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Original Research

Functional movement screen and Y balance tests in adolescent footballers with hip/groin symptoms

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Highlights

Y balance test results were associated with hip and groin symptoms and pain.

The trunk stability push-up and rotatory stability test of the FMS were associated with hip/groin symptoms.

The FMS and Y balance test should be investigated further in studies of adolescent footballers with hip/groin problems

ABSTRACT

Objectives: To assess the correlation between the functional movement screen (FMS) and Y balance test (Y-BT) performance, and the self-reported hip/groin problems, and to compare healthy with hip/groin pain participants.

Design: a cross-sectional study.

Setting: Sports hall in a football club.

Participants: 43 elite adolescent football (soccer) players

Main Outcome: The Copenhagen Hip and Groin Outcome Score (HAGOS), Anterior, posterolateral and posteromedial distance of Y-BT, FMS score.

Measures: Y balance and FMS test kit**,** HAGOS questionnaire.

Results: The posterolateral, posteromedial distance and composite reach score of the Y-BT were lower in participants with hip/groin problems ($p<0.05$). FMS performance was similar in healthy and hip/groin groups. There was a weak correlation (r=0.32, p=0.03) between the HAGOS Activities of Daily Living subscale and FMS_{stabil}. In the Y-BT the posterolateral reach was weakly correlated with Symptoms (r=0.35-0.44, $p<0.02$) and moderately correlated with Pain (r=0.44, $p<0.01$) subscales. Posteromedial direction reach with the right leg was weakly correlated with Symptoms (r=0.32, p=0.04) and Pain (r=0.39, p=0.01). The Y-BT composite score was moderately correlated with Symptoms and Pain (r=0.42-0.44, $p<0.01$).

Conclusions: The Y-BT and the FMS subtests were weakly or moderately correlated with self-reported hip/groin problems. Thus, these tests should be investigated further in adolescent footballers because they may have potential to predict hip and groin problems.

Key words: football, soccer, hip and groin pain, children, adolescent, movement control

INTRODUCTION

Hip/groin pain is common in footballers, as football is characterised by quick accelerations and decelerations as well as sprinting, jumping, turning and kicking, which create high loads and torsional forces on the hip (Saw and Villar, 2004). A recent epidemiological study by Kerbel et al. (2018) found that the overall hip/groin injury rate amongst athletes was above 53 per 100,000 athlete-exposures and that football had the highest rates of hip/groin injuries. The prevalence of hip/groin symptoms was high amongst elite, sub-elite and amateur players, with 59% of male and 45% of female football players at difference levels of player reporting at least one episode of hip/groin symptoms in a study by Harøy et al., (2017). Two studies of adolescent footballers found that the incidence of hip/groin pain was about 14-22% during 9-14 weeks of observation (Crow et al., 2010; Lovell et al., 2006). Additionally, the risk of experiencing hip/groin symptoms is similar between elite, sub-elite and amateur footballers (Harøy et al., 2017).

Studies have attempted to identify factors that differentiate between athletes with and without hip/groin pain by assessing, e.g.: a) performance on tests such as the hip adductor squeeze test, bent knee fall out test and active straight-leg raise test; b) hip adductor and abductor strength; c) range of motion of the hips; d) trunk muscle function; e) plain radiography (Besjakov et al., 2003; Jansen et al., 2010; Malliaras et al., 2009; Mens et al., 2006; Mohammad et al., 2014). A systematic review by Mosler et al., (2015) concluded that of these variables tested in different studies, reduced strength on the adductor squeeze test, reduced internal hip rotation and bent knee fall out were the measures that best differentiated between athletes with and without hip/groin pain.

