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Original Research

Return to Play Assessment After Lateral Ankle Sprains – German Male Elite Youth Football (Soccer) Academy Baseline Data

Zacharias Flore[1,2a], Götz Welsch[3,4], Hendrik Bloch[5]

[1] School of Sport and Exercise Sciences, University of Kent, [2] Medical Department, 1. FC Magdeburg, [3] UKE-Athleticum, University Medical Center Hamburg-Eppendorf, [4] Department of Trauma and Orthopaedic Surgery, University Medical Center Hamburg-Eppendorf, [5] Bezirksverwaltung Bielefeld, Verwaltungs-Berufsgenossenschaft (VBG)

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Background

Lateral ankle sprain (LAS) is one of the most common types of injury in football (soccer). Normative baseline data of performance tests for Return to Play (RTP) decision are still lacking.

Purpose

The primary aim of this study was to generate baseline values for uninjured elite youth football players for a multifactorial RTP assessment and compare with previously published data. A secondary aim was to investigate the use of the Limb Symmetry Index (LSI) as a method to determine whether an athlete passes a performance test or not.

Study Design

Observational Cohort study

Methods

Baseline data of performance tests (Y-Balance [YBT-LQ], Heel Rise [HRT]; Singe Leg Squat [SLST]; Single Leg Drop Jump [SLDJ]; Side Hop [SHT]; Figure of 8 Hop [F-8]; Modified Agility T-Test [MAT]) were assessed in 20 elite youth football players, aged 16-21 years. Additionally, the traditional LSI (dividing the result of the non-dominant leg by the result of the dominant leg and multiplying by 100) and directionally corrected LSI (the worst value is divided by the better value and multiplied by 100) were calculated. The test values were compared to previously reported study results. LSI and side-to-side comparisons between dominant and non-dominant leg sides were analyzed using the Wilcoxon test.

Results

Male elite youth football players achieved better results in the dynamic performance tests (SHT, F-8, and MAT) compared to reference values of the cohorts previously described in the literature: YBT-LQ total score (cm) dominant (dom) 99.3±8.3, non-dominant (ND) 99.5±10.4; HRT (average number) dom. 27.1±5.4, ND 25.2±5.1); SLDJ height (cm) dom 15±5, ND 15±5 and contact time (sec) dom 0.29±0.08, ND 0.29±0.07, Reactive Strength Index (RSI) dom 0.52±0.12, ND 0.50±0.13); SHT (sec) dom 7.12±0.73, ND 7.39±0.93; F-8 (sec) dom 10.52±1.02, ND 10.37±1.04; and MAT (sec) 5.82±0.22. Directionally corrected LSI differed significantly from the traditional calculated LSI ($p<0.05$).

a Corresponding author:
Zacharias Flore
University of Kent, School of Sport and Exercise Sciences
Kapellenstraße 8a
39104 Magdeburg, Germany
zf43@kent.ac.uk
+4915203090096

Conclusion

The findings of this study highlight the need to determine specific baseline data for RTP testing in male elite youth football players after LAS. The traditional LSI should not be used as a "stand alone method" for determining RTP. LSI calculations should consider the direction of asymmetry to determine passing a performance test or not.

Level of evidence

3b

INTRODUCTION

Ligamentous ankle injury is one of the most common types of injury in sports, especially in sports characterized by multi-directional movement patterns such as cutting, start-stop loading, or frequent jumping and landing.[1] The injury rate of ligamentous ankle injuries is particularly high in soccer (football): 10-21% of all injuries occurring in football involve the ankle.[2,3] In professional youth football, the prevalence is 9-19%.[4-9] A large proportion (75%) of these injuries involve the lateral ligaments.[3] Thus, the later al ligament injury of the ankle joint is, in total, one of the most common types of injury in football, and the ankle joint is the third most frequently injured region (12.9%), along with injuries to the knee (15.2%) and the thigh (25.0%).[10] In addition, up to 20% of affected athletes who sustain ankle injuries develop functional or mechanical ankle instability.[11]

