

**CORRELATION OF INTRINSIC FOOT MUSCLE STRENGTH WITH  
REACTIVE STRENGTH INDEX IN SPINTERS - AN OBSERVATIONAL  
STUDY.**

**BY**

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Odisha University of Health Sciences, Bhubaneswar, Odisha**

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**MASTER OF PHYSIOTHERAPY (MPT)**

**In**

**SPORTS SCIENCE**

**Under the Guidance of**

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**ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE  
BHUBANESWAR, ODISHA - 2023-2025**



**Odisha University of Health Sciences, Bhubaneswar, Odisha**

**DECLARATION BY THE CANDIDATE**

I hereby declare that this dissertation/thesis entitled “**CORRELATION OF INTRINSIC FOOT MUSCLE STRENGTH WITH REACTIVE STRENGTH INDEX IN SPRINTERS – AN OBSERVATIONAL STUDY**” is a bona fide and genuine research work carried out by me under the guidance of Dr. Asma Parveen (PT), Senior Assistant Professor, HOD of Neuroscience, Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar, Odisha.

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Thank you.

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## **LIST OF ABBREVIATIONS USED**

1. ABSMARI- Abhinav Bindra Sports Medicine and Research Institute.
2. AMTI force plate- Advanced Mechanical Technology, Inc
3. IFM- Intrinsic Foot Muscle
4. MPT- Masters of Physiotherapy
5. OUHS- Odisha University of Health Sciences
6. RSI- Reactive Strength Index
7. SSC- Stretch Shortening Cycle
8. SPSS- Statistical Package of The Social Sciences

## **ABSTRACT**

**Title:** Correlation of intrinsic foot muscle strength with reactive strength index in sprinters  
– An Observational Study

**Background:** Intrinsic foot muscles (IFMs) play a major role in enhancing the efficiency of the stretch-shortening cycle (SSC), optimizing energy transfer, and stabilizing the medial longitudinal arch. One factor that determines sprint performance is the Reactive Strength Index (RSI), which measures the ability to rapidly transition between eccentric and concentric muscle activity. Although the role of large lower-limb muscles in sprinting has been well established, the direct link between IFM strength and RSI remains to be completely studied.

**Objective:** To investigate the correlation between intrinsic foot muscle strength and reactive strength index in adolescent sprinters.

**Methods:** An observational study was conducted among 80 sprinters (12–18 years) from ABTP, Kalinga Stadium, Bhubaneswar. Intrinsic foot muscle strength was evaluated with a toe dynamometer, while RSI was evaluated with drop jump tests on an AMTI force plate. Data were analyzed using Spearman's rank correlation and multiple linear regression, with  $p < 0.05$  considered the level of significance.

**Results:** Mean age of the participants was  $15.18 \pm 1.44$  years, of which 61.25% were males and 38.75% were females. The average IFM strength of the left foot was  $6.19 \pm 0.92$ , the right foot was  $5.32 \pm 0.97$ , and the mean RSI was  $1.24 \pm 0.37$ . Correlation analysis showed a moderate positive relationship between left foot strength and RSI ( $\rho = 0.457$ ,  $p < 0.001$ ), and a lower level of significance for the right foot ( $\rho = 0.261$ ,  $p = 0.019$ ).

**Conclusion:** This study shows a strong correlation between intrinsic foot muscle strength and RSI in sprinters, where the left foot strength was a greater predictor. The results indicate that the inclusion of IFM strengthening in training programs has the potential to improve reactive strength and sprint performance, although longitudinal and interventional research is required to determine causality.

**Keywords:** Intrinsic foot muscle strength, Reactive Strength Index, Sprinters, Stretch-shortening cycle, Toe dynamometer, AMTI force plate

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## **Introduction**

Sprinting is one of the most fundamental and thrilling demonstrations of human performance, showcasing speed, power, and explosive ability, and is often regarded as the pinnacle of athleticism. While sprinting is typically associated with large muscle groups such as the gluteals, quadriceps, and hamstrings, the contribution of smaller stabilizing muscles, particularly the intrinsic foot muscles (IFMs), is often overlooked. These muscles play a critical role in stabilizing the foot, absorbing forces, and enabling efficient transition from ground contact to propulsion. Their contribution becomes particularly important during sprint phases—start, acceleration, and top speed—where even small changes in movement efficiency can affect overall performance<sup>(1)</sup>.

A critical factor in sprinting efficiency is ground contact time. Elite sprinters are known to keep contact times shorter than sub-elite sprinters, which contributes to faster sprinting velocities<sup>(2)</sup>. During these brief contacts, the foot acts as the main point of interaction with the ground, taking on the dual responsibility of cushioning forces while preparing for the next push-off. This process heavily depends on the stretch–shortening cycle (SSC), where tendons and muscles store elastic energy during the eccentric phase and release it during the concentric phase, boosting explosive performance<sup>(3)</sup>. The efficiency of this cycle can be assessed with the Reactive Strength Index (RSI), a measure that reflects how well an athlete can quickly generate force. Higher RSI values indicate more effective energy storage and faster transitions between landing and take-off<sup>(4)</sup>. While the larger lower-limb muscles have been studied extensively in relation to sprinting, the IFMs have received less attention. Muscles such as the abductor hallucis, flexor digitorum brevis, and quadratus

plantae do not generate high levels of force directly, but they stabilize the arch, distribute loads, and provide sensory input that helps the body respond rapidly to changes in movement <sup>(5)</sup>. Without the proper function of these small muscles, energy transfer from larger muscle groups may become inefficient, leading not only to reduced performance but also to a higher chance of injury <sup>(6)</sup>.

Recent studies indicate that strengthening the IFMs may enhance performance. Short-foot training and toe-grip exercises have been shown to improve balance, postural control, and toe flexor strength <sup>(7)</sup>. <sup>(8)</sup> demonstrated that five weeks of toe flexor training improved both toe strength and RSI, suggesting a clear link between IFM capacity and SSC efficiency. Likewise, <sup>(9)</sup> associated metatarsophalangeal joint strength with better sprinting skills, particularly acceleration and direction changes. These findings indicate that IFMs are not just passive stabilizers but may actively contribute to sprint performance.

The RSI itself is considered a reliable measure of athletic ability. Typically assessed through drop jump tests, RSI reflects how effectively an athlete can use elastic energy during fast movements. Because sprinting also relies on repeated eccentric–concentric actions, RSI has been recognized as a reliable indicator of sprint capacity <sup>(4)</sup>. Newer approaches, like the RSI RUN, extend this measurement to sprinting itself, showing strong associations with sprint times and muscle quality <sup>(10)</sup>. Athletes with higher RSI values are capable of maintaining shorter ground contact times without sacrificing force production, a decisive factor in sprint success.

Despite the theoretical basis linking IFM strength to RSI, few studies have directly explored this relationship in sprinters. Most available studies have looked at IFM strength, toe flexor strength, or RSI separately, leaving a gap in knowledge regarding their combined

role. This is surprising since stronger IFMs are expected to enhance arch stiffness, reduce excessive pronation, improve sensory feedback, and speed up SSC transitions, all of which could improve RSI. Beyond performance, these muscles also have a protective role, as sprinting places high stress on the lower limbs, often leading to injuries such as plantar fasciitis, ankle sprains, and shin splints. Since weak IFMs may reduce arch stiffness, compromise SSC function, and increase injury risk, exploring this connection is both relevant and practical. Injuries such as plantar fasciitis, shin splints, and ankle sprains are common in sprinting and may be linked with poor foot muscle function <sup>(11)</sup>.

In practical terms, identifying a clear relationship between IFM strength and RSI could help coaches and athletes refine training strategies. While current programs emphasize large muscle groups and plyometric drills, adding simple foot-specific exercises like toe curls or short-foot exercises could provide additional gains. The dual benefit of enhancing performance and minimizing injury risk highlights the applied value of this line of inquiry.

In summary, sprint performance results from a complex interplay of biomechanics, neuromuscular coordination, and musculoskeletal strength. The IFMs, though small in size, play a disproportionately significant role in stabilizing the foot, supporting efficient energy transfer, and providing proprioceptive feedback. The RSI serves as a critical measure of SSC efficiency and explosive performance, particularly relevant to sprinting. While prior studies support a theoretical link between IFM strength and RSI, direct empirical evidence is lacking.

**Literature Gap:** Despite growing evidence on the role of intrinsic foot muscles in balance, proprioception, and general lower-limb performance, few studies have directly examined their relationship with RSI specifically in sprinters. Most existing research has focused on

either IFM strength or RSI independently, leaving a critical gap in understanding how foot muscle function influences sprint-specific explosive performance. Addressing this gap is essential for developing targeted training interventions that can enhance both performance and injury prevention in competitive sprinters.

The current study, therefore, aims to investigate the correlation between intrinsic foot muscle strength and reactive strength index in sprinters, using validated measurement tools such as toe dynamometers and force plates. By focusing on competitive adolescent sprinters, this study seeks to provide both theoretical insight into sprinting biomechanics and practical strategies for training, rehabilitation, and performance enhancement.

## **NEED FOR THE STUDY**

The intrinsic foot muscles play an important role in providing stability to the foot and helping transfer forces during sprinting. These functions are directly linked to the efficiency of the stretch–shortening cycle and, in turn, to the Reactive Strength Index (RSI). Despite this, very few studies have directly examined how IFM strength affects RSI, particularly in sprinters.

Understanding this relationship could give valuable insight into the factors that influence reactive ability in athletes. Such knowledge would not only contribute to improving performance but could also help in preventing common lower-limb injuries seen in sprinters. Since no earlier research has specifically tested this link, the present study is necessary to address this gap.

## **AIM AND OBJECTIVE**

### **AIM OF THE STUDY**

To assess the relationship between intrinsic foot muscle strength and the reactive strength index in sprinters

### **OBJECTIVE OF THE STUDY**

The primary objective of the study is to investigate the correlation of intrinsic foot muscle strength with the reactive strength index in sprinters using a toe dynamometer and an AMTI force plate.

## **HYPOTHESIS**

### NULL HYPOTHESIS

There will be no significant correlation between intrinsic foot muscle strength and the reactive strength index in sprinters

### ALTERNATIVE HYPOTHESIS

There will be a significant correlation between intrinsic foot muscle strength and the reactive strength index in sprinters.

