

Preventing injuries in basketball

Purpose

The purpose of this policy briefing is to highlight the main risks involved in basketball and to give an overview of promising measures and implementation strategies for reducing basketball injuries in number and in severity of outcome.

It also presents preliminary results of a pilot project in collaboration with FIBA-Europe, the European basketball federation, and the Swedish and Slovak national Basketball Federations, implementing a set of most promising measures adapted to local needs.

The policy briefing has been developed for national basketball federations and local associations and is in particular of interest for coaches, trainers and players. It aims to assist coaches and players in developing and implementing safety management schemes in clubs at national and local level and to promote sustainable compliance of coaches as well as athletes to such schemes. More detailed information as to the methodology, results and literature used can be found in the reports listed on the last page, which are accessible at www.safetyinsports.eu

Key messages

- Basketball is characterized by intensive body contact, frequent intermittent running and jumping, demanding one-on-one situations, quick direction changes in combination with challenging technique and coordination aspects like catching, throwing, passing and dribbling.
- The overall incidence of an acute injury in basketball is at around 3-6 incidents over 1000 hours of exposure. In competition the incidence is at least twice as high as during training practice. Within the EU-region it is estimated that at least 720,000 basketball-related injuries occur each year, at a direct medical cost of about € 500 million a year, among which knee injuries represent a cost of around € 100-200 million/year.
- Most of the incidents happen during matches, causing injuries to the lower extremities, followed by head and finger injuries. Sprains, strains and contusions are the predominant injury types. More than one third of all injuries affect the ankle joint, mainly as a result from landing on an opponent's foot when coming down from rebounds and from jump shots. Women are in particular vulnerable to knee injuries, in particular to ACL-ruptures.
- Centre players seem to be more prone to injuries compared to other players. The paint (or key) area is also a clear high-risk zone. Typical movement patterns are running with quick direction changes, sharp cutting manoeuvres; and particularly jumping and landing.
- Quite some efforts are invested in preventing injuries in particular by adjusting the training protocols. Enhancing athletic condition as well as improvements in balance, coordination and technique skills are typically recommended to prevent injuries of the lower extremities. In addition, core stabilisation, flexibility and advanced elementary coordination and technique skills are being advised. In addition to these measures, the use of protective equipment is being promoted such as high-top shoes, mouth guards, taping, ankle braces and orthoses.
- Despite efforts of trainers to integrate injury prevention measures in the training schemes, the issue still seems to be not very popular among basketball players themselves. Fortunately, the importance of the issue is increasingly being recognised, in particular by coaches and trainers.
- Athletic training, e.g. muscle strengthening, stabilization and proprioception, contributes to performance enhancement as well as injury prevention. It is therefore advised that training sessions should be tailored towards the prime interest of players in enhancing their athletic performance and thus indirectly helping them to prevent injuries.
- More efforts should be invested in monitoring injuries in order to be better able to identify particular individual and situational risk factors, to monitor injury trends and to evaluate effects of preventive interventions in the specific club setting.



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Game characteristics

Basketball is a so-called transition game, continuously switching between defensive and offensive play. The play includes running forwards, backwards and sideward, planting, cutting, feints, jumps, landings, turns during repeated one-on-one situations where additional contact can occur.

Thus, the game action is characterized by frequent intermittent running and sprinting. Motion analysis has shown that depending on individual playing-time basketball players cover a distance between 4.6 and 5.8 km per game, with mean heart rates between 80 and 90% of individual maximum heart rates. Therefore, players need to dispose of highly-developed basic endurance and a proper athletic condition with regard to strength, agility, acceleration, deceleration and in particular jumping. It also requires a well-trained anaerobic metabolism: athletes that are in bad athletic condition are prone to injury.

Modern basketball is a highly dynamic and demanding sport, with frequent body contact, even though the rules do not allow many forms of body contact with other players. The game is quite complex as it requires technical, tactical, athletic and cognitive skills, all at the same time. In most cases, an injury in basketball is not caused by one single factor but is often the result of a combination of multiple factors which are finally leading to an unintended result, respectively causing a physical injury.

Injury characteristics

In general terms we have to make a distinction between acute and chronic injuries. Acute injuries result from a specific, identifiable event whereas chronic injuries are caused by repeated micro-traumas without a unique identifiable event being responsible for the injury.

Although chronic injuries, in particular chronic knee pains (jumper's knee), frequently occur among basketball players, overuse injuries are not so well recorded yet.