For the most part, rehabilitation is still managed in a time-based manner based on clinical impressions and experience of the physician and/or therapist. Nevertheless, an international consensus has defined return to sports as a continuum emphasising a graded, criterion-based progression.[12] Furthermore, a more recent and complex model underlines the importance of objective criteria for return to play decision making.[13] While there is widespread consensus on the measures and criteria for a return to competition (RTC),[14,15] there are few criteria-based rehabilitation programs and test batteries after lateral ligament injury of the ankle joint in sport.[16,17]

For this reason, the German statutory accidental insurance for professional athletes (VBG) organized a consensus conference "Return to Competition after Ankle Injuries" in cooperation with the German Federal Institute of Sport Science. Participants included experts from different fields and disciplines, such as rehabilitation medicine, sports medicine, orthopaedics and surgery, physiotherapy, and sports science. After the consensus conference, a manual for a multifactorial return to play test battery was published.[18] The results of the multifactorial test battery were proposed to be used for an interdisciplinary exchange ("shared decision-making") of the stakeholders involved in the rehabilitation process for the assessment of the athlete's unrestricted participation in team training.[19] In addition to addressing the clinical release for testing and the recording of the subjective perception of the athletes, the test battery focuses on the testing postural control, ankle muscle strength, hopping, jumping and landing quality, as well as agility. The order, setup and execution of the corresponding tests is described in the test manual.[18] Overall, the final test battery considers the domains of: Pain, Ankle impairments, Athlete perception, Sensorimotor control, and Sport/functional performance of the PAASS-Framework.[20]

Due to the frequent lack of sport-specific orientation or individual reference values, the comparison between injured and uninjured leg side (Lower Limb Symmetry Index, LSI) was established in the interpretation of test results. With the help of the LSI, a possible deficit on the affected side of the leg can be objectified during strength or jump tests. However, ligament injuries to the knee and ankle lead to changes in the somatosensory cortex and motor cortex. Therefore, bilateral strength or control deficits and altered movement patterns can be the consequence.[21] Examinations of subjects with anterior cruciate ligament injuries have revealed deficits on the uninjured side when compared to healthy controls. The mere use of the LSI in the context of a return-to-play test must therefore at least be questioned.[22] The primary aim of this study was to generate baseline values for uninjured elite youth football players for a multifactorial RTP assessment and compare with previously published data. A secondary aim was to investigate the use of the Limb Symmetry Index (LSI) as a method to determine whether an athlete passes a performance test or not. Both of these aims will allow professionals to able to take these values into account as an additional factor in the decision to return to sport.

METHODS

INCLUSION AND EXCLUSION CRITERIA

Players from three German youth football teams (U17, U19, U21) of one elite youth football academy were recruited after the study project had been presented verbally and written to the head coaches and players. Players had to be older than 16 years at the time of testing to be included in this study. All participants or their legal guardians gave their written consent to participate in the study. Withdrawal was possible at any time without giving reasons or expected disadvantages. The study was approved by the Ethics Committee of the Hamburg Medical Association (PV6090).

PARTICIPANTS

20 uninjured male youth players were recruited. All included players trained and played without external ankle stabilization. Of all players, leg dominance was recorded as the leg with which the player preferred to kick the ball.

LIMB SYMMETRY INDEX

The Lower Limb Symmetry Index (LSI) was used for the side-by-side comparison of the jump tests. The LSI was formed in the cohort of uninjured players by dividing the result of the non-dominant leg by the result of the dominant leg and multiplying by 100.[23,24] Typically, an LSI cut-off of ⩾90% is used to classify a side difference as normal. This carries the risk that asymmetries are overlooked to the detriment of the supposedly better leg side, when using the magnitude of between-limb deficits alone.[25,26] Therefore, the LSI in this study was also calculated directionally corrected (LSI_{dc}), in which the worst value (regardless of dominant or non-dominant limb) is divided by the better value and multiplied by 100.[26,27]

PROCEDURE

WARM-UP

Prior to the test, the subjects performed a fifteen-minute standardized warm-up program consisting of a five-minute run on the treadmill at a standard speed of 11 km/h followed by ten minutes of movements of the hip, knee and ankle joints, balance, core stabilization and bodyweight exercises, as well as jumping and landing exercises and change-of-direction runs (Supplemental Material 1).

