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**Male basketball players who report hip and groin pain perceive its negative impact both on- and off-court: a cross-sectional study**

**Running Head:** Hip and groin pain in male basketball players

Katherine Dooley<sup>1</sup>, Michael K. Drew<sup>2</sup>, Suzanne J. Snodgrass<sup>1</sup>, Adrian Schultz<sup>3</sup>, Tye McGann<sup>1</sup>, Sarah Blyton<sup>3</sup>, Tania Pizzari<sup>4</sup>, Ebonie Rio<sup>4</sup>, Luke Donnan<sup>5</sup>, Suzi Edwards<sup>3</sup>

<sup>1</sup>*School of Health Sciences, The University of Newcastle, University Drive, Callaghan, NSW, Australia;* <sup>2</sup>*Department of Physical Therapies, Australian Institute of Sport, Leverrier Street, Bruce ACT Australia;* <sup>3</sup>*School of Environmental & Life Sciences, The University of Newcastle, Chittaway Road Ourimbah, NSW, Australia;* <sup>4</sup>*Sport and Exercise Medicine Research Centre, La Trobe University, Plenty Road & Kingsbury Drive Bundoora, VIC, Australia;* <sup>5</sup>*School of Community Health, Charles Sturt University, Elizabeth Mitchell Drive Thurgoona NSW, Australia*

**Corresponding author:**

Katherine Dooley BPhys(Hons)

Faculty of Health & Medicine, School of Health Sciences

Hunter Building

University Drive, Callaghan

NSW 2308 Australia

Phone: +61 438 169 913

Email: katherine.dooley@uon.edu.au

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**Abstract:**

**Objectives:** To identify if basketball players aged <20 years (U20) self-report hip and/or groin pain and if they perceive this as a problem. To determine potential differences in self-reported playing (training and match play) loads and Copenhagen Hip and Groin Outcome Score (HAGOS) between those with and without hip/groin pain.

**Design:** Cross-sectional.

**Methods:** Fifty-one pre-elite (state/national representative level) male U20 basketball players (Australian n = 38; Italian n = 13) self-reported current/historical hip/groin 'discomfort/pain' and 'problems', and playing loads. A two-factor regression model was fitted including main effects for hip/groin pain and Cohort and their interaction, with outcome variables playing loads and HAGOS subscale scores and dependent variable hip/groin pain.

**Results:** Twenty-one players (41%) self-reported hip/groin 'discomfort/pain', of which nine perceived no 'problems'. Two of these nine players reported training/playing time loss due to pain. Those self-reporting hip/groin discomfort/pain scored lower than those without in HAGOS subscales Symptoms (mean difference in score 8.94; 95%CI -25.24, -5.97), Pain (5.00; -16.42, -2.81), Function in daily living (0.00; -26.72 to -5.59), Function in sport and recreation (6.25; -21.24, -5.33), and hip and/or groin Quality of Life (5.00; -28.63, -8.10), indicating worse hip/groin problems. Participation subscale scores were different only for Italian players (36.25; -51.25, -20.00), with players self-reporting hip/groin discomfort/pain scoring lower.

**Conclusion:** Most players who perceive both hip/groin 'discomfort/pain' and 'problems' also report training/playing time loss, suggesting players' perceptions of problematic symptoms and time-loss are associated. Adolescent basketball players perceive hip/groin pain to negatively impact their daily lives and sporting function.

**Keywords:** groin problems; athletic injuries; activities of daily living; quality of life; thigh.

## Introduction

The cornerstone of sports medicine research is exploring athletic injury, with one of the most important steps in epidemiological research being how an injury is defined.[1] There are multiple ways to define an injury, ranging from match time-loss to any and all complaints by the athlete.[2, 3] Although time-loss injury definitions are considered the most reliable, this narrow injury definition may result in the under-reporting of overall injury prevalence.[2]

The use of time-loss injury definitions in hip-related and/or groin pain research in sporting populations is not recommended, as it likely under-estimates groin pain prevalence.[4] This is evident in football, where at least one third of athletes continue to participate with groin pain.[5, 6] Due to limited hip/groin pain research in basketball populations, injury surveillance systems using time-loss definitions have been employed by the National Collegiate Athletic Association (NCAA) and the National Basketball Association (NBA) stating that hip/groin pain accounts for 3-8% of time loss injuries.[7, 8] By employing narrow time-loss injury definitions these injury surveillance systems may not capture all athletes with hip/groin injuries.

