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The Relationship between Self-Reported and on Field Lower Extremity Functional Assessment Tools Used for Assessing Functional Status in Hip Dysfunction Athletes

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Abstract **Background**: Hip injuries are fairly common in athletes. Hip pain in runners and soccer players is a common problem treated by orthopedic and sports physical therapist. Effectiveness of the current functional tools available in hip dysfunction athletes is requires further study.[1] Objective: To find out the relationship between self reported and on field lower extremity functional assessment tools used for assessing functional status in hip dysfunction athletes and to determine which is better. **Methods**: This study was conducted on 50 athletes with hip dysfunction. The test procedures consisted of a general warm-up, a task specific warm-up, actual testing, and a cool down. Participants performed FMS, triple hop distance (THD), and timed 6m hop test, finally LEFS scores were taken. The scores for THD and 6m THT were expressed as limb symmetry index scores (LSI). Co-relation between all of them was determined. **Results**: FMS and LEFS were found to be significantly co-related, 6m THT and THD were found to be significantly correlated, while FMS and hop tests, LEFS and hop tests were not correlated with each other. **Conclusion**: We concluded that there is a relationship between self-reported functional assessment tool LEFS and on field functional assessment tool FMS used for assessing L.E. functional status. FMS and LEFS do not prove to be useful while 6m THT and THD prove to be useful tools for assessing functional status in hip dysfunction athletes.

Keywords LEFS, Functional Movement Screen (FMS), Hop Tests, 6m Timed Hop Test, Triple Hop Distance (THD), Hip Dysfunction

1. Introduction

1.1. Prevalence of Hip Injuries

Hip injuries are fairly common, accounting for roughly 5% to 6% of musculoskeletal complaints in adults and 10% to 24% of complaints in children.[2] These injuries are particularly common in certain athletes, such as dancers, runners, and soccer players, because their sports activities involve a high degree of increased force and extremes of movement across the hip.[2] Hip pain in runners is a common problem treated by orthopaedic and sports physical therapists[4]

1.2. Common Hip Injuries in Athletes

Dysfunction can be defined as pain, asymmetry, or injury that impairs normal movement and performance of a functional activity[1]. The common hip injuries in athletes are muscle strains, hip contusions, avulsion and apophyseal injuries, hip dislocations and subluxations, labral tears and hip fractures. Many of these injuries occur early in the athletic season.[6] Muscle strains are most common. The adductor muscles are frequently involved in strains, especially in hockey, football, and soccer players.[2] Strains of the rectus femoris muscle are common, result from an explosive hip flexion maneuver, such as sprinting or kicking, or from eccentric overload as the hip is extended, athletes have painful and possibly weak knee extension or hip flexion. Strain or rupture of the iliopsoas muscle can also occur during resisted hip flexion or passive hyperextension (eccentric overload). Soccer players often suffer from this type of injury when they are hit as they extend their leg to kick.[6]

1.3. Functional Performance Testing

Functional performance tests require the integration of multiple body regions and systems to execute movement patterns and therefore may have an advantage over more traditional clinical measures.[1] Components of ROM, flexibility, muscular strength, endurance, coordination, proprioception,[9] balance, and motor control of multiple

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regions can be assessed simultaneously by observing the movement patterns in which the athlete normally functions.[1,9] Functional performance tests have been commonly used to identify impairments related to ankle or knee injuries and determine the readiness of an athlete to return to sports after injury.[1]

The Lower Extremity Functional Scale (LEFS) is a region-specific, self-report functional status measure.[14] Individuals' scores on this 20-item questionnaire range from 0 to 80, with higher scores indicating better functional status.[14] Each LEFS item is scored on a Likert scale from 0 to 4 with higher scores representing higher functional levels, the maximum score being 80.[40]

Functional movement screen:

Gray Cook designed the FMS to determine if an individual possesses or lacks the ability to perform fundamental movement patterns[11] and in an effort to bridge the gap between the pre-participation medical screening and performance testing.[10,11] and to determine potential injury risk.[1] Inter-rater reliability (ICC3,1) for the composite FMS score was .971.[9] The FMS has been used in sports teams to screen pre-season for injury risk and to develop specific intervention programs to prevent injuries. [9]

Triple-hop distance(THD) was designed originally as a test for those recovering from injury or surgery to gauge readiness for activity and frequently has been reported to require a combination of muscular strength, power, and balance.[13] THD is a strong predictor of lower limb muscular strength and power in a healthy soccer population and support its clinical usefulness as a preseason screening test.[7] The test-retest reliability of this standardized protocol is excellent with intraclass correlation coefficient (ICC) as 0.97[13].

