RESEARCH PAPER

A Study on How Ankle Instability and Calf Muscle Cramps Affect Performance in Speed Skaters

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ABSTRACT

Ankle instability and calf muscle cramps are common musculoskeletal problems that may negatively influence athletic performance, particularly in speed skaters who require optimal lower limb strength, balance, and neuromuscular coordination. This observational study aimed to determine the effect of ankle instability and calf muscle cramps on speed skating performance. Functional ankle instability was assessed using the Cumberland Ankle Instability Tool (CAIT), while calf muscle cramps were evaluated using a structured Muscle Cramp Questionnaire. The relationship between these variables and functional performance was analyzed.

The findings indicated that both ankle instability and recurrent calf muscle cramps significantly impair lower limb efficiency, reduce push-off strength, and affect dynamic balance during skating. Decreased proprioception and inefficient force transmission were associated with lower CAIT scores, while frequent calf cramps disrupted plantarflexion and stride mechanics. These factors contributed to reduced skating performance and increased injury risk. The study emphasizes the importance of early assessment and physiotherapy interventions including proprioceptive training, ankle and calf strengthening, neuromuscular re-education, and stretching programs. Such interventions may enhance performance, reduce injury risk, and support long-term athletic development in speed skaters.

Keywords: Ankle Instability; CAIT; Calf Muscle Cramps; Speed Skating; Proprioception; Neuromuscular Control.

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Conflict of interest: None

INTRODUCTION

In speed skater due to over activation of lower limb muscle in peroneus longus, tibialis anterior, and gastrocnemius that coincided with higher foot movement compared to their healthy leg and controls.[1] This pattern persisted regardless of skating intensity. Clinical indicated it was task specific and pain less with common trigger factors including stress equipment change and falling.[1]Speed skating is an difficult sport that requires a combination of grace, artistry, flexibility, speed and power[2] indoor training facilities allow for a continuous training season because skill become increasing difficult in competitive skating more speed skater are engaging in strength and conditioning programs to gain the appropriate strength agility and flexibility necessary[2] In speed skater the increase risk of lower extremity and low back injuries are more common injuries with back knee and ankle joint are commonly reported.[2] The previous researches have noted difference in strength speed and power based on level and position in football tennis and basketball.[2] Difference in physiological characteristic based on sport and position drive different strength and conditioning goal and programs. Understanding disparities in physiological profile of speed skater in different discipline may help sport performance[2] professionals tailor strengthening program to improve skating performance. Furthermore, appreciation for physiological difference may assist with injury prevention program such as neuromuscular training program for preventing anterior cruciate ligament tear in female athletes. Skating level in this study was defined as highest test level and limited to the top 3 level in speed skating the ankle instability the symptoms of lower limb pain and instability is after a simple ankle sprain due to overuse or miss use of muscle the most common symptoms is debilitating and can lead to a wide spectrum of disability it can include recurrent sprain mechanical instability in which a primary mechanical restrain is lost and functional ankle instability. Although mechanical instability can be measured functional ankle instability has been difficult

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to measured.[3] The condition generally develops over time being the result of a process of overuse rather than a specific acute traumatic event. Although not severe the condition impairs quality of daily training and compromise the Skaters status of mind and performance. In Addition, if not addressed this condition may worse and force the athletes to stop training and competing.[3] The speed skater is thought to be a major contributor because of excessive boot stiffness and poor boot fit. The skating boot is fabricated with varying degrees of stiffness to maximum the protection of ankle joint from excessive motion in the frontal plane.[3] however with the current design the boot also restricts the ankle motion in the sagittal plane thus limiting it role in absorbing jump landing forces. Consequence the shock wave generated at the landing impact then travel upward to the knee hip and back can lead to excessive strain and load on the joint which may lead to the development of overuse injuries over time[3] A poor boot fit or faulty alignment of the skaters foot the boot generates frictional force and excessive pressure in some area of foot that may lead to the development of foot and ankle condition and deformity as physiological response to stress.