TEST DESCRIPTIONS

Initially, all tests were performed with the dominant leg. To avoid bias due to the influence of footwear, both the Y-Balance Test (YBT-LQ), Heel Rise Test (HRT), and Single Leg Squat Test (SLST) were performed without shoes. All other dynamic assessments were performed with footwear, the T-Test on artificial turf with appropriate football cleats. One trial was permitted prior to the testing followed by the judged assessments. Detailed test descriptions are presented in supplementary material (Supplemental Material 2).

Y-BALANCE TEST (YBT-LQ)

Postural control was tested using the YBT-LQ and a corresponding test kit (Perform Better, Munich, Germany). Prior to testing, leg length was measured bilaterally in the supine position with a tape measure from the anterior superior iliac spine (ASIS) to the medial malleolus and this measurement was utilized for normalization.[28]

HEEL RISE TEST (HRT)

The HRT measures the eccentric and concentric muscle strength of the plantar flexors during a single-leg heel raise.[29] The rhythm during completion of heel raises every two seconds, was controlled by a metronome app (Metronome Beats, version 4.3.1). The maximum number of completed repetitions per leg side was counted.

SINGLE LEG SQUAT TEST (SLST)

The SLST was used to assess the function of the hip abductors. The test was performed in single-leg stance on a 24 inch plyo jump box with arms crossed in front of the chest.[30] An experienced physiotherapist assessed the quality of movement using five objective criteria (Table 1).[31]

SINGLE LEG DROP JUMP (SLDJ)

The Single Leg Drop Jump is a common method to evaluate jump performance (e.g. jump height, reactive strength index) and dynamic postural stability.[32-34] The player was instructed to drop from a 20-centimeter-high box with their hands resting on their hips at their sides by stepping forward without jumping off. Movement quality was assessed using the objective criteria of the Single-Leg Landing Error Scoring System (SL-LESS) in the sagittal and frontal (Table 2).[35] The reactive jumps were recorded with an optical measuring instrument (Optojump, Microgate USA, Mahopac (NY), version 1.10.19) and also recorded using a 50 Hz HD camera (Sony HDR-CX405, Tokyo, Japan) for the purpose of retrospective evaluation (SL-LESS).

SIDE HOP (SHT)

The SHT can be used to identify players with chronic ankle instability.[36] The individual hops with their standing leg over two tape strips, placed at a distance of 30 centimetres apart on a start command.[37] The player was instructed to complete 10 hops as quickly as possible. A hop was considered invalid if the test person fell down, touched the tape on landing, or if the contralateral foot was set down. Once per leg, the hop was performed as a trial (80 per cent of maximum power) and twice as a measured attempt, with a one-minute break between the trials. The time in how many seconds the subject performed 10 complete hops per leg was measured by using a commercially available stopwatch and was rounded to the second decimal place. The LSI and LSI_{dc} were also calculated for side-by-side comparisons.

FIGURE-OF-8-HOP (F-8)

The Figure-of-8-Hop exhibits excellent reliability and is helpful in identifying athletes with ankle instability.[36] The individual was instructed to hop a figure of eight around slalom poles (distance of five meters) on one leg as quickly as possible, twice in succession. The time needed to complete the parcous twice was measured in seconds. A light barrier system (Brower, TCI timing, Draper, USA) recorded the duration of the trial. The time was rounded to the second decimal place. The LSI and LSI_{dc} were also calculated for side-by-side comparisons.

