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**No relationship between a movement screening test and risk of overuse  
problems in low back, shoulder and knee in elite handball players  
- A prospective cohort study**

**Running head:**

**Risk of overuse problems in Icelandic male handball**

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## **Abstract**

Many handball studies have reported injuries that cause absence from participation. In this prospective cohort study on elite Icelandic male players, the aim was to examine the prevalence of overuse problems in low back, knee and shoulder.

Sixteen Icelandic teams were invited. Thirteen teams agreed to participate. The OSTRC overuse questionnaire was distributed every second week during 32-week period. In addition, the 9+ Screening Test was performed on 130 players.

In total, 229 players participated with a weekly average response rate of 72%. The average weekly prevalence for shoulder was 28% (95% CI 25% to 31%), for knee 33% (95% CI 30% to 36%) and for low back 32% (95% CI 29% to 35%). Substantial problems were 10% (95% CI 9% to 11%) in shoulder and knee and 11% (95%CI 10% to 12%) in low back. Only 1% (95% CI 1% to 2%) of the overuse problems caused time loss from participation. In total, 61% of the players played with at least one overuse problem and 25% with one affecting their performance. There was no association between the 9+ Screening Test score and overuse problems among Icelandic male handball players.

**Keywords:** Handball, injuries, overuse problems, screening test, injury risk.

## Introduction

Despite a growing research interest on handball, relatively few papers have reported on overuse injuries.<sup>1-4</sup> Most studies have described the incidence of injuries but using a variety of research approaches and differing injury definitions, making a comparison between studies difficult.<sup>1, 5, 6</sup> The studies shows a high incidence of time-loss injuries, particularly during matches (13.3-15.0 injuries/1000 match h vs. 0.6-2.4 injuries/1000 training hrs.)<sup>1-3, 7-9</sup> and up to 31-50 and 13-36 injuries/1000 h respectively for males and females in international tournaments with a congested match schedule.<sup>6, 10</sup>

However, a limited number of studies have recorded overuse injuries and the proportion with current complaints has ranged widely.<sup>1, 2, 4, 11</sup> A recent study on Icelandic elite handball players showed that the most common sites for overuse problems were the shoulder, low back and knee.<sup>1</sup> Employing a time-loss injury definition may represent a significant limitation, since it may not capture injuries which still may affect performance and participation.<sup>12</sup> The Oslo Sports Trauma Research Center (OSTRC) Overuse Injury Questionnaire was developed to better capture the full burden of overuse injuries and a study comparing the traditional time loss method with the new method illustrated that the standard methodology, based on time loss, captured only 10% of overuse problems registered by the new method.<sup>12, 13</sup>

The high number of injuries in sports have been a source of concern for many researchers who are attempting to develop methods that may have a positive impact on injury risk. One of these methods are movement screening tests, used in various sports as tools to identify players with an increased risk for injury based on their test profile, that aim to prescribe preventive measures at the individual level.<sup>14, 15</sup> A low score on Functional Movement Screening Test (FMS) has been claimed to be associated with a higher injury risk,<sup>16</sup> while other studies have failed to show a relationship between injury risk and FMS scores<sup>17, 18</sup> or pain.<sup>19</sup> The 9+ Screening Test, an advanced version of the FMS, has in one study failed to show such a relationship in a study on professional footballers.<sup>20</sup> No studies have examined possible association between 9+ test score and the risk of overuse problems in handball.

Thus, the aims of this study were to assess the prevalence and severity of overuse problems in the dominant shoulder, low back and knee among Icelandic male handball players using

the OSTRC overuse injury questionnaire and to test if total score on the 9+ screening battery was associated with the risk of overuse problems in these regions.