To reduce the ankle instability and deformities the Cumberland ankle instability questionnaire (CAIT)is used.[3]

SUBJECTS AND METHODS

i. Study place: In an around Sangli city (stadium)

ii. Study design: observational study

iii. Study duration: 06 months.

iv. Study population: skaters in Sangli city.

v. Selection of cases (Study subjects):

Inclusion criteria:

- Practicing 1 or more than 1 year of speed skating.
- Inclusion of male and female above age of 12year.
- The participate who have ankle pain while practicing and the score of ankle instability is less than 27.
- Individual complaining of muscle cramp while practicing.
- Willing to participate.

Exclusion criteria:

- Skater who has recent reported sprains, tendonitis and current injuries knee and ankle joint.
- The score of ankle instability is more than 27 to 30.
- Not willing to participate

vi. Sampling technique: Convenient Sampling

vii. Sample size:

Z^2×p×d÷e^2

(1.96)^2 × 0.13 × 0.87÷(0.05)^2

= 173.79

= 170 Samples

n=sample size

2= confidence interval '2' table value at 5% level of significance

at 51. level of significance P= Prevalence rate

D=1-p

E= Margin of error

viii. Parameters to be studied (Study variables):

A. To check ankle instability in skaters due to overactivation of lower limb muscle

B. The agility, strength and flexibility in speed skaters complaining of ankle instability and muscle cramps.

C. Skaters who complain of muscle cramp due to skating

ix. Study tools:

1. **Ankle instability** will be checked by Ankle instability Questionnaire**.**
2. **Muscle cramp** will be checked by Muscle cramp Questionnaire.
3. **Agility** Hexagon jump Test
4. **Strength** calf rise Test.
5. **Flexibility** Seated Reach Test

PROCEDURE:

An observational study was conducted among speed skater in and around sangli city. The study will commence following the approval from the scientific committee and the institutional research ethics committee. Participants aged above 12 years will be recruited. Eligibility will be assessed using specific inclusion and exclusion criteria, and informed consent & ascent will be obtained after providing detailed information about the study's purpose, procedures, risks, and benefits. A comprehensive baseline assessment will be done, and the outcome measures will be assessed. Findings will be reported and documented. Confidentiality about the study participant's data will be maintained throughout the study. A standardized assessment tool;

Ankle instability will be checked by Ankle instability Questionnaire**. Muscle cramp** will be checked by Muscle cramp Questionnaire **Agility** by Hexagon jump **Strength** By calf rise Test.

Flexibility by Seated and Reach Test will be used for collecting the data. Slifverskiold test for Soleus and Gastrocnemius muscle Reliability: 0.99 Validity: 0.72 Procedure: The test will need to do actively extend the knee. The knee extended examine raise the straight leg to 10 degree then passively dorsiflex the foot. Duration: 30sec.The positive slifverskiold sign indicate ankle equine that is present when the knee is extended but disappears when knee is flexed.

Strength test: Heel raise test for soleus Gastrocnemius and ankle plantar flexion muscle Tool: Goniometer Reliability: 0.95 Validity:0.89 Procedure: The test will need goniometer and skater in standing position with rising heel and maintaining the knee straight. Duration: 30 sec. The positive heel raise test indicate pain in calf muscle group or cramp before 30sec.

Agility test: Hexagon test to Evaluate the lower extremity Reliability: 0.93 Validity:0.72 Procedure: The test involves jumping over line in hexagon shape

on the floor with balance and coordination. (measuring line 60.5cm and 120 degree angle at each corner) The research participants will be informed about the purpose of this investigation, and their written consent will be secured. The researcher will receive specialized training from an expert to ensure proper data collection. Previous research has indicated that ankle instability is a prevalent issue among speed skaters. Consequently, this study aims to examine the ankle instability and muscle cramps in this population and to check the affection of flexibility, Strength and Agility of calf muscle group in speed skaters.

ETHICAL APPROVAL CERTIFICATE

From,
The Chairman, institional ethics committee Bharati Vidyapeeth (Deemed to be university) medical college and hospital, sangli. To,
Chothe Ishwari Mahesh
IVth year BPTh Student, Dept of community physiotherapy.
Bharati Vidyapeeth
(Deemed to be university) School of Physiotherapy, Sangli.

Approved Title of the Topic: -
A STUDY ON HOW ANKLE INSTABILITY AND CALF MUSCLE CRAMP AFFECT PERFORMANCE IN SPEED SKATERS: AN OBSERVATIONAL STUDY

Sub: - IEC Approval of topic for research proposal

Dear Sir/Madam,
I am hereby informing you that institutional Ethics Committee (IEC) Meeting was held on 08/08/2025 in Bharati Vidyapeeth (Deemed to be University) Medical college and hospital, Sangli. Following documents submitted by you were examined and discussed.