MODIFIED AGILITY T-TEST (MAT)

Reacting quickly to a stimulus, starting and stopping repeatedly, and fast direction changes are permanent and performance determining elements of sports. Change of di-

Table 1. Objective rating criteria for single leg squat. Adapted from Perrot et al. (2012)[31]

Single Leg Squat	
Good	Poor
Overall impression • Smooth, good quality movement • General control • Controlled change-over between repetitions • Ease of movement	• Staggered movement • Increased speed to attempt to control movement • Effort to control movement • Trunk "wobble“
Weight transfer • Minimal translation of centre of mass • Upright trunk	• Discernible translation of center of mass • Trunk leaning forward or side • Extended time to transfer
Lumbar spine & pelvic alignment • Minimal movement in all three phases • Frontal plane: ASIS level • Sagittal plane: A-P tilt, rotation • Lateral view: stable lordosis, minimal trunk flexion	• Discernible movement with pelvis tilting up or down, rotating toward or away from weightbearing leg, tilting in anterior or posterior direction • Lumbar lordosis increasing or trunk flexion occuring
Leg alignment • Minimal movement out of the starting plane of movement. This takes into account the alignment of the limb, influenced by pelvic width, and Q angle at the knee	• Discernible movement out of the starting plane of movement
Foot alignment • Neutral foot position – remains stable during movement	• Excessive pronation of foot during squat descent • Externally rotated starting position of lower leg / foot

A-P, anterior-posterior; ASIS, anterior superior iliac spine

rection (COD) speed and COD situations should be evaluated during a RTP assessment.[20] Following the distance specifications of Sassi, Dardouri & Yahmed et al. 2009, the MAT was completed outdoors on a certified artificial turf training pitch (Heiler Master 40/200) in firm ground football cleats (FG).[38]

STATISTICAL ANALYSIS

All statistical analyses were carried out using IBM SPSS Statistics V.25 (IBM, Amonk, New York, USA). Continuous data are expressed as the mean, standard deviation (SD), median, and range, and categorical data are expressed as frequency counts (percentages). The significance level was set to $p<0.05$. LSI and side-by-side comparisons between dominant and non-dominant leg sides were analyzed using the Wilcoxon test.

RESULTS

20 uninjured male youth players (age 18.4 ± 1.5 years, height 177.4 ± 5.8 cm, body weight 74.6 ± 5.3 kg) participated. For three quarters the players, the right leg was the dominant leg and for one quarter, the left leg.

Y-BALANCE TEST (YBT-LQ)

Table 3 presents the results of the YBT-LQ for the dominant leg and the opposite side as a raw score and as a score normalized to leg length. In addition to the individual ranges, side differences and the total score are also presented.

HEEL RISE TEST (HRT)

The results of the HRT show a wide inter-individual range of the number of repetitions. Of note, the best players achieved twice as many repetitions as the worst players (Table 3).

SINGLE LEG SQUAT TASK (SLST)

For all players, the movement execution of the SLST was rated as good in all categories (overall impression, weight transfer, lumbar spine, and pelvic alignment, leg axis, and foot position).

SINGLE LEG DROP JUMP (SLDJ)

The qualitative assessment of the SLDJ with the help of the SL-LESS was scored, on average, a 2.6 for both leg sides, which corresponds to mediocre movement quality. The direction-corrected LSI of the jump height ($p=0.006$) and the ground contact time ($p=0.002$) is significantly lower than the conventionally calculated LSI. The results of the SLDJ are summarized in table 4. With the traditional LSI, three players (15.0%) were below the recommended cut-off of 90% asymmetry for the ground contact time and five players (25.0%) for jump height. When using the LSI_{dc}, nine players (45%) were identified for the ground contact time and 13 players (65%) for the jump height.

Table 2. Objective rating criteria for SL-LESS. Adapted from O´Connor (2015)[35]