## **REVIEW OF LITERATURE**

1. **Zhen Wei, Ziwei Zeng, et al. Systematic Review and Meta-Analysis, 2022. Effect of Intrinsic Foot Muscle Training on Foot Function and Dynamic Postural Balance: A Systematic Review and Meta-Analysis.** In the paper "Effect of intrinsic foot muscle training on foot function and dynamic postural balance," the authors compiled evidence concerning the effects of IFM training. The evidence in their analysis proved that the training of IFMs had positive effects on medial longitudinal arch support and dynamic balance. The results point out IFM training as an excellent method for rehabilitation as well as sports performance improvement.

2. **E. P. Flanagan and others. Journal of Sports Sciences, 2007. Reliability of the Reactive Strength Index and Time to Stabilization During Depth Jumps.** In "Reliability of the Reactive Strength Index and Time to Stabilization during Depth Jumps," the researchers tested whether repeated trials could be reliably measured for RSI, jump height, and contact time. Results indicated high reliability for these variables, and they convey that RSI from depth jumps can be used by practitioners and coaches with confidence as a one-test measure to track plyometric and reactive strength.

3. **Jun Xu, David D. Goss, and Steven A. Saliba. International Journal of Sports Physical Therapy, 2023.** In "A Novel Intrinsic Foot Muscle Strength Dynamometer Demonstrates Moderate-To-Excellent Reliability and Validity," the authors tested a new budget-friendly dynamometer for assessing IFM strength. The instrument had good intra- and inter-rater reliability and validity against a handheld dynamometer. These findings indicate that this new tool provides a cost-effective, practical, and reliable measure of foot muscle strength for research and clinical purposes.

4. **Matt Patterson and Brian Caulfield. Sports Biomechanics, 2010. A Method for Monitoring Reactive Strength Index Using a Wearable Accelerometer.** In "A method for monitoring reactive strength index," the research outlined the development and testing of an algorithm to compute RSI from an accelerometer worn on the ankle. The RSI values calculated showed an excellent correlation ( $r = 0.98$ ) with those derived from a force plate and little error in measurement. This suggests that monitoring with accelerometers represents a valid and portable alternative to classical force plate testing for monitoring reactive strength in athletes.

5. **Tourillon et al. (2024). Human Foot Muscle Strength and Its Relationship to Sprint, Cutting, and Jumping Performance.** In the paper "Human Foot Muscle Strength and Its Relationship to Sprint, Cutting, and Jumping Performance," Tourillon and colleagues investigated the contribution of metatarsophalangeal (MTP) flexion torque to elite performers. Their results indicated close associations between MTP torque, passive foot stiffness, and foot-ankle reactive strength with sprinting-specific measures such as vertical impulse and ground contact time during maximal-speed running. These findings highlight that foot muscle strength is not only a key to stability but also directly affects explosive sprint and multidirectional performance.

6. **Junichiro Yamauchi (2020). Importance of Toe Flexor Strength in Vertical Jump Performance.** In the article "Importance of Toe Flexor Strength in Vertical Jump Performance," Yamauchi analyzed the role of toe flexor strength and arch structure in explosive jump capacity. The research revealed that individuals with greater toe flexor strength and more superior arches produced higher ground reaction forces, leading to better vertical jumping performance. This emphasizes the critical contribution of distal foot

strength towards the optimization of power generation in explosive actions like jumping and running.

**7. Kayhan et al. (2024). Ankle Dorsal/Plantar Strength, Reactive Strength Index, and Balance in Youth Soccer Players.** Through their research on "Ankle Dorsal/Plantar Strength, Reactive Strength Index, and Balance in Youth Soccer Players," Kayhan and others explored ankle strength in the determination of reactive strength and balance performance. The findings revealed that stronger dorsiflexors and plantar flexors of the ankle were linked with increased RSI values and better balance performance. These results indicate that distal lower-limb strength is an important contributor to the development of reactive athletic skills, and by association, highlight the potential importance of intrinsic foot muscle strength in comparable high-demand tasks.

**8. Runner Strike Patterns and IFM Strength Variability (2023) Runner Strike Patterns and Intrinsic Foot Muscle Strength Variability.** A study involving 70 recreational runners compared intrinsic foot muscle profiles between rearfoot strikers and non-rearfoot strikers. The results showed that individuals with a rearfoot strike pattern tended to have thicker intrinsic foot muscles and stronger toe-flexion capacity. These findings suggest that habitual running mechanics influence IFM strength and morphology, pointing to strike pattern as a common factor in the variability of foot muscle characteristics among runners.

**9. Morphology of Foot Muscles in Sprinters and Non-Sprinters (2018). Morphological Differences in Foot Muscles Between Sprinters and Non-Sprinters.** A study that utilized ultrasound imaging investigated variations in foot muscle thickness between sprinters and non-sprinters. Sprinters were found to have foot muscles measuring 10.2% to 17.1%

greater in thickness than the foot muscles of non-sprinters. Surprisingly, a significant relationship was only found for the abductor hallucis thickness, which was positively correlated with slower sprint performance. This would imply that although sprinters tend to have more foot muscle development, the performance contribution and prevalence of certain muscles could be different.

10. **Montoro-Bombú R., Sarmiento H., Elferink-Gemser M., et al. (2024). The Integral Reactive Strength Index (IRSI): An Accurate Measurement for Evaluating Drop Jump Performance in Sprinter Athletes.** In their paper entitled "The Integral Reactive Strength Index (IRSI): An Accurate Measurement for Evaluating Drop Jump Performance in Sprinter Athletes," Montoro-Bombú and colleagues proposed the IRSI as an evolution of the classic reactive strength index. The research particularly tested its use in sprinters during drop jumps and showed that IRSI provided a more sensitive measurement of stretch–shortening cycle effectiveness by factoring in both jump height and ground contact dynamics. The results confirmed that IRSI is a sensitive and valid measure for the assessment of reactive strength in sprinting athletes, making it very applicable for performance testing and training assessment.

11. **Suchomel et al. (2021). The Importance of Muscular Strength in Athletic Performance: A Review.** Their review emphasized the role of muscular strength as a foundation for explosive performance. They highlighted RSI as a sensitive tool for monitoring training adaptations in power-based sports. This strengthens its relevance in sprint-related studies.

12. **Foster et al. (2019). Running mechanics and energetics: Effects of foot muscle strength on stride efficiency.** In their work on running mechanics, the authors found that

stronger foot muscles improved stride efficiency and reduced energy cost during prolonged running. These results show that intrinsic muscle strength contributes not only to sprinting but also to endurance performance.

13. **Zebis et al. (2016). Neuromuscular asymmetry in athletes: Implications for reactive tasks.** This study explored neuromuscular asymmetry in athletic populations. Findings indicated that imbalances in strength and control can impair reactive tasks such as sprinting and jumping. This supports the assessment of both feet individually when examining IFM strength and RSI relationships.

14. **Kelly et al. (2014). Plantar intrinsic foot muscle activation in response to postural demand.** In their work on plantar intrinsic foot muscles, the authors examined how increasing postural demands recruit these muscles. Results showed greater activation of intrinsic foot muscles under challenging balance conditions, reinforcing their role in stabilizing the medial longitudinal arch. This suggests that intrinsic muscles are not only passive supporters but also active contributors to performance.

15. **McKeon et al. (2015). The foot core system: A new paradigm for foot function in athletes.** Through the “*foot core system*” framework, McKeon and colleagues conceptualized intrinsic foot muscles as local stabilizers similar to the core muscles of the trunk. Their analysis indicated that these muscles maintain foot integrity and dynamic control during movement. The study provided a new paradigm for considering the foot as a functional unit in athletic performance.

16. **Farris et al. (2019). Role of intrinsic foot muscles in bipedal locomotion.** This study assessed the role of foot muscles in bipedal locomotion. Findings revealed that intrinsic

muscles are essential for modulating arch stiffness and enabling efficient elastic energy return during running and jumping. The research emphasized their functional significance in high-performance athletic activities.

**17. Ridge et al. (2019). Minimalist footwear and intrinsic foot muscle volume: Effects on performance.** In research comparing footwear types, the authors demonstrated that training in minimalist shoes significantly increased intrinsic foot muscle volume. These changes correlated with improved running efficiency, suggesting that strengthening the foot musculature through specific footwear or training interventions can enhance performance.

**18. Wei et al. (2022). Effects of intrinsic foot muscle training: A systematic review and meta-analysis.** In a systematic review and meta-analysis, Wei and colleagues analyzed the effects of intrinsic foot muscle training. They found that IFM interventions improved arch morphology, foot strength, and postural control. This confirms the broader functional benefits of foot-specific exercise programs.

**19. Hollman et al. (2022). Foot core training and athletic performance: A systematic review.** Through a systematic review, the authors examined the role of foot core training in athletic performance. Results indicated that targeted IFM strengthening reduces injury risk while supporting performance outcomes in running and jumping tasks. This underscores the preventive and performance-related value of foot training.

**20. García-García et al. (2023). Intrinsic foot muscle activation in athletes with chronic ankle instability.** Their work explored intrinsic foot muscle activation capacity in athletes with chronic ankle instability. Findings showed impaired muscle recruitment in these

athletes compared to controls. This suggests that reduced intrinsic muscle activation may compromise stability and performance.

**21. Abbis et al. (2023). Intrinsic foot muscle training interventions: A meta-analysis.**

In a meta-analysis, the authors reviewed evidence on IFM training interventions. Results confirmed significant improvements in foot function and muscle strength following structured programs. These outcomes strengthen the rationale for incorporating IFM training into athletic conditioning.

**22. Baca (1999). Drop-jump performance assessment: Comparing methods of**

**analysis.** This study compared methods of analyzing drop-jump performance. The results demonstrated that force plate measurements provided the most accurate assessment of ground contact and jump metrics. This supports the use of validated instruments such as AMTI force plates for RSI calculations.

**23. Ciacci et al. (2024). RSI RUN: A sprint-specific measure of reactive strength.**

In their study introducing RSI RUN, the authors developed a new sprint-specific measure of reactive strength based on stride length and ground contact time. They found strong correlations between RSI RUN and sprint performance indicators. This demonstrates the importance of adapting RSI to sport-specific demands.

**24. Sulowska-Daszyk et al. (2024). Short foot exercise vs. minimalist footwear: Effects**

**on runners.** Their study compared short foot exercises and minimalist footwear for runners. Both interventions led to improvements in foot muscle morphology and running performance at lactate threshold velocity. The findings suggest that intrinsic muscle training can enhance both structural and functional outcomes.