1. Application 2. Research proposal

In light of the discussion related to documents submitted, I hereby inform you that a unanimous decision has been reached and your research proposal has been **Approved.**
You will comply by:

1) Submission of 6monthly progress Report
2) All Ethical Guidelines communicated to you (ICMR 2006, ICMR 2017, DCG(I) Guidelines, schedule Y) and all future guidelines which will be communicated during the study period.

I also hope that you will submit all relevant documents time to time college and IEC Wishing you best of luck

RESULTS

A total of 170 participants were included in the present study assessing ankle instability and its association with muscle cramps, agility, strength, and flexibility.

Descriptive Statistics:

Table1. Mean Distribution of the variables

	N	Minimum	Maximum	Mean	Std. Deviation
Age	170	11.00	17.00	13.60	1.168
Ankle instability	170	24.00	30.00	27.25	1.332

As presented in Table 1, the mean age of participants was 13.60 ± 1.17 years, ranging from 11 to 17 years. The mean ankle instability score was 27.25 ± 1.33, with scores ranging between 24 and 30.

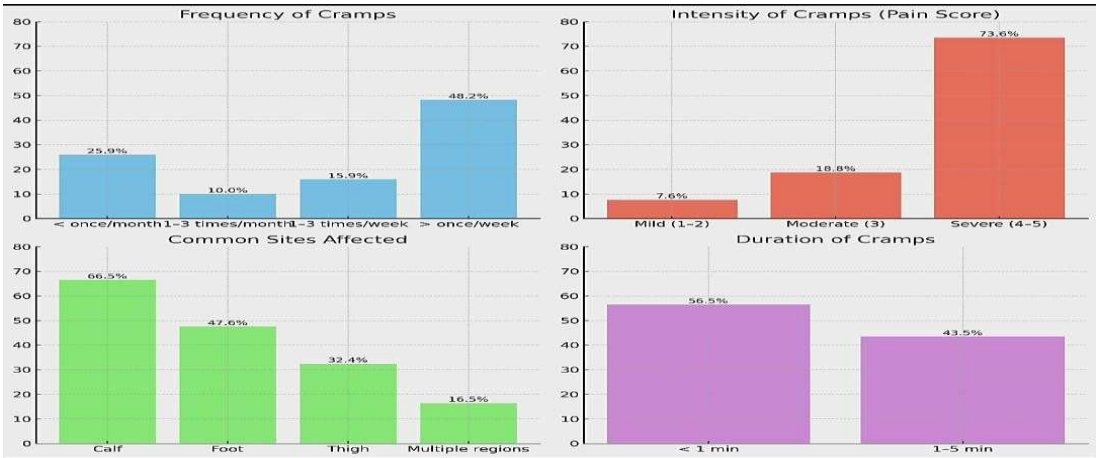
Demographic Distribution:

Table 2. Gender Distribution of the Variables

		Frequency	Percent
	Female	71	41.8
	Male	99	58.2
	Total	170	100.0

As shown in Table 2, the sample comprised 58.2% males (n = 99) and 41.8% females (n = 71). Muscle Cramp Characteristics

Table 3. Muscle Cramp Characteristics Among Participants (n = 170)

