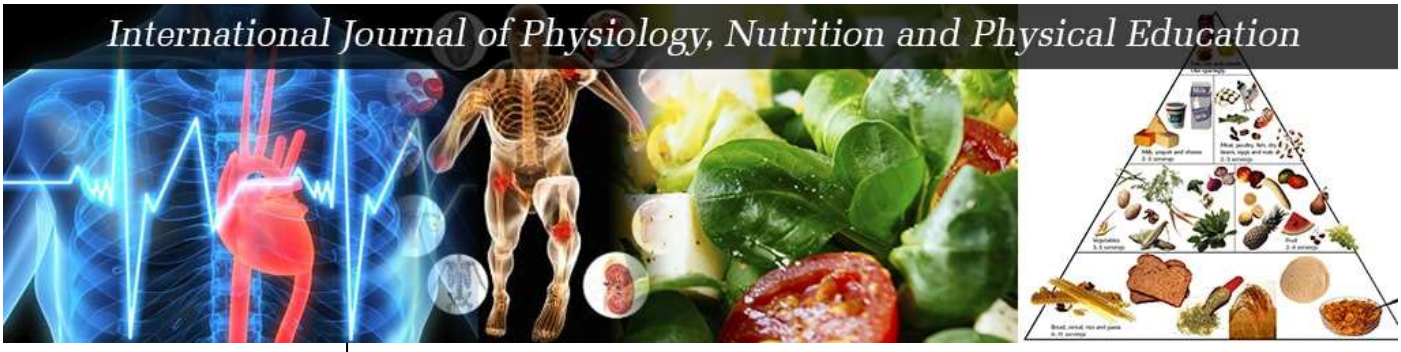

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Dr. Kuldeep Singh
Associate Professor, Department of Physical Education, I.G.N. College, Ladwa, Kurukshetra, Haryana, India

Dr. Mahender Singh
Associate Professor, Department of Physical Education, M.L.N. College, Radaur, Yamuna Nagar, Haryana, India

Corresponding Author:
Dr. Kuldeep Singh
Associate Professor, Department of Physical Education, I.G.N. College, Ladwa, Kurukshetra, Haryana, India

Comparative analysis of athlete performance with 5,7 and 8-nail spikes configurations

Kuldeep Singh and Mahender Singh

Abstract
Purpose: The study investigates performance differences among five-nail, seven-nail, and eight-nail track spikes, providing insights into how spike nail configurations may impact competitive performance.
Design/Methodology/Approach: Thirty-one male sprinters (n = 31), aged 17 to 25 years, who had competed at the state or inter-collegiate level, were purposively selected from the eastern districts of Haryana, India. The following parameters were assessed under three spike conditions (five-nail, seven-nail, and eight-nail): acceleration ability (30 m run), speed (50m run), speed endurance (100 m run), explosive leg strength (Standing broad jump), and forward and backward stride frequency (High knee action and back kick test). One-Way ANOVA was used to compute mean differences, standard deviation (SD), F-value, and p-value.
Findings: No statistically significant differences were observed in acceleration ability, speed, speed endurance, explosive leg strength, or forward stride frequency across the three spike conditions. However, significant differences were found in backward stride frequency.
Conclusion: The study found no statistically significant differences in running performance across the 5, 7-, and 8-nail spike configurations in the 30 m, 50 m, and 100 m tests (all $p > 0.05$). While 8-nail spikes showed slightly better performance in acceleration (30 m) and sprinting (100 m), and 7-nail spikes outperformed in speed (50 m), these differences were not significant enough to reject the null hypothesis. The 5-nail spikes showed better performance in the Back Kick Test, with a trend favoring 8-nail spikes in explosive strength. The only statistically significant result was observed in the Back Kick Test.
Originality/Value: This study offers a unique perspective on the use of five-nail, seven-nail, and eight-nail track spikes in practice and competition. It contributes to understanding how the number of spike nails affects performance in acceleration, stride frequency, speed endurance, and explosive activity.