## Methods

This prospective cohort study included 13 elite Icelandic male handball teams. All players with a team contract were eligible for participation (n=229). Players who consented to participate (parents signed for those who were under 18 years of age) were asked to respond to the OSTRC Overuse Injury Questionnaire by e-mail every second week for 32 weeks (n=16), from September 2012 to April 2013. Each questionnaire was active for a week, with two automatic reminders sent, on the third and the fifth day after distribution. Players were also informed, reminded and encouraged to respond through a Facebook group administrated by the first author (EThR) who collected all the data. Players were asked to report on any overuse problems in the shoulder, low back or knee during the previous week. For each anatomical area, players answered four questions to report on possible consequences of overuse problems, on the player's participation, training volume, performance and extent of pain. Although the questions asked were related to overuse problems, the team physical therapists registered and identified the injury types (acute injuries or overuse problems). If the injury classification was not fully clear, the player was contacted for further classification. Second opinions were sought by physicians, if needed. Acute injuries, defined as injuries with a clear onset as a result of trauma,<sup>21</sup> were excluded from the research data.<sup>13</sup>

Overuse problems (OP) were defined if players reported any reduction in participation, training volume, or performance, or if pain was present. Substantial overuse problems (SOP) were defined if players reported moderate or severe reductions in participation or training volume.<sup>13</sup> Time-loss overuse problems (TLOP) were defined if players reported the maximum value in at least one of the first three questions in the questionnaire. As recommended by Clarsen et al., (2013), the data from the first questionnaire was removed from all analyses due to answers fatigue.<sup>13, 22</sup>

During the pre-season and the beginning of the season, the 9+ Screening Test<sup>14</sup> was performed on 130 of the players from the 13 teams. Their demographic values were identical to the original cohort. The players performed each of the ten tests once.<sup>15</sup> The 9+

tests total score was calculated for each player and used to assess possible associations with OP and SOP.

### **Statistical analyses**

Player age was presented as mean values with standard deviation (SD). Prevalence was calculated as the mean with 95% CI for OP, SOP and TLOP for each anatomical area by dividing the number of players reporting a problem by the number of questionnaire respondents, multiplied by a hundred. The cumulative severity score was calculated for each of the three body parts as the sum of severity scores for each instance a player reported having a problem.<sup>13</sup> The time-loss/substantial overuse problem (TL/SOP) ratio was calculated by dividing the number TLOP by the number of SOP reported in the questionnaires, multiplied by a hundred.

Linear regression was performed to assess the relationship between OP reported and the player's score on the 9+ Screening Test. The significance level was set as  $p < 0.05$ .

The statistics was calculated, and figures created in Excel 2013, and SAS Enterprise guide 7.1.

The study was approved by The National Bioethics Committee in Iceland (VSN12-043) and reported to The Icelandic Data Protection Authority.

## **Results**

### **Participants**

A total of 229 players from the 8 Premier division teams and 5 of 8 teams in the 1<sup>st</sup> division participated with participation being defined as responding to at least one questionnaire (age  $23.8 \pm 4.6$  yrs., height  $187 \pm 7.6$  cm., weight  $89.7 \pm 10.2$  kg., BMI  $25.6 \pm 2.3$  kg/m<sup>2</sup>). Almost 40% of the participants had played at junior national level and 13% at full national level. The first questionnaire was completed by 205 players, 137 completed the last one. Sixteen players dropped out, 12 due to acute injuries, two transferred to clubs abroad and two quit playing handball. The players data were included in the analyses until the player dropped out. The overall response rate was 72%. Complete data were reported by 92 participants (40%) and 141 (62%) completed at least 13 of 16 questionnaires.

## **Registered problems**

During the 32-week observation period, the participants completed a total of 2590 questionnaires. The majority (68%) of problems reported were mild, not affecting performance or participation. Substantial problems, affecting performance or participation occurred in 28% of cases and problems causing absence from participation (time-loss injuries) occurred in 4% of cases (Figure 1).

## **Prevalence and severity score**

In total, 95% of the participating players reported at least one overuse problem and 64% at least one substantial problem in one or more anatomical areas during the study period, while 4% reported problems causing absence from participation. The average prevalence of all OP during the study period was 31% (95% CI: 29% to 33%). The average prevalence of SOP during the study period was 10% (95% CI 9% to 11%). The average prevalence of TLOP was 1% (95% CI 1% to 2%), with no difference between anatomical areas.

The average ratio between TLOP and SOP was 13% (95% CI 11% to 15%), with the highest ratio for knee problems 17%.

The average severity score of the problems reported was 10 (95% CI 9% to 11%), with no difference between anatomical areas (Table 1).

The average percentage of players affected by problems from any of the three anatomical areas at any given time during the observation period was 61% (95% CI 57% to 65%) for all OP and 25% (95% CI 23% to 27%) for SOP (Table 1).