The functional movement screen (FMS) (Cook et al., 2006a, 2006b) and Y balance test (Y-BT) (Gribble et al., 2012) are considered to assess athletes' risk of becoming injured and identify deficiencies in functional movement, neuromuscular control, balance and trunk stability. Some studies have shown that college athletes and American professional football players with a low composite score (≤ 14) and movement asymmetry score on the FMS are at high risk of injury (Garrison et al., 2015; Kiesel et al., 2014). Some systematic reviews presented controversy about the potential ability of the FMS to be used as an injury prediction tool (Bonazza et al., 2017; Moran et al., 2017; Whittaker et al., 2017). Two reviews (Moran et al., 2017; Whittaker et al., 2017) concluded the FMS was a poor predictor of injury-risk because of small and heterogeneous samples, inconsistent injury definitions, and lack of control for confounding variables (e.g. previous history of injury). However, the third review (Bonazza et al., 2017) concluded the FMS composite score demonstrates the injury predictive value. Additionally, a recent study found that adolescent athletes demonstrating asymmetrical movement during pre-season FMS testing were more likely to sustain an injury during the regular season than players without asymmetry (Chalmers et al., 2017). Asymmetry of more than 4 cm in anterior reach distance and a normalized composite reach score ≤ 89.6% on the Y-BT were found to be associated with increased risk of noncontact injury in athletes (Butler et al., 2013; Smith et al., 2015). Recently, Stiffler et al., (2017) showed that the assessment of side-to-side reach asymmetry in the anterior direction, which is part of the star excursion balance test (SEBT; the Y-BT is a modified version of the SEBT), may assist in identifying athletes who are at risk of sustaining noncontact injuries to the knee or ankle. Additionally, adolescent athletes with a history of lateral ankle sprain exhibit functional performance deficits on the SEBT (Ko et al., 2018). Furthermore another study demonstrated that performance of 15 × 30 meter sprints with a period of 1 minute rest between repetitions, was related to football players' SEBT results (Khan et al., 2016).

To the best of our knowledge there have not been any studies using the FMS or Y-BT in adolescent football players complaining of hip/groin symptoms. Given that both these functional tests are used routinely in athletes' management (injury risk screen, corrective and rehabilitation exercise programs, pre-participation examination), the authors considered that it would be useful to investigate how well they discriminated between athletes with and without hip/groin symptoms and pain. This knowledge may: a) improve understanding of factors contributing to the development of hip/groin pain; and b) help with the development rehabilitation strategies. The existing literature indicates that athletes with hip/groin pain have limited range of motion (internal rotation), weaker hip adductor (Mosler et al., 2015) and abductor (Kloskowska et al., 2016) muscles than peers without such pain, so we hypothesized that athletes with more problematic hip/groin (demonstrated by diminished self-reported questionnaire score) would show reduced performance on the FMS and Y-BT. Such a relationship may be expected as both these tests are used to assess balance, postural control, and identify postural stability imbalances in mobility and stability during functional tasks. The aims of this preliminary study were, therefore, a) to assess the correlation between FMS and Y-BT performance, and the self-reported hip/groin problems; b) to compare adolescent football players with and without hip/groin pain.

MATERIAL AND METHODS

Setting and study design

This was a cross-sectional study conducted at a professional football club in the Silesian region of Poland. All outcomes (FMS, Y-BT and HAGOS) were collected by experienced, qualified physiotherapists who were not informed of the purpose of the research, so as not to bias the results. The study was designed in accordance with the Declaration of Helsinki and was approved by the local medical ethics committee (Ethics Approval number: 4/2017, 18 May 2017). All participants and their parents and/or legal guardians received oral and written information about all procedures and gave written, informed consent to participation.

Sample

The sample consisted of 45 elite adolescent athletes (mean age: 15.6 years, min: 15, max: 17; mean body mass: 65.4±8.22 kg; mean body height 176.6±6.52 cm; BMI: 20.9±1.86

kg/m^2). Prior to the study all athletes had been playing football regularly for at least 3 years (mean: 7.74 years, min: 3, max: 11). This was a sample of convenience. The inclusion criterion were: a) had not experienced an injury that prevented participation in training or competition for longer than one week during the four months prior to the examination; b) able to perform the FMS and Y-BT. Athletes were excluded if they had any history of surgery or were unwilling to participate.

Included athletes were also divided into subgroups based on their Copenhagen Hip and Groin Outcome Score (HAGOS). The healthy athlete (HA) group consisted of participants who scored ≤ 1 (no more than 1 positive answer out of all questions contained in Symptoms, Activities of daily living - ADL, Sport and recreational activities - Sport, Participation in physical activity -PA, Quality of Life – QOL subscales) in the HAGOS and no positive answers out of all questions contained in Pain subscale of HAGOS. The hip and groin (H/G) group consisted of those who had at least 5 scores among all questions in the HAGOS questionnaire and at least one positive answer contained in the Pain subscale. Athletes who had 2, 3 or 4 scores among all questions in the HAGOS were not included in the between-group comparisons. Thus, those with a HAGOS score of 2-4 were arbitrarily excluded from between-group analysis. This categorization was to achieve sufficient separation between the two groups examined, and to enable a clear comparison.