The timed 6m hop is a power test, which assesses the time taken to cover a distance of 6m by hopping.[14] The ICC range from .88 to .97 when analyzing mean scores between the sessions[14]. For patients with unilateral hip symptoms, hop tests may be used in comparison of the uninvolved side.[1]

Correlation was determined between LEFS with FMS, 6m timed hop test and THD. In order to utilize a functional tool to see the progress of a rehabilitation protocol or patient progress, it is important to know the relationship between these functional performance tests. Further study is needed to find out the relevancy of existing functional performance tests to be used in a young, athletic population with hip dysfunction.[1]

2. Methods

Fifty collegiate athletes of soccer and runner teams (both male and female) from the different universities were recruited and volunteered for the study. The subjects were required to read and sign consent forms approved by Amity Institute of Physiotherapy. Each subject completed a short questionnaire/assessment regarding their injuries history, usual physical activity levels, and demographic information. Athletes that did not clear the pre-participation physical exam were excluded from the study. The assessment form is provided in the appendix.

Inclusion criteria :

- Subjects with the history of greater than 4 months[1] and less than 8 months of hip pain.
- 18-26 years old who had not sustained an injury within the previous 30 days that prohibited full participation in preseason practice and/or conditioning programs[11],
- Patients with BMI 20-29 Kg/m sq.[14],
- Those players who were on the active roster at the start of the competitive season[12], and
- Membership on the injured reserve and time loss of 3 weeks was utilized as the injury definition.[12]

Exclusion criteria:

- An injury sustained within the 30 days preceding testing that excluded the athlete from participating in practice and/or competition[11],
- Recent surgical intervention that limited the athlete's participation in sport due to physician-imposed restriction [11] and
- Athletes who have any other recent unresolved dysfunction of shoulder, spinal, elbow, wrist, knee, SI joint, or ankle

2.1. Instrumentation

The required equipment includes a 2x6 Board, 4 foot dowel rod, 2 smaller dowel, an elastic band, measuring tape. The picture of the equipment is provided in Figure 1.

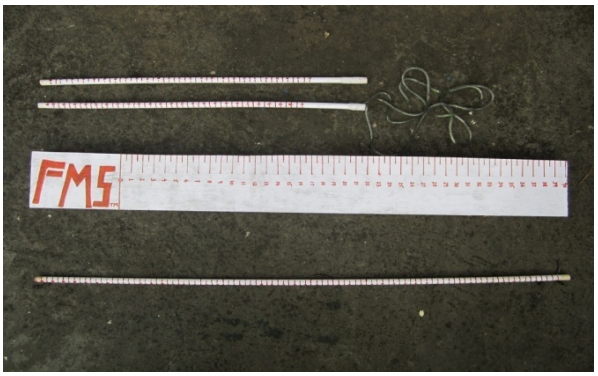

Figure 1. FMS equipment

2.2. Procedures

2.2.1. Overview

The subjects involved in the study (n= 50) comprised of hip dysfunction athletes. The test procedures consisted of a general warm-up, a task specific warm-up, actual testing, a cool down.[29] The general warm-up required participants to ride a stationary bike at a steady, comfortable speed for 3min followed by gentle quadriceps, hamstrings, and calf stretches.[29] Stretching involved 3 repetitions of each stretch using a 10-second hold.[29] The task specific

