UPDATED RECOMMENDATIONS FOR THE PREVENTION OF PHYSICAL ACTIVITY-RELATED INJURIES IN ADOLESCENTS

– ON BEHALF OF THE PARIPRE PROJECT PARTNERS

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2023

Physical activity-related injuries prevention in adolescents
PARIPRE

Co-funded by the Erasmus+ Programme of the European Union

PHYSICAL ACTIVITY-RELATED INJURIES PREVENTION IN ADOLESCENTS (PARIPRE)
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1. BACKGROUND

Regular physical activity (PA) has undisputed health benefits, such as reduced risk of premature mortality and many diseases[1]. However, the risk of injury and long-term disability can diminish the health benefits of PA[2-5]. The consequences of physical activity-related injuries (PARI) do not appear only in short-term. Adolescent athletes after having sustained a severe injury are more prone to have functional deficits, decreased quality of life, and are at increased risk of obesity compared to uninjured athletes[5]. Furthermore, injuries may cause other long-term disabilities, such as early osteoarthritis[6,7] and lead to reduced activity. Finally, the costs of injuries and their consequences represent a great burden for the society as well[8]. Thus, despite the general health benefit, injuries and their long-term consequences represent a significant side effect of PA.

Measurement of the health burden of PARI is essential for understanding the magnitude and impact of the problem[9]. Currently, in many countries, prevention of PA-related injuries is not a priority because of the lack of high-quality evidence about the magnitude of the problem and its public health burden[10]. In Australia, the availability of the International Statistical Classification of Diseases and Health Related Problems, 10th Revision (ICD-10), Australian Modification, external cause chapter activity codes allow for PA related injuries to be specifically identified in routine data collections coded to the ICD. According to this state-wide data on all public and private hospitalization discharges in Victoria, Australia, over a 7-year period showed that PA related injuries in children aged <15 years accounted for a larger population health burden compared with road traffic injury on all measures (years lived with disability, number of bed-days, and direct hospital costs). PARI in children accounted for 3-times higher number of years lived with disability, 1.9-times more bed-days and 2.6-times higher direct hospital costs compared with road traffic injuries[10].

Approximately 20% of injuries treated at emergency departments in hospitals is related to sporting activities. In the EU-27 region alone, estimated of 6 million PARI is treated in hospitals every year. The risk of PARI substantially increases when children enter school, with a peak in the 10–19 years age group11. Physical activity related injuries among adolescents mainly occur in three settings: organized sports in sports clubs, leisure-time PA, and school physical education (PE)[12]. Highest prevalence of injuries has been reported in organized sports (around 50%), whereas PARI prevalence in leisure time PA is around 39 % and in school-based PA around 26%[13].

The incidence of medically treated sports-related injuries in 6–12-year-old children ranges from 0.2 to 0.6 injuries per 1 000 hours of sports participation. The corresponding number for medically treated PA injuries in leisure time is around 0.15–0.17[14]. The risk of PARI seems to be high both in physically active adolescents due to their increased PA participation, but also in inactive adolescents[12,14], especially in school PE[12]. As the results of a recent umbrella review suggests, the methodology used in studying the epidemiology of PARIs should be more uniform in order to obtain comparable results of injury incidence and prevalence across different sports and settings. The lack of reviews conducted outside organized sports outlines the need for large-scale surveillance studies capturing injuries occurring in different settings to provide current data on the full spectrum of PARIs in adolescents.[15]

Children and adolescents are at an inherent risk of physical activity related injury. Health benefits of PA need to be optimised by effective injury prevention strategies, that should be implemented in all three settings including organized sports, leisure time, and school-based PA. The proved reduction in injury risk, along with the improvements in neuromuscular function, underscores the importance of implementing evidence-based injury prevention strategies in adolescents physical activities.[16] In addition to implementation of the effective programs, adequate adherence of the participants should be ensured in order to improve the real-world effectiveness of the program.[17] In light of current evidence, we have gathered recommendations for the prevention of PARI in adolescents.

2. EVIDENCE-BASED INJURY PREVENTION STRATEGIES

Although it is impossible to eliminate all PARI, injury prevention strategies can unquestionably reduce the number and severity of PARI. Evidence-based injury prevention strategies can be divided into three main categories: 1) changes in rules and policies, 2) changes in environment and equipment, and 3) changes in behavior e.g., training. Injury prevention strategies have been evaluated in sport-specific (primarily team sports) and more general populations (e.g., schools, military). Training strategies targeting modifiable and intrinsic (person related) risk factors are the most studied methods. In addition, prevention strategies targeting extrinsic (environmental) risk factors have been evaluated through rule and equipment modifications in certain high-risk sports.

The optimal method to evaluate the efficacy of an injury prevention strategy is a randomized controlled trial (RCT). However, RCTs are not always feasible or ethical to conduct, and hence, less rigorous study designs including quasi-experimental, cohort, and case-control studies are also used to evaluate efficacy and effectiveness of a prevention method[18]. In these recommendations we will describe evidence-based injury prevention strategies primarily based on published systematic reviews and meta-analyses of RCTs and/or original RCTs, and secondarily high-quality cohort studies and case-control studies.