The Functional Movement Screen

The FMS consists of seven motor tasks: a deep squat, a hurdle step, an in-line lunge, a shoulder mobility test, an active straight-leg raise, a rotary stability test and a trunk stability push-up. Performance on all tasks was assessed on a 0 to 3 scale, where 3 indicates appropriate execution of the locomotor pattern, 2 indicates execution of the locomotor pattern with some compensatory adjustments, 1 indicates inability to perform the motor pattern and 0 indicates pain during movement. Each task was performed three times, and the best result was used for further analysis (Cook et al., 2006a, 2006b). In the case of tasks completed on left and right side, the lower score was used in the calculation of the total FMS score. The procedure used in similar studies of adolescent footballers was followed (Campa et al., 2019; Portas et al., 2016). Three separate FMS scores were calculated for stability (FMSstab: the sum of scores on the 2 stability tests, trunk stability push-up and rotatory stability), flexibility (FMSflex: the sum of scores on the 2 mobility tests, shoulder mobility and active straight-leg raise) and movement (FMSmove: the sum of the 3 movement tests, the overhead squat, hurdle step and inline lung). In the case of tests completed on both the left and right sides the asymmetry in performance was also considered in further analysis.

Y balance test

The Y-BT was performed using the Y-balance test kit, which consists of a single central plastic plate to which three tubes are attached in anterior, posteromedial and posterolateral positions (Plisky et al. 2009). All Y-BT attempts were performed in the same order: anterior direction, posterolateral direction and finally posteromedial direction. Participants always started moving the pointer with their dominant leg. The measurement procedure consisted of nine attempts. The first six attempts were performed to familiarize the athlete with the test procedure; only the final three measurements were used for statistical analysis. The Y-BT protocol has been described in detail elsewhere (Linek et al., 2017). The Y-BT was conducted by a qualified, experienced physiotherapist who was not informed of the purpose of the research.

To assess the normalized Y-BT results we measured the athlete's lower limb length - the distance from the anterior superior iliac spine to the medial malleolus. The measurement was performed with a tape measure, with the athlete in a supine position on a therapeutic table. This allowed the percentage value of the distance obtained in Y-BT to be calculated (normalization by the length of the lower limb). The normalization was performed by using following formula:

(the average Y-BT distance from the last three trials / relative length of the limb) x 100. Additionally, the sum of the reach distance for each of the three directions was divided by three times the limb length and multiplied by 100 = [(anterior+posterolateral+posteromedial)/(limb length x3)] x 100, to calculate composite reach distance for each leg (Plisky et al., 2006).

The Copenhagen Hip and Groin Outcome Score (HAGOS)

Before the FMS and Y-BT were performed, all players completed paper form of the English version of HAGOS questionnaire (Thorborg et al., 2011). There are six HAGOS subscales: Pain, Symptoms, ADL, Sport, PA and QOL. Responses were given using a five-point Likert scale ranging from 0 to 4 (0 = no hip/groin problem; 4 = extreme hip/groin symptoms). Raw scores were then transformed into percentages, so all subscales were scored on a 0–100 scale, where lower scores indicate more hip/groin symptoms. The questions were answered considering hip and groin function during the past week.

One week prior to the study, all participants were familiarized with the HAGOS. They were informed that one week later they would be asked to fill out the HAGOS. They were encouraged to focus on how their hip and groin were functioning during the forthcoming week. During the meeting all items and questions were also detailed and explained by a polish speaking physiotherapist fluent in English. Questionnaires were filled out in a separate room, with only one athlete and the physiotherapist present. The physiotherapist was available to answer any questions whilst participants were completing the questionnaire.

Statistical analysis

Levene's test was used to assess the homogeneity of variances. Demographic, FMS and Y-BT differences were assessed with the independent t-test or, in the case of variables for which the variances were unequal, Welch's test. The results are presented as mean differences with 95% confidence intervals (CIs). Mean values, standard deviations and number of participants were used to assess effect sizes. Hedges's g (H_g) was used as an index of effect size for betweensubject effects and common language (CL) effect sizes (Cumming, 2012; McGraw and Wong, 1992) are also reported. The criteria for H_g effect size were as follows: trivial (<0.20), small (0.20–0.49), medium (0.50–0.79) and large (≥0.80).

Data from all participants was used to examine correlations between HAGOS subscales and Y balance and FMS data were analysed using Spearman's r and interpreted as negligible (0.00-0.10), weak (0.10-0.39), moderate (0.40-0.69), strong (0.70-0.89), very strong (0.90-1.00) (Schober et al., 2018). All statistical analyses were performed with the Statistica 12PL software and p-values < 0.05 were considered significant.