*(Figure 1 near here)*

*(Table 1 near here)*

## **Relationship between overuse injuries and 9+ screening test score**

We observed no significant association between total score on the 9+ Screening Test and any type of overuse problems. The effect sizes found were: In shoulder; OP,  $R^2=0.008$ ; SOP,  $R^2=0.03$ , in low back; OP,  $R^2=0.011$ ; SOP,  $R^2=0.024$  and in knee; OP,  $R^2=0.011$ , SOP,  $R^2=0.003$ .

## **Discussion**

Our main finding was that there was no association between the players score on the 9+ Screening Test and the risk of overuse problems. At any given time, one in three players reported an overuse problem and one in ten a substantial problem, affecting their performance and participation.

### Relationship between risk for overuse problems and 9+ Screening Test score

No study has provided data on the association between OP in sport and scores on movement screening tests. Furthermore, this is the first study in handball assessing the association between overuse injuries and movement screening tests.

We detected no association between the 9+ test score and the risk for OP. A re-run of the analysis in a mixed model regression, adding the teams as a cluster variable (random factor) to check for possible cluster between clubs, gave same results. This finding is comparable to results published on professional football players.<sup>20</sup> Most of the screening tests, including the 9+ test measure physical performance characteristics like strength, mobility and stability<sup>23</sup> – all representing modifiable variables, believed to be intrinsic risk factors.<sup>24</sup> Most of the tests use total score to assess injury risk, where a high score (better performance) is interpreted as low risk of injury.<sup>15-17</sup> The screening tests do not account for factors like age and history of previous injuries – non-modifiable factors believed to be two of the strongest risk factors for injuries in sports.<sup>21, 25, 26</sup> Injury history should be recorded to clarify if participants are newly recovered from injury, when the risk of reinjury is greatest, as well as distinguish between recurrent injuries and new ones.<sup>27</sup> When assessing athlete's injury risk, it is also important to keep in mind that extrinsic factors like equipment, environment, training intensity and athlete behavior are difficult to assess. In a study like the current, focusing on OP, training exposure and intensity are believed to be fundamental risk factors rather than physical contact and accidents.<sup>28</sup>



### Average overuse problems

When comparing our results with other studies, care should be taken since the research populations differ regarding age, gender and level of play.<sup>22, 29-31</sup> The prevalence of all reported OP for the three anatomical areas was around 30% for each area, greater than in recent studies, where 14% of Norwegian elite male junior handball players<sup>29</sup> and 18% of Norwegian elite handball players<sup>22</sup> reported OP. Even if the minor OP reported have less of an effect on player participation and performance, the overall high prevalence must be taken seriously by coaches, physical therapists and physicians. Continuous, intensive training may be a fundamental factor in aggravating symptoms and creating SOP.

One tenth of male Icelandic handball players have SOP in these three anatomical areas and play handball with symptoms affecting their performance and participation at any given time during the observation period. Our numbers are greater than in similar studies<sup>22, 29</sup> where the prevalence of pain in the low back in our study is the main cause for the difference. When looking at the proportion of players affected by a problem in any of the three anatomical areas, more than half of the players participated with at least one overuse problem at any given time and one out of four played with OP affecting their performance.

### Shoulder

For all OP in shoulder, the prevalence (28%) was in line with the 32% that Asker et al (2017) reported on the dominant shoulder in female handball players. It was a higher prevalence than was reported by Aasheim et al<sup>29</sup> (17%) and Asker et al<sup>31</sup> (23%). The prevalence of substantial problems (10%) is in line with what has been reported in Swedish male handball players (10%), but lower than what is reported in Swedish female players (15%).<sup>32</sup> Shoulder injuries in handball are well known and either caused by acute events and overuse injuries.<sup>1, 3, 4, 11, 30, 31</sup> The fact that 10% of all players are performing every week with SOP affecting their performance demonstrates the need for this new method in injury registration as well as the need for prevention programs similar to what Andersson et al (2017) have shown in their research.