	Item	Error (1)	Good (0)
Sagittal plane	*1 Forward Trunk Flexion at IC*	At IC the trunk is vertical or extended on the hips	The trunk is flexed on the hips
	2 Knee Flexion at IC	At IC the knee is flexed more than 30°	The knee is not flexed more than 30°
	3 Ankle Plantarflexion at IC	The foot lands heel to toe or with a flat foot	The foot of the test leg lands toe to heel
	4 Forward Trunk Flexion Displacement	Between IC and MKF there is no additional trunk flexion	There is additional trunk flexion
	5 Knee Flexion Displacement	Between IC to MKF the knee does not flex additional 30°	The knee flexes an additional 30°
	6 Ankle Dorsiflexion Displacement	Between IC and MKF the heel does not touch the ground or the ankle does not move into a dorsiflexed position during landing	The heel touches the ground and the ankle becomes dorsiflexed during landing
Frontal plane	*7 Knee Valgus at IC*	At IC, a line drawn straight down from the center of the patella is medial to the midfoot	The line goes through the midfoot
	8 Lateral Trunk Flexion at IC	At IC, the midline of the trunk is flexed to the left or the right side of the body	The trunk is not flexed to the left or the right side of the body
	9 Knee Valgus Displacement	At MKV a line drawn straight down from the center of the patellar runs through the great toe or is medial to the great toe	The line is lateral to the great toe
	10 Pelvic Drop	During landing the contralateral pelvis positioned lower than the ipsilateral pelvis	Both sides of the pelvis remain level
	11 Tibial Rotation (toe point in / out)	Between IC and MKF the foot is internally / externally rotated more than 30°	If the foot is not internally / externally rotated more than 30°

IC, initial contact; ROM, range of motion; MKF, maximum knee flexion; MKV, maximum knee valgus

SIDE HOP

For the Side Hop, there was a non-significant trend (p=0.067) for slower times achieved with the non-dominant leg compared to the dominant leg side. The direction-corrected LSI was significantly less than the conventional LSI (p=0.001, Table 4). With the traditional LSI, two players (10.0%) were below the recommended cut-off of 90% asymmetry, while five players (25%) were identified when using the LSI_{dc}.

FIGURE-OF-8-HOP

There was a tendency for faster times on the non-dominant leg side in all age groups, although these were not statistically significantly different. The direction-corrected LSI was significantly less than the conventional LSI (p=0.043, Table 4), but no player had a side difference >10% neither for the tradional LSI nor the LSI_{dc}.

MODIFIED AGILITY T-TEST (MAT)

The mean time for the best of the two trials of the MAT was 5.81 (± 0.22) seconds (range 5.37 – 6.18) (Table 4). In 35% (7/20) of the cases, the first attempt was faster than the second trial, but there was no statistically significant difference (p=0.349) between trials. Within subjects, the difference between the two trials ranged from 0.01 sec to 0.15 sec.

There is a wide range of test results due to heterogenous study cohorts (age, sports, elite vs. non-elite level) reported in the literature. The heterogeneous data of previous reports hampers a direct comparison. The results of this investigation demonstrate that male elite youth football players achieved better results in the dynamic performance tests (SHT, F-8, and MAT) compared to reference values of the cohorts previously described in the literature. Previously reported study results and results of this investigation are summarized in Supplemental Material 3.

DISCUSSION

This study presents baseline data from uninjured elite youth football players for the components of a multifactorial ankle sprain RTP assessment. Male elite youth football players achieved better results in the high dynamic performance tests (SHT, F-8, and MAT) compared to results of the cohorts previously described in the literature. The current results can be used as baseline or standard values during the rehabilitation process of elite youth footballers. The results also highlight the need to interpret LSI calculations with caution and should encourage professionals to consider the direction of the asymmetry.

Table 3. Results of the Y-balance Test and the Heel Rise Test (n=20)

Y-Balance Test Dominant leg	ANT reach (cm) ANT normalized (cm)	57.6 ± 6.8 62.3 ± 7.1
	PM reach (cm) PM normalized (cm)	110.9 ± 9.5 119.9 ± 9.1
	PL reach (cm) PL normalized (cm)	106.9 ± 10.6 115.6 ± 11.5
	Total score	99.3 ± 8.3
Y-BalanceTest Non dominant leg	ANT reach(cm) ANT normalized (cm)	57.6 ± 6.7 62.1 ±7.1
	PM reach (cm) PM normalized (cm)	112.8 ± 11.3 121.8 ± 13.2
	PL reach (cm) PL normalized (cm)	106.3 ± 11.4 114.7 ± 13.8
	Total score	99.5 ± 10.4
Y-Balance Test Reach direction difference between limbs	ANT (cm)	0.0 ± 2.7
	PM (cm)	2.0 ± 6.5
	PL (cm)	0.6 ± 6.5
Heel Rise Test Dominant Leg	Number repetitions (Mean ± SD)	27.1 ± 5.4
	Number repetitions (median; range)	27; 19-40
Heel Rise Test Non dominant Leg	Number repetitions (Mean ± SD)	25.2 ± 5.1
	Number repetitions (median; range)	23.5; 18-40