RESULTS

Hip/groin symptoms

Two of the original 45 athletes were excluded from the sample because they did not answer all the HAGOS questions. Only 10 of the 43 athletes had scores of 100 % on all the subscales; the remaining participants (77.8%) reported some hip/groin symptoms. Mean scores on the subscales, with minimum scores in parentheses, were as follows, Symptoms 91.9 (67.8); Pain 97.1 (72.5); ADL 97.8 (85); Sport 94.9 (43.7); PA 97.1 (75): QOL 92.4 (35). Nineteen athletes met criteria to be included in the healthy athlete (HA) group, whereas 16 athletes met criteria to be included in hip and groin (H/G) group. Detailed profiles of the HA and H/G groups are given in Table 1. Thus, between-group comparisons were performed on data from 35 athletes, whereas correlation analyses were performed with the full sample of 43 athletes.

Among the HAGOS questions, the most common positive answers were for question no. 1 (Do you feel discomfort in your hip and/or groin?) and 3 (Do you have difficulties stretching your legs far out to the side?) in the Symptoms subscale.

Functional Movement Screen score

There was no difference between the FMS performance of the HA and H/G groups. Detailed FMS data with 95% CIs are presented in Table 2. Analysis of asymmetry in performance on the bilateral tests also revealed no group differences. Additionally, there were no participants reporting pain during the FMS.

Y balance test

The posterolateral distance gained was lower in the H/G group than the HA group (left leg: Hg = 0.77, CL = 71%). Posteromedial distance was also lower in the H/G group, but for the right lower leg (Hg = 0.72, CL = 70%). Composite-reach score (total Y score) was lower in the H/G group than the HA group (Hg = 0.72, C L= 70%). There were no group differences in side-to-side asymmetry with respect to any of the distances investigated. The anterior distance was similar in both groups. Detailed Y balance data with 95% CIs and p values are presented in Table 3.

Correlations between HAGOS and other variables

The only correlation found between HAGOS and the FMS was a positive weak correlation between FMS_{stabil} and the ADL subscale of HAGOS ($r = 0.32$, $p = 0.03$). There were no correlations between FMS_{total}, FMS_{move}, FMS_{flex} and the HAGOS subscales (all $p > 0.05$).

The Y-BT results were only correlated with the Symptoms and Pain subscales of HAGOS. Posterolateral reach was correlated (from weak to moderate) with Symptoms (right leg: $r = 0.35$, $p = 0.02$; left leg: $r = 0.44$, $p = 0.01$) and Pain (right: $r = 0.42$, $p < 0.01$; left: $r = 0.43$, $p < 0.01$) (Figure 1). Posteromedial direction reach with the right leg was weak correlated with Symptoms ($r = 0.32$, $p = 0.04$) and Pain ($r = 0.38$, $p = 0.01$) (Figure 2). Composite score was moderate correlated with Symptoms ($r = 0.44$, $p < 0.01$) and Pain ($r = 0.42$, $p < 0.01$) (Figure 3). In all cases athletes with lower HAGOS subscale values received lower scores in Y-BT. Posteromedial reach with the left leg and anterior reach (both legs) were not correlated with the HAGOS (all $p > 0.05$).

DISSCUSSION

The present study has shown that 10 out of 43 of the adolescent footballers examined did not have any hip/groin symptoms as measured by the self-reported HAGOS (100% on all subscales). A further 9 athletes reported one positive answer (among all HAGOS subscales one was below 100%). Minor problems were detected among 8 participants (2-4 scores among all questions) and 16 footballers reported more serious hip/groin symptoms (at least 5 scores among all questions in HAGOS questionnaire) confirming that hip/groin problems are common in adolescent athletes (Karlsson et al., 2014). It also confirms the need for further studies to identify factors that differentiate healthy athletes from those complaining of hip/groin symptoms. The aims of the study were a) to assess the correlation between FMS and Y-BT performance, and the HAGOS subscales in adolescent football players; and b) to compare adolescent football players with and without hip/groin pain. To the best of our knowledge, there have not been any other studies of FMS and Y-BT performance in this population. We found that adolescent football players with hip/groin symptoms and pain had reduced posterolateral reach (left leg) and posteromedial reach (right leg) on the Y-BT compared with healthy athletes and this was reflected in lower composite scores in the H/G group. Additionally, posteromedial, posterolateral and composite Y-BT results were correlated with hip/groin Symptoms and Pain subscales of HAGOS, whereas the trunk stability push-up and rotatory stability tests of the FMS were correlated with hip/groin Symptoms subscale of HAGOS.