### Knee

The prevalence of all OP in the knee (33%) was higher than in other handball studies (14% and 20%)<sup>22, 29</sup> but in line with a Norwegian volleyball study (36%).<sup>22</sup> The prevalence of substantial problems (10%) is in line with reports regarding Norwegian handball players (8%), but higher than what is reported in junior handball players (5%) and lower than what is reported in Norwegian volleyball players (15%).<sup>22, 29</sup> The average prevalence of knee problems is believed to be higher among elite players than in junior players<sup>29</sup> and it is understandable that the prevalence in volleyball is higher since the sport consists of intensive jumping during games and training.<sup>33, 34</sup>

### Low back

Registered OP in the low back (32%) were higher in our study than in other studies on handball players (12%).<sup>22, 29</sup> Only floorball (29%) is in line with our results.<sup>22, 35</sup> The prevalence of SOP in the low back (11%) in our study is higher than presented in any other study (2-4%).<sup>22, 29, 31, 35</sup> Even though 11% of Icelandic handball players are reporting SOP, higher than in any other study published, these results correspond with the results from our previous study where the ratio of time loss overuse injuries in low back among Icelandic handball players were higher than in similar studies.<sup>1</sup> Our results raise questions about internal factors in Icelandic handball, such as training culture or intensity in high quality sport environment with relatively few players in every squad, possibly pushing them to play with overuse problems without enough rest.

One limitation in this research where that the group performing the 9+ screening test were consisted only of 130 players, even though the group did not differ from the whole cohort in injury prevalence or demographic values. The response rate dropped somewhat during the observation period, affecting the prevalence of minor OP, but not SOP. The players seemed to keep reporting substantial problems rather than the minor ones. The dropout during the research period can partially be explained by the manner of the Icelandic tournament, where the teams head in to knock out stages. The losing teams dropped out of the competition with many of their players taking a break for a week or two from training before starting a new pre-season. As well, it should be noted that the data pertains to elite men, not women and youth players, and collecting data on only three anatomical regions does not

give a complete picture of the extent of OP in Icelandic handball as it excludes, for example, the elbow, groin and foot.

One strength of the study is that the participants were players from 13 of the 16 teams in the Icelandic handball leagues, with a decent response rate (72%). Secondly, the research period covered eight months – a full competitive season, giving comprehensive data.

Another strength is that the methodology used in this study gives new information regarding OP in Icelandic male handball, creating a database useful for coaches and health teams when planning injury prevention for the players.

### **Conclusions**

There was no association between the 9+ screening battery score and reported overuse problems in shoulder, low back or knee among Icelandic male handball players. A substantial number of players are playing with overuse problems, affecting their performance at any given time during the competitive season. The prevalence of overuse problems in low back was higher than in other studies.

### **Perspectives**

Researchers have used functional screening tests to assess possible risk of injuries in sports,<sup>16-18, 20</sup> with different outcomes. A study on football players has failed to show an association between 9+ Screening Test total score and risk of injuries. Until now, no studies have examined possible association between 9+ test score and the risk of overuse problems in handball. The results from this study shows that there is no relationship between 9+ screening test total score and the risk of overuse problems. Therefore, the test should not be used to assess injury risk in handball.

The new method to capture the full burden of overuse problems adds a new dimension to injury registration since the traditional time loss registration, captured only 10% of overuse problems registered by the new method.<sup>12, 13</sup> It can provide information and knowledge to clinicians and coaches, helpful to control intensity and training load during training and competition.

## **Data availability statement**

The data supporting the findings of the study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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**Table 1.** Average prevalence of all overuse problems and average severity score in Icelandic handball for the 32-weeks observation period.

	Knee	Low back	Shoulder	Any proportion†
All overuse problems*	33 (30-36)	32 (29-35)	28 (25-31)	61 (57-65)
Substantial overuse problems*	10 (9-11)	11 (10-12)	10 (9-11)	24 (22-26)
Time loss overuse problems*	2 (1-2)	1 (1-2)	1 (1-2)	4 (3-5)
TL/SOP ratio*	17 (13-21)	11 (8-14)	11 (10-13)	
Severity score**	10 (9-11)	11 (10-12)	9 (8-10)	

† Proportion of any overuse problems at any given time.

TL/SOP ratio=Time loss/substantial overuse problems ratio.

\*Values are shown in percentages with 95% CI in parentheses.

\*\*Values are shown as arbitrary units with 95% CI in parenthesis.

**Figure 1.** Prevalence of overuse problems in 32 weeks research period (16 questionnaires). OP= Overuse problems, SOP= Substantial Overuse problems, TL OP= Time loss overuse problems. The bar above the chart shows the timespan during the research period.