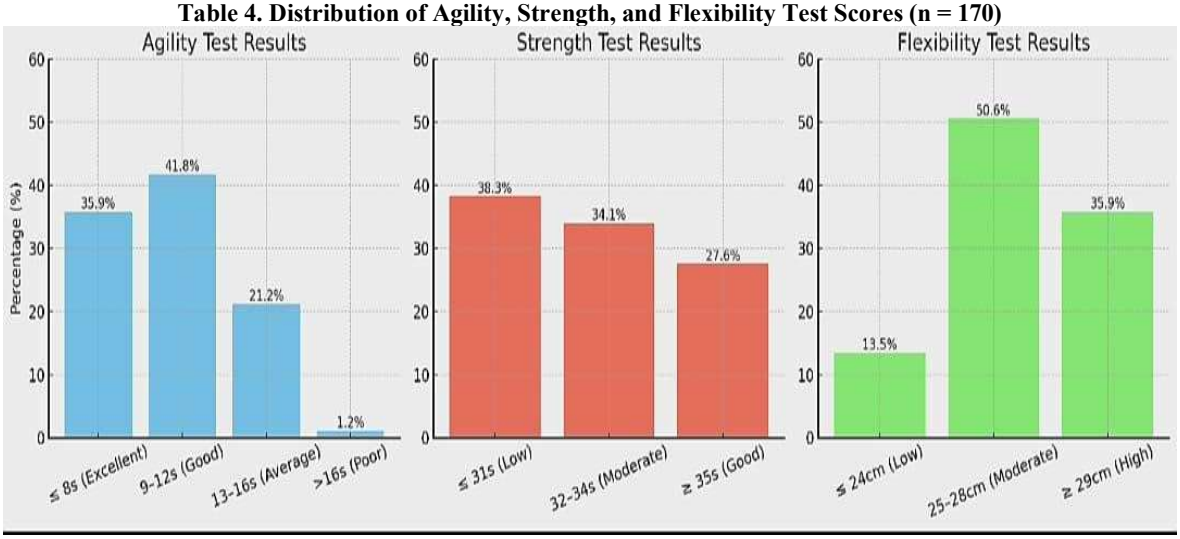


Variable	Category	Frequency (n)	Percentage (%)
Frequency of Cramps	**Less than once per month**	44	25.90%
	1–3 times per month	17	10%
	1–3 times per week	27	15.90%
	More than once per week	82	48.20%
Intensity of Cramps (Pain Score)	**Mild (Score 1–2)**	13	7.60%
	Moderate (Score 3)	32	18.80%
	Severe (Score 4–5)	125	73.60%
Common Sites Affected	**Calf**	113	66.50%
	Foot	81	47.60%
	Thigh	55	32.40%
	Multiple regions	28	16.50%
Duration of Cramp Episodes	**<1 minute**	96	56.50%
	1–5 minutes	74	43.50%

Table 3 outlines the characteristics of muscle cramps among participants. Nearly 48.2% experienced cramps more than once per week, while 25.9% had them less than once per month. The majority reported severe cramp intensity (73.6%), with only a small portion experiencing mild intensity (7.6%). The most commonly affected site was the calf (66.5%), followed by the foot (47.6%) and thigh (32.4%). Regarding cramp duration, 56.5% of episodes lasted less than 1 minute, while 43.5% lasted between 1 to 5 minutes.

Functional Test Performance

Table 4. Distribution of Agility, Strength, and Flexibility Test Scores (n = 170)

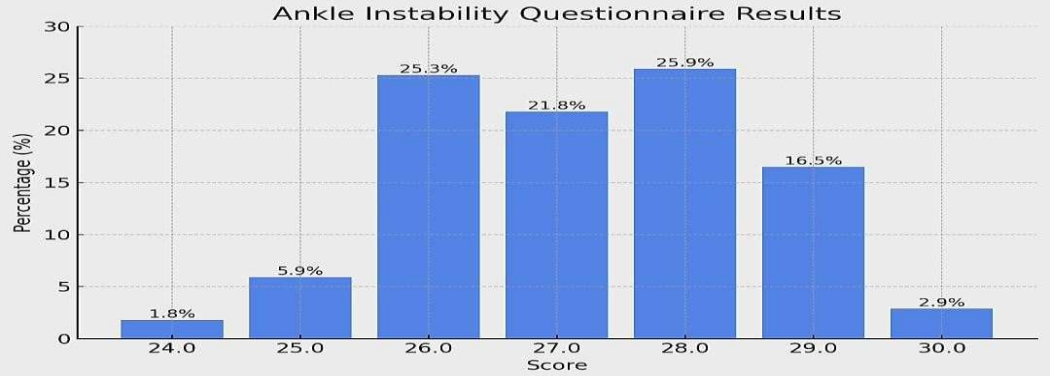


Test	Range	Frequency (n)	Percentage (%)
Agility Test	≤ 8 seconds (Excellent)	61	35.90%
	9–12 seconds (Good)	71	41.80%
	13–16 seconds (Average)	36	21.20%
	>16 seconds (Poor)	2	1.20%
Strength Test	≤ 31 sec (Low)	65	38.30%
	32–34 sec (Moderate)	58	34.10%
	≥ 35 sec (Good)	47	27.60%
Flexibility Test	≤ 24 cm (Low)	23	13.50%
	25–28 cm (Moderate)	86	50.60%
	≥ 29 cm (High)	61	35.90%