warm-up allowed subjects the opportunity to practice each functional performance test.[29] First, the test administrator demonstrated each functional performance test.[29] Participants then practiced each test 3 times in the following order: FMS, triple hop distance (THD), and timed 6m hop test. Practice was done in this order so as to get the athlete acquainted with what they have to do in the final testing and hence, minimizing errors while final testing. Participants rested approximately 30 sec between each practice trial and rested 1 minute prior to actual testing.[29] Actual testing had participants perform each functional performance test in a randomly determined order.[29] The scores for THD and timed 6m hop test were expressed as lower symmetry index scores (LSI). The limb symmetry index (LSI) has been the most frequently reported criterion for assessing whether muscle strength and hop performance are normal or abnormal, i.e. that the capacity of the injured leg is, or is not, as good as that of the non-injured leg. An LSI of <90%, i.e. more than 10% difference between limbs has been regarded as unsatisfactory for both strength and hop performance. [30,31] Hop limb symmetry index (LSI) for THD was expressed as the percentage of the longest involved limb hop distance divided by the longest uninvolved limb hop distance.[27] In 6-m timed hop, LSI was expressed as the percentage of the fastest uninvolved limb time divided by the fastest involved limb time.[27] Testing consisted of 3 consecutive trials for each functional performance test.[29] Participants received no verbal encouragement during actual testing.[29] A cool down period followed actual testing.[29] Subjects were verbally instructed to perform the gentle stretching as previously done during the general warm-up period.[29] Then, LEFS scores were taken, that is a subjective tool.

2.2.2. Functional Movement Screen (FMS)

The FMS™ consists of seven movement tests, described by Cook et al[10,17,18] that include: Deep Squat, Hurdle Step, In-Line Lunge, Shoulder Mobility, Active Straight Leg Raise, Trunk Stability Push-Up, and Rotary Stability.[11]

Scoring the Functional Movement Screen™

The scoring for the FMS™ consists of four possibilities. The scores range from 0 to 3, three being the best possible score. An individual is given a score of zero if at any time during the testing he/she has pain anywhere in the body. If pain occurs, a score of zero is given and the painful area is noted. A score of one is given if the person is unable to complete the movement pattern or is unable to assume the position to perform the movement. A score of two is given if the person is able to complete the movement but must compensate in some way to perform the fundamental movement. A score of three is given if the person performs the movement correctly without any compensation. Specific comments should be noted defining why a score of three was not obtained.[10]

Grades from 3 - 0

– 3 perform functional movement pattern

– 2 perform functional movement pattern with compensation

– 1 inability to perform the movement pattern

– 0 pain with movement

The majority of the tests in the FMS™ test right and left sides respectively, and it is important that both sides are scored. The lower score of the two sides is recorded and is counted toward the total; however it is important to note imbalances that are present between right and left sides.[10]

Three tests have additional clearing screens which are graded as positive or negative. These clearing movements only consider pain, if a person has pain then that portion of the test is scored positive and if there is no pain then it is scored negative. The clearing tests affect the total score for the particular tests in which they are used. If a person has a positive clearing screen test then the score will be zero. The best total score that can be attained on the FMS™ is 21.[10]

A lower score on the FMS™ was significantly associated with injury, those scoring 14 or less sustain an injury, and experiencing a 4-fold increase in injury risk.[11] An FMS scoring sheet is provided in the annexure.

2.2.2. Timed 6-m Hop Test

The timed 6-m hop was performed as outlined by Barber et al[20]. Subjects were instructed to perform large one-legged hops in series over the total distance. A standard stopwatch was used to record time. The stopwatch was started when a subject's heel lifted from the starting position and was stopped the moment that the tested foot passed the finish line. Measurements were recorded to the nearest 10th of a second.[14]

2.2.3. Triple Hop Distance (THD)

The triple hop for distance was performed as outlined by Noyes et al[19]. Subjects were instructed to stand on one leg and perform 3 consecutive hops as far as possible, landing on the same leg. The total distance for 3 consecutive hops was recorded[14]

2.2.4. Lower Extremity Functional Scale (LEFS)

The Lower Extremity Functional Scale (LEFS) is a region-specific, self-report functional status measure. Individuals' scores on this 20-item questionnaire range from 0 to 80, with higher scores indicating better functional status. [14]

The LEFS is provided in the annexure[21]

3. Results

In total, 50 athletes with hip dysfunction who fulfilled the inclusion criteria were recruited for the study. We have co-related LEFS with FMS, Triple hop distance (THD) and timed 6m hop test, and also correlation was found between the FMS and hop tests. Pearson's co-relation test (2-tailed)

was run to quantify the results within the groups at a 5% level i.e. the statistical significance was set at $p \leq 0.05$. The results were found to be statistically significant at 5% level for LEFS being correlated to FMS, both the hop tests were found to be correlated with each other but there was no correlation found between LEFS and hop tests; FMS and hop tests. Statistical analysis software (SPSS version 16) was used for all analyses.

