



## Research Article

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# The Effects of Self-Driving Treadmill Training on Running Performance: A Retrospective Analysis

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## Abstract

**Background:** Sprint speed is a critical factor in the performance of collegiate soccer players. While various training methods exist to improve sprinting ability, self-driving treadmills may offer a unique and effective approach. This study aimed to explore the effects of self-driving treadmill training on sprint speed in female NCAA Division II soccer players. **Methods:** A retrospective, observational analysis was conducted using data from 29 female collegiate soccer players who completed a minimum of 3, 5-second resisted sprints per session, with sessions ranging from 2 to 5 times per week over 3 weeks. Sprint speed was measured using GPS tracking, and data analysis was performed using descriptive statistics, independent t-tests, and Pearson's correlation to assess relationships between training volume and sprint speed. **Results:** On average, participants completed  $4.67 \pm 5.00$  training sessions, with an average top sprint speed of  $20.34 \pm 1.29$  mph. A statistically significant correlation was observed between the number of training sessions and performance metrics such as work rate, hard running distances, and sprint frequency. However, no significant improvement was found in top speed ( $p = 0.24752$ ). **Conclusion:** The findings suggest that while increased training volume improves work rate, sprint frequency, and hard running distances, it does not significantly affect top sprint speed. Tailored training approaches focusing on maximal velocity may be necessary to enhance top speed. These results provide insights into speed training interventions and suggest areas for future research and practical application in training programs.

**Keywords:** Resisted sprinting, High speed running, Athlete development, Sport science.

## INTRODUCTION

Sprinting, one of the most fundamental skills in sports, demands a rapid and powerful contraction of muscles <sup>[1]</sup>. Improving sprint speed is a multifaceted process that involves utilizing power-improvement tools and integrating them into a well-rounded training program <sup>[2]</sup>. Such programs may enhance speed, provided strength, technique, and recovery are also prioritized in training, especially among athletes participating in team sports that require multiple sprinting tasks throughout a competition. The personalization component could play an integral part in how well these programs are able to enhance speed, impressing the importance of working with trained professionals to develop and implement them, as well as the importance of identifying which tools should be utilized to achieve these improvements <sup>[3]</sup>. Determining how often to implement these resistance focused training sessions in order to positively impact top speed among athletes may prove to be complex, with many factors impacting this decision for practitioners.

Soccer players are exposed to specific physical demands during matches, which vary according to the level/standard of play <sup>[4]</sup>. Sprinting is an integral part of soccer. It is a high-intensity anaerobic activity that involves repeated impacts and significant eccentric stress to overcome body mass inertia <sup>[5]</sup>. It is a key factor in differentiating successful match performance in soccer. In female soccer players, sprint mean recovery time duration between repeated high-speed bouts in female matches are 10 seconds or less <sup>[6]</sup>. Maximal sprinting, decelerations, and accelerations at different speeds have been shown to be significant contributors to player load in collegiate women's soccer players <sup>[7]</sup>.

To increase sprint speed, resisted sprint (RS) training methodologies such as sled pushing or parachute towing, are commonly used among field sport athletes <sup>[8]</sup>. RS training is based on the theory of overload and specificity to increase force output <sup>[9]</sup>. RS has been shown to be an effective way to improve sprint performance among young soccer players <sup>[10]</sup>. Professional women's soccer players that utilize RS training,

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when combined with high intensity running, report positive changes in acceleration [11]. With this correlation at the professional and amateur levels, this study sought to find a similar improvement among collegiate women's soccer players' acceleration, as well.

Self-driving treadmills significantly enhance the development of explosive power in athletes by providing a controlled environment for sprint training that optimizes performance metrics [12]. These self-driving treadmills allow athletes to engage in high intensity sprinting while manipulating speed and incline, which can lead to improved power output and running mechanics [13]. Athletes using self-driving treadmills experience significant improvements in sprint times and vertical jump scores, indicating enhanced explosive power [14,15].