1.1.Training

1.1.1. Neuromuscular training

Effectiveness of neuromuscular training (NMT) in reducing the risk of sports injuries has been studied in several systematic reviews and meta-analyses, where data are combined from multiple prospective studies. NMT programs are typically coach or trainer led programs that are designed to improve balance, strength, agility, coordination, and movement control. Ideally, NMT programs are introduced to coaches by a comprehensive training workshop led by a physiotherapist or strength and conditioning coach with expertise in NMT[18]. NMT programs are often implemented as a part of a structured warm-up program, which includes running, agility, balance, plyometrics, and strengthening exercises. The intensity of warm-up is moderate, and the focus is on proper movement technique.

NMT has been demonstrated a 37% reduction in overall injury risk, 33% reduction in acute injury risk, and 47% reduction in overuse injury risk in various sports and age groups[19]. Even larger reductions have been reported with programs focusing on balance/proprioception and strength, where 45% and 66% reductions in overall injury risk have been reported, respectively[18,20].

In youth sports, multifaceted NMT programs have shown to reduce the overall risk of injury by 40%[22]. Furthermore, NMT training has shown to reduce the risk of ankle injuries by 44–86% and the risk of knee injuries by 45–83% in youth athletes23. NMT training is extremely effective to reduce the risk of anterior cruciate ligament (ACL) injury, which is one of the most common severe sport related injury leading to long absence from sports and is associated with permanent disabilities in knee function and high risk of early osteoarthritis4,5. It has been estimated that implementing NMT programs to 12–25-year-old youth athletes participating in high-risk sports could reduce the prevalence of ACL injuries by at least 40%[23]. In addition to preventive effect, NMT warm-up programs have shown to improve sports performance including strength, sprint abilities, agility, leg power, balance, and stability as well as sport-specific skills, especially among youth athletes[24,25].

The effectiveness of NMT warm-up has also been studied in school PE context. Increasing number of studies have shown that NMT warm-up is effective to reduce the risk of PA related injury in a school PE across different age groups of children and adolescents[26-28].

2.1.2. Management of training load

The musculoskeletal system of a growing athlete is vulnerable to high and repetitive external forces. Youth athletes have high prevalence of growth-related overuse injuries,[29,30] which are often related to high amounts of organized training[31]. Repetitive activities such as running, jumping, or throwing without sufficient rest between such high load activities increase the risk of injuries[32]. Moreover, youth athletes who specialize in a single sport are 37% more likely to get injured compared to youth athletes participating in multiple sports[33]. Hence, early specialization in a single sport should be avoided. In addition to good management of training load, sufficient amount of sleep is important for the overall health and recovery and may also help preventing injuries[34,35]. The recent findings suggest that good sleep quality and sufficient sleep duration play a protective role in relation to PARI in adolescents and thus the implementation of sleep interventions should be considered as a part of PARI prevention programes[36].

2.1.3. Injury rehabilitation

Many injuries have a high recurrence rate. Previous injury is a strong risk factor for re-injury of the same body part and also increase the risk of other injuries. Sufficient injury rehabilitation is important to prevent re-injuries. Return-to-play guidelines can help decision making in rehabilitation and also help prevent re-injuries[37].

2.2. Equipment and environment

Various protective equipment can help reduce PA related injuries and/or their severity. Ankle bracing and taping are effective to reduce the risk of recurrent ankle sprain in previously injured adult and youth athletes[18,20]. However, the evidence does not support the use of ankle supports in the primary prevention of injuries. Similarly, knee braces have in some studied shown to prevent re-injuries.[18] Use of external joint supports should not exceed the importance of NMT in youth athletes. Wrist guards have shown to reduce the number of wrist injuries in snowboarding[20], and are likely effective in other similar type of sports. Shock-absorbing and orthotic insoles may help reduce the risk of lower limb overuse injuries[20].

Helmets have long been used to prevent head and brain injuries in different high-risk sports. Although helmets are essential in reducing many potentially severe head injuries, their ability to reduce concussions is limited[39]. In youth ice hockey, use of mouth guards has been associated with lower odds of concussion[40]. In addition, protective eyewear can prevent eye injuries in activities including rackets or sticks and balls[41].

Environmental aspects, such as material of the playing surface and material of the rink, can also have effect on injury risk. Importantly, friction and flexibility features of the surface as well as flexibility of the rink materials should be taken into account when planning and reconstructing sports facilities[42].

2.3. Rules and policies

Sometimes there is a need to change sporting rules and policy in order to protect safety of the participants, especially in youth activities. Research knowledge can guide and support the decision making. An example of an evidence-informed policy change is disallowing body checking in youth ice hockey in Canada, which re-

sulted in reduced injury rates[43]. Furthermore, in Finland, the use of protective eyewear is mandatory in youth floorball, and in international ice hockey tournaments youth players must wear full-facial protection. These measures have decreased the risk of eye and facial injuries significantly[44].