Also, significant values for both the hop tests were also found out, Z test was applied for the same. 6m timed hop test was found to be significant at 99.9% probability ($p \leq 0.001$) i.e. highly significant and THD was found to be significant at 99% probability ($p \leq 0.01$).

Table 1. Subject demographics

	Female subjects	Male subjects	Total
Sample size(N)	15	35	50
Age(yrs)	22.6±2.37		
Height(m)	1.75±0.037		
Weight(kg)	65.38±3.55		
BMI (kg/m^2)	21.30±0.68		

The calculated value for Z test for 6m timed hop test was found out to be 19.82, that is significant at 99.9% confidence limits($p \leq 0.001$) i.e. highly significant while the calculated value for Z test for THD was found to be 19.70 that is significant at 99% confidence limits ($p \leq 0.01$) i.e. it was significant. Hence, these hop tests may be used for the athletes with hip dysfunction.

The calculated value for Pearson's co-relation (2 tailed) between LEFS and FMS is 0.032, hence the p value is less than 0.05, there is significant co-relation between them. The Pearson's co-relation (2-tailed) value between LSI 6m timed hop test and LSI triple hop distance is 0.044, hence the p value is less than 0.05, therefore there is significant co-relation between them(fig.3). There is no significant co-relation between FMS and either of the hop tests, LSI 6m timed hop test and LEFS, and between LSI triple hop distance and LEFS as we can see from the following graphs.

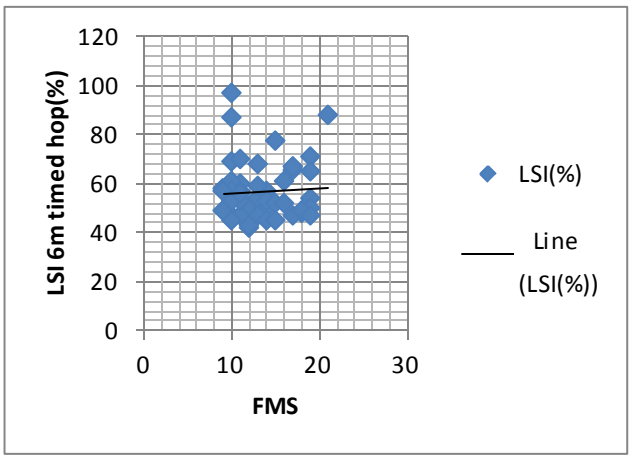

Figure 1. Scatter diagram for FMS and LSI 6m timed hop

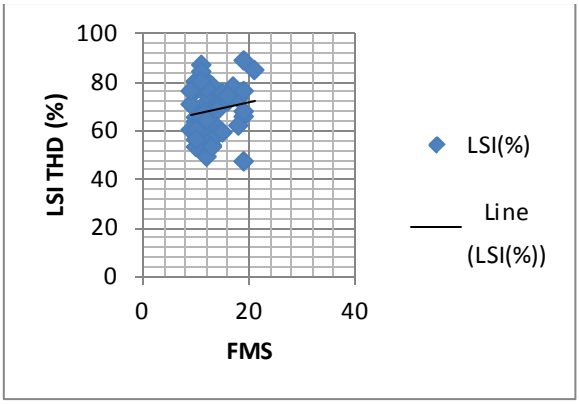

Figure 2. Scatter diagram for FMS and LSI Triple hop distance

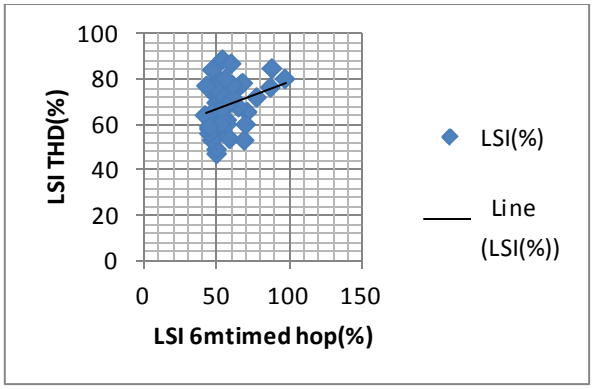

Figure 3. Scatter diagram between LSI Triple hop distance and LSI 6m timed hop test