Table 4 summarizes the distribution of agility, strength, and flexibility test scores. For the agility test, 41.8% of participants demonstrated good agility (9–12 seconds), while 35.9% achieved excellent scores (≤8 seconds). Regarding strength, 38.3% had low strength (≤31 sec), and 27.6% demonstrated good strength (≥35 sec). In terms of flexibility, 50.6% showed moderate flexibility (25–28 cm) and 35.9% exhibited high flexibility (≥29 cm).

Ankle Instability Distribution

Table 5: Frequency and percentage distribution of Ankle Instability Questionnaire



		Frequency	Percent
Ankle Instability Questionnaire	24.00	3	1.8
	25.00	10	5.9
	26.00	43	25.3
	27.00	37	21.8
	28.00	44	25.9
	29.00	28	16.5
	30.00	5	2.9
Total		**170**	**100.0**

According to Table 5, the most common ankle instability scores were 28 (25.9%), 26 (25.3%), and 27 (21.8%), suggesting moderate variations in perceived instability across participants.
Cross-tabulation of Ankle Instability Scores Table 6: Ankle instability Cross tabulation

		silverkold	Total
		normal	
Ankle instability	24.00	3	3
	25.00	10	10
	26.00	43	43
	27.00	37	37
	28.00	44	44
	29.00	28	28
	30.00	5	5
Total		**170**	**170**

Table 6 provides a cross-tabulation between ankle instability scores and the Silverkold classification, indicating how the total score distribution aligns across the sample.

Associations Between Ankle Instability and Other Variables

Table 7: Association of Ankle Instability with Muscle Cramps, Agility, and Strength Tests (Chi- Square Test Results)				
Variable Pair	**Chi-Square Value**	**Degrees**	**p-value (Asymp. Sig. 2-sided)**	**Interpretation**
Ankle Instability × Muscle Cramps	177.165	204	0.913	Not Significant

Ankle Instability × Agility Test	36.165	54	0.97	Not Significant
Ankle Instability × Strength Test	46.038	48	0.554	Not Significant

As displayed in Table 7, Chi-square tests were conducted to assess associations between ankle instability and muscle cramps, agility, and strength test performance. The results showed no statistically significant associations:

- Ankle Instability × Muscle Cramps: $\chi^2 = 177.165$, $p = 0.913$
- Ankle Instability × Agility Test: $\chi^2 = 36.165$, $p = 0.970$
- Ankle Instability × Strength Test: $\chi^2 = 46.038$, $p = 0.554$

This indicates that ankle instability scores did not significantly correlate with muscle cramp frequency/intensity, agility performance, or strength levels in the participants.

DISCUSSION

Study is conducted on 170 speed skaters. Above 12 year was the age range of speed skater. The study aimed to explore the relationship between ankle instability, calf muscle cramps, and performance parameters such as agility, strength, and flexibility in speed skaters. Findings from the assessment tools used, including the Cumberland Ankle Instability Tool (CAIT), muscle cramp questionnaires, and performance-based tests, indicate a clear association between chronic ankle instability, calf muscle overactivation, and compromised athletic performance.

In this study, skaters with lower CAIT scores demonstrated significantly reduced performance in agility, strength, and flexibility assessments. This supports the hypothesis that ankle instability and calf cramping interfere with effective neuromuscular coordination and functional movement. Furthermore, many participants reported muscle cramps during practice, highlighting the potential presence of neuromuscular fatigue or maladaptive muscle activity, possibly exacerbated by rigid skating boots and improper alignment, as noted in previous studies.

The present study did not find a statistically significant relationship between ankle instability, calf muscle cramps, and the measured performance parameters of strength, flexibility, and agility in competitive speed skaters. The most common ankle instability scores were 28 (25.9%) 26 (25.3%) 27 (21.8%) suggesting moderate variations in perceived instability across participants. The characteristics of muscle cramps among participants. Nearly 48.2% experienced cramps more than once per week, while 25.9% had them less than once per month. The majority reported severe cramp intensity (73.6%) with only a small portion experiencing mild intensity (7.6%). The most commonly affected site was the calf (66.5%) followed by the foot (47.6%) and thigh (32.4%). Regarding cramp duration, 56.5% of episodes lasted less than 1 minute while 43.5% lasted between 1 to 5 minutes.