As well as expanding injury definitions, understanding an athlete's perceptions of their injury is important to improve athlete-centred research.[9] Athletes' injury perceptions can be affected by both personal and external factors, which will change how they define an injury.[10] The benchmark for objectively measuring patients' perspectives are Patient-reported outcome measures (PROM).[11] The Copenhagen Hip and Groin Outcome Score (HAGOS) is a PROM recommended for use in football players to quantify the extent of hip/groin problems experienced on six subscales including pain, symptoms, disability and impaired performance.[4]

Due to the narrow injury definitions previously used, and with no identifiable research exploring current players' perceptions of hip/groin pain, there is a limited understanding of the prevalence and impact of hip/groin pain on current basketball players. The first aim of this study was to identify self-

reported hip/groin pain in U20 male basketball players and if those with pain perceive this pain as a problem. The second aim of this study was to determine if there were any differences between basketball players with and without self-reported hip/groin pain in their perceived function both on- and off-court through self-reported training and playing loads, and their HAGOS subscale scores.

## Methods

Cross-sectional data were from a reference population of male pre-elite U20s basketball players. All male players ( $n = 93$ ) who either (1) competed at the Australian U20 Basketball Championships (Terrigal, Australia) or (2) attended the Mens Sana Basketball Academy (Siena, Italy) were invited to participate in this study. Any player attending either the Championship or Academy were eligible for inclusion in this study if they were (1) male; (2) defined as a pre-elite level basketball player; or (3) aged 20 years or younger at the time of testing. Pre-elite was defined as participation at state or national representative level, as per the Australian Institute of Sport Foundation, Talent, Elite and Mastery criteria.[12] Data on Australian players (Cohort 1) were collected in the two days prior to the start of a congested fixture tournament, the Australian U20 Basketball Championships (February 2018; teams  $n = 8$ ; players  $n = 80$ ). The tournament is played in addition to normal state run competitions in Australia. As each state has varied time-frames for their competition seasons, players participating at the Australian U20 Basketball Championships may be in either pre-, mid- or post-season in their normal competition seasons. Data on Italian players (Cohort 2) was collected mid-season, over a 7-day period, on players attending the Mens Sana Basketball Academy (September 2018; teams  $n = 1$ ; players  $n = 13$ ). Characteristics of all participants were collected to define the sample: age, height (cm) and body mass (kg). Written informed consent was obtained from all participants and parent/guardian consent was obtained for participants under 18 years of age. Ethics (protocol number: H-2017-0110) approval was provided by the University of Newcastle Human Research Ethics Committee. This study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[13]

All participants completed a custom sporting history questionnaire, which included the HAGOS, under the supervision of an investigator. Players were asked to report if they had experienced any

hip/groin pain or problems in their lifetime via two questions: (1) "Have you experienced any hip and/or groin discomfort/pain?"; (2) "Have you had hip and/or groin problems?". Lifetime prevalence was chosen over period prevalence as the true burden of hip/groin pain in basketball players is unknown and requires further investigation,[14] as such recent injuries were not given precedence over historical injuries. If a player responded 'yes' to either of the above questions players were to report: (1) onset of hip/groin pain prior to the date of data collection; (2) location of hip/groin pain; (3) time-loss due to hip/groin pain; (4) treatment received for hip/groin pain. Training and match playing load information; including average number of training sessions per week (with and without recovery sessions), average number of games per week and average percentage of game played each week, was self-reported by players and used to examine if any differences were present between those who self-reported hip/groin pain and those who did not.[4] Players also reported all basketball competitions they regularly competed in. The HAGOS is a valid[15] and reliable[16] questionnaire that contains 37 questions answered on a Likert scale, and is divided into six subscales covering different aspects of an athlete's life: (1) Symptoms; (2) Pain; (3) Function in daily living (ADL); (4) Function in sport and recreation (Sport/Rec); (5) Participation in Physical Activities (PA); and (6) hip and/or groin Quality of Life (QOL).[15] Each subscale was scored independently and values were then normalised to a 100 point scale, with 100 equating to no problem and 0 indicating severe problems. If a participant failed to answer more than one question for PA subscale or more than two questions for all other subscales (Symptoms; Pain; ADL; Sport/Rec; QOL) then the individual subscale was excluded from analysis and treated as 'missing data'. [15]

For both hip/groin 'discomfort/pain' and hip/groin 'problems' prevalence was calculated by dividing the number of players who self-reported hip/groin symptoms by the number of players who did not self-report hip/groin symptoms. To determine if any difference was present in basic characteristics of Cohorts 1 and 2, continuous data underwent Wilcoxon rank-sum testing due to data failing normality checks via both visual inspection and Shapiro-Wilk testing. While categorical data underwent Fisher's exact testing due to cell counts being less than five.