Over three weeks, this study utilized a self-driving treadmill (Matrix S-Drive, Johnson Health Tech, Tokyo, Japan) in women's soccer preseason training, explicitly, while monitoring top speed throughout. The unique design of the self-driving treadmill and capabilities allow athletes to specifically target and train the key components of sprinting, such as explosive power, stride length, and technique. The purpose of this study was to determine the effects of the self-driving treadmill on running performance for collegiate NCAA Division II women soccer players.

## MATERIALS AND METHODS

### Study Design

This study utilized a retrospective, observational design, analyzing post hoc data from pre-season training sessions of 29 female collegiate soccer players over a three-week period. The data were collected from the athletes' regular pre-season training routine, which included sprint training using a self-driving treadmill. Existing data from the athletes' training sessions were examined to understand the impact of the treadmill training on running performance. The analysis focused on the frequency of sprint sessions, their corresponding top sprint speeds, and other related performance metrics.

The observational design was advantageous in providing real-world insights into the practical application of self-driving treadmill training within the context of collegiate soccer players, while also acknowledging the constraints of using post hoc data that did not account for all potential confounding factors, such as fitness levels, diet, or other concurrent training activities.

### Procedures

As part of pre-season training, all participants completed three days of two-a-day training and game-like practices. On the fourth day, practices were reduced to one per day. During this time, athletes were instructed to perform three 5-second resisted sprints at a minimum of two times per week and a maximum of five times per week over a three-week period. Training sessions were completed before team-based participation activities during pre-season at an indoor, climate-controlled exercise science lab.

Each participant completed a minimum of 3, 5-second resisted sprints per session, with a range of 2–5 sessions per week. The treadmill resistance was standardized using a brake mechanism, and top sprint speed was measured with GPS monitoring during each session. The number of training sessions completed on the self-driving treadmill per day were recorded and paired with top speed (mph) using Sport Performance Tracking (SPT) GPS monitoring software Gametraka by the researcher. The GPS device was calibrated according to manufacturer specifications. Data was collected over a three-week period. GPS devices were worn for all outdoor training sessions throughout preseason by each player as per manufacturer's recommendations.

## Statistical Analysis

Statistical analysis was performed using descriptive statistics, independent two-sample t-tests for between-group comparisons, and Pearson's correlation to assess relationships between the number of training sessions and sprint speed. The effect size was calculated using Cohen's d, with significance set at  $p \leq 0.05$ . Data in text is reported as mean difference  $\pm$  standard deviation,  $p$  value, and  $r$  value. Significance was set at  $p \leq 0.05$ . Tukey Fence was conducted for outliers within the data and Cohen's d was used to measure the effect size.

## RESULTS

Following 29 observations, the average number of training sessions performed was  $4.67 \pm 5.00$ , with an average top speed of  $20.34 \pm 1.29$  mph (Table 1). Statistical analysis revealed that the number of Speed Training sessions was significantly associated with Work Rate ( $p = 0.00000$ ), Hard Runs ( $p = 0.00657$ ), and Sprints ( $p = 0.00129$ ), suggesting that as the number of training sessions increased, so did these performance metrics (Table 2). This indicates that the more sessions athletes completed, the greater the intensity and frequency of their work rate, hard running distances, and sprint attempts. In contrast, the relationship between Top Speed and the number of training sessions was not statistically significant ( $p = 0.24752$ ), implying that, despite an increase in training volume, the top speed did not show a clear improvement in this dataset.

