

# ACL PREVENTION IN (FEMALE) HANDBALL

## WHERE ARE WE NOW – WHAT'S NEXT?

– Written by *Grethe Myklebust, Norway*

Multiple studies across several sports have demonstrated that tailored exercise programs reduce the risk of sport injuries in general by around 50%<sup>1,2</sup>. Most of published ACL prevention studies have been done in football (soccer)<sup>3,5</sup> with up to 64% reduction in ACL injuries among players and teams who use the exercise program<sup>5</sup>. ACL prevention studies in handball are limited. In a newly published review by Naderi et al (2023) analyzing exercise-based injury prevention studies in handball, they concluded “that current exercise-based injury prevention programmes may be effective in preventing lower extremity, knee, ankle, and ACL injuries in handball players”<sup>6</sup>. These training programs typically include exercises to improve balance and neuromuscular control, optimize landing and turning techniques, and increase muscle strength and endurance. The same program content seems to be the case in ACL prevention studies. In the following the ACL prevention studies that has been performed among handball players will shortly be presented.

In a study by Myklebust et al (2003), a five-phase neuromuscular training programme was tried out among

approximately 1,000 female players in the top three divisions in Norwegian handball. The programme consisted of three different balance and strength exercises focusing on neuromuscular control and cutting and landing skills. The players were encouraged to be focused and conscious of the quality of their movements, with emphasis given to core stability and hip and knee position in relation to the foot (the ‘knee-over-toe’ position). The intervention resulted in a substantial reduction in the risk of ACL injuries from the control season to the second intervention season among the elite players who completed the programme<sup>7</sup>.

In the study by Petersen et al (2005), 10 female handball teams (134 players) took part in a prevention programme to prevent ankle and ACL injuries. The programme consisted of: Information to the coach/players about injury mechanism, balance board exercises and jump training was introduced. The 10 control teams (142 players) were instructed to train as usual.

They followed the teams over one season and achieved a non-significant reduction of ACL injuries with 5 vs 1 ACL injuries in the control group compared to the intervention group<sup>8</sup>.

A high-quality study design was used in the first randomised controlled trial in handball by Olsen et al (2005) among youth female and male players. They showed that a structured warm-up programme including running exercises with and without ball, technique training focusing on safe cutting movements, two-feet landings after jump shots, balance training and strength and power exercises gave a highly significant reduction (50%) in the rate of acute lower extremity injuries among players in the intervention group. In this study the teams were highly compliant with the programme – 87% of the teams performed the programme as intended. In addition, the sample size was high enough to detect a difference between the intervention and the control group<sup>9</sup>.

In a RCT study by Achenbach et al (2018) they tested the effect of a knee injury-prevention program among adolescent handball players. Twenty-three teams (279 players), both female and male athletes participated. The intervention group regularly participated in an injury-prevention program with neuromuscular exercises for one season. Handball exposure and sustained injuries were documented



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for both groups monthly. Knee injury was the second most frequent injury among the players. Severe knee injury occurred significantly more often in the control group than in the intervention group. They concluded that frequent neuromuscular exercises prevent severe knee injury in adolescent handball players and should thus be included in the practical routine as well as in the education of team coaches<sup>10</sup>.

Despite the relatively sparse number of studies, we can conclude that it is possible to prevent severe knee injuries in handball—we can even reduce the risk of ACL injuries

by 50%! Prevention studies from other team sports supports this conclusion<sup>3,5,11,12</sup>.

#### WHO GETS INJURED?

The studies that are available in handball shows that female players are at higher risk for ACL injuries compared to male players<sup>12,13</sup>. Studies from Norway have shown that female players have a 5 times higher risk of an ACL injury compared to male players at the same level<sup>12</sup>.

Most ACL injuries occur in players in their late teens and early 20s. Data from the national ACL registries in Scandinavia

show an increase in ACL reconstructions among young female players<sup>14</sup>, which is a concern. This trend emphasizes the need for introducing ACL injury prevention training as soon as young girls (and boys) start playing handball. Introducing good training routines at early age can make what we today call “prevention training” to be only regular handball training/ warm-up routines.

#### MATCH VS TRAINING & LEVEL OF PLAY

There is no doubt that the risk of getting an ACL injury is much higher in matches compared to training, perhaps as much as 30 times higher<sup>12</sup>. The highest risk is found among females playing at the elite level<sup>12</sup>. The exact reasons for this are not known, although it’s probably safe to assume that it is related to the intensity of play.