## **METHODOLOGY AND PROCEDURE**

- 1 STUDY POPULATION:** Elite Sprinters
- 2 STUDY DESIGN:** Observational study
- 3 SAMPLING TECHNIQUE:** Purposive sampling
- 4 SAMPLE CRITERIA:**

**INCLUSION CRITERIA:**

1. Sprinters aged 12-18 participated.
2. Sprinters who ran for 100 meters were included.
3. Their training period was more than 6 months, and they had participated at the district level.

**EXCLUSION CRITERIA:**

1. Participants who had sustained any injury within the previous three months were excluded.
2. Individuals who were not in an active training phase, or those who were untrained or only recreationally trained, were not considered
3. Athletes who experienced discomfort or symptoms such as muscle cramps or soreness that could have influenced their sprinting performance were excluded.

**5 STUDY SETTING:** ABTP, Kalinga Stadium, Bhubaneswar

**6 SAMPLE SIZE:** 80

**7 STUDY DURATION:** 1 year

**□ MATERIALS REQUIRED:**

1. Force Plate
2. 30cm Wooden Box
3. Toe Dynamometer

**Sample Size Calculation:** The formula to calculate the sample size for correlation is:

$$n = [(Z_{\alpha/2} + Z_{\beta})^2 / (\text{Effect Size})^2] + 3$$

Where:

- $Z_{\alpha/2}$  is the critical value of the normal distribution for the significance level. (for  $\alpha=0.05$ ,  $Z_{\alpha/2}=1.96$  for a two-tailed test).
- $Z_{\beta}$  is the critical value for the desired statistical power. (for 80% power,  $Z_{\beta}=0.84$ ).
- Effect size (d) was considered as 0.30; the sample size of 80 sprinters was obtained

**OUTCOME MEASURES:**

- 1) **Reactive Strength Index-** Reactive strength index (RSI) was evaluated using the drop jump test, which is a recognized method for assessing the efficiency of the stretch–shortening cycle in athletes. RSI was calculated as the ratio of jump height to ground contact time, with higher values reflecting superior neuromuscular efficiency and explosive capacity. For the test, participants stepped from a standardized box height. They performed a maximal vertical jump immediately upon landing, while contact time and jump height were recorded using an electronic jump mat. Previous studies have reported that RSI demonstrates high reliability for monitoring reactive ability in both youth and adult populations ( $ICC > 0.90$ ) <sup>(4,10)</sup>. In the present study, it served as the primary outcome variable to represent lower-limb reactive performance in sprinters.
  
- 2) **Intrinsic Foot Muscle Strength-** Intrinsic foot muscle strength was assessed using a hand-held dynamometer, which provides an objective and reliable method of evaluating the force generated by the small muscles located within the foot. These muscles play a critical role in stabilizing the medial longitudinal arch, supporting balance, and assisting in propulsion during sprinting and jumping activities. Testing was conducted separately for the left and right feet. This method provides an objective way to capture the contribution of the small foot muscles that stabilize the arch and support propulsion. Earlier studies have demonstrated good reliability for this tool ( $ICC > 0.85$ ) <sup>(12,13)</sup>.

## Instruments to be used for outcome measures

- 1) **Toe Dynamometer**- The intrinsic foot muscle (IFM) strength was measured using a handheld toe dynamometer. The instrument measures the peak isometric force produced while flexing the toes. It is lightweight, simple to use, and can be utilized in clinical and sports environments. The tool has been described as having good reliability in the past ( $ICC > 0.85$ ) and can be used as a reliable means of measuring small muscle groups in the foot <sup>(12,13)</sup>.



- 2) **AMTI Force Plate**-An AMTI force plate was used to test the Reactive Strength Index (RSI) via the drop jump test. The platform measures ground reaction forces and precisely records contact time and flight time. These measures are utilized to compute RSI. The AMTI force plate is commonly cited as a gold-standard tool in biomechanics studies because of its high accuracy and reproducibility



## **PROCEDURE**

### **Ethical Considerations**

Before data collection, ethical clearance was obtained from the Institutional Ethical Committee. Athletes who met the inclusion criteria were recruited, and informed consent was taken from each participant. For those under 18 years, consent was also obtained from their parents or guardians.

All participants first completed a standard warm-up session to prepare for testing and reduce injury risk.

## **Test Procedures**

### **Reactive Strength Index (RSI)**

RSI was measured using a drop jump test on an AMTI force plate. Each participant stepped off a 30 cm box, landed on the force plate, and immediately performed a vertical rebound jump with maximum effort. A one-minute rest interval was provided between trials to allow adequate recovery. For each drop jump, participants were instructed to step forward off the box naturally, without pushing off or jumping upward, and upon landing on the force platform, to rebound vertically as high and as quickly as possible. Performance data were collected using the AMTI Force Plate. The Reactive Strength Index (RSI) was calculated using the formula:

$$RSI = JH / GCT$$

where *RSI* represented the reactive strength index, *JH* denoted jump height, and *GCT* referred to ground contact time.

### **Intrinsic Foot Muscle Strength**

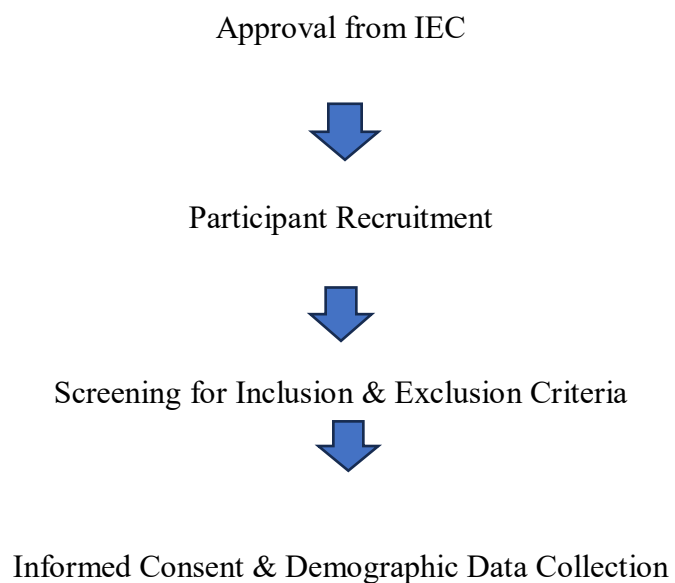
For the intrinsic foot muscle assessment, participants first performed two familiarization trials in a supine hook-lying position to ensure proper understanding of the isometric toe flexion task. Following familiarization, each participant completed three recorded trials of maximal isometric toe flexion using the Intrinsic Foot Muscle Toe Dynamometer. A 30-second rest period was provided between each toe-pressing effort for each foot. Additionally, a

five-minute rest interval was maintained between assessors. All assessors remained blinded to each other's results to reduce bias and ensure objectivity.

### **Data Collection and Analysis**

Data were systematically recorded during all test sessions. The collected values for IFM strength and RSI were then subjected to statistical analysis using SPSS software. The results were interpreted to identify the correlation between intrinsic foot muscle strength and the reactive strength index.

## **PROCEDURE FLOW CHART**





Standardized Warm-up (Jogging + Dynamic Stretches)



Intrinsic Foot Muscle Strength Testing

(3 Trials per Foot using Dynamometer)



Reactive Strength Index Testing

(Drop Jumps on Force Platform/Jump Mat, 3 Trials)



Data Recording & Documentation



Statistical Analysis

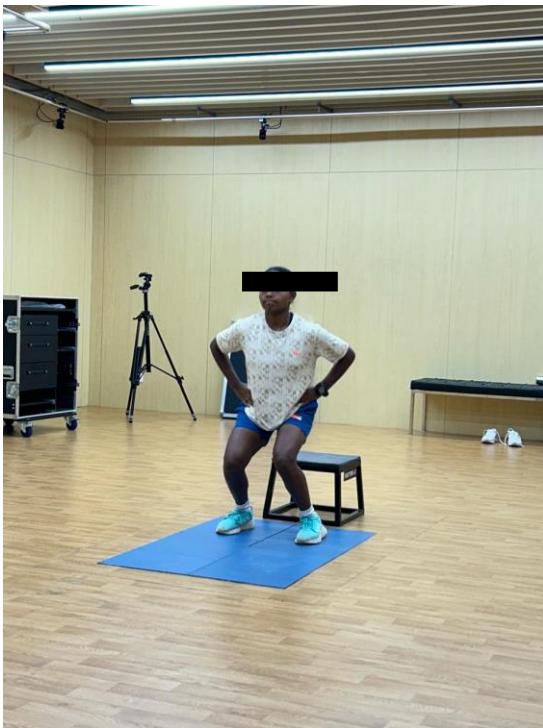
**Fig 1,2,3-IFM strength Testing**





**Fig 4,5,6- RSI Testing**





## **STATISTICAL ANALYSIS**

Data analysis was performed using IBM SPSS Statistics software. The Shapiro-Wilk test was used to assess the normality of the data. Spearman's rank correlation coefficient ( $r$ ) was used to correlate intrinsic foot muscle strength with the reactive strength index in sprinters. The level of significance was set at  $p < 0.05$ .