**Table 1:** Descriptive Data on Number of Training Sessions

	Total # of Trainings Sessions	Average # of Training/Week	Top Speed
Mean	4.67	1.57	20.34
Median	5.00	1.67	20.20
Mode	4.00	1.33	20.20
Range	7.00	2.33	5.20
High	8.00	2.67	23.20
Low	1.00	0.33	18.00
StDev	2.25	0.82	1.32
Count	33.00	33.00	33.00

**Table 2:** Number of Trainings Sessions Effect on Performance

Performance Metric	P-Value	Significance ( $p=0.05$ )
Work Rate (yds/min)	0.00000	Significant
Hard Runs (yds)	0.00657	Significant
Number of Sprints (#)	0.00129	Significant
Top Speed (mph)	0.24752	

\* Significant value at  $p < 0.001$

Furthermore, Tukey Fence analysis was conducted to identify any outliers, and the results indicated that there were no significant outliers in the data ( $k = 1.5$ ). The effect size, calculated using Cohen's d, was found to be 8.55, which suggests a large effect for the associations that were statistically significant, particularly for Work Rate, Hard Runs, and Sprints. This large effect size underscores the strength of the relationship between the number of training sessions and these variables, reflecting meaningful changes in performance with increased training exposure.

Pearson correlation analysis provided further insight into the relationships between training sessions and performance outcomes. A weak positive correlation ( $r = 0.37$ ) was found between the total number of training sessions completed and Sprint Speed (mph) (Figure

1), suggesting that there was a modest but noticeable association between the frequency of training sessions and sprinting performance. While this correlation was statistically significant, the effect was not as strong as other variables like Work Rate and Hard Runs. Additionally, a slightly stronger correlation ( $r = 0.41$ ) was observed between the average number of training sessions per week ( $1.57 \pm 0.82$ ) and Top Running Speed (Figure 2), indicating that more frequent training sessions within a given week may have a more immediate impact on sprinting velocity compared to total training volume over time.

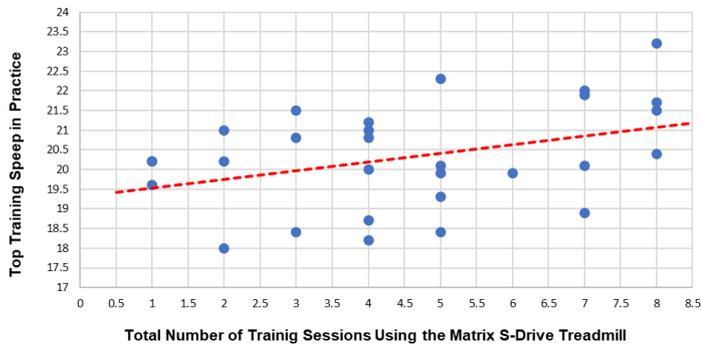


Figure 1: Total Number of Training Sessions and Top Speed (mph)

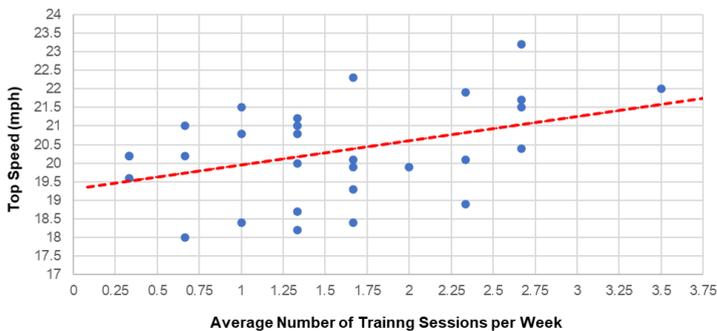


Figure 2: Average Number per Week of Training Sessions and Top Speed (mph)

## DISCUSSION

The purpose of this study was to examine the relationship between the number of Speed Training sessions completed by athletes and their subsequent performance metrics, including work rate, hard running distance, sprint frequency, and top speed. The results from this study indicate that there is a statistically significant positive association between the number of Speed Training sessions and work rate, hard running distance, and sprint attempts. In contrast, the relationship between top speed and the number of Speed Training sessions was not statistically significant. These findings provide insight into the broader effects of speed training on performance and highlight the nuances of how volume-based interventions may affect different aspects of athletic ability.