The effect sizes for group differences in reaching in all directions and in composite score were medium, and there was a 70% probability in randomly selected pairs of healthy and symptomatic adolescent footballers that the symptomatic footballer would have a shorter posterolateral reach distance (left leg) and shorter posteromedial reach distance (right leg). The mean between-group differences varied from 5% to 8%. A reliability study of the Y-BT in adolescent football players (Linek et al., 2017) showed fair and good intra-rater reliability for Y-BT measurements with the minimal detectable change being 7-14%. The mean group differences in Y-BT performance in the present sample were below the minimum practically significant difference. Although the between-group differences did not reach the benchmark of 7-14% for Y-BT measurements, the changes found in the current study may potentially be higher (and clinically relevant) among participants with more serious hip/groin problems and pain. Our correlation analyses suggest this was the case, because the Symptoms and Pain subscales of HAGOS were positively correlated with Y-BT results, which means that reduced Y-BT performance may be partly due to higher hip/groin symptoms and pain. This is plausible, because athletes with hip/groin symptoms have reduced internal hip rotation and reduced hip adductor (Mosler et al., 2015) and abductor (Kloskowska et al., 2016) strength. Recently, López-Valenciano et al. (2018) revealed that along with core stability and hip abduction isometric peak torque, passive hip flexion is one of the main variables associated with Y-BT performance in football players. Studies of other populations have reported that Y-BT performance is correlated with hip abductor strength and extension and external rotation of the hips (Wilson et al., 2018) as well as the combination of hip flexion and lateral trunk bending (Kang et al., 2015).

The Y-BT can also be considered as a postural control test. In our study most athletes in the H/G group showed rather minor hip/groin problems. These minor symptoms in such a young population maybe be the start of motor control adaptations, which then in turn may lead to more movement alterations, pain and injury. Additionally, side-to side asymmetry with respect to any of the distances investigated in the Y-BT was similar in the healthy and hip/groin athletes. This suggests that the presence of symptoms in the hip/groin group did not significantly affect the distance reached on only one side of the body (symptomatic or asymptomatic).

Hodges (2011) claims that pain lead to changes in motor control, involving redistribution of muscle activity, changes to the mechanical behaviour causing altered movements and stiffness, leading to protection from further pain or injury and multiple level motor system changes. This may explain the correlation found between the HAGOS Pain subscale and Y-BT results in the present study. Thus, the Y-BT is a complex movement test and many aspects of the tasks depend directly on the hip joint, so it may be useful in further studies of adolescent footballers complaining of hip/groin symptoms.

In the present study the FMS did not differentiate between healthy athletes and those complaining of hip/groin symptoms. There was, however, a weak correlation between FMS_{stabil} and the ADL subscale of HAGOS. The FMS_{stabil} score is based on the trunk stability push-up and rotatory stability tests. The trunk stability push-up requires a combination of trunk and upper extremity stability, whilst the rotatory stability test requires multi-plane trunk stability in conjunction with simultaneous motion of the upper and lower extremities (Cook et al., 2006a, 2006b). Improper performance of these tests may be due to inadequate stability of the trunk. According to Agresta et al. (2014), athletes with lower rotatory stability FMS scores have impaired control of the trunk, pelvis and hip muscles, which contributes to abnormalities of lower extremity mechanics (Powers, 2010). Some studies have shown that athletes with hip/groin symptoms have changes to the deepest trunk stability muscle – the transversus abdominis muscle (Cowan et al., 2004; Jansen et al., 2010). Thus the tests that contribute to the FMS_{stabil} score may have the greatest potential of all the FMS tests to discriminate between footballers with and without hip/groin problems. Recently, Campa et al., (2019b) have shown that a 20-week exercise program improved all FMS components (including FMSstabil) in adolescent footballs. Similarly, exercise protocols used by Dinc et al., (2017) improved trunk stability push-up (test included in FMSstabil) in adolescent footballs. It would therefore be worth examining whether exercise programs could change FMS and functional scores in footballers with hip and groin symptoms.

A limitation of the present findings is that they may only apply to the group examined, i.e. professional male adolescent football players. They may not generalise to athletes involved in other sports or to female footballers and any extrapolations should be made with caution. Another limitation of the study is the relatively small sample size and the minor nature of the hip/groin symptoms reported. However, other studies using the FMS and/or functional tests used similar sample sizes (Agresta et al., 2014; Butler et al., 2013; Kang et al., 2015; Ko et al., 2018; McCann et al., 2017). We would expect footballers with more prominent hip/groin symptoms to show poorer performance on the Y-BT.