Injury incidence rates in basketball are comparable to those in other team sports where

one-on-one situations with inevitable body contact frequently occur, such as in handball or in football. Research evidence indicates that the overall incidence is at about 3-6 injuries per 1000 hours of exposure.

Taking into consideration an active population of 1.7 million basketball players within the EU -27 with an average 140 hours a year spent in training and competition, one has to expect at least 720,000 basketball-related injuries a year, excluding injuries during recreational basketball. One fifth of these injuries are severe knee which cause an average of € 2,300 direct medical cost per case, while the average expenses of all other injuries are at around € 700 for treating the injury. A quick calculation indicates that basketball injuries cost approximately € 500 million a year, including knee injuries at a cost of around € 100-200 million/year.

These estimations are quite conservative and the actual costs are probably higher as leisure time play is not included and chronic injuries are seriously underreported.

Injuries in competition gain more significance with advanced age: while in young players nearly two third of all injuries occur during training, among adolescents and adults almost half of all injuries occur in match plays, even though with rising age more time is being spent in training compared to time spent in competition. There is no certainty as to possible differences in injury rates between recreational and elite athletes.

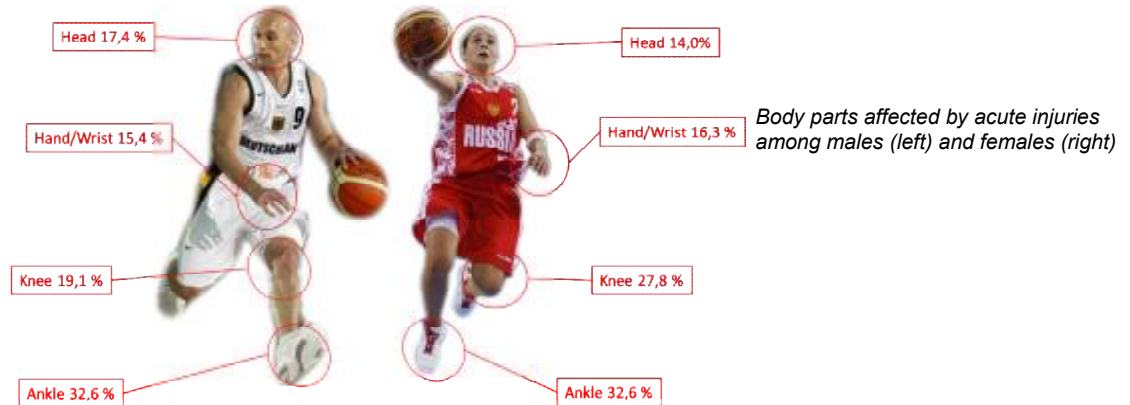
Some studies suggest that the injury rate for female players is higher compared to men. For instance, WNBA players reported in one study more injuries than NBA players, both during training practices and in competitive games. However, it is absolutely certain that women are more vulnerable to specific injuries, in particular to suffering knee injuries.

Regardless age, gender and performance level of players, there is a general tendency that the majority of injuries affect the lower limbs with the ankle joint being the most affected body part: in more than one third of all cases, ankle joints are injured. Women are



Basketball injuries

(14-45 years, N=970, own database)



more prone to non-contact knee injuries possibly due to deficits in neuromuscular control as well as greater joint laxity and lesser muscular stiffness.

Younger athletes seem to be more prone to injuries of the upper body regions, especially finger injuries, resulting from incorrect ball handling, or head injuries. With advancing age there is an increase in injuries of the lower extremities, in particular in knee injuries. Still, throughout all age groups ankle injuries are the leading injury cause.

Irrespective of age, gender or performance level, sprains (ankle, knee and finger joints) are the most common type of acute injury followed by muscle strains, contusions and fractures. Younger athletes are typically more vulnerable to fractures than older athletes, in particularly affecting fingers or wrists, as well as to facial and dental injuries.

Chronic injuries usually result from repetitive stress on biological tissues such as capsules, ligament or tendons, leading to instabilities of the affected joints. In basketball, the most common overuse injury is the so called jumper's knee resulting from patellar inflammation, patellar tendinopathy or anterior knee pain.

Circumstances

At least half of all injuries occur *in contact* with other players and also in rebounds. An-

kle sprains typically occur while a player lands on the opponent's foot after a jump shot or rebound. The paint (or key) area is also a clear high-risk zone.