4. Discussion

The purpose of this study was to find the relationship between self reported functional assessment and on field functional assessment tools in hip dysfunction athletes and so, we co-related the four tools (FMS, LEFS, 6m timed hop test and THD) for assessing functional performance in hip dysfunction athletes. In the present study, self reported tool LEFS was found to be positively correlated to FMS, a newly devised tool. The two hop tests were also found to be positively correlated with each other, but no correlation was observed between LEFS and the hop tests, and FMS and hop tests. In the literature, it has been stated that LEFS is administered during the initial assessment to patients with lower-extremity musculoskeletal dysfunction referred for physical therapy.[15] It has also been stated that deep squat and single leg stance test demonstrated evidence of validity in a population of patients with hip related dysfunction.[1] FMS tool thus incorporates deep squat as one of its components for evaluating hip dysfunction athletes. On the other hand, in the literature it is suggested that hop tests have the ability to discriminate injured from uninjured lower extremities and also may be used for evaluation in patients with unilateral hip symptoms in comparison to uninvolved side.[1] Thus, considering these facts, these four assessment tools were used in this study.

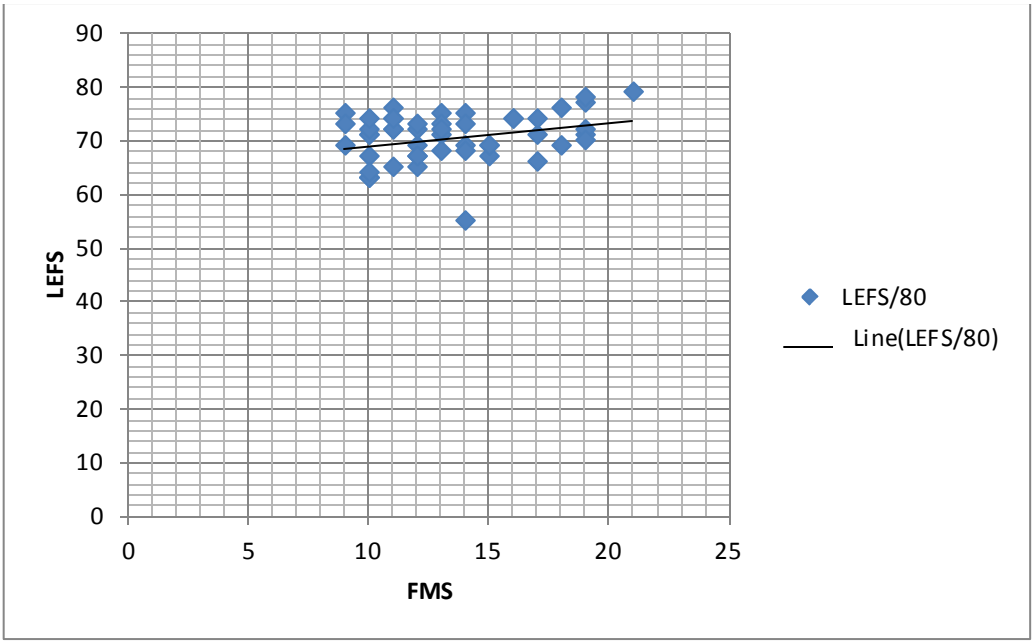

Figure 4. Scatter diagram for FMS and LEFS

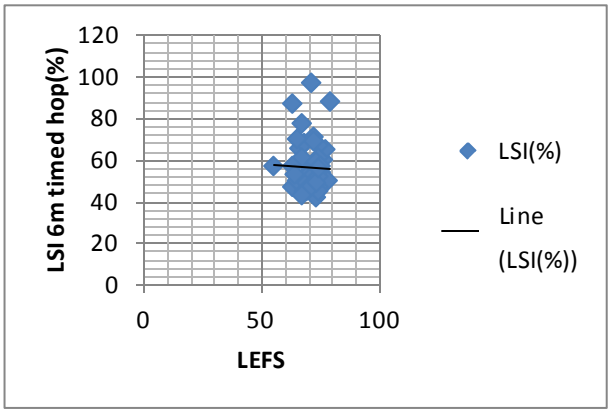

Figure 5. Scatter diagram for LEFS and LSI 6m Timed hop test

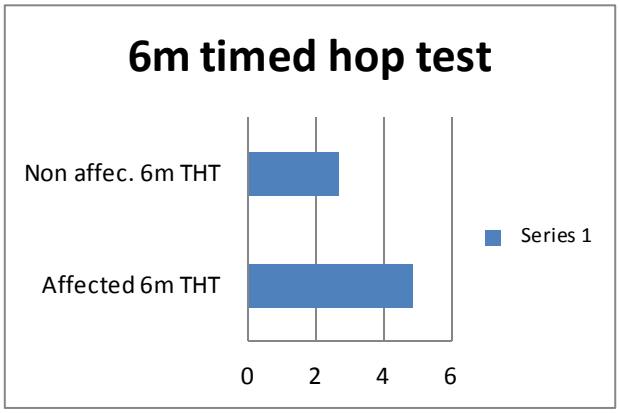

Figure 7. Mean graph for 6m timed hop test

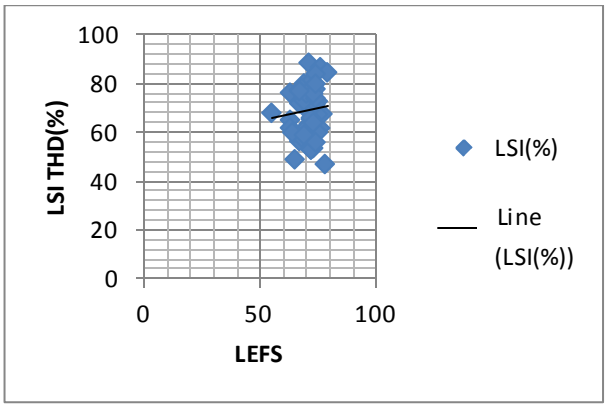

Figure 6. Scatter diagram for LEFS and LSI triple hop distance