CONCLUSIONS

Adolescent football players with hip/groin problems (including pain) had reduced posterolateral reach, posteromedial reach and composite scores on the Y-BT compared with healthy peers. These Y-BT results were also correlated (from weak to moderate) with hip/groin symptoms and pain. The FMS performance was not different between the healthy and hip/groin pain groups. However, the trunk stability push-up and rotatory stability tests of the FMS were weakly correlated with hip/groin symptoms. These tests are quick and easy to use in the field or clinical practice, having the potential to screen and/or predict players with hip/groin symptoms, as suggested by the present results. This could assist clinicians in determining which players may require further evaluation, and when to initiate early management and preventative interventions. Also, pain may lead to motor control changes, which could be a modifiable risk factor and, if recognised early, could be managed by timely implementation of preventative movement control exercises. This could consequently have an impact on preventing the development of hip and groin pain in this population. Thus, performance of movement control tests and interventions should be investigated further in future studies of adolescent footballers.

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TABLE 1. Basic data of participants

Characteristic	Athletes[1]		
	HA (n=19)	H/G (n=16)	p value
Age (*yr*)	15.8 (0.53)	15.5 (0.51)	0.11[b]
Weight (*kg*)	66.6 (7.43)	63.7 (10.4)	0.33[b]
Height (*cm*)	177.2 (4.80)	175.2 (9.27)	0.46[c]
BMI (kg/m^2)	21.2 (2.00)	20.6 (1.82)	0.35[b]
Sports practice (yr)	7.76 (1.58)	7.3 (1.95)	0.75[b]
Right dominant leg[a]	77.8%	92.8%	0.35[d]
HAGOS (%)			
Symptoms	98.5	82.6	<0.001[e]*
Pain	100	92.2	<0.001[e]*
ADL	99.7	94.7	0.02[e]*
Sport	100	86.3	<0.001[e]*

PA	100	93.8	0.06[e]
QOL	99.7	82.8	<0.01[e]*

[1]without those with 2, 3 or 4 scores among all HAGOS questions; HA – Healthy Athlete Group (no more than 1 positive answer out of all HAGOS questions); H/G - Hip and Groin Group (at least 5 positive answers among all HAGOS questions) HAGOS - Hip and Groin Outcome Score; ADL – Activities of Daily Living; Sport – Sport and Recreational Activities; PA - Participation in Physical Activity; QOL – Quality of Living;
[a] Which leg do you prefer when playing football?; [b] test t for independent samples; [c] Welch`s test; [d]from Fischer`s exact test; [e] from Mann–Whitney test; *significant differences

TABLE 2. The mean (SD) of groups and the mean (95% CI) of differences between groups in FMS test.

FMS	Groups		Difference between groups	
	HA	H/G	HA minus H/G	p value
Total score	15.8 (2.45)	14.6 (2.33)	1.22 (-0.54 – 2.98)	0.17[b]
Move score	6.52 (1.47)	6.18 (1.11)	0.33 (-0.57 – 1.25)	0.45[b]
Flex score	4.53 (1.26)	4.00 (1.21)	0.52 (-0.32 – 1.38)	0.22[b]
Stabil score	4.79 (0.63)	4.44 (0.89)	0.35 (-0.17 – 0.88)	0.18[b]
<u>Asymmetry incidence - number (%):</u>				
HS	11 (61%)	6 (43%)	-	0.48[d]

INLL	9 (50%)	5 (36%)	-	0.49[d]
SM	7 (39%)	6 (43%)	-	1.00[d]
ASLR	8 (44%)	9 (64%)	-	0.31[d]
RS	5 (28%)	3 (21%)	-	1.00[d]

HA – Healthy Athlete Group; H/G - Hip and Groin Group; HS – hurdle step; INLL – in-line lunge; SM – shoulder mobility; ASLR – active straight leg raise; RS – rotation stability; [b]test t for independent samples; [d]from Fischer`s exact test

TABLE 3. The mean (SD) of groups and the mean (95% CI) of differences between groups in Y balance test.

Reach direction (%)	Groups		Difference between groups	
	HA	H/G	HA minus H/G	p value
Anterior – R	66.9 (6.98)	66.7 (5.12)	0.18 (-3.99 – 4.35)	0.93[b]
Posterolateral – R	110.2 (10.4)	104.9 (6.17)	5.29 (-0.52 – 11.1)	0.07[c]
Posteromedial – R	108.5 (9.06)	103.1 (5.77)	5.42 (0.25 – 10.6)	0.04[b]*
Anterior – L	67.8 (7.21)	66.8 (5.92)	0.95 (-3.57 – 5.47)	0.67[b]
Posterolateral – L	113.3 (11.7)	105.7 (6.31)	7.59 (1.21 – 13.9)	0.02[c]*
Posteromedial – L	108.6 (10.5)	105.1 (7.01)	3.50	0.26[b]