Keywords: Track spikes, acceleration ability, stride frequency, athletes

Introduction
As athletes step onto the track, spectators often focus on their movements, gear, and especially their competition spikes. After a 100-meter race, media coverage frequently highlights the winner's performance, often emphasizing the design and brand of their spikes. This attention is well-founded, as the toe section of the spikes makes the primary contact with the track, playing a crucial role in maximizing traction and force during the race.

Evolution of Track Spikes
Track spikes have evolved over a century, beginning with Joseph William Foster's invention in the 1890s. Adolf Dassler further revolutionized the design by creating spikes for Jesse Owens at the 1936 Berlin Olympics. Modern spikes now feature advanced materials like carbon plates, but their core purpose-enhancing grip and transferring force-remains unchanged. Today, many brands claim to create the "fastest" shoes, but the key factor in performance is biomechanical efficiency, particularly during the critical acceleration phase of sprinting.

How Track Spikes Work
Track spikes are designed to:

- **Enhance Traction:** The sharp nails dig into the track surface, improving grip and reducing slippage.

- **Optimize Force Transfer:** Spikes maximize ground contact to efficiently transfer force forward, minimizing energy loss.
- **Reduce Weight:** Lightweight designs lower the energy required for fast foot turnover.
- Spikes are most effective during the initial sprint phase, where stability and grip are crucial for rapid acceleration.

Why Use Running Spikes?

- **Increased Speed:** Spikes optimize traction, improving overall speed.
- **Improved Grip:** The nails provide superior traction for better force application.
- **Better Acceleration:** Spikes help maximize force during the critical first strides of a race.
- Sprinters typically use spikes with 4-10 nails, with 5-8 nails common for enhancing acceleration and speed.

The Key Question: Does the Number of Nails Matter?

The number of nails affects performance. Fewer nails concentrate force on fewer contact points, offering deeper penetration into the track. More nails distribute force evenly, enhancing stability and traction. For shorter sprints, the nail configuration can influence acceleration and stride efficiency.

Objective of the Study

This study examines how 5-nail, 7-nail, and 8-nail spikes affect sprinting performance, focusing on acceleration, speed, strength, and stride efficiency.

Selection of Subjects

Thirty-one (n = 31) male inter-collegiate and state-level sprinters, aged 17-25 years, from Haryana (Sonipat, Panipat, Karnal, and Kurukshetra districts), were purposively selected for the study. Each subject was tested under three different conditions:

1. Running with 5-nail track spikes.
2. Running with 7-nail track spikes.
3. Running with 8-nail track spikes.

5 Nails Track Spikes	7 Nails Track Spikes	8 Nails Track Spikes
		

The athletes were assessed for key performance metrics, including:

Sr. No.	Variables used	To measure
1	30 Meters	Acceleration Run Ability
2	50 Meters	Speed
3	100 Meters	Speed Endurance
4	SBJ	Explosive Leg Strength
5	High Knee Action	Forward Steps Stride Frequencies
6	Back Kick	Backward Steps Stride Frequencies

Data Collection

Data were collected on a 100-meter straight clay track. The subjects used their routine training 8-nail spikes for all trials. For the 5-nail trials, three nails were removed from each spike: two from the center beneath the midfoot and one from the inner side of the foot. For the 7-nail trials, one nail was removed from the midfoot and the inner side of the foot.

Statistical Technique Employed

The data were analyzed using the mean, standard deviation (SD), F-value, and p-value. One-way ANOVA tests were conducted to identify significant mean differences among the running conditions (5-nail, 7-nail, and 8-nail track spikes) using the Statistical Package for the Social Sciences (SPSS, Version 11.5).