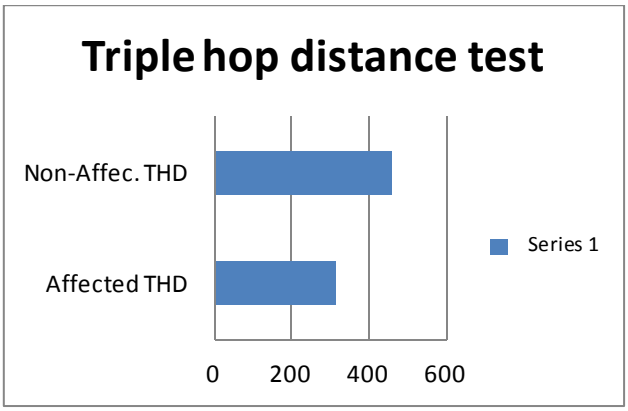

Figure 8. Mean graph for THD

LEFS was found to be correlated with FMS scores. A possible explanation to this finding can be that both of these functional tests are full body screen tools. LEFS focuses on all the aspects including time, pain and exertion but in a shorter time while FMS being a performance based test, increases the breadth of health concepts (i.e., time, pain, and exertion) associated with the performance score, hence, greater correlation is achieved with the self-report measure. [40]

Both the hop tests were found to be correlated to each other in hip dysfunction athletes. This may be due to the fact that studies on biomechanical analysis of hopping have suggested that the negative joint power was two to three times greater for the knee than for the hip and five to 10 times greater for the knee than for the ankle during landing.[41] Thus, indicating that hopping imposed maximum stresses on knee joint followed by hip joint and least on ankle joint. Also, it has been shown that the hip-joint angles were greater during the crossover hopping and also greater hip adduction and flexion joint angles.[42] This is further supported by studies which make use of hop tests as valid and reliable performance-based outcome measure for the patients undergoing rehabilitation following ACL reconstruction[14] as well as for non-operatively treated individuals with ACL injury.[27]

Another study has concluded that there is a strong correlation between single leg hop for time and single leg hop for distance, suggesting that each test measures similar constructs of function[43]. The same observation was observed in our results where THD in terms of distance correlated with 6m timed hop test in terms of time duration required covering 6 m distance.