The outcome variables, four on training and match playing loads and six HAGOS subscales, were examined to determine if there was a difference due to the presence of self-reported hip/groin pain and if this difference existed, whether it was the same across the two Cohorts. A two-factor regression model was fitted with main effects for self-reported hip/groin pain and Cohort and their interaction. As the distribution of the outcome variables was found to be skewed, both bootstrapping and permutation tests were undertaken to determine the significance of the three model terms. Stepwise elimination was performed, whereby the significance of the interaction in the model was determined and if found to be non-significant was removed from the model and the significance of the two main effects were determined. The bootstrapping tests estimated the size of the differences with 95% confidence intervals used to determine statistical significance when the interval did not include zero. A null hypothesis reference distribution was used to determine the significance of permutation tests. Significance was set at the 0.05 level for permutation, Wilcoxon rank-sum and Fisher's exact testing. If a significant interaction was detected between self-reported hip/groin pain and Cohort, follow-up bootstrapping was performed to compare the means for those with and without hip/groin pain for each of the two Cohorts. All statistical analysis was performed in Stata 15.1 (Stata 15.1 IC, StataCorp, USA).

## Results

Fifty-two pre-elite U20 basketball players (Cohort 1 n = 39; Cohort 2 n = 13) from five teams (Cohort 1 n = 4; Cohort 2 n = 1) volunteered to take part in this study (response rate of 56%). One player was excluded from the study due to a substantial amount of missing data, resulting in 51 players being included in analysis (Cohort 1 n = 38; Cohort 2 n = 13) (Supplementary 1). Due to time constraints from the congested fixture tournament format, Cohort 1 coaching staff did not allow body mass measures to be collected on one team of eight participants. Significant differences were found between Cohort 1 and 2 for height and mass only, with no other significant differences found in characteristics between the two Cohorts (Table 1).

For all participants surveyed, 21 (41%) players self-reported current or historical hip/groin 'discomfort/pain' (Cohort 1 n = 11, 29%; Cohort 2 n = 9, 69%), although only 12 of the 51 players

reported experiencing current or historical hip/groin ‘problems’ (Cohort 1  $n = 4$ , 11%; Cohort 2  $n = 8$ , 62%) (Figure 1). Of the nine participants self-reporting hip/groin ‘discomfort/pain’ but not hip/groin ‘problems’, only two participants reported either missing games or missing/modifying training sessions. All 12 participants reporting both hip/groin ‘discomfort/pain’ and ‘problems’, also reported either missing games or missing/modifying training sessions. The amount of time that the 14 participants reported either missing games or missing/modifying training sessions due to hip/groin pain was:  $>4$  weeks ( $n = 4$ ); 1-4 weeks ( $n = 4$ ); 3-4 days ( $n = 3$ ); 1-3 days ( $n = 3$ ). Only four participants reported bilateral hip/groin ‘discomfort/pain’. Treatment was sought by 13 participants (all undertaking physiotherapy), of which one also sought other non-specified treatment. Ten players reported hip/groin pain onset within three months prior to the date of data collection, four of whom reported ongoing symptoms “weekly or more” at the time of completing the questionnaire.

As bootstrapping and permutation yielded similar results, only bootstrapping results are reported. Table 2 shows the bootstrapped 95% confidence intervals for the differences between those with and without self-reported hip/groin pain for each of the outcome variables. A significant interaction was found between self-reported hip/groin pain and Cohort for HAGOS subscale PA only. There was no difference in HAGOS PA scores between those with and without self-reported hip/groin pain in Cohort 1 (mean difference = 2.84 95% CI = -3.63 to 9.62), while in Cohort 2 those with self-reported hip/groin pain scored significantly lower than those without (mean difference = -36.25 95% CI = -51.25 to -20). No significant interaction was present between Cohort and any other variable, nor was there any significant main effect of cohort in the regression model. When Cohorts were combined, those with self-reported hip/groin pain scored significantly lower than those without pain for HAGOS subscales Symptoms, Pain, ADL, Sport/Rec and QOL. There were no differences between those with and without hip/groin pain for any participation load variable (training or match play).