ANT, anterior; PM, posteromedial; PL, posterolateral

Table 4. Results of the Single Leg Drop Jump, the Side Hop and Figure-of-8-Hop and T-Test (n=20)

Single Leg Drop Jump	Jump height, dominant (m), Mean± SD	0.15 ± 0.05
	Ground contact time, dominant (sec), Mean ± SD	0.29 ± 0.08
	RSI dominant	0.52 ± 0.12
	Jump height, ND (m), Mean ± SD	0.15 ± 0.05
	Ground contact time, ND (s), Mean ± SD	0.29 ± 0.07
	RSI non-dominant	0.50 ± 0.13
	LSI jump height (%), Mean ± SD	96.71 ± 15.99
	LSI jump height direction corrected (%), Mean ± SD	86.01 ± 9.20
	LSI ground contact time (%), Mean ± SD	101.20 ± 9.91
	LSI ground contact time direction corrected (%), Mean ± SD	91.18 ± 5.38
Side Hop	Time dominant leg (s), Mean ± SD	7.12 ± 0.73
	Time ND leg (s), Mean± SD	7.39 ± 0.93
	LSI time (%)	104.28 ± 12.60
	LSI time direction corrected (%)	92.05 ± 7.42
Figure-of-8-Hop	Time dominant leg (s), Mean ± SD	10.52 ± 1.02
	Time ND leg (s), Mean± SD	10.37 ± 1.04
	LSI time (%)	98.65 ± 3.90
	LSI time direction corrected (%)	96.72 ± 2.26
Mod. Agility T-Test	Time (s), Mean ± SD	5.81 ± 0.22

Y-BALANCE TEST (YBT-LQ)

When interpreting the results of the YBT-LQ, age, performance, and sport-specific differences are described in the literature, which underlines the need for target group-specific standard values.[39] Butler, Lehr & Fink et al. found out that American football players with a total score below 89.6% are 3.5 times more likely to be injured during the season.[40] There are also indications that in male football players, injury risk increases with poorer or more asymmetrical YBT-LQ scores.[41] Gonell et al. 2015 showed that male elite and amateur soccer players with a total score of less than or equal to 99.9% are two times more likely to be injured.[42]

In the current study, total YBT scores on the dominant leg side of two players (10.0%) were below 89.6%, seven players (35.0%) were below 94.0% and ten players (50%) were below 99.9%. On the non-dominant leg side, three players (15%) were below 89.6%, seven players (35.0%) were below 94.0% and ten players (50%) were below 99.9%. Two players (10%) were below 89.6% on both sides, three players (15.0%) were below the 94.0% on both sides and seven players (35.0%) were below the 99.9% on both sides. When considering lateral differences, different cut-off values are described for assessing asymmetries that are associated with an increased risk of injury.[39] In male professional football, it has been shown that a posteromedial range difference of four centimeters or more is associated with an almost fourfold higher probability of a non-contact injury during the season.[42] In this study, 45.0% (9/20) of the players had a posteromedial range difference of four centimeters or more.