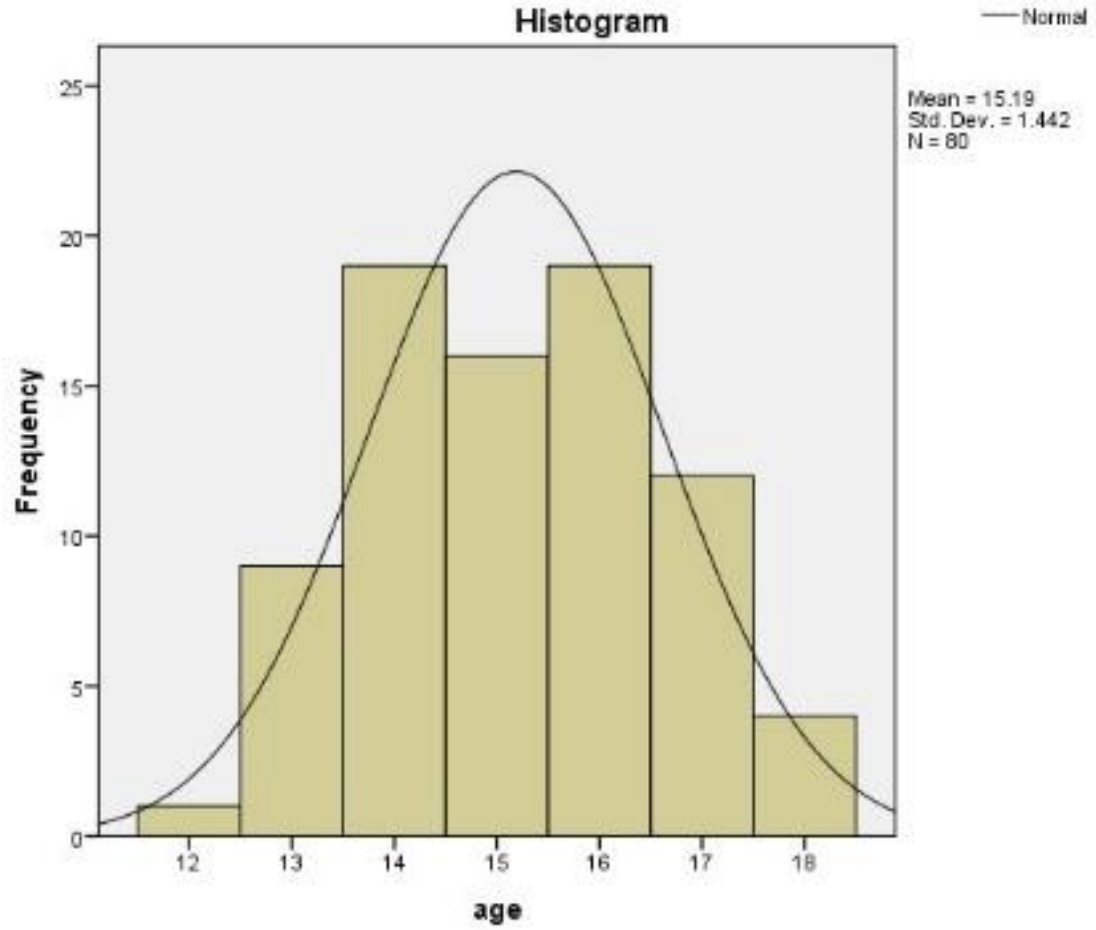
## **RESULT**

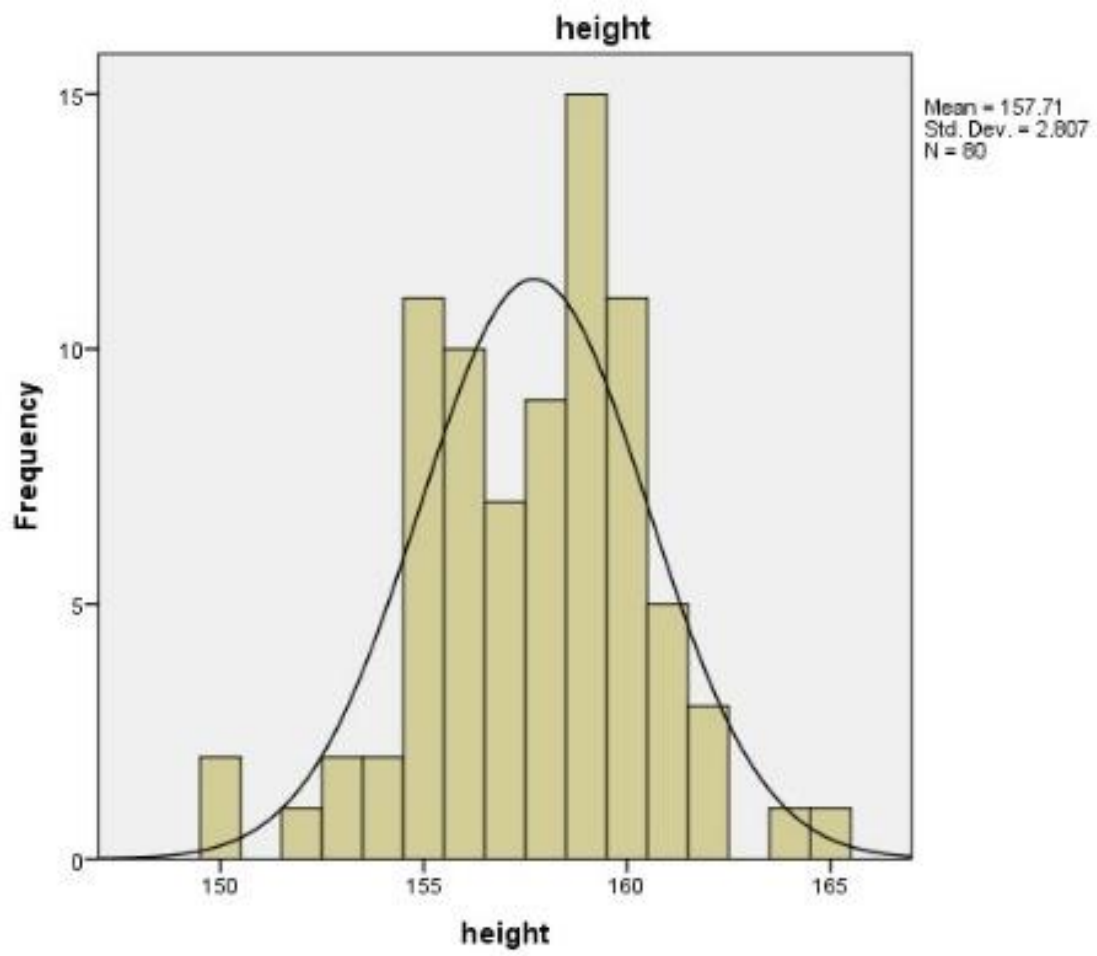
A total of 80 sprinters were involved in the research, with an average age of 15 years [range (IQR)- 2.0: 12–18 years]. The participants' average height was  $157.71 \pm 2.80$  cm (range: 150–160 cm), and average body weight was 50 kg [range (IQR) 10: 38–61 kg]. There was greater intrinsic foot muscle strength for the left foot 6.1 than the right foot 5.35. The average Reactive Strength Index (RSI) was 1.18 [range (IQR) 0.49: 0.50–2.39]

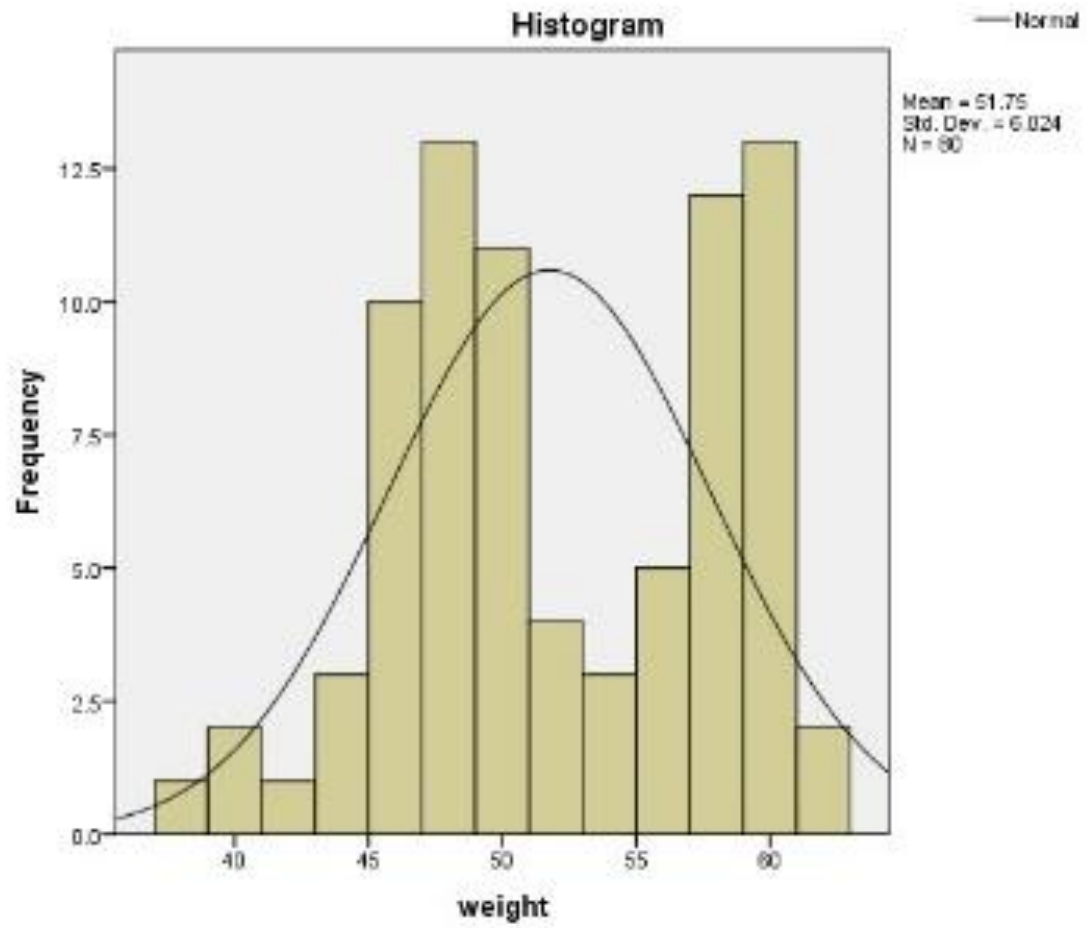
**Table 1. Descriptive statistics of participants**

Variable	SAMPLE (N=80)	P- VALUE
Age (years)		
[Median (IQR)]	15 (2.0)	.001
Height (cm)		
[Mean $\pm$ SD]	157.713 $\pm$ 2.807	.074
Weight (Kg)		
[Median (IQR)]	50(10)	<.001
Intrinsic Foot Muscle Strength (Left Foot)		
[Median (IQR)]	6.1(1)	<.001
Intrinsic Foot Muscle Strength (Right Foot)		
[Median (IQR)]	5.35 (1.4)	<.001
Reactive Strength Index (Value)		
[Median (IQR)]	1.18(0.49)	.005