## Discussion

The results of this study indicate that a high proportion of pre-elite U20 basketball players self-report hip/groin pain (41%), although fewer players report hip/groin ‘problems’ (24%). Nearly all players who reported hip/groin ‘discomfort/pain’ but not ‘problems’ reported no training/playing time loss

due to hip/groin pain. This likely reflects players' perceptions of problematic symptoms being defined by time lost on court. Players who self-reported hip/groin pain scored significantly lower on five of the six HAGOS subscale scores: Symptoms; Pain; ADL; Sport/Rec; and QOL. This indicates that adolescent basketball players perceive hip/groin pain to have a negative impact on their daily lives and sporting function despite continued participation on-court. The lack of a between-group difference in HAGOS PA subscale scores of players in Cohort 1 may be due to either the subscale's limited scoring spectrum or different expectations placed on players competing in the Australian Championship tournament. Overall, 21 of the 51 players surveyed self-reported current and/or historical hip/groin 'discomfort/pain' (41%), which is consistent with a recent survey on retired male NBA players in which 39% of respondents reported a hip/groin injury during their NBA playing career.[17]

Players may not perceive pain as a problem unless it affects their participation. Recent qualitative research on Olympic level athletes found they reported pain to occur both during normal training and when injured, although the addition of training or competition time-loss delineated what athletes' considered an 'injury' from what they considered a 'normal experience' of playing sport.[10]

Although not quantified in the present study, it is possible this concept may be present in pre-elite basketball players. Only 12 of the 21 players who self-reported hip/groin 'discomfort/pain' also reported 'problems', with the majority of players who reported both pain and problems also reporting missing games or missing/modifying training sessions due to their hip/groin. Similar research in soccer players has shown the use of varied hip/groin pain definitions impact on research outcomes.[18] Care needs to be taken in word choice when defining self-reported hip/groin injuries.

Pre-elite basketball players with self-reported hip/groin discomfort/pain scored lower on five of the six HAGOS subscale scores, indicating that players perceive hip/groin pain to affect them both on- and off-court. The largest mean between group difference was 8.9 for subscale Symptoms. However, players who self-reported no hip/groin discomfort/pain had a mean Symptoms score of 94.7, indicating the presence of some symptoms. This suggests basketball players may perceive symptoms in the hip/groin region without perceiving this as an injury or problem, similar to Olympic athletes[10]

and soccer players.[18] Although the mean between group differences for subscales Pain, ADL and QOL were less than or equal to five, the increased accuracy achieved by employing bootstrap confidence intervals clearly indicates a difference between those with and without hip/groin pain. The lack of chronicity of symptoms in our population may have influenced the between-group differences, as six of the 21 players self-reporting pain indicated their pain lasted less than four days. In soccer players, HAGOS subscale scores have been shown to have a negative correlation with injury duration.[19] The mean difference in HAGOS subscale scores between soccer players without hip/groin pain and those who self-reported one to two weeks duration of pain, ranged from 5 to 17.1 units, while the mean difference between those without hip/groin pain and those with greater than six weeks duration of pain ranged from 20 to 45. In the current study only four basketball players reported a time-loss of more than four weeks.

A recent study by Patel et al. on NBA players' performance parameters after returning to play following a hip adductor injury identified that performance was unaffected.[20] Performance was evaluated by the authors via per-minute statistics (e.g. points, rebounds, assists), All-Star selection, player efficiency rating, games and minutes played. The lower HAGOS Sport/Rec subscale scores in pre-elite players with self-reported hip/groin pain in our study, suggests that perceptions of performance are an important adjunct to objective measures. Players' perceptions of reduced performance in sporting function has been reported as a key factor in defining injury,[10] and is associated with a players' ability to act autonomously, maintain interpersonal relationships and achieve a sense of belonging within social contexts.[21] These negative psychological effects are suggested in the current study, as those with pain scored significantly lower than those without for HAGOS subscales ADL and QOL. Although the ADL subscale indicates responders' everyday physical function, QOL covers the overall impact of hip/groin pain, including its effect on mood: 'Does your hip and/or groin problem affect your mood in a negative way?'.[15]

No difference is noted in HAGOS PA subscale scores between Cohort 1 players with and without self-reported hip/groin pain, whereas a difference is present in Cohort 2. Further research is suggested to better understand the PA subscale,[22] as it behaves unlike other HAGOS subscales and measures a

different domain from alternate PROMs.[15] Criticism of the PA subscale stems from the limited two-item scoring, suggested to cause floor[15] and ceiling effects.[23] Regardless, it is an important indicator of overall ability to participate in sport[15] and when included in groin pain injury definitions, impacts on prevalence estimates.[24] As the HAGOS PA subscale has respondents report the impact hip/groin pain has on their participation in the preceding week,[15] it would be expected that Cohort 1 players attending a national competition would be participating at full capacity and may have been motivated to participate regardless of pain status as the tournament is important in elite-level selection pathways. Cohort 2 players would not have these expectations or pressures, as players could attend the academy irrespective of whether they were able to participate in games and/or training sessions. It is possible some players in Cohort 2 may have been discouraged from participation by medical staff to allow adequate rehabilitation.