HEEL RISE TEST (HRT)

The results of the HRT show comparable results for the dominant leg (27.1±5.4) to previously published values of healthy, non-athletic male subjects (mean age 34.7 ± 8.5 years) who achieved an average of 27.8 repetitions (± 11.5).[29] For the ND leg, less repetitions were achieved (25.2±5.1). The norm values published by Hébert-Losier et al. 2017 cannot be used for comparison because in their study heel rises were performed on a 10° incline.[43]

SINGLE LEG SQUAT TEST (SLST)

In the current study, all players were able to achieve good results in the SLST. This differs considerably from the results from Norwegian female competitive football and handball.[44] Even though the SLST was modified in the study of the female athletes, it should be noted that only around 34% of the female players examined had good hip control and around 17% had good knee control. One explanation for this could be gender-specific differences in motor strategies when performing the SLST.[45] However, a study of male and female high school athletes also showed that only 49% performed satisfactorily.[46] In a study of physically active adults, only around 6% performed poorly.[47] In contrast to the U14 players in the study of Räisänen et al. 2016 the current study showed that the players were well able to master the test requirement.[48] One explanation for this could be that the players in the current study regularly undergo neuromuscular control training. However, it is also possible that the dichotomous assessment of the test requirement that was used is not sufficiently differentiated to capture differences in movement performance via visual observation.

SINGLE LEG DROP JUMP (SLDJ)

Only six players managed to complete the SLDJ on the dominant leg side within a time frame reflecting a stretch shortening cycle (< 250ms), with only three players on the non-dominant leg side. Thus, it may be important to either change the test instruction and focus on the lowest possible ground contact time or to keep the instruction and reduce the jump height. A recent study of Level 1 and 2 athletes after anterior cruciate ligament rupture used a box height of 15 cm.[32] However, the included players achieved slight higher jump heights (0.15 ± 0.05) than the healthy controls (13.7 ± 2.1) in the study mentioned above.

SIDE HOP (SHT)

To the authors' knowledge, there are no reference data for the side hop test in elite youth players without ankle injury. The results show slightly better results than reported in previous studies of adult amateur football players and healthy subjects in an ACL study, although differences in test set-up complicate comparability.[37,49] In the literature, the cut-off value for subjects with chronic ankle instability is defined to be 12.88 seconds, and all tested players were faster than 12.88 seconds as would be expected (due to no chronic instability).[36] In a study of 62 (n=31 healthy; n=31 Functional Ankle Instability [FAI]) adult athletes, an average time of 8.79 and 8.98 sec was determined for the SHT.[50] Comparable results were obtained in a study with 60 athletically active subjects.[51] Elite youth football players in this study, however, showed shorter times (7.12 and 7.39 sec.) when compared to the forementioned cohorts, which can be attributed to the elite youth players being more trained.

FIGURE-OF-8 HOP

All players were below the cut-off value of 17.36 seconds indicated for individuals with chronic ankle instability on both the dominant and non-dominant leg sides.[36] Itoh et al. 2009 found a time of 11.36 ±1.30 for the dominant leg and 11.39 ±1.38 for the non-dominant leg in his study of 23 male subjects (average age 21.6 years), and Caffrey et al. 2009 recorded an average time of 11.0±0.4 sec (matched uninvolved limb) and 11.15±0.4 sec. (matched uninjured limb) in a cohort of an athletically active, healthy study controls (n=30; mean age 20 years).[37,50] Thus, the results of the current study indicate that elite youth football players perform the Figure-of-8 test faster than other cohorts in previous studies (10.52 sec dominant and 10.37 sec non-dominant respectively). One possible explanation might be that the non-dominant leg is usually the jumping leg and is characterized by better jumping abilities.

MOD. AGILITY T-TEST (MAT)

Agility and speed were tested using the MAT according to the methods of Sassi et al. 2009.[38] In contrast to trained male sports students (n=52; 22.4±1.5 years), who completed the test in 6.25±0.36 sec, elite youth football players completed the task in 5.81±0.22 seconds. Even though the distance, direction, and procedure were identical to those of Sassi et al. 2009, the MAT was performed outdoors on artificial turf in football shoes.[38] If, or to what extent the results may be influenced by these external circumstances and different footwear is uncertain. For example, the external influences (weather, artificial turf pitch, footwear) could affect the speed values of the elite youth football players compared to measurements when performed indoors on an alternative surface. Even if the testing conditions indoor are therefore easier to standardize, the testing chosen in this study mimics a football-specific scenario and generates results that provide the rehabilitation practitioner with orientation values for outdoor testing.