Results & Discussion

Table 1: Mean, Standard Deviation, and One-Way ANOVA of 5, 7, and 8 Nail Spikes Running Conditions

Group	Mean	SD	Source of Variance	Sum of Square	DF	Mean Square (MS)	F	p-value
30Mts 5Nail Spikes	4.641	0.236	Between Group	0.098	2	0.049	0.869	0.422
30Mts 7Nail Spikes	4.581	0.212						p≥0.05 Null Hypothesis
30Mts 8Nail Spikes	4.566	0.262	Within Group	5.082	90	0.057		
There exist no difference among the means of 3 groups i.e., 5, 7, 8 Nail Spikes running conditions.								
50Mts 5Nail Spikes	7.026	0.347	Between Group	0.091	2	0.045	0.353	
50Mts 7Nail Spikes	6.959	0.390		11.550				0.704
50Mts 8Nail Spikes	6.962	0.335	Within Group	11.641	90	0.128		p≥0.05 Null Hypothesis
There exist no difference among the means of 3 groups i.e., 5, 7, 8 Nail Spikes running conditions.								
100Mts 5Nail Spikes	13.526	0.860	Between Group	1.709	2	0.855	1.336	
100Mts 7Nail Spikes	13.376	0.792		57.596				0.268
100Mts 8Nail Spikes	13.194	0.743	Within Group	59.306	90	0.639		p≥0.05 Null Hypothesis
There exist no difference among the means of 3 groups i.e., 5, 7, 8 Nail Spikes running conditions.								

Here df= Number of observations (93) - Number of groups (3)= 90

Table value for df 2, 90, at 0.05 level for significance is 3.10

Table-I presents the mean, standard deviation (SD), F-value, and p-value for the running conditions of 5, 7, and 8 nail spikes over different distances (30 meters, 50 meters, and 100 meters). The calculated F-values are 0.8699 for the 30-meter, 0.3527 for the 50-meter, and 1.3358 for the 100-meter tests. All of these values are less than the critical F-value at the 0.05 level of significance, indicating that there are no statistically significant differences in acceleration ability (30 meters), speed (50 meters), and speed endurance ability (100 meters) among the different nail spike conditions.

However, the mean values suggest that in the 30-meter acceleration run and 100-meter sprint tests, the 8-nail spikes performed better compared to the 5- and 7-nail spike conditions. Conversely, in the 50-meter stride test, the 7-nail spikes outperformed the 5- and 8-nail spike conditions.

Overall, the findings suggest that the 7- and 8-nail spike conditions are better than the 5-nail spike condition. However, since the p-values for the 30-meter, 50-meter, and 100-meter running tests are all greater than 0.05, the null hypothesis cannot be rejected. This means there is no significant difference in performance between the three groups (5, 7, and 8 nail spikes).

More spikes (7 or 8) generally provide better traction, which could improve acceleration and sprinting performance, but the differences were not statistically significant.

The distribution of force and traction efficiency are crucial in acceleration (30 m) and sprinting (100 m), with higher nail counts offering better grip, but the effect was too small to be statistically meaningful in this study.

Effect of Distance

- **30 m (Acceleration):** The 8-nail spikes performed best, likely due to better grip at the start.
- **50 m (Speed):** The 7-nail spikes were superior, possibly due to a balance of grip and flexibility.
- **100 m (Sprint):** The 8-nail spikes again showed better performance, suggesting they offer consistent traction over longer distances.

Lack of Statistical Significance

Despite the performance trends, the p-values > 0.05 suggest the differences between spike configurations were not large enough to be considered statistically significant, possibly due to sample size or within-group variability.

Biomechanics of Spikes

Table 2: Mean, Standard Deviation, and One Way ANOVA of 5, 7 and 8 Nail Spikes Running Condition