			(-2.59 – 9.59)	
Anterior – A	2.45 (2.26)	2.41 (1.38)	0.04 (-1.23 – 1.31)	0.95[b]
Posterolateral – A	5.65 (8.81)	3.65 (2.70)	1.99 (-2.42 – 6.42)	0.36[c]
Posteromedial – A	3.11 (2.92)	4.14 (2.54)	-1.03 (-2.91 – 0.84)	0.27[b]
Composite score – T	96.7 (7.4)	92.2 (4.57)	4.50 (0.33 – 8.68)	0.04[b]*

HA – Healthy Athlete Group; H/G - Hip and Groin Group; R – reach distance by right leg; L – reach distance by left leg; A – relative side-to-side asymmetry; T – sum of anterior, posteromedial and posterolateral distance divided by 3; *significant differences; [b] test t for independent samples; [c] Welch`s test

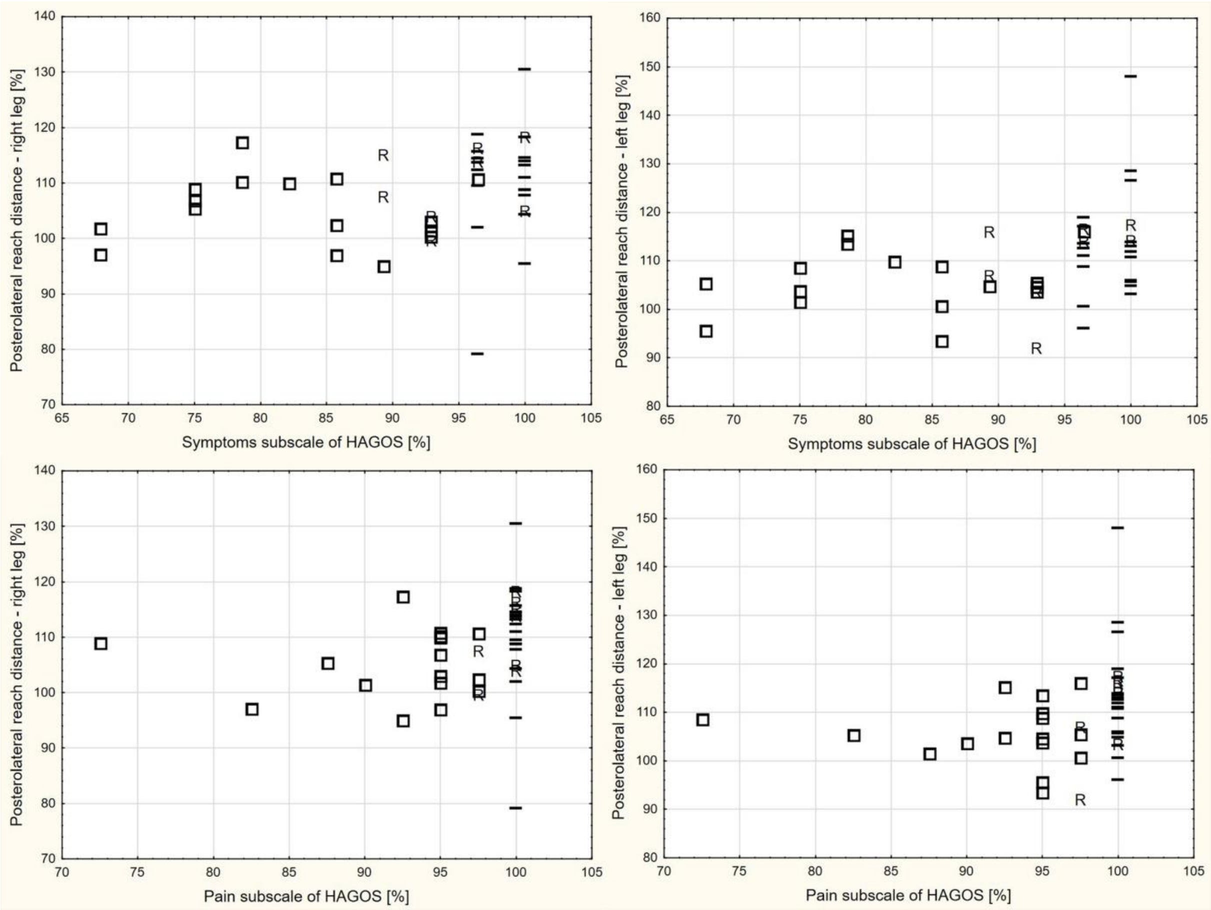

Figure 1. Posterolateral reach distance and Symptoms and Pain distribution. Each participant was labelled according to the group they belonged to for between-group comparisons: `square`- hip and groin pain; `short horizontal line` - healthy athletes; letter `R` - removed from between-group comparison due to not meeting the criteria.