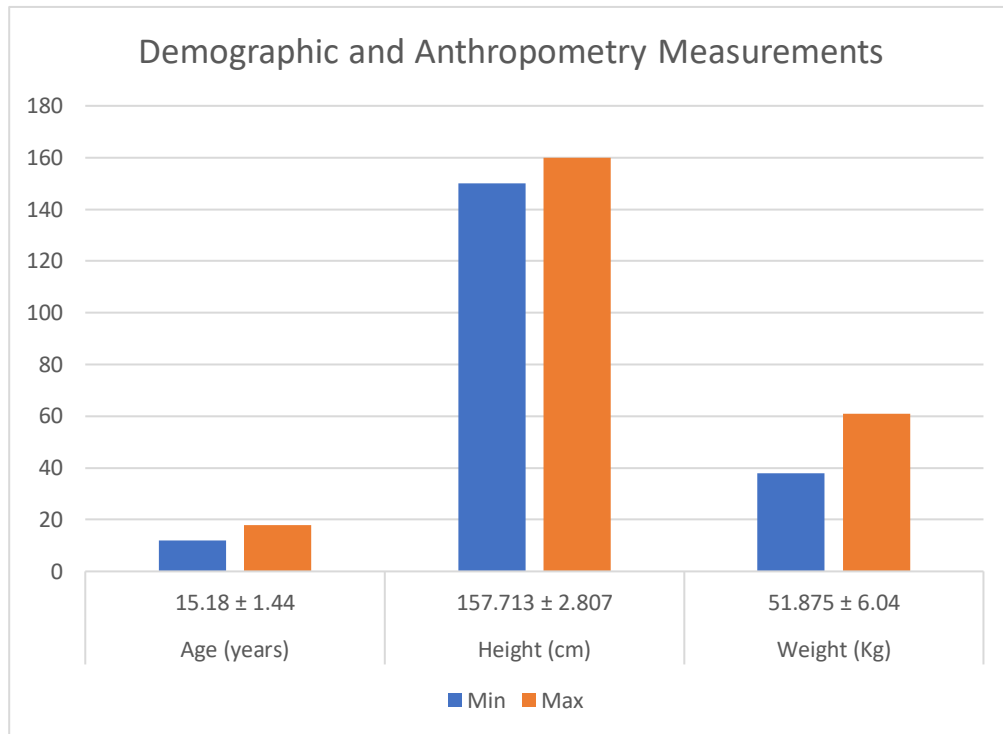
**Graph 1. Normality graph of Age, Height, Weight**







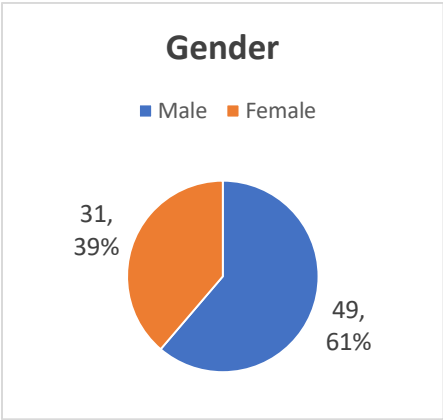
**Graph 2. Demographic and Anthropometric Measurements**



**Table 2. Sex distribution**

Frequencies for SEX		
SEX	Frequency	Percent
F	31	38.75
M	49	61.25
Total	80	100

**Chart1. Chart for Gender**



The Shapiro-Wilk test of normality revealed that both pairs of variables—Left Foot Strength and RSI ( $W = 0.945, p < 0.001$ ) and Right Foot Strength and RSI ( $W = 0.950, p < 0.001$ )—were significantly different from a normal distribution. Therefore, non-parametric Spearman's rank correlation was done for further analysis.

**Table 3. Normality Testing**

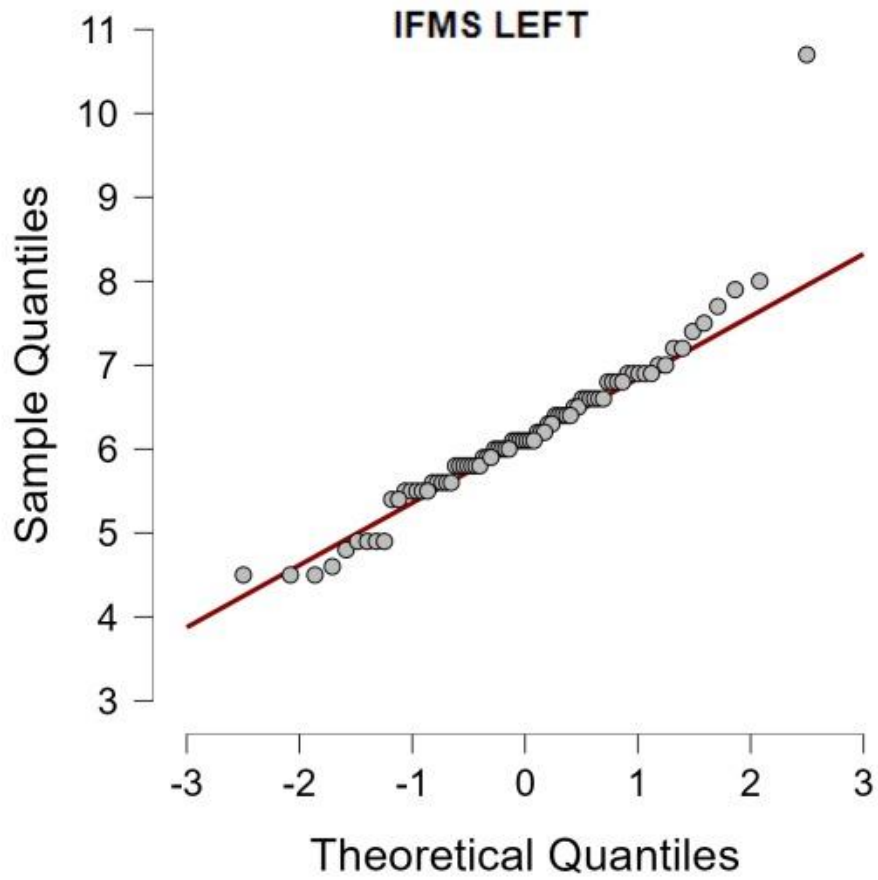
<b>Variable Pair</b>	<b>W Statistics</b>	<b>p-value</b>
Left Foot Strength - RSI	0.945	<0.001
Right Foot Strength - RSI	0.95	<0.001

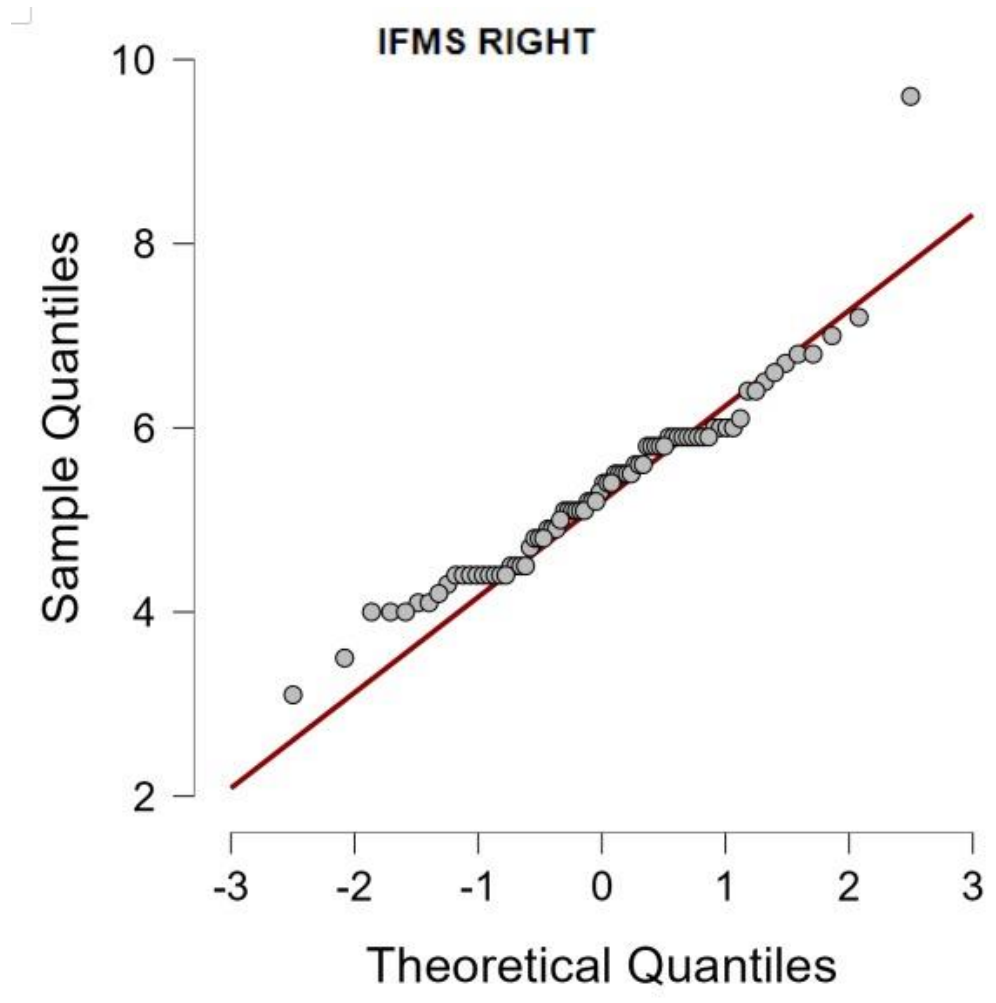
Correlation analysis indicated that left foot intrinsic muscle strength was moderately and positively correlated with RSI ( $\rho = 0.457$ ,  $p < 0.001$ , effect size = 0.494), showing that greater left foot muscle strength was significantly correlated with greater RSI values. Conversely, the right foot had a weaker but statistically significant sub-moderate correlation ( $\rho = 0.261$ ,  $p = 0.019$ , effect size = 0.267). This indicates that greater intrinsic foot muscle strength in the left foot was correlated with a higher RSI value.