The risk of suffering a serious knee injury may even increase during championships when the best players are exposed to an abnormally high number of matches during a short time period. In planning championships, Olympic Games and other tournaments, it is important to allow an adequate number of days for the athlete to recover. For young players who participate at a high level there is a clear tendency for participation on many teams and to compete at different age levels. This increases the number of matches/ competition and reduces the time they have available for rest and training. Playing matches is a high-risk situation for ACL injuries. Every handball federation should be aware of this and try to protect young athletes from over-participation in sports.

#### PLAYING POSITION

Are some playing positions at greater risk than others? The standard line-up in handball is three back players (43% of the team), two wing players (29%), 1 line player (14%) and 1 goalie (14%). When summarising data from three different studies reporting the playing position of ACL-injured players, the distribution is as follows: 112 (60%) were back players, 52 (28%) were wing players, 9 (4%) were line players and 15 (8%) were goalkeepers. This means that the relative risk of an ACL injury appears to be higher among back players and lower among goalies and line players. Another trend is that it seems that at the elite level, the proportion of injured back players is even higher. One likely explanation for this

tendency is that back players perform at-risk movements such as planting, cutting and jumping more often<sup>7,12,13</sup>.

### INJURY MECHANISMS AND RISK FACTORS

Most ACL injuries in handball are non-contact in nature; approximately 90% of injuries occur without contact with an opponent<sup>7,10,13</sup>. Of the two main injury mechanisms, approximately 70% of injuries occur when the player performs a cutting or turning movement, or in a one-leg landing after a jump. Even if there is no direct player contact to the knee, some perturbation by opponent interaction can sometimes be observed before the injury.

In a comprehensive ACL risk factor study among more than 800 elite female handball and football players in Norway the athletes went through several strength, balance, laxity, and functional tests, one- and two-legged drop jump tests and 3D motion analyse tests. The athletes were followed prospectively, and any ACL injury were reported to the study group. None of the tested variables pointed out to be a risk factor for an ACL injury among these elite athletes. Peak strength cannot be used to screen for ACL injury risk and the vertical drop jump test cannot be used to identify female elite athletes with increased risk of sustaining ACL injury. However, they found

a four-time higher risk for an ACL injury for athletes with a previous ACL injury<sup>15,16</sup>.

Video analyses of ACL injuries in several ball sports for both sexes have repeatedly shown that knee valgus is a key component of ACL injury mechanisms<sup>17-19</sup>. Considering that ACL ruptures are likely to occur within 40ms after the initial contact of the foot on the ground, avoiding knee valgus is still a good advice for handball players<sup>17</sup>. In addition to avoid a too wide cutting technique<sup>20</sup>. (See Figure 1 and 2).

So far, we do not have a complete understanding of the risk factors and mechanism of ACL injuries, and neither researchers or clinicians have a complete understanding of what exactly makes ACL injury prevention programs. Multiple meta-analyses have found that effective ACL injury prevention programs include both strength and plyometric exercises<sup>21,22</sup>, and the presented prevention programs in handball have included both. However, there is a need for more research in this area to achieve a better understanding on how and why the injury prevention programs work.

Studies from handball have shown that success in ACL prevention in the short term is possible. However, that an intervention is efficacious in a controlled trial does not mean that it will be widely adopted and

sustained and have an impact on handball players worldwide. In a mixed method study from Denmark, they studied the use of injury prevention exercises and injury prevention exercise programs in Danish youth handball. In addition, they investigated coach and player experiences, beliefs and attitudes of injury and their prevention<sup>23</sup>. They found that both players and coaches recognized the importance of injury prevention, however, the use of established programs was marginal. They conclude that experiences, beliefs, and attitudes about injury and injury prevention influence program uptake and should be addressed through continued education and training in this context in combination with making the programs more handball specific<sup>23</sup>.

Where are we now? With the knowledge from injury prevention programs in handball and other team ball sports we realize that our attention must be on how we can implement the current knowledge in ACL prevention.

### Implementation of our knowledge

Despite the low number of knee and ACL prevention studies in handball, they have showed that a substantial risk reduction is possible. The knowledge must reach the out to the governing bodies, the decision makers,

1a



1b



**Figure 1a:** A more narrow cutting technique (preferred).

**Figure 1b:** A wide cutting technique (higher ACL injury risk).



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the handball federations, club management and not at least the coaches!

#### *Coach as the key partner*

Winning and performance are the key factors for coaches and players. Injured players will not improve their own or the team's performance. Coach education is a key factor. Well-trained coaches will be able to deliver a new exercise programme in the correct way. Knowledge of sports injuries, injury prevention, attitudes and beliefs around the importance of injury prevention training is quite variable among coaches. Without doubt, injury prevention should be mandatory as part of coach education and certification at all levels.