The next finding of our study was that 6m timed hop test and THD were found to be significant. Hence, hop tests can differentiate between affected limb and unaffected limb, so we may say that these hop tests may be used for the patients with hip dysfunction. This is supported by a similar suggestion given in a study by Benjamin R. Kivlan.[1]

Another finding of our study suggests that FMS is not significantly correlated to hop tests. The possible reason for this could be that FMS is a full body screen tool and hop tests concentrate specifically on lower extremity. Out of the seven components of FMS; shoulder mobility, trunk stability push-up and rotary stability are the components that clearly don't require the contribution of hip joint. The other components like deep squat, hurdle step, inline lunge and active SLR require the contribution of hip joint with the contribution from the other joints also, if the muscles around the hip joint are weak, compensation can be provided by the other joints, and the subject will be able to complete the movement, we can't isolate the hip movement and therefore, the predictability of FMS for hip joint or the patients with hip dysfunction becomes less. Deep squat requires flexion of hips[10], hip flexion excursion and peak hip extension moment[33], hurdle step requires stance-leg stability and flexion of hip while maintaining hip extension of the opposite leg requires the athlete to demonstrate relative bilateral, asymmetric hip mobility.[10] The ability to perform the in-line lunge test requires stance leg stability of the hip and that of active SLR requires functional hamstring flexibility[10].Therefore, this gives a possible explanation of FMS not being correlated to hop tests.

Also, a similar finding was observed by Parchmann et al where no significant correlations were determined between FMS, 1RMs, 10-m sprint time, 20-m sprint time, VJ height, agility T-test time. The lack of relationship suggests that FMS is not an adequate field test and does not relate to any aspect of athletic performance[38]. Also, as it is not co-related with hop tests, and hop tests are found to be good tools for hip dysfunction athletes, hence, FMS is not proved to be a good tool for hip dysfunction athletes.

No significant correlation was observed between LEFS and either of the hop tests. Thomas J Hoogeboom et al studied the Dutch version of LEFS on hip and knee OA patients and proved that LEFS has good psychometric qualities and ability to discriminate between pain and functioning, hence recommended the LEFS as the outcome measure of choice to assess self-reported physical functioning in individuals with hip or knee osteoarthritis[26]. But, LEFS depends mainly on moderate activities that can be performed by the athletes with minimal hip symptoms and hop tests require more of the lower extremity movement. So, this can be contrary to our previous finding where LEFS was correlated to FMS. Also, LEFS is used as a self report measure to assess the progression of a rehabilitation protocol while hop test can be a component of a rehabilitation protocol[14]. Hence, this may further support our finding.

In terms of deciding which measure to select for clinical and research purposes, the final choice must be directed by the measure's measurement properties, desired outcome of interest, and the goal of the investigation. Self-report measures do offer an efficient and cost effective method of comprehensively sampling from the domain of interest. However, there are situations where the choice of a physical performance measure is preferable. For example, if the goal were to determine whether a patient is able to cross an intersection in the time allocated by a traffic signal, then a timed walk test would be the measure of interest. Clearly, other examples favoring a performance measure can be found in the field of rehabilitation. In these cases, using a self-report measure might not truly capture the degree of disability specific to the desired task.

5. Future Research

Further research is needed in this area to explore more functional tools that can be used specifically on hip dysfunction athletes and more research is still necessary before implementing these functional tools used, into a hip assessment tools, but due to the low cost and there simplicity to implement, they should be considered by clinicians and researchers in the future.

6. Conclusions

What are the new findings:

- There is a relationship between self-reported functional assessment tool LEFS and on field functional assessment tool FMS used for assessing lower extremity functional status.
- FMS and LEFS do not prove to be useful in assessing functional status in hip dysfunction athletes.
- 6m timed hop test and triple hop distance prove to be useful tools for assessing functional status in hip dysfunction athletes.