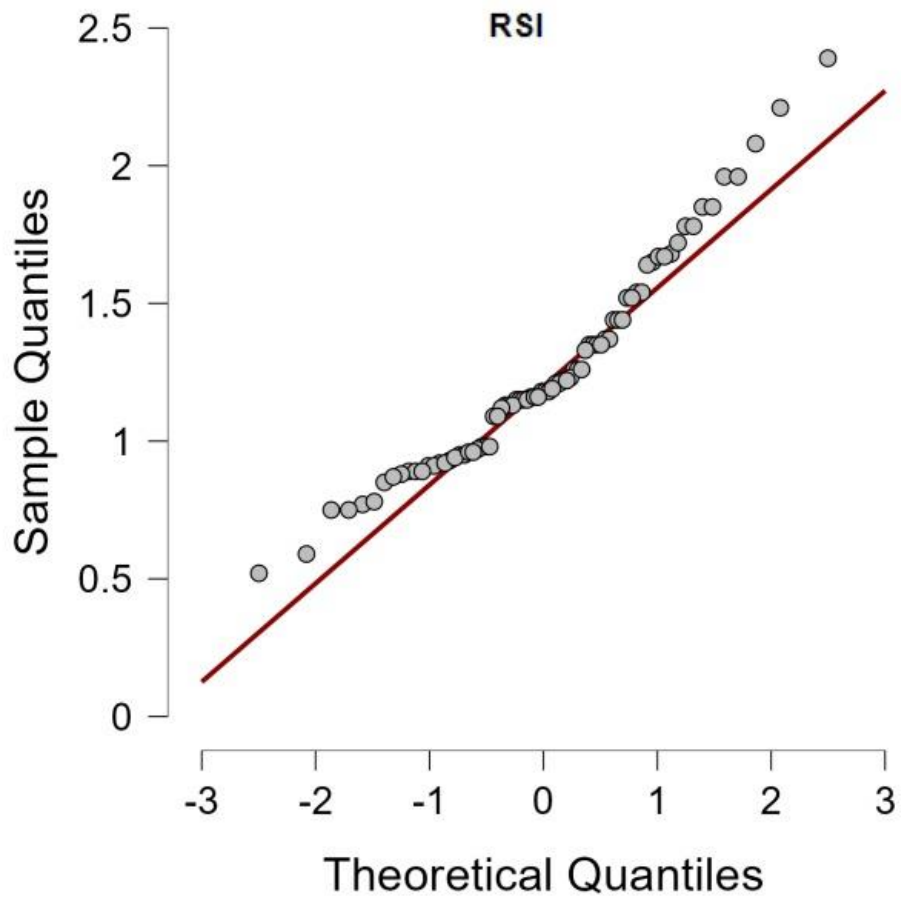
**Table 4. Correlation Analysis**

Variable Pair	Correlation Coefficient (Spearman's rho $\rho$ )	p-value	effect size
Left Foot – RSI	0.457	0.001	0.494
Right Foot – RSI	0.261	0.019	0.267

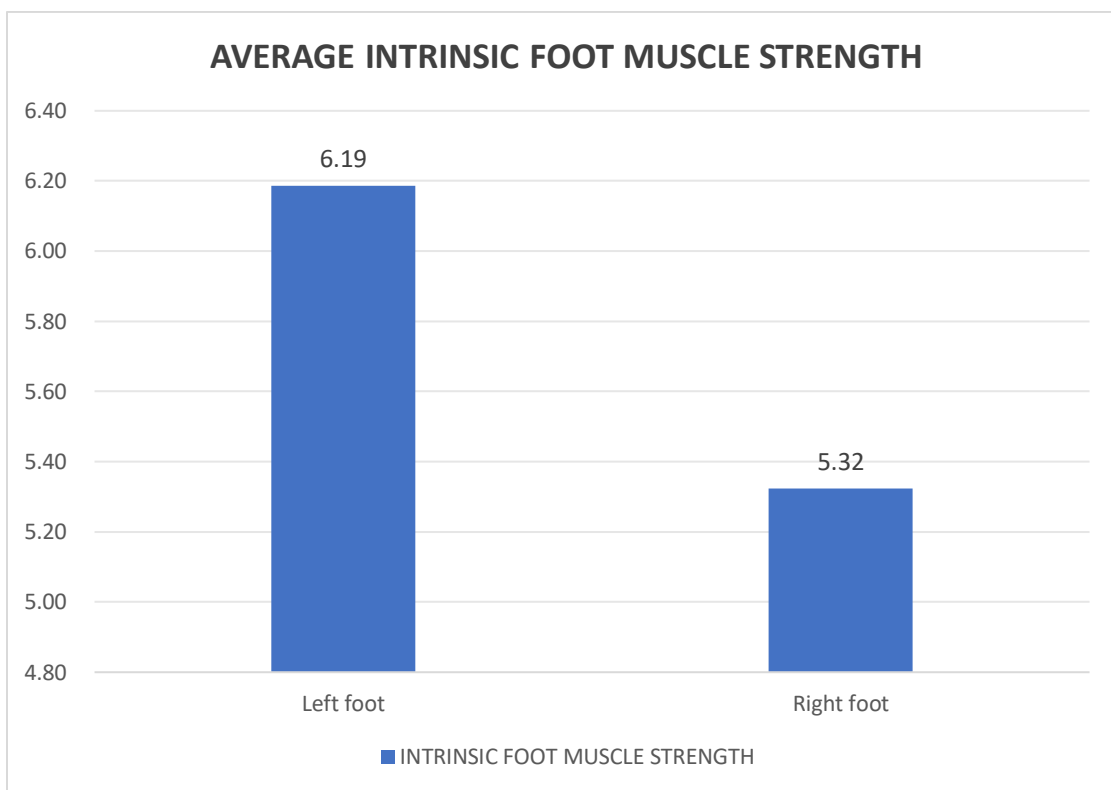
Graph 2- Q-Q (Quantile-Quantile) plot for IFM strength left and right, RSI

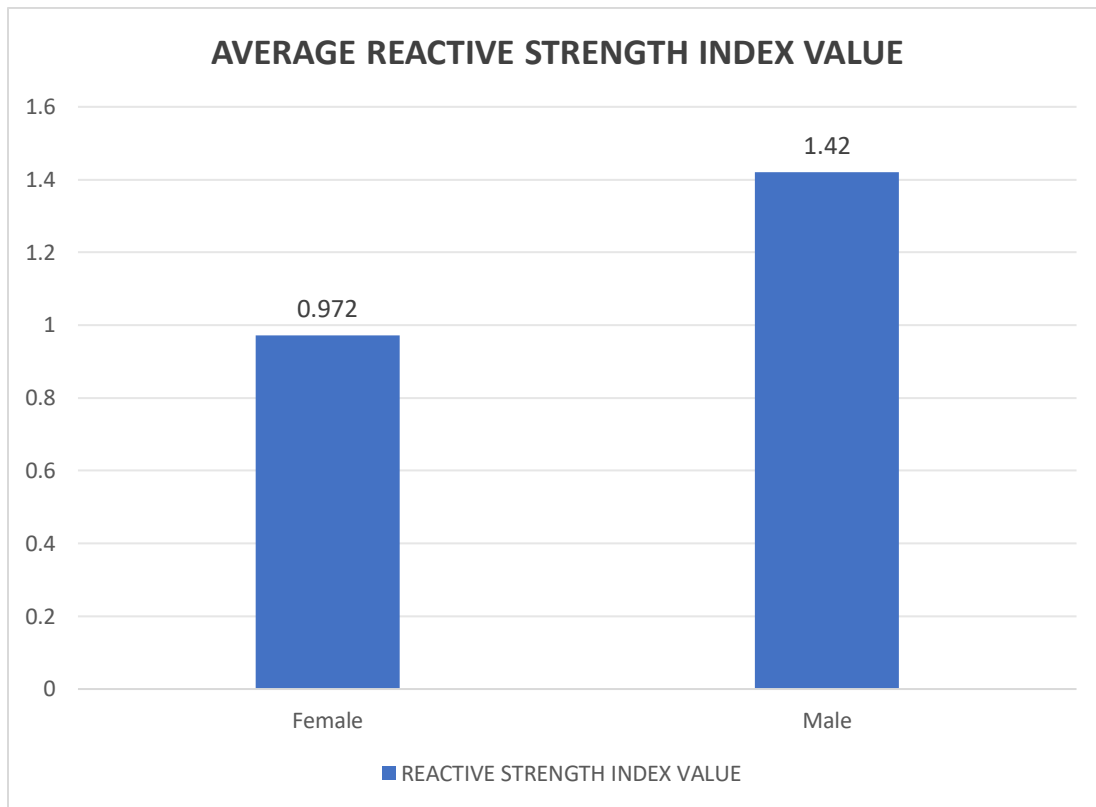






**GRAPH 3- AVERAGE IFM STRENGTH AND REACTIVE STRENGTH INDEX VALUE**





## **Discussion**

This study shows the relationship between intrinsic foot muscle (IFM) strength and reactive strength index (RSI) among sprinters aged 12 to 18 years. The outcome measures included IFM strength, assessed with a dynamometer, and RSI, derived from drop jump performance on a force platform. The results demonstrated a positive relation between the two variables, showing that participants with stronger intrinsic foot muscles were able to produce higher RSI values. These findings highlight the contribution of the "foot core" to explosive movements like sprinting and jumping—a field that has not been investigated as widely as the impact of the larger muscles in the lower limb. By turning attention to these small stabilizing muscles, the findings bring a new dimension to the biomechanics of sprinting.

The research started with the supposition that stronger IFM would be associated with improved RSI scores. This expectation was confirmed in that left foot strength had a moderate and statistically significant correlation with RSI, while right foot strength had a weaker yet still significant relationship. The RSI scores obtained in the present study were similar to those documented in previous studies on young sprinters <sup>(10)</sup>, whose validation of RSI as a reliable measure during drop jump protocols was confirmed. Likewise, the levels of IFM strength. The findings in the current study were aligned with those of <sup>(13)</sup>, which showed the reliability of using dynamometry to assess foot muscle output. The current findings also mirror the study of Yamauchi (2020), where athletes with greater toe flexor strength were capable of generating higher ground reaction forces and better jump

capabilities<sup>(14)</sup>. Collectively, these comparisons help to support the contention that IFM strength plays a significant part in explosive sporting performance.

Beyond the straight results, the study highlights the significance of taking into account smaller stabilizing muscle groups in sprint training regimens. Classic conditioning for sprinters tends to focus most on the hamstrings, quadriceps, and gluteal muscles, but the evidence in this case indicates that the intrinsic foot muscles contribute significantly, too, to reactive performance. This aligns with Hollman et al. (2022), who demonstrated that foot core training might improve running and jumping capacity as well as reduce the risk of injury<sup>(15)</sup>. Taken collectively, these results confirm the perspective that the strength of IFM should not be merely regarded as an assisting factor but also as a performance-enhancing element deserving of intentional training.