Group	Mean	SD	Source of Variance	Sum of Square (SS)	DF	Mean Square (MS)	F	p-value
SBJ 5Nails Spikes	244.0322	20.7694	Between Group	654.8602	2	327.4301	0.7486	0.4759
SBJ 7 Nails Spikes	244	-18.7599		39364.0645		437.3785		p≥0.05 Null Hypothesis
SBJ 8 Nails Spikes	249.6452	22.9965	Within Group	40018.9247	90			
There exist no difference among the means of 3 groups i.e.,5, 7, 8 Nail Spikes running conditions								
High Knee Action 5Nails Spikes	111.9355	12.0137	Between Group	697.8279	2	348.9139	2.4149	0.0952
High Knee Action 7Nails Spikes	107.6452	12.3708		13003.7419		144.4860		p≥0.05 Null Hypothesis
High Knee Action 8Nails Spikes	105.3226	11.6659	Within Group	13701.5699	90			
There exist no difference among the means of 3 groups i.e., 5, 7, 8 Nail Spikes running conditions								
Back Kick 5 Nails Spikes	102.709	8.4939	Between Group	571.634	2	285.8172	5.898*	0.0039
Back Kick 7Nails Spikes	97.3871	6.9459		4361.4839		48.4609		p≤0.05 Alternate Hypothesis
Back Kick 8 Nails Spikes	97.5161	4.9991	Within Group	4933.1183	90			
There exist difference among the means of 3 groups i.e.,5, 7, 8 Nail Spikes running conditions.								

Here df= Number of observations (93) - Number of groups (3)= 90

Table value for df 2, 90, at 0.05 level for significance is 3.10

Table-I presents the mean, standard deviation (SD), F-value, and p-value for 5, 7, and 8 nail spike conditions in various performance tests. The calculated F-values for the Standing Broad Jump Test (F = 0.7486) and the High Knee Test (F = 2.4149) are lower than the critical F-value at the 0.05 significance level, indicating no significant difference among the three nail spike conditions.

From the results, it is clear that there is no significant difference in explosive leg strength (Measured by the Standing Broad Jump) and forward step stride frequency (Measured by the High Knee Test) across the different nail spike configurations. However, the mean values show that athletes with 8 nail spikes performed better in explosive leg strength compared to those with 5 or 7 nail spikes, while 5 nail spikes athletes performed better in forward step stride frequency than the others.

Since the p-values for both the Standing Broad Jump and High Knee tests are greater than 0.05, the null hypothesis (which states there is no significant difference) cannot be rejected, meaning there is no significant difference in performance between the three spike conditions.

On the other hand, the calculated F-value for the Back Kick Test is 5.898, which is greater than the required F-value at the 0.05 significance level. This indicates a significant difference in backward step stride frequency ability among the different nail spike conditions. The mean values show that athletes with 5 nail spikes performed better in the Back Kick Test compared to those with 7 and 8 nail spikes.

In the Back Kick Test, the p-value is less than 0.05, which supports the alternative hypothesis, confirming that there is a significant difference in backward step stride frequency ability among the three nail spike conditions.

Biomechanics of Spikes

- **Explosive Leg Strength:** The 8-nail spikes may provide better traction during the Standing Broad Jump, enhancing explosive strength, but this effect wasn't significant enough to reject the null hypothesis.
- **Stride Frequency:** The 5-nail spikes performed better in the High Knee Test (forward step stride frequency), possibly due to reduced weight or more flexible foot movement, though this difference was not significant.

Significant Findings

Back Kick Test: The F-value for the Back Kick Test (5.898) was higher than the critical value, indicating a significant

difference in backward step stride frequency. The p-value for this test was less than 0.05, supporting the alternative hypothesis that the spike configuration does affect performance in backward stride frequency.

Conclusion

The study found no statistically significant differences in running performance across the 5, 7, and 8 nail spike configurations for the 30-meter, 50-meter, and 100-meter tests, as indicated by the F-values and p-values (all > 0.05). While the mean values suggested that 8-nail spikes performed better in acceleration (30 m) and sprinting (100m), and 7-nail spikes performed better in speed (50 m), these differences were not significant enough to reject the null hypothesis. Overall, the 7- and 8-nail spikes showed better performance than the 5-nail spikes, but the differences were not statistically significant, likely due to sample size and variability.

The 5-nail spike condition showed better performance in the Back Kick Test, and there was a trend of better performance with 8-nail spikes in explosive strength, but the key statistical difference was found only in the Back Kick Test

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