2.4. Nutrition

Although less studied in randomized controlled settings, prospective studies have found associations between nutritional factors and injuries. Sufficient energy intake and meeting requirements for calcium and vitamin D intake is important to maintain bone health and prevent stress fractures[45,46]. In addition, maintaining normal body weight can help preventing PA related injuries[47].

3. RECOMMENDATIONS FOR PARI PREVENTION IN ADOLESCENTS

State and government

1. Governing bodies should ensure continuous, nation-wide injury monitoring to measure the public health burden of PA related injuries and to estimate the effect of prevention actions.

2. Sports disciplines should be integrated to ICD-11 injury codes.

3. Sufficient resources should be directed to PARI prevention along with the PA promotion.

Sports associations and sports clubs

Implementation of neuromuscular training warm-up

1. NMT warm-up should be a part of training routines in children and adolescents from age 7 forward. Children and adolescents' organized training should include NMT routines 2–3 times per week, 15–20 minutes at a time, year-round, and with adequate progression and variety in exercises. NMT warm-up should be instructed by a coach or physiotherapist, who has been trained to NMT.

2. In addition to multicomponent NMT warm-up procedures, sport and exercise specific NMT training should be included to prevent certain sports injuries in high-risk sports. These include:
   - balance/proprioceptive exercises to prevent ankle sprains,
   - strength and movement control exercises (i.e. cutting and landing technique training) to prevent knee injuries,
   - eccentric strength training to prevent muscle injuries,
   - strength and stabilization exercises to prevent shoulder injuries.

Equipment and environment

3. Children and adolescent athletes should always use available and appropriate protective equipment designed for each sport.

4. Suitable friction and cushioning of the playing surface, flexibility of the rink materials as well as safety of the surroundings should be taken into account when planning and reconstructing sports facilities.

Rules and regulations

5. Helmets with full-facial protection, neck guards, mouth guards, and protective eyewearshould be mandatory for youth athletes in high-risk sports.

6. Rule modifications, such as disallowing body checking in youth ice-hockey, should be considered in contact youth sports, where the risk of severe injuries is high.

7. Harder sanctions should be given for head-checking and other risky behaviour.

8. Education on sports injury prevention should be mandatory for all coaches in youth sports.

Load management

9. Training program of children and adolescents should include diverse training that considers the phase of physical development individually, and balanced loading of different organ systems (cardio-vascular, musculoskeletal, and nervous system).

10. Repetitive exercises causing high stress to immature skeleton should be avoided and replaced with less straining activities especially during the rapid growth and in case the athlete experiences symptoms.

11. Adequate amount of rest and sleep as well as sufficient nutrition should be ensured.

12. Training load (duration, frequency and intensity) of elite level youth athletes should be monitored, and rapid changes in training load should be avoided.

13. Early specialization in single sport should be avoided.

Injury rehabilitation

14. Treatment and rehabilitation of sports injuries should be guided by a sports physician and/or sports physiotherapist, and ideally, in close collaboration with coaching team.

15. Available evidence-based return-to-play consensus and guidelines should be used to assess readiness to return to competition.

Schools and teachers

Implementation of neuromuscular training warm-up

1. Teachers are recommended to deliver the NMT warm-up program as the minimal standard of practice for injury prevention in youth sport and recreation in school physical education classes (ages 11–16). The NMT warm-up should include aerobic, agility, strength, and balance exercises, and the duration of the warm-up should be approximately 15 minutes at a time.

Education and counseling of safety in sports

2. Education of sports and leisure time safety (rules, equipment, preventive actions) should be included in the curriculum of school physical education in all 12 to 15-year-old students.

Families, children, and adolescents

Participation on regular PA

1. Adolescents should participate in moderate- to vigorous-intensity, mostly aerobic, physical activity at least on average 60 minutes per day across the week. Adolescents should incorporate vigorous-intensity aerobic activities, as well as those that strengthen muscle and bone, at least 3 days a week, and also limit the amount of sedentary time[48].

2. Regular participation in activities requiring strength, balance, coordination, and agility, can help reduce the risk of PA related injury, and is recommended for all adolescents.

3. Early specialization in single sport can increase the risk of sports injuries and hence, should be avoided.

4. New physical activities and sports are recommended to be started gradually.

5. Every sport session, which includes running, sprinting, kicking, throwing or other rapid or intense movements, should start with a proper warmup and with moderate intensity.

6. In case of an injury, adequate rehabilitation should be ensured to avoid re-injuries or other injuries.

Nutrition and sleep

7. Sufficient energy intake, meeting requirements for protective nutrients, and maintaining normal body weight should be ensured to obtain good bone health and decrease the overall risk of injuries.

8. Chronic sleep deprivation should be avoided.

Equipment and environment

9. Guardians of the children and adolescents should ensure that they have and wear good quality equipment and protectors to decrease the risk of severe injuries.

10. The highest risk of fatal injury exists when commuting to school and leisure time activities, and thus, issues of safe routes and traffic safety should be acknowledged and guided by the guardians.

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The Physical activity-related injuries prevention in adolescents project has been funded with support from the European Commission. These recommendations reflect the views only of the authors, and the Commission cannot be held responsible for any use, which may be made of the information contained therein.

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