## **CONCLUSION**

In this observational study, the reactive strength index (RSI) and intrinsic foot muscle strength (IFMS) in juvenile sprinters were found to be strongly positively correlated, with left foot strength being a better predictor of reactive capability than right. These results underscore the functional significance of intrinsic foot muscles for sprint performance, with their role in supporting arch stability, energy transfer, and efficiency of the stretch-shortening cycle. Although the cross-sectional design of this study restricts causal inference, the findings imply that focused strengthening of the intrinsic foot muscles may help enhance reactive strength and sprint performance. Prospective longitudinal and intervention research is warranted to confirm these findings in larger cohorts and to investigate their implications for training, rehabilitation, and prevention of injury in athletes. These findings highlight the function of the "foot core" in explosive movements like sprinting and jumping—a topic not investigated as much as the role of the larger muscles in the lower limb. By moving attention to these small stabilizing muscles, the results bring new insight to the biomechanics of sprinting.

The research started with the following hypothesis that higher IFM strength would correlate with improved RSI scores. The findings confirmed this expectation, with strength on the left foot revealing a moderate and statistically significant relationship with RSI, and right foot strength revealing a weaker but still significant correlation. The RSI values

obtained in this study were similar to those found in previous research on young sprinters<sup>(10)</sup>, who legitimized RSI as a reliable measure in drop jump tests. Likewise, the IFM strength values observed herein concurred with those of Xu, Goss, and Saliba (2023), who showed the reliability of dynamometry to assess foot muscle output<sup>(13)</sup>. The current findings also resonate with the work of Yamauchi (2020), where it was reported that individuals with stronger toe flexors could generate larger ground reaction forces and better jump performance<sup>(14)</sup>. Collectively, these comparisons affirm the argument that IFM strength has a meaningful contribution to make in explosive athletic performance.

Looking beyond the immediate outcomes, the research highlights the value of including smaller stabilizing muscle groups in sprint training protocols. Conventional sprinter conditioning tends to focus primarily on the hamstrings, quadriceps, and gluteal muscles, but the findings here indicate that the intrinsic foot muscles also contribute significantly to reactive performance. This aligns with Hollman et al. (2022), who demonstrated that foot core training could improve running and jumping performance as well as reduce the risk of injuries<sup>(15)</sup>. Combined, this evidence supports the argument that IFM strength should not only be regarded as an auxiliary factor but also a performance-increasing component worth intentional training.

**LIMITATION AND RECOMMENDATION FOR FUTURE SCOPE**

This investigation has some limitations that need to be considered. First, because it used a cross-sectional observational design, the findings only show an association between intrinsic foot muscle strength and reactive strength index (RSI) and cannot prove cause and effect. Second, the participants were all adolescents within a fairly narrow age range, which makes it difficult to apply these results to older athletes, elite sprinters, or those from different sporting backgrounds.

Another limitation lies in the way IFM strength was measured. Although dynamometry is widely accepted as reliable and valid, it may not fully reflect how these muscles work during fast and dynamic tasks like sprinting or jumping. Second, other potential factors, including training background, strength of the larger lower-limb muscles, and coordination patterns, were not controlled in the analysis. Although anthropometric information like height and weight was taken, their effects on RSI performance were not directly examined. Finally, the study did not control for foot preference or performance asymmetry, which may have influenced the stronger relationship of left foot strength over right.

## **FUTURE SCOPE**

Future studies should be based on interventional designs to determine if training specific intrinsic foot muscles can enhance RSI and sprint performance directly. Research with larger and more diverse groups of athletes, including elite sprinters and across a range of ages, would enhance generalizability. More sensitive assessment tools, including ultrasound or pressure plate measures, could provide a better insight into the function of foot muscles in dynamic activity. Exploring variables such as foot dominance, asymmetry, and lower-limb biomechanics can potentially illuminate the contribution of intrinsic foot strength to reactive performance and prevention of injury.

## **SUMMARY**

This study sought to explore the relationship between the intrinsic strength of foot muscles and the reactive strength index (RSI) for adolescent sprinters. Eighty subjects in the age group 12-18 years participated, with right and left foot intrinsic foot muscle strength measured along with RSI values. The main objective was to find out if intrinsic foot muscle strength affects reactive performance in a significant way, which is a major factor that determines the efficiency of sprinting.

The results showed that left foot muscle strength had a moderate and statistically significant positive correlation with RSI, while right foot strength displayed only a weaker, sub-moderate correlation.

These findings demonstrate the functional significance of intrinsic foot musculature in the performance of reactive strength. The research implies that training the intrinsic musculature of the foot, specifically through specific training protocols, could augment explosive capability, sprint performance, and perhaps lessen the risk for injury. These findings underscore that foot-specific conditioning should be given equal consideration to traditional strength and plyometric training for sprint athletes.

**STATEMENT OF FUNDING**

Source of funding: NIL

Nature of funding: NIL

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## **ANNEXURES**



**ABSMARI**

# ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,  
BHUBANESWAR, ODISHA

CDSOReg. No.: ECR/1981/Inst/OD/24

Prof. (Dr.) E. Venkata Rao  
Chairperson

Mr. Chinmaya Kumar Patra  
Member Secretary

Ref. No. ABSMARI/IEC/2025/147

Date: 02/05/2025

**APPROVAL LETTER**  
**APPENDIX- VIII**

To,

**SHARON PANDA**  
ABSMARI  
273, PAHAL, BHUBANEWAR-752101

**Protocol Title: Correlation between Intrinsic Foot Muscle Strength and Reactive Strength Index in Sprinters – An Observational Study**

**Protocol ID.:** ABS-IEC-2025-PHY-073

**Subject:** Approval for the conduct of the above referenced study

Dear **Mr./Ms./Dr Sharon Panda**

With reference to your Submission letter dated 06/01/2025 the ABSMARI IEC has reviewed and discussed your application for conduct of the study on dated 25/04/2025.

The following documents were reviewed and discussed

S.N.	Documents	Document (Version/Date)
1	IEC Application Form	25/04/2025
2	Informed Consent Form	25/04/2025
3	Undertaking form PI	25/04/2025
4	CRF	25/04/2025
5	COI from the Investigators	25/04/2025

MEMBERS
<b>Dr. Smaraki Mohanty</b> Clinician
<b>Dr. Satyajit Mohanty</b> Scientific Member
<b>Mr. Shib Shankar Mohanty</b> Legal Expert
<b>Ms. Annie Hans</b> Social Scientist
<b>Ms. Subhashree Samal</b> Lay Person
<b>Mr. Deepak Ku. Pradhan</b> Scientific Member
IEC-SECRETARIAT
<b>Mr. Gouranga Ku. Padhy</b> <b>Mr. Susant Ku. Raychudamani</b>

The following members were present at meeting held on 25-04-2025



1



Utkal Signature, Plot No.-273,  
Ground Floor, Pahal, Bhubaneswar-752101

+91-63707-03654



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**ABSMARI**

# ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,  
BHUBANESWAR, ODISHA

CDSO Reg. No.: ECR/1981/Inst/OD/24

Prof. (Dr.) E. Venkata Rao  
Chairperson

Mr. Chinmaya Kumar Patra  
Member Secretary

Ref. No. ABSMARI/IEC/2025/147

Date: 02/05/2025

### MEMBERS

**Dr. Smaraki Mohanty**  
Clinician

**Dr. Satyajit Mohanty**  
Scientific Member

**Mr. Shib Shankar Mohanty**  
Legal Expert

**Ms. Annie Hans**  
Social Scientist

**Ms. Subhashree Samal**  
Lay Person

**Mr. Deepak Ku. Pradhan**  
Scientific Member

### IEC-SECRETARIAT

**Mr. Gouranga Ku. Padhy**  
**Mr. Susant Ku. Raychudamani**

S.N.	Name of the Member	Designation & Qualification	Representation as per NDCT 2019	Gender (M/F)	Affiliation with the Institution (Y/N)
1	Prof. Dr. E. Venkata Rao	Professor (MBBS, MD, Dept. of Community Med.) IMS & Sum Hospital, BBSR	Chair Person	M	N
2	Dr. Smaraki Mohanty	Asst. Prof-IMS & Sum Hospital/MBBS, MD (Community Med)	Clinician	F	N
3	Mr. Shiba Sankar Mohanty	Junior Counsel-Lt. Ramachandra Sarangi's Chamber / BA LLB	Legal Expert	M	N
4	Mr. Chinmaya Kumar Patra	Principal-ABSMARI, MPT	Member Secretary	M	Y
5	Ms. Annie Hans	Disability Inclusive Development Co-Ordinator in Humanity and Inclusion (India/Nepal/Srilanka). /MA in Social Work	Social Scientist	F	N
6	Ms. Subhashree Samal	Ref. Reader-Pol Sc.	Lay Person	F	N
7	Mr. Deepak Kumar Pradhan	Asst. Prof-ABSMARI, MPT	Scientific Member	M	Y

This is to confirm that only members who are independent of the Investigator and the Sponsor of the trial have voted/ provided opinion on the trial.

**This Committee approves the documents and the conduct for the study in the presented form with necessary recommendation.**

The ABSMARI IEC must be informed about the progress of the study in the prescribed format attached, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent/assent and request to provide a copy of the final report.

The ABSMARI IEC follows procedures that are in compliance with the requirements of ICH (International Conference on Harmonization) guidance related to GCP (Good Clinical Practice) and applicable Indian regulations.

Yours sincerely,

Mr. Chinmaya Kumar Patra  
Member Secretary

ABSMARI Ethics Committee

Pahal, Bhubaneswar  
Member Secretary

ABSMARI ETHICS COMMITTEE



2

Utkal Signature, Plot No.-273,  
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Appendix - XVIII

ASSENT FORM

(Supplement to informed consent form — for children 12 — 18 years of age)

Study Title: CORRELATION BETWEEN INTRINSIC FOOT MUSCLE STRENGTH AND REACTIVE STRENGTH INDEX IN SPURTERS  
: An observational study

Study Number:

Investigator's Name: Sharon Panda

Details of the participant subject -

Subject's Name:

Subject's Initials:

Date of Birth / Age:

Address of the Subject:

Qualification:

Occupation: (If any)

Part 1:

1. Introduction

*I am going to give you information and invite you to be part of a research study. You can choose whether you want to participate. We have discussed this research with your parent(s)/legal guardian, and they know that we are also asking you for your agreement. If you are going to participate in the research, your parent(s)/guardian must also agree. But if you do not wish to take part in the research, you do not have to, even if your parents have agreed.*

*You may discuss anything in this form with our parents or friends or anyone else you feel comfortable talking to. You can decide whether to participate or not after you have talked it over. You do not have to decide immediately.*

*There may be some words you don't understand or things that you want me to explain more about because you are interested or concerned. Please ask me to stop at any time, and I will take the time to explain.*

2. Purpose of the study: Intrinsic foot muscle helps to provide stability and flexibility for shock absorption and the reactive strength index increases sprint performance. However, no studies have examined the impact of intrinsic foot muscle strength on the reactive strength index in sprinters.