LIMB SYMMETRY INDEX (LSI)

Around 20 years ago, the principle of LSI was introduced to detect bilateral differences. Classically, the LSI is set at 85-90% and deviations of 10-15% are treated as normal.[26] Increasingly, experts critically discuss LSI, especially when no directional correction is made and only the dominant side is compared with the non-dominant side.[24,51] Due to these reasons LSI results can be (over-)interpreted in a false-positive way which may lead to true deficits going unnoticed (small LSI if the injured side is the non-dominant side and is compared with the dominant side; false negative by detraining the reference side). Therefore, considering the LSI exclusively offers considerable potential for distortion in both directions, which can lead to premature RTS decisions and increase the risk of recurrent injuries.[51] Dos Santos et a. 2021 provides potential options for quantifying, monitoring, and the interrelation of interlimb asymmetries and suggests using “asymmetry thresholds” (low-moderate; high-extreme).[52] In addition, cohort-specific absolute values should be defined, as an LSI >90% can also be achieved if both sides (injured/non-injured; dominant/non-dominant) are at a low level and if absolute values required for the sport are generally not achieved. In this case, a “positive” or acceptable LSI masks true deficits and does not reveal fundamental deficits.[22] The results of the current study emphasize the need for criticism of the traditional calculation of the LSI. In this cohort of healthy footballers, the usage of the LSI_{dc} identified more players with leg symmetry differences >10% in SLDJ and side hop. This is because a single cut-off specification of ⩾90% leads to asymmetries being overlooked to the detriment of the supposedly better side (e.g. LSI values >110). Therefore, the direction of the asymmetry should be considered when calculating LSI. In addition, ranges of “asymmetry thresholds” (e.g. ⩾90 % to ⩽110%) and the orientation towards absolute normative values should be advocated for a broad injury risk stratification, instead of using traditional LSI alone.

LIMITATIONS

Although the setting (e.g. test selection, necessary equipment) of the test battery applies to a professional football training center, it was not possible to test a complete squad of the respective youth teams. Therefore, the small sample size of only male athletes is considered as a limitation of this study even though its value is the specific cohort in an elite environment. The results cannot be generalized to other levels of athletes or to female athletes. The time required (about 60 minutes per athlete) corresponds to the duration of an individual training session in rehabilitation training. Nevertheless, it might be too time consuming for players and coaches in the daily practice in a football academy environment, which comes at the expense of compliance and prevented a larger sample.

For the YBT-LQ, six trial runs are recommended due to possible learning effects.[53] For reasons of practicality and the limited time window in professional football, only three trial runs were conducted in this study.

CONCLUSION

A multifactorial RTP assessment is recommended for those with LAS to evaluate various sport motor (sport-specific) requirements (e.g. proprioception, jumping ability, etc.). The current results in male elite youth football players highlight the need to collect baseline data for this specific cohort, as male elite youth football players achieve better results in the dynamic performance tests compared to reference values of the cohorts previously described in the literature. Furthermore, the conventional representation of the LSI should be used with caution, as it may overlook asymmetries to the detriment of the supposedly better side. While the direction corrected LSI can show the extent of the asymmetry, without looking at the raw scores LSI values do not indicate which side the asymmetry is due to. Therefore, the authors recommend specifying the LSI cut off in interval limits, e.g. ⩾90 % to ⩽110% or to consider different approaches. The extent to which this RTP assessment leads to a reduction in the high rate of recurrent injuries after LAS in elite youth football players should be explored in further prospective studies.

CORRESPONDING AUTHOR

Zacharias Flore
University of Kent, School of Sport and Exercise Sciences
Kapellenstraße 8a
39104 Magdeburg, Germany
zf43@kent.ac.uk
+4915203090096

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CONFLICT OF INTEREST

HB is employed by the Verwaltungs-Berufsgenossenschaft (VBG). ZF and GW were employed by Hamburger SV. All authors declare that there are no conflicts of interest.

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SUPPLEMENTARY MATERIALS

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