been the total amount of PA hours per week, but we chose to assess the number of occasions per week. The assessment of injury prevalence was self-reported, which also can be a limitation. The injury prevalence in our study is in accordance with that reported in other studies. Additional limitations are

linked to our use of self-report. We did not ask about level of competition, participation in team or individual sports, or demographics such as body mass index.

There were also some study strengths. The sample included more than 1000 adolescents from four countries, the participation rate was high and the data collection carefully done. To our knowledge, this is the first study to focus on PA and injuries in both school PE and leisure-time sport activities. Most studies focus on one activity area, not on both simultaneously. The focus in our study included both biological and psychological issues to highlight some interesting aspects of injuries in adolescents.

Conclusions

Injury rates in child and adolescent sports are high for both leisure-time sports and school PE. It is necessary to reduce the incidence of injuries without conflicting with educational goals in school PE, or with public health strategies to promote a physically active lifestyle. In this study, the high prevalence of PE injuries appears to have two mechanisms: the renewal of inadequately recovered leisure-time injuries among highly active adolescents, and injuries among fragile inactive adolescents unfamiliar with exercise. The risk of injuries is a didactic challenge for PE educators. Injury prevention should focus primarily on these two groups, which have in common the negative consequences of injury, but have completely different injury mechanisms. School PE should be educational and contain training in fundamental and complex skills, which could prevent injuries and increase the likelihood of lifelong PA. Knowledge of inadequately recovered injuries, as well as consideration of the volume and intensity of early sport-specific training in children and adolescents, are important parameters in the design of lesson plans for PE.

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