Knowing this relation will help to understand the components that can alter the reactive strength index and help in injury prevention and performance orientation. So, this study needs to be conducted.

3. Choice of participants: Elite Sprinters

4. Participation is voluntary.

4. Participation is voluntary:

5. Procedure: **Participants:** Competitive sprinters aged 12-18, with at least 6 months of training experience, and no recent foot injuries.

**Informed Consent:** Participants will be fully informed about the study and will give consent voluntarily.

2. **Pre-testing procedure-** conduct initial screening (health, injury history, etc.)

### 3. Intrinsic Foot Muscle Strength Assessment

**Method:** Foot strength will be measured using an isometric dynamometer.

**Procedure:** Participants perform maximum isometric contractions of the foot's intrinsic muscles while seated. Three trials are done per foot, and the highest value is recorded.

### 4. Reactive Strength Index (RSI) Measurement

**Method:** A drop jump test will assess RSI by measuring jump height and ground contact time.

**Procedure:** Participants drop from a platform, immediately jumping as high as possible. The jump height and contact time are recorded to calculate RSI using the formula:

$$RSI = \frac{\text{Jump Height}}{\text{Ground Contact Time}}$$

6. **Risks:** There will be no risk in this study; we will take a proper warm-up session before the study.

7. **Discomforts:** Will during the research if you fell any discomfort, please let me know immediately

8. **Benefits:** Is there anything good that happens to me?

9. **Reimbursements:** No reimbursement will be provided.

10. **Confidentiality:** your data will be kept secure.

11. **Compensation details:** if you get hurt during the study, treatment will be provided by me.

12. **Sharing the Finding:** post-study, your result will be shared.

13. **Right to Refuse or Withdraw:** Can I choose not to be in the research? Can I change my mind?

14. **Whom to Contact:** You can contact me.



Print the Name of the Person who explained the form:

Signature of Person who explained this form: \_\_\_\_\_ Date: \_\_\_\_\_

Part 2:

**Certificate of Assent**

I / my parent or legal guardian has read the previous page(s) of the consent form, and the investigator has explained the details of the study.

I/my parent, or legal guardian, understand that I am free to ask additional questions.

I/my parent or guardian understands that participation in this study is voluntary

I/my parent, or legal guardian may refuse to participate or may discontinue participation at any time without penalty, loss of benefits, or prejudice to the quality of care which I will receive.

I/my parent or legal guardian, acknowledge that no guarantees have been made to me regarding the results of the treatment involved in this study, and I agree to participate in the study and have been given a copy of this form.

Statement by the Child

Print the name of the child:

Signature of child: \_\_\_\_\_ Date: \_\_\_\_\_

parent's or legal guardian's name:

signature of parent or legal guardian: \_\_\_\_\_ Date: \_\_\_\_\_

***If illiterate:***

A literate witness must sign (if possible, this person should be selected by the participant, not be a parent, and should have no connection to the research team). Illiterate participants should include their thumbprint as well.

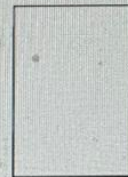
I have witnessed the accurate reading of the assent form to the child, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print name of impartial witness (not a parent): \_\_\_\_\_

Thumbprint of participant

Signature of witness \_\_\_\_\_

Date \_\_\_\_\_



**Statement by the researcher/person taking assent**

I confirm that the child and respective parents or legal guardian were allowed to ask questions about the study, and all the questions asked by him/her have been answered correctly and to the best of my ability. I confirm that they have not been coerced into giving assent, and the assent has been given freely and voluntarily.

A copy of this assent form has been provided to the participant.

Print Name of Researcher/person taking the assent \_\_\_\_\_

Signature of Researcher /person taking the assent \_\_\_\_\_

Date \_\_\_\_\_

# MASTERSHEET

1	NAME	AGE	SEX	WEIGHT	HEIGHT	INTRINSIC FOC	INTRINSIC FC	REACTIVE	STRENGTH INDEX	VALUE
2	Bhumiya Toppo	13	F	42	155		6.2	5.8		0.77
3	Smriti Ekka	14	F	40	156		5.8	5.9		0.78
4	Urmila Bharasagria	13	F	38	150		4.3	4.3		0.32
5	Kairi Pingul	14	F	40	155		4.9	4.7		0.75
6	Rutu Panbia	15	F	53	159		5.5	4.9		0.89
7	Tanuja Barla	14	F	48	156		5.8	5.9		0.89
8	Sujata Mallik	13	F	45	155		6.9	6.7		0.52
9	Anushka Ghadei	14	F	49	156		7.9	4.5		0.88
10	Barsha Durei	15	F	53	160		8	9.6		1.13
11	Aarti Pradhan	16	F	54	159		6.4	5.2		0.59
12	Ankita Suna	15	F	52	156		6.3	4.4		1.68
13	Archita Dhala	13	F	46	152		6.4	4		0.85
14	Champa Bhutua	14	F	45	155		4.9	5.1		0.91
15	Kavita Tadingi	15	F	47	157		4.6	5.4		1.18
16	Sushree Swagatika Samantraya	16	F	52	156		6.1	5.9		0.95
17	Jeena Majhi	14	F	48	158		6.9	5.1		1.54
18	Raj Mallik	17	M	58	161		4.5	6		1.09
19	Pratyusha Maharana	14	F	45	158		4.5	3.1		1.26
20	Dev Sarkar	15	M	59	160		5.6	6		1.44
21	Srinath Murnu	16	M	61	162		7.4	7.2		1.96
22	Satyajeet Mohapatra	15	M	55	159		6	6.8		1.37
23	Sai Pritam Sahu	16	M	56	160		6.6	7		1.35
24	Aruna Barik	14	F	46	158		5.6	4.5		1.15
25	Rohan Kumar Das	17	M	60	160		7.5	5.3		0.98
26	Surai Marandi	18	M	60	165		10.7	4.4		2.08
27	Rutuparna Biswal	15	F	50	159		6.5	3.5		0.93
28	Tuna Majhi	16	M	57	159		7	6.5		1.22
29	Birendra Kumar Sahu	14	M	48	156		7.2	5.5		1.85
30	Mahendra Hansda	16	M	59	160		7.5	5.5		2.39
31	Basant Gadnayak	15	M	50	158		5.8	4.5		1.15
32	Bibun Mali	14	M	49	159		5.5	4.5		1.26
33	Soumya Routray	17	F	55	161		4.5	4		0.98
34	Krishna Nayak	16	M	55	160		6.6	5.5		1.18
35	Gupta Nayak	17	M	58	161		6	5.5		1.23
36	Goutam Mali	15	M	52	158		6.4	4.4		1.52
37	Mantu Nayak	14	M	48	157		6.5	5.8		1.72
38	Sahil Kuldeep	13	F	45	156		5.6	4.1		1.18
39	Pratyusha Khora	15	F	48	158		5.4	4.4		0.91
40	Abhishek Htal	16	M	59	159		6.1	5.9		1.21
41	Gaytri Pangi	17	F	50	158		4.9	5.1		0.97
42	Namrita Mali	16	F	51	154		5.8	4.4		0.75
43	Bidisha Samal	13	F	43	155		6.6	5.9		1.13
44	Sai Sradha	16	F	49	159		7.7	6		1.15
45	Dibyani Khora	16	M	48	156		6.3	4.4		0.92
46	Subhani Singh	14	F	46	155		5.9	4.9		0.95
47	Subhasmita Mali	16	F	50	159		5.8	5.9		0.89
48	Sarita Nayak	13	F	45	153		5.4	4.9		0.94
49	Sabitri Bag	16	F	48	160		6.1	5.8		0.87
50	Salomi Khora	14	F	46	155		6.4	4		1.13
51	Prabhas Nayak	15	M	50	159		6.1	5.4		1.54
52	Shubham Behera	12	M	45	153		6.4	5.6		1.16
53	Sai Patnaik	17	M	58	159		6.9	5.1		1.44
54	Rohan Khora	16	M	57	157		6.6	5.9		1.35
55	Adarsh Patnaik	15	M	49	158		6	6.8		1.37
56	Raj Khosla	13	M	43	155		7.2	6.4		1.96
57	Akash Khora	17	M	59	162		5.9	4.9		1.28
58	Kadesh Hartian	16	M	58	159		6.8	5.5		1.85
59	Som Prakash Nahak	13	M	43	150		5.8	4.4		1.21
60	Rudra Narayan Nanda	14	M	47	154		6.1	5.4		0.98
61	Harish Mali	15	M	57	157		6.2	5.8		0.96
62	Jayesh Bhatra	17	M	58	158		6.8	5.2		1.15
63	Kabir Khandpan	16	M	57	159		6.9	5.1		1.52
64	Manoj Gouda	16	M	59	157		6.6	5		1.35
65	Devendra Gouda	17	M	60	160		6.2	5.6		1.65
66	Deepak Gouda	14	M	48	157		5.8	4.4		0.96
67	Bikash Nayak	15	M	58	155		5.6	4.1		1.12
68	Chiranjib Pujan	16	M	59	156		6	5.6		1.19
69	Gourav Nayak	18	M	61	164		6.6	5		1.78
70	Paresh Muduli	17	M	59	160		7	6.4		2.21
71	Narendra Gouda	16	M	57	159		6.9	5.1		1.64
72	Nirad Jani	14	M	50	156		5.9	4.8		1.33
73	Niranjan Gouda	17	M	58	161		6.1	5.8		1.67
74	Prangashu Nag	18	M	60	162		6.9	6.6		1.78
75	Prince Hantal	14	M	50	155		5.8	4.4		1.16
76	Asit Nayak	15	M	56	159		5.5	5.9		1.16
77	Reemil Lugun	16	M	59	160		6	5.9		1.22
78	Amit Bhola	14	M	48	155		5.5	4.2		1.09
79	Sandeep Marandi	17	M	60	160		6.1	5.2		1.44
80	Sankalp Rath	14	M	48	157		5.9	4.8		1.35
81	Pradeep Das	18	M	60	161		6.8	6.1		1.67
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# ANNEXURE- PLAG REPORT



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**Sharon Panda**

## Correlation of intrinsic foot muscle strength with reactive strength index in sprinters- An observational Study



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