Knee injuries, in particular anterior cruciate ligament (ACL) injuries, often occur in situations while there is *no immediate contact* with another player, typically while running with quick direction changes, in cutting manoeuvres, in dynamic starts and stops, in twisting or turning and in single-leg landings. Many so-called non-contact injuries may have been provoked by some minor contact shortly before the injury event. It has been shown that even a minor contact during jumping phase, pivoting or feinting can make players lose body control.

Centre players are destined to collect most of the rebounds. In addition, they normally play most of their time in the key area, which is by definition a high risk area. Therefore it is not surprising to find that centre players have higher incidences compared to guards and forwards who have more game action around the three-point-arch.

Taking into account all these risk factors, it seems appropriate to educate and train players in how to successfully manage contact situations, to enhance performance in typical basic motor patterns such as jumping, landing and cutting – also in combination with contact (body control) – and to improve the general



fitness level of the athletes. As previous injuries may often lead to recurring injuries and therefore sufficient attention should be paid to proper rehabilitation and regeneration.

Prevention approaches

In general, measures aiming at preventing sport injuries can be roughly divided into four more or less distinct categories, namely into measures focusing on 'training and physical preparation', 'technical and political approaches', 'equipment and facilities', and 'medical and non-medical support'.

A literature search, carried out in the framework of the Safety in Sports project (see acknowledgement section), identified 109 preventive recommendations in 70 publications related to preventing injuries in basketball. Most of the 70 references originated from the United States of America. Half of the published recommendations were based on strong scientific evidence, all others were at least based on expert opinion.

In order to better assess the value of these conclusions and recommendations from the literature survey, a selected group of experts in the field was invited to review each of the publications on three criteria:

- potential effectiveness of recommended measure or programme in terms of expected contribution to the reduction of injuries in number and/or severity;
- potential applicability of measure in terms of required efforts for implementation (e.g. time, money, infrastructures, competencies); and
- potential chance of acceptance of measures by athletes, coaches and associations and expected level of compliance on the longer term.

The feedback from the consulted 20 experts led to a reduced list of recommended practices that are promising as to their actual contribution to injury reduction and the potential of being accepted and applied in a sustainable manner in day to day practices and training of basketball players.

Experts opinion

It is evident that athletic training, e.g. muscle strengthening, stabilization and proprioception, contributes to performance enhancement as well as injury prevention. Therefore, it is advised by the consulted experts that training sessions should be tailored towards the prime interest of players in enhancing their athletic performance. There are ample opportunities to integrate into these training programmes preventive measures that are addressing high risk injury situations, in particular contact situations with opponents, and the well known injury mechanisms. Also at early age, the correct technique should be trained in basketball movement patterns, e.g. jumping, landing and feints, that are frequently associated with increased injury risks.

More specifically the following (mixtures of) approaches are recommended by the consulted experts in developing training and basketball practicing programmes:

- Very basic exercises focussing on stabilisation of the core, balancing and coordination practices and proper jumping and landing techniques. These exercises should be integral parts of the warm-up routine (10-15 min).
- The use of balance training in general is being strongly recommended as a routine practice with the aim to prevent ankle sprains.
- Structured warm-up programme are being advised that contain agility, balance, strength and playing technique exercises and that are designed to improve knee and ankle control during landing and pivoting movements with the aim to prevent knee and ankle injuries among youth athletes.
- Technique, such as cutting and landing movements, and balance training on wobble boards or mats should be trained from the age of 12 years onwards.
- Preventive training programmes should also include strength and power exercises, neuromuscular training, plyometrics and agility exercises, and be integrated into warm-up routine.
- Twenty minute training programmes that include warm up, stretching, strengthening, plyometrics, agility drills and cool down can



improve flexibility, strength and biomechanical aspects that are associated with ACL injuries.

- Neuromuscular training may help to reduce ACL injuries in female athletes, under the condition that it includes plyometrics, balance, and strengthening exercises and that the training sessions are performed more than once in a week and over a period of at least 6 weeks in a row.
- Athletes playing basketball can also benefit from a supervised athletic conditioning programme that includes dynamic warm-up, agility/quickness drills, sport-specific plyometrics, functional weight training, core training and an appropriate cool down with static stretching.
- It is recommended to have young female basketball athletes participating in pre-season jump training programmes that include progressive resistance weight training for the lower extremities.
- Prophylactic neuromuscular and proprioceptive training programme may also have direct effect in decreasing the number of ACL injuries in female athletes when emphasizing proper landing technique.
- Individualized season-attending athletic conditioning and technique training with particular regard to basic basketball-specific movement patterns that commonly lead to injuries. Ligament sprains and knee internal derangements may be at least partially preventable with interventions such as taping, bracing and neuromuscular training. External ankle support, e.g. orthoses, tape and/or high-top shoes, may in particular help to prevent injuries to re-occur.