In order to obtain the cost-effective effects from injury prevention training it is important to successfully implement these programs at the grassroots level, reaching the majority of young handball players. There is an urgent need to translate science into action and increase everyday injury prevention training for handball players at all ages, by reaching out and involving coaches, athletes, and parents, as well as key stakeholders in handball at the organizational level. The goal is to establish good training routines from an early age,

with preventive programs as a natural, integrated part of practice and training.

As a possible way of closing the gap on injury prevention, the Oslo Sport Trauma Research Center 4 -platform model for translating research into practice will be presented<sup>24</sup>.

The Oslo Sports Trauma Research Center (OSTRC) was established in May 2000 as an inter-disciplinary research center focusing on methods to prevent sports injuries (and

other health problems) with both sports and medical expertise and as the hub in the wheel for a national research network. In collaboration with the International Olympic Committee, we developed the free mobile application Skadefri (Get Set) and the website [www.skadefri.no](http://www.skadefri.no) ([fittoplay.org](http://fittoplay.org)) to translate science into action, spreading the word on the significant potential benefits from injury prevention training at the individual, team, club, and societal level.



Website: [www.fittoplay.org](http://www.fittoplay.org).



App: GetSet Train Smarter.



## ***Injury prevention should be a mandatory part of coach certification.***



### FOUR FOCUS AREAS

#### ***1. National coach certification programs***

Coaches are instrumental in the implementation of injury prevention. We have developed a two-hour e-learning course, “Sports without injuries”, which covers the crucial elements of injury prevention and injury prevention training. This is a basic course, directed at all coaches, particularly for children and youth.

#### ***2. Sport club events***

These two-hour in-person workshops are intended to engage coaches, athletes, parents, and sports club staff at the local, grassroots level. Conducted by Skadefri-trained sports physiotherapists and physicians across the nation, these workshops adhere to a standard template encompassing both theoretical context and practical injury prevention sessions for routine training. These local sports club events contribute towards the establishment of a national sports movement that is safer, more sustainable, and inclusive by fostering safer sports organizations and environments for athletes of all levels.

#### ***3. Sport academy high school educational programs***

The Norwegian Olympic committee acknowledges specialized national sport academy high schools that nurture gifted youth elite athletes at the highest level. Through a 10-hour specialized educational curriculum, we aim to foster more resilient youth elite athletes. The “Prep to be Pro” program is athlete-centric and encompasses

practical and theoretical sessions on sport-specific physiological and psychological demands, with modules adapted for each grade level from 8th through 13th. The program is ingrained within the national educational system with a commitment from management and coaches at each school.

#### ***4. SoMe***

The SoMe channels provide us with a platform to generate and translate credible, engaging, and relevant content that benefits the sports community at all levels. Instagram and Facebook are our primary channels. Multiple small inputs over time, across different areas, augment knowledge and the probability of behavioral change through the adoption and maintenance of injury prevention training. Through SoMe, we directly reach our target audience in an organic, non-intrusive, and self-determined environment. We employ videos, exercises, and “did you know” posts to educate and enhance knowledge on injury prevention by translating research into practice in an informal and entertaining manner<sup>24</sup>.

Skadefri (Get Set) aims to contribute to promote sport for all and to the fundamental principles in the field of sport and education, by supporting athlete health and integrity at all levels of sport. It promotes safe sport, educates young people, their coaches and their parents and addresses issues of safeguarding, healthy lifestyles, and injury prevention training. We believe the combination of e-learning, in-person grassroots workshops, specialized

programs where appropriate, and engaging SoMe content provide the framework to increase implementation and close the gap on injury prevention.

### TAKE HOME MESSAGE

Numerous studies across various ball sports, including handball, have demonstrated a significant potential for reduction in ACL injury risk. The current body of evidence confirms the efficacy of incorporating an exercise program into the warm-up sessions for the players. The program should integrate a blend of strength, plyometric, coordination and technique exercises. A growing concern is the escalating incidence of ACL injuries among young female athletes. Consequently, it should be mandatory to include preventive programs/exercises as soon as children, both girls and boys, commence their handball training. By initiating these programs early, we can normalize prevention training as a standard element of training. The dissemination of this knowledge amongst all handball coaches is likely our most prudent investment. Utilizing accessible digital resources such as websites and applications, we can effectively reach the primary stakeholders in this matter: the players and coaches.

*Grethe Myklebust, PT, PhD  
Oslo Sports Trauma  
Research Center  
Norwegian School of Sport  
Oslo, Norway*

*Contact: grethem@nih.no*