Two potential sampling biases limit the results of this study. First, data collection for Cohort 1 occurred during a tournament, so basketball players missing the tournament due to injury were not included. Second, due to tournament time-constraints, coaching staff determined team participation, potentially resulting in coaches who had players previously reporting hip/groin pain more likely to agree to testing. Recall bias may have also influenced the study findings. Players may have incorrectly recalled their hip/groin discomfort/pain history, such as the presence or absence of pain or the onset, location, time-loss or treatment related to pain, as well as their reported playing load information. These factors may have resulted in either the under- or over-estimation of prevalence in this study. Clinical classification of groin pain did not occur as per the Doha agreement.[4] Future investigations are warranted to determine factors associated with different clinical classifications of groin pain in this population.

## **Conclusion**

Hip/groin 'discomfort/pain' were reported by nearly half of the pre-elite U20s basketball players included in this study. Of the players who self-reported discomfort/pain, almost half did not perceive this to be a problem, likely due to the fact that they reported no training/playing time loss. Those who self-reported hip/groin pain scored lower on five of the six HAGOS subscales (Symptoms; Pain;

Function in daily living; Function in sport and recreation; and hip and/or groin Quality of Life), indicating these late-adolescent basketball players perceive hip/groin pain negatively impacts on their performance of sporting tasks and also affects their daily lives.

### **Practical implications**

- Adolescent basketball players do not readily identify hip/groin discomfort/pain to be problematic, so are less likely to report it.
- Self-reporting of hip/groin ‘problems’ is more likely when participation is impacted, so early detection of mild symptoms and resultant intervention could improve injury prevention.
- The HAGOS can potentially be employed to help differentiate between adolescent basketball players with and without hip and/or groin discomfort/pain.

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### **Declaration of Interest**

The authors declare that they have no conflict of interest.

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## Figure legends

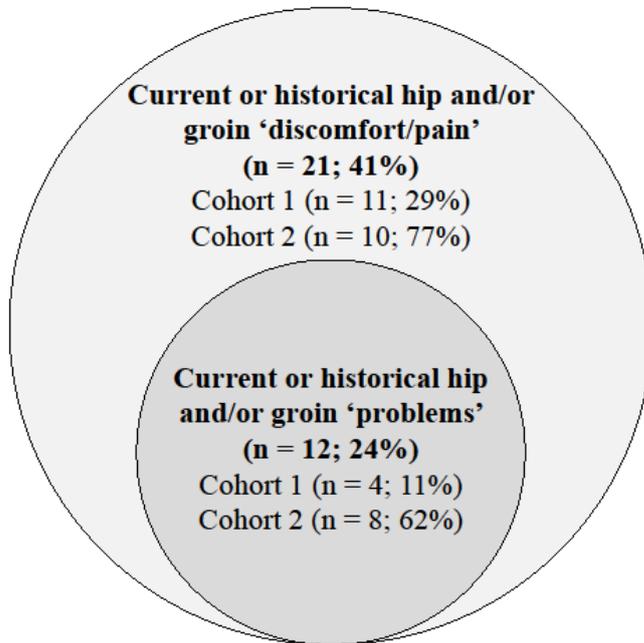


Figure 1: Venn diagram showing how U20 basketball players self-report hip and/or groin pain within this study.

Supplementary 1: Flow of participants through study protocol and analysis

Table 1: Characteristics of Cohort 1 and Cohort 2 of pre-elite U20 basketball players (n=51).