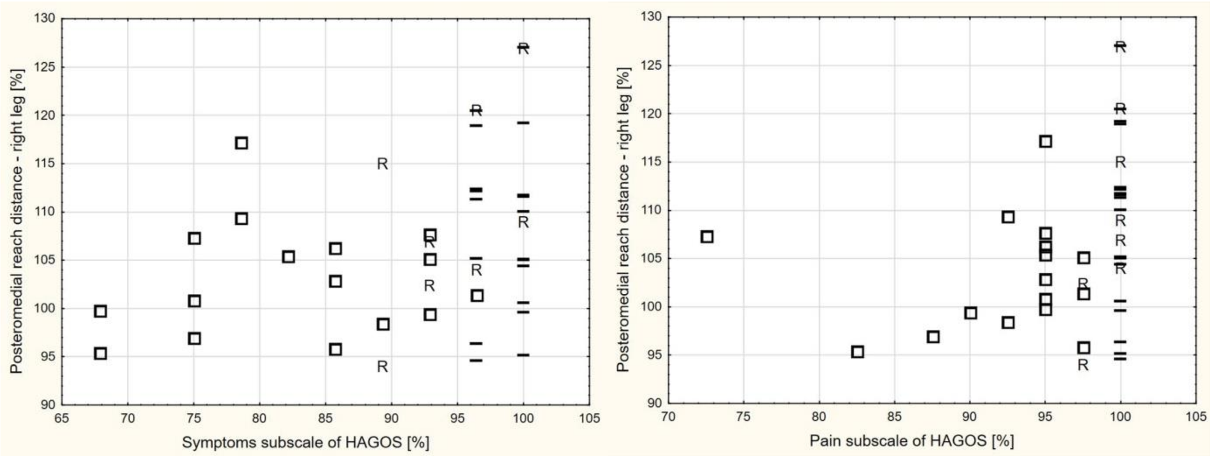

Figure 2. Posteromedial reach distance and Symptoms and Pain distribution. Each participant was labelled according to the group they belonged to for between-group comparisons: `square`- hip and groin pain; `short horizontal line` - healthy athletes; letter `R` - removed from between-group comparison due to not meeting the criteria.

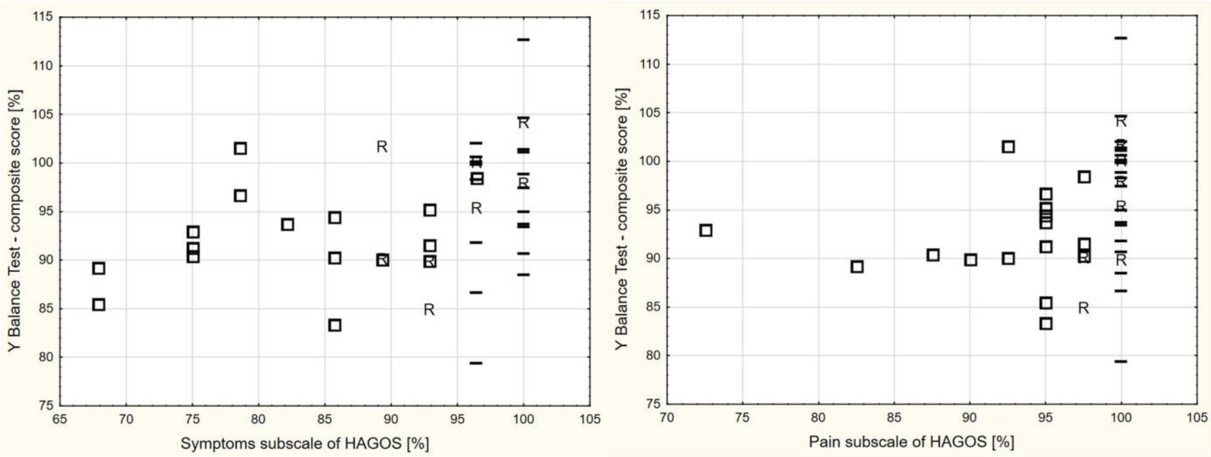

Figure 3. Composite score of Y balance test and Symptoms and Pain distribution. Each participant was labelled according to the group they belonged to for between-group comparisons: `square`- hip and groin pain; `short horizontal line` - healthy athletes; letter `R` - removed from between-group comparison due to not meeting the criteria.