How to get the right mix of interventions

In team sports, coaches play a decisive role in implementing prevention evidence into practice and to integrate injury control measures into current training and practices. Therefore, it is essential to understand the perception and knowledge of these practitioners as to the injury problem itself as well as their views on how to tackle the issue within existing training practices, organisational structures and capacities.

In the framework of the Safety in Sports-project (see acknowledgement section), collaborations could be established with the Slovak and Swedish basketball federations. These federations were invited to have coaches and officials participating in surveys that aimed to better understand their views and support needs. Many coaches positively responded to that invitation, more than one hundred in each of the two countries. These coaches were also involved in developing tailor made set of promising prevention strategies and measures ('national toolkits') and in pilot testing these toolkits within their respective clubs.

Awareness and consumer practices

The majority of Slovak coaches recognized injuries as a (very) important issue, while the Swedish coaches seemed to be less aware of the urgency. In both countries, coaches believed that injuries can be reduced through better athletic preparation and by allowing longer regeneration and rehabilitation periods.

Stretching seemed to be the most preferred preventive measure among the Slovak coaches, while the Swedish coaches are more focusing on muscle strengthening exercises. Coaches from both federations recognised the moderate or even low level of interest among players to increase training efforts in view of preventing injuries. Nevertheless, simple measures such as taping and use of orthoses and protectors, appear to be more widely accepted.

Both national groups of experts underlined the importance of educating coaches, as in team sports particularly coaches play a decisive role in translating the prevention evidence into practice. Therefore, coaches are the best advocates and change managers for implementing effective, applicable and acceptable injury prevention.

Both federations are already active in educating coaches. In Sweden, the "Basketsmart" knee prevention programme is being promoted through coaching clinics and a website for clubs, coaches and athletes. In Slovakia, there is a strong university-based tradition in educating basketball coaches, however, the curriculum of these courses are addressing



injury prevention not always in a consistent manner.

Pilots

Both groups of experts were involved in critically reviewing the evidence based recommended practices and in assessing the applicability and acceptability of these practices within their federation. Based on the results of that review, a draft toolkit of promising injury prevention measures was made for each of the two groups for integration in current programmes offered by the national federations to their coaches and into the training practices of the involved coaches. This process included a couple of consultation meetings with the respective national basketball associations, consultations with national experts and the organisation of coaching clinics and training seminars in the respective two countries. A baseline and follow up survey was carried out to assess the impact of the pilot programme on the attitude of coaches as well as their training practices.

The results of these pilot-projects are encouraging:

- Through the pilots, coaches became more aware of the necessity to invest in injury prevention;
- Owing to the pilots, coaches became more willing and able to direct their training practices towards training contents that are more effective in reducing injuries, in particular muscle strengthening and coordination exercises;
- Through the programme, coaches seem to have found better opportunities to motivate their team members in appreciating and accepting the training practices offered;
- The information provided, including web-pages, reached the target audiences very well; and
- The pilots led to injury prevention injury prevention being more strongly anchored into the education and training curricula of these federations.

What needs to be done

While taking into consideration the results of the expert consultations as well as the pilot testing of recommended measures, the four components of a comprehensive safety man-

agement programme for basketball players, to be implemented at national and club level, can be specified as follows:

Training and physical preparation

- Basic physical preparation

Basketball is a highly demanding team sport. To meet the demands of the game, players at all levels and ages need a proper basic athletic condition as to endurance, strength, flexibility and speed. Athletes in bad athletic condition are significantly more vulnerable for acute injuries and in particular for developing overuse symptoms like jumper's knee or low back pain.

Structured and supervised athletic conditioning programmes should be offered to sportsmen and women at all ages and at all levels of performance, as part of pre-season physical preparation and condition training during seasons. Such programmes should include individually adapted endurance training, functional weight training, dynamic mobilization and agility drills.

- Structured warm-up routines

General cardiovascular activation for 10-20 minutes prior to basketball sessions is essential and should include basic running drills but also neuromuscular, proprioceptive and balance exercises, and core stabilization and coordination practices. Plyometrics and agility drills should be included at the end of warming up.

All these highly effective training elements can be easily included in routine training and warming up practices and do not require extra time and efforts.