SUMMARY BOX
How might it impact on clinical practice in the near future • Knowing the relationship between the self-reported functional tool and performance based functional tool in a hip dysfunction athlete, a clinician can confidently choose a test or combination of them based on its performance, hence interpret test results and utilize the tests to measure patient progress. • This will further help him know the extent of functional and balance dysfunction in this population which can further help us for rehabilitation purpose and eventually correlate these limitations with outcomes. • This may lead to an improved proactive approach to injury prevention.

Limitations of the Study

- Only those athletes with injuries of more than 4 months and less than 8 months were included in the study. There can be variations in the extent of injuries and its symptoms.
- There was no stratification based on the individual's sport.
- The number of subjects in the study was limited.

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And above all I thank God for being with me and guiding me to the best path all through my life.

Last but not the least I would like to thank all the participants who agreed to be a part of this study and without whom this study would not be complete.

ANNEXURES

FUNCTIONAL MOVEMENT SCREEN

SCORING SHEET

NAME		DATE		DOB
ADDRESS				
CITY, STATE, ZIP				PHONE
SCHOOL/AFFILIATION				
SSN	HEIGHT	WEIGHT	AGE	GENDER
PRIMARY SPORT		PRIMARY POSITION		
HAND/LEG DOMINANCE		PREVIOUS TEST SCORE		

TEST	RAW SCORE	FINAL SCORE	COMMENTS

DEEP SQUAT				
HURDLE STEP	L			
	R			
INLINE LUNGE	L			
	R			
SHOULDER MOBILITY	L			
	R			
IMPINGEMENT CLEARING TEST	L			
	R			
ACTIVE STRAIGHT-LEG RAISE	L			
	R			
TRUNK STABILITY PUSHUP				
PRESS-UP CLEARING TEST				
ROTARY STABILITY	L			
	R			
POSTERIOR ROCKING CLEARING TEST				
TOTAL				

Raw Score: This score is used to denote right and left side scoring. The right and left sides are scored in five of the seven tests and both are documented in this space

Final Score: This score is used to denote the overall score for the test. The lowest score for the raw score (each side) is carried over to give a final score for the test. A person who scores a three on the right and a two on the left would receive a final score of two. The final score is then summarized and used as a total score

THE LOWER EXTREMITY FUNCTIONAL SCALE

We are interested in knowing whether you are having any difficulty at all with the activities listed below because of your lower limb

Problem for which you are currently seeking attention. Please provide an answer for **each** activity.

Today, do you or would you have any difficulty at all with:

	Activities	Extreme Difficulty or Unable to Perform Activity	Quite a Bit of Difficulty	Moderate Difficulty	A Little Bit of Difficulty	No Difficulty
1	Any of your usual work, housework, or school activities.	0	1	2	3	4
2	Your usual hobbies, recreational or sporting activities.	0	1	2	3	4
3	Getting into or out of the bath.	0	1	2	3	4
4	Walking between rooms.	0	1	2	3	4
5	Putting on your shoes or socks.	0	1	2	3	4
6	Squatting.	0	1	2	3	4
7	Lifting an object, like a bag of groceries from the floor.	0	1	2	3	4
8	Performing light activities around your home.	0	1	2	3	4
9	Performing heavy activities around your home.	0	1	2	3	4
10	Getting into or out of a car.	0	1	2	3	4
11	Walking 2 blocks.	0	1	2	3	4
12	Walking a mile.	0	1	2	3	4
13	Going up or down 10 stairs (about 1 flight of stairs).	0	1	2	3	4
14	Standing for 1 hour.	0	1	2	3	4
15	Sitting for 1 hour.	0	1	2	3	4
16	Running on even ground.	0	1	2	3	4
17	Running on uneven ground.	0	1	2	3	4
18	Making sharp turns while running fast.	0	1	2	3	4
19	Hopping.	0	1	2	3	4
20	Rolling over in bed.	0	1	2	3	4
	Column Totals:					

Minimum Level of Detectable Change (90% Confidence): 9 points **SCORE: ____/ 80**

Reprinted from Binkley, J., Stratford, P., Lott, S., Riddle, D., & The North American Orthopaedic Rehabilitation Research Network, The Lower Extremity Functional Scale: Scale development, measurement properties, and clinical application, Physical Therapy, 1999, 79, 4371-383, with permission of the American Physical Therapy Association.

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