The significant positive correlation between the number of Speed Training sessions and work rate ( $p = 0.00000$ ), hard runs ( $p = 0.00657$ ), and sprint frequency ( $p = 0.00129$ ) aligns with previous research indicating that increases in training volume are associated with improved performance in endurance and repeated sprint tasks [2,16]. Specifically, our study found that as athletes completed more training sessions, their work rate and total hard running distances increased significantly. These results suggest that Speed Training has a profound effect on an athlete's ability to maintain high-intensity efforts over time. This improvement can be attributed to adaptations in both the aerobic and anaerobic systems, enhancing the athlete's ability to sustain high-intensity efforts without significant fatigue [17]. The increased sprint frequency also indicates that athletes who engage in more Speed Training are more capable of performing multiple sprints during a training session, suggesting an improvement in their ability to recover between efforts and perform repeated high-intensity tasks.

However, the lack of a statistically significant relationship between the number of Speed Training sessions and top speed ( $p = 0.24752$ ) is an intriguing finding. While the athletes in the study participated in a relatively high number of Speed Training sessions, there was no clear evidence that their maximal sprinting velocity improved as a result. This finding suggests that, while volume-based training approaches may enhance performance in certain metrics like repeated sprint ability, they may not be the most effective for improving peak velocity. This outcome is consistent with existing literature, which suggests that maximal speed is typically more responsive to targeted interventions such as maximal velocity sprint training or strength and power training [18]. It is possible that the type of training stimulus (e.g., focusing on top-end speed vs. endurance-based sprinting) is more important for improving maximal speed than simply increasing the total volume of training sessions. Furthermore, top speed may be influenced by a variety of biomechanical factors such as stride length, frequency, and neuromuscular efficiency, all of which may require specific and nuanced interventions [19].

The significant effects observed for work rate, hard runs, and sprints emphasize the role of Speed Training in enhancing athletes' ability to perform repeated high-intensity efforts, which is critical for sports that involve frequent bursts of maximal effort, such as football, soccer, and rugby. The adaptation to repeated sprinting, in particular, could be highly beneficial for athletes who need to maintain performance during the latter stages of a competition [20]. These findings further corroborate the importance of structured, high-intensity training sessions that focus not only on maximal velocity but also on improving an athlete's capacity to perform at high intensities over extended periods [21].

Despite these compelling results, the lack of significant improvement in top speed raises important considerations for future training practices and research. It highlights the complexity of training adaptation and the necessity for tailored approaches when seeking to improve specific aspects of athletic performance [22]. While increasing training volume appears to improve performance in tasks involving repeated sprints and high-intensity efforts, maximal speed likely requires specialized training techniques aimed at enhancing power output, stride mechanics, and neuromuscular coordination [23]. This finding suggests that programs designed to improve top speed should incorporate more specific sprint technique drills, strength training (particularly focusing on lower body power), and plyometric exercises, which have been shown to enhance sprinting velocity [2, 24].

## Limitations and Future Directions

There are several limitations to this study that must be acknowledged when interpreting these results. The relatively small sample size ( $n = 29$ ) may reduce the generalizability of the findings to a broader population of athletes. Additionally, the data collected were observational, meaning that causality cannot be definitively established. Other confounding factors, such as the athletes' baseline fitness levels, recovery protocols, nutrition, and sport-specific demands, were not controlled for in this study.

Future research should aim to examine these relationships in larger, more diverse populations of athletes, while also considering other variables that may influence performance outcomes. Furthermore, exploring the dose-response relationship between training volume and performance could provide further insights into the optimal number of Speed Training sessions required to produce meaningful improvements in different performance metrics.

## CONCLUSION

This study provides valuable insights into the effects of Speed Training on various performance metrics, highlighting significant improvements

in work rate, hard runs, and sprint frequency in response to increased training volume. However, no significant improvements were observed in top speed, suggesting that different training strategies, particularly those focusing on maximal velocity, may be required to elicit improvements in this area. The findings underscore the importance of tailored training interventions and offer practical implications for coaches and athletes seeking to optimize their training programs for specific performance outcomes. Further research is needed to explore the mechanisms underlying these adaptations and to refine training strategies that maximize both repeated sprint performance and maximal speed.

#### Conflicts of interest

None declared.

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