- Basic and advanced technique training

Technique training is not only most helpful in enhancing the game performance of athletes but also to reduce the risks related to crucial movement patterns and game situations. Proper jumping and landing technique in terms of knee and ankle control help athletes to sustain crucial situations like single-leg landings. Correct ball handling is an important factor to prevent numerous finger sprains and quick and controlled feet assist in coping pivoting movements.

Technique training, should start at young



age. With increasing age and performance level technique training should be adapted to the advanced demands of the athletes. This means for example, progressively adding controlled perturbations during exercising these movement patterns. Intense physical contact is inherent element of modern basketball and players should be trained to cope with intense body contacts in match plays. Basically, this also helps athletes performing better e.g. better scoring efficiency in contested jump shots.

- Neuromuscular training

There is sufficient scientific evidence that exercises on unstable devices such as wobble boards, slings or mats in combination with core stabilization and plyometrics are helpful when conducted regularly (at least 1-2 times per week) during pre-season and season. These training components can be easily integrated into warm-up routines and have even stronger positive effects while athletes are not yet tired out.

Technical and political measures

- Awareness raising

Continuous awareness of the positive contribution of injury prevention measures to sports performance is essential. Individual athletes and coaches and the responsible staff in clubs and federations need to systematically share information on basketball-specific injuries, risk factors, injury mechanisms as well as available knowledge on effective, applicable and acceptable countermeasures.

- Adaptation of the education programmes

Athletes and in particular coaches should receive at least a basic education in basketball injury prevention. The development and implementation of a safety management scheme at club level and at national level should be one of the core learning objectives within current curriculums for continuous education of coaches and club managers.

- Restriction on number of matches

Sufficient regeneration will reduce overuse symptoms and acute injuries due to fatigue or inadequately cured disorders. Therefore,

for professional players but also for lower level players, a revision of the competition schedule can help to shrink the dramatic number of injuries during and immediately after (inter-) national competitions.

Equipment and facilities

- Mouth Guards

Dental injuries are rather severe and are often leaving long-lasting scars. Custom-made mouth guards have shown to prevent dental and orofacial injuries as well. It is therefore strongly recommended that basketball players, in particular centre players wear custom-made mouth guards.

- Ankle Support

It is evident that ankle sprains are at least partially preventable when athletes use ankle braces, orthoses or taping as means of external protection. Especially, players with a history of ankle injuries should be advised to use external ankle support to prevent recurring injuries.

Medical and non-medical support

- Pre-Season Screenings

At least for professional athletes it is recommended to have a pre-season screening to detect potential risk factors for injuries, e.g. cardiovascular problems, muscular imbalances, athletic and neuromuscular deficits. Moreover performance diagnostics will help to identify better the athlete's individual needs for a training programme to enhance his/ her physical condition. If this is carried out under close supervision of coach and/ or physiotherapist this will contribute to increase overall performance and to reduce acute and chronic injuries.

To conclude

Basketball associations and clubs should follow a pro-active strategy as to the risk of injury and communicate with members and the general public openly about risks involved and necessary measures to be taken by clubs and individuals. Players should be provided with educational materials, such as brochures and video productions presenting basic exercises, which should be for instance downloadable from the FIBA's Coaching



Website and national websites. Such a pro-active approach will also contribute to the positive image of the game and the organisations involved, and will help to attract new members.

It is recommended to have all national associations to include an injury prevention module in their trainer education curriculums and to designate an official staff member as 'safety promotion ambassador' of the federation. And last but not least, all sustained injuries should be reported to trainers and coaches and should be systematically recorded at club and national level, in order to identify individual and situational risk factors, to monitor injury trends and to evaluate effects of measures taken.

References

All information presented in this policy briefing are based on studies carried out by the

Ruhr University in Bochum and published under the titles:

- P. Luig & T. Henke, Inventory of the burden of basketball injuries, existing prevention measures and safety promotion strategies, Ruhr University, Bochum, March 2010
- P. Luig & T. Henke, Best injury prevention measures and implementation of strategies in handball and basketball, Ruhr University, Bochum, November 2010
- P. Luig & T. Henke, Safety in Sports, Safety management schemes in Basketball, implementation and testing, Ruhr University, Bochum, August 2011

For references to sources of information presented in this policy briefing and for further references, readers are advised to consult the above mentioned reports which will be also accessible through the websites: <http://www.safetyinsports.eu> and <http://www.eurosafe.eu.com/>

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