Characteristic	All players (n = 51)	Cohort 1 (n = 38)	Cohort 2 (n = 13)	p-value
Age ( <i>yr</i> ; median (IQR))	17 (1)	18 (1)	17 (2)	0.17
Height ( <i>cm</i> ; median (IQR))	193.5 (9.5)	196.0 (12.0)	183.0 (16.0)	0.02
Mass ( <i>kg</i> ; median (IQR))	86.6 (13.0) <sup>d</sup>	87.5 (14.3) <sup>e</sup>	83.7 (11.7)	0.04
Semi-professional basketball <sup>a</sup> (n; (%))	17 (33.3)	16 (42)	1 (8)	0.13
Other sports <sup>b</sup> (n; (%))	5 (10) <sup>f</sup>	5 (13) <sup>g</sup>	0 (0)	0.54
Average training time per session (n; (%))				0.09
60-90 minutes	17 (35) <sup>h</sup>	15 (42) <sup>i</sup>	2 (15)	
>90 minutes	32 (65) <sup>h</sup>	21 (58) <sup>i</sup>	11 (85)	
Average length of game <sup>c</sup> (n; (%))				0.30
30-60 minutes	19 (37)	12 (32)	7 (54)	
60-90 minutes	26 (51)	21 (55)	5 (38)	
>90 minutes	6 (12)	5 (13)	1 (8)	
Average number of games per week <sup>c</sup> (n; (%))				0.70
1 game	9 (18) <sup>f</sup>	7 (19) <sup>g</sup>	2 (15)	
2 game	33 (66) <sup>f</sup>	23 (62) <sup>g</sup>	10 (77)	
3 game	7 (14) <sup>f</sup>	6 (16) <sup>g</sup>	1 (8)	
4 game	1 (2) <sup>f</sup>	1 (3) <sup>g</sup>	0 (0)	

†Wilcoxon rank-test, significant at the 0.05 level. ‡ Number of observations does not equal number of participants as some missed questions within questionnaire.

<sup>a</sup> Players played in an open-aged pre-elite competition level, where players are contracted to a team and paid to participate. <sup>b</sup> Players regularly participated in sports other than basketball. <sup>c</sup> Official basketball referee present to officiate. <sup>d</sup> Observations on 43 participants. <sup>e</sup> Observations on 30 participants. <sup>f</sup> Observations on 50 participants. <sup>g</sup> Observations on 37 participants. <sup>h</sup> Observations on 49 participants. <sup>i</sup> Observations on 36 participants.

Table 2: Comparison of self-reported average training and game load and HAGOS subscale between pre-elite U20 basketball players with and without hip/groin pain (n=51).

Outcome measures	Self-reporting pain/discomfort (n=21)		Nil reporting of pain/discomfort (n=30)		Bootstrap	
	n	Median(IQR)	n	Median(IQR)	Effect	95%CI
<b>Self-reported participation load</b>						
Training <sup>a</sup> , including recovery ( <i>n</i> )	20	9.00 (7.50-11.50)	26	8.00 (6.00-12.00)	0.70	-1.55 to 2.82
Training <sup>a</sup> , excluding recovery ( <i>n</i> )	20	8.00 (7.00-9.50)	26	7.50 (6.00-11.00)	0.75	-0.76 to 2.56
Percentage of regular competition game played	21	70.00 (60.00-80.00)	28	80.00 (65.00-80.00)	-3.93	-14.64 to 5.71
Number of games per week	21	2.00 (2.00-2.00)	29	2.00 (2.00-2.00)	-0.16	-0.51 to 0.20
<b>HAGOS subscale</b>						
Symptoms	21	85.71 (60.71-92.86)	30	94.65 (85.71-100.00)	-14.63	-25.24 to -5.97
Pain	21	95.00 (82.50-100.00)	30	100.00 (97.50-100.00)	-8.55	-16.42 to -2.81
Activities of daily living	21	100.00 (85.00-100.00)	30	100.00 (100.00-100.00)	-12.09	-26.72 to -5.59
Sport and recreational activities	21	93.75 (75.00-100.00)	30	100.00 (96.88-100.00)	-12.44	-21.24 to -5.33
Participation in physical activity <sup>‡</sup>	21	100.00 (62.50-100.00)	29	100.00 (100.00-100.00)	2.84 <sup>b</sup>	-3.63 to 9.62 <sup>b</sup>
Quality of living	21	95.00 (65.00-100.00)	29	100.00 (95.00-100.00)	-36.25 <sup>c</sup>	-51.25 to -20.00 <sup>c</sup>

†Bootstrap significant when 95%CI does not include 0. ‡Significant interaction present between Cohort 1 and Cohort 2.

<sup>a</sup> Number of training sessions in an average week; <sup>b</sup> values are for Cohort 1; <sup>c</sup> values are for Cohort 2.