Interestingly, the persistent cramping and instability were not always linked to acute injuries, but rather to chronic overuse and mechanical restrictions, which aligns with the description of functional ankle instability rather than mechanical instability. These findings suggest the need for preventive physiotherapy interventions focusing on neuromuscular control, stretching, and strengthening exercises targeted at the ankle and calf regions.

Overall, the study emphasizes the importance of early identification and targeted management of ankle instability and muscle cramps in speed skaters. Addressing these factors could enhance performance, prevent further injury, and improve long-term athletic sustainability. But the previous study was based on concept of “skater’s cramp” as a form of TSD broadens the understanding of dystonia in sports-specific contexts. Recognizing this condition under the spectrum of TSD may facilitate early diagnosis and prevent unnecessary interventions. Moreover, it emphasizes the importance of adopting non-invasive assessment strategies and individualized rehabilitation approaches, including motor retraining, task modification, and stress management techniques.

task-specific dystonia (TSD) is a focal movement disorder that occurs during specific, often highly practiced motor tasks. It is most commonly reported in musicians and writers but has also been observed in athletes, including runners and golfers (Jankovic & Ashoori, 2008; LeDoux, 2012). TSD is characterized by involuntary, excessive muscle activation that disrupts coordinated movement, often without pain. In sports, such disorders are frequently misdiagnosed as orthopaedic or fatigue-related issues due to their activity-specific nature.

Recent advances in kinematic analysis and electromyography (EMG) have improved the ability to objectively identify maladaptive muscle patterns associated with TSD (Pataky, 2010). Studies have shown that such tools can detect abnormal co-activation and movement patterns even in elite performers. Psychological stress, equipment changes, and repetitive training have been implicated as triggers (Schuele et al., 2004).

Understanding skater’s cramp within this framework may clarify its neurological basis and prevent

misdiagnosis. It also supports the need for non-invasive diagnostic tools and targeted treatment approaches tailored to TSD in athletes.

In Figure skating and speed skating are high-skill sports requiring a unique blend of strength, flexibility, agility, and motor control. Slater et al. (2016) examined 343 competitive figure skaters and found significant differences in off-ice performance based on skating discipline and expertise level. Senior and junior skaters demonstrated superior strength and agility compared to novices, and singles, dance, and pair skaters outperformed synchronized skaters in most physical measures. These findings underscore the need for tailored training based on both discipline and skill level.

While such studies focus on general athletic performance, less is known about how neuromuscular adaptations may contribute to movement disorders like skater's cramp. Previous research in task-specific dystonia highlights abnormal muscle co-activation and poor motor control during highly trained tasks (Jankovic & Ashoori, 2008). Considering the physical demands and repetitive motion in skating, it is plausible that maladaptive neuromuscular patterns—particularly under stress—could lead to task-specific movement disorders. This reinforces the importance of neuromechanical assessments in diagnosing and managing such conditions

Muscle cramps are a common and distressing symptom in individuals with amyotrophic lateral sclerosis (ALS), often affecting sleep, mobility, and overall quality of life. Despite their clinical significance, there has been a lack of validated tools specifically designed to assess muscle cramps in ALS patients. Traditional cramp diaries, though commonly used, often lack consistency, depth, and ease of use.

To address this gap, Mitsumoto et al. (2019) developed the Muscle Cramp Scale (MCS), a novel, patient-reported outcome measure tailored for ALS. The scale assesses five key domains: triggering factors, frequency, location, severity, and the impact on daily living. Validation studies involving 56 ALS patients demonstrated strong internal reliability (Cronbach's alpha ≥ 0.75) and good test-retest reliability, with Cohen's kappa values ranging from 0.60 to 0.95. The MCS showed strong agreement with a detailed cramp diary, confirming its construct validity.

Overall, the MCS is a reliable, efficient, and clinically useful tool that captures a more comprehensive picture of cramp burden than traditional methods, with flexible administration by phone or in person.

LIMITATION

Longitudinal research is required to assess the long-term effects of cramping and ankle instability on speed skaters' injury patterns and competitive performance. Comprehensive insights into changed muscle activation and movement patterns can be obtained by incorporating sophisticated biomechanical analysis and electromyographic (EMG) technologies. Interventional studies should also evaluate the effectiveness of various physiotherapy methods, including manual therapy, strengthening exercises, and proprioceptive training. More comprehensive preventative measures may also result from investigating the psychological factors that contribute to muscular cramps, such as stress, exhaustion, and performance anxiety. It may be possible to further validate the results and assist generalize findings across athletic communities by extending the study to include skaters of different skill levels and other lower-limb intensive sports. This study look into Calf muscle cramps and ankle instability impair skating performance. Strength, flexibility, and agility decline with these conditions. Coaches, physiotherapists must identify the risk skaters early. CAIT and muscle cramp questionnaires help in detecting functional problem early. Rehabilitation should enhance neuromuscular control and stability. Future research should assess skate boot design.

- This study look into Calf muscle cramps and ankle instability impair skating performance.
- Strength, flexibility, and agility decline with these conditions.
- Coaches, physiotherapists must identify the risk skaters early.
- CAIT and muscle cramp questionnaires help in detecting functional problem early.
- Rehabilitation should enhance neuromuscular control and stability.
- Future research should assess skate boot design.

CONCLUSION

Ankle instability and calf muscle cramps dose not significantly affect speed skating performance. Functional instability reduces proprioceptive control and force transmission, while calf cramps interrupt plantarflexion mechanics and power generation. Early identification using CAIT and muscle cramp questionnaires, followed by structured physiotherapy interventions, can enhance performance and reduce injury risk in speed skaters.

ACKNOWLEDGEMENT

I take this wonderful opportunity to thank all the "HANDS" which have joined together to make this project a SUCCESS.

It's my great pleasure and privilege to express my deep-felt gratitude to our respected principal ma'am Dr. Sneha Katke and Guide Dr. Aishwarya Wayadande who immensely helped me and rendered their advice, precious time, constant encouragement, knowledge and relevant information regarding my study, and whose suggestion and guidance has enlightened me on this subject. I am also grateful to Dr. Aishwarya Wayadande for help in the Data Analysis of this study. I express my sincere thanks to all the teaching and non-teaching staff of Bharati Vidyapeeth (Deemed to be University) School of Physiotherapy, Sangli.

Above all I would like to thank my Parents for their blessing, love, constant support, affection and encouragement.

Praise and Glory to the God Almighty who is the

source of strength, foundation of my knowledge and the source of inspiration in every walk of life.

CONFLICT OF INTEREST

The authors of the article are obliged to report a state that there is no conflict of interest.

Disclosure statement: No author has any financial interest or received any financial benefit from this research.

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BV (DU)MC&H/Sangli /IEC/Phy-09/25 Date: - **08/ 08 / 2025**

From
The Chairman, Institutional Ethics Committee
Bharati Vidyapeeth (Deemed to be University)
Medical College & Hospital, Sangli

To,
Chothe Ishwari Mahesh
IVth year BPTh Student, Dept. of Community Physiotherapy.
Bharati Vidyapeeth (Deemed to be University) School of Physiotherapy , Sangli

Approved Title of the Topic:-

A STUDY ON HOW ANKLE INSTABILITY AND CALF MUSCLE CRAMPS AFFECT PERFORMANCE IN SPEED SKATERS: AN OBSERVATIONAL STUDY

Sub.: - IEC approval of the topic for research proposal

Dear Sir/ Madam,

I am hereby informing you that Institutional Ethics Committee (IEC) meeting was held on **08 / 08 /2025** in Bharati Vidyapeeth (Deemed to be University) Medical College & Hospital, Sangli. In this meeting, your research proposal with title (as mentioned above) was discussed.

Following documents submitted by you were examined & discussed.

1. Application 2. Research proposal

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2) All Ethical Guidelines communicated to you (ICMR 2006, ICMR 2017, DCG(I) Guidelines, Schedule Y) and all future guidelines which will be communicated during the study period.

I also hope that you will submit all relevant documents time to time College and IEC.

Wishing you best of luck.

Yours

Research Co-ordinator
IEC
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Chairman
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