Can Post-Activation Performance Enhancement (PAPE) Improve Running Speed and Gait?

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Introduction

- Post-Activation Performance Enhancement (PAPE) refers to acute performance improvements following an explosive conditioning activity, likely due to increased motor unit recruitment and force production[1]
- Several mechanisms have been proposed to explain PAPE-related performance improvements, including elevated muscle temperature, increased muscle-fiber water content, and enhanced neural drive[5]
- Step rate (SR) and ground contact time (CT) are two performance variables associated with competitive running[3]. Typically, higher SR values correspond with faster running speeds, while longer CT values are associated with slower running[3]
- SR and CT are influenced by muscle stiffness, force output, and neuromuscular coordination[3], it is reasonable to assume that a PAPE-induced increase in muscle readiness could acutely modify SR and CT
- While PAPE effects are well established in resistance and power-based exercise using protocols such as plyometrics or heavy resistance training[1], its acute effects on distance running mechanics and performance remain understudied

Purpose

To determine the effects of a PAPE protocol on 3k running time and gait variables of step rate and contact time.

Hypothesis

The PAPE intervention will improve 3k running time resulting from increased step rate and decreased contact time.

Participant Data

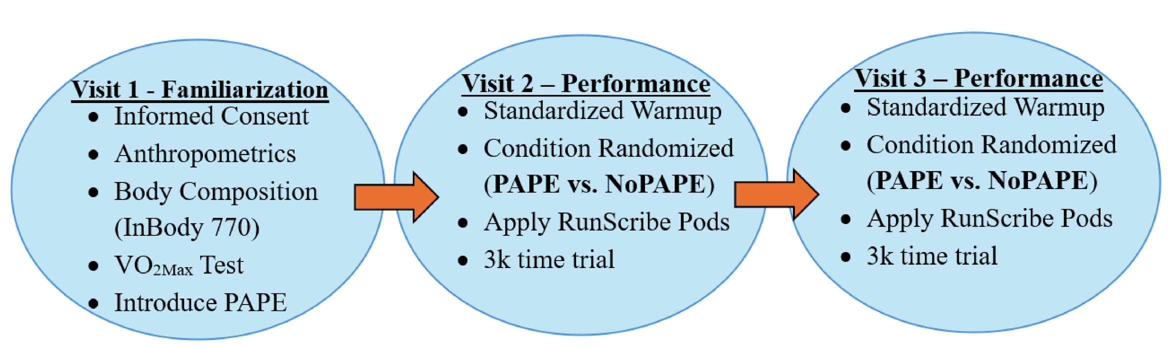
- Ten collegiate and post-collegiate runners
- Ages 18-24 years old
- 6 males, 4 females
- Completed a race within the last 6 months
- 5k personal best times < 19:08 for females and < 16:52 for males
- No significant lower body injuries

N Total	10 (6M & 4F)
Age (yrs)	22 ± 1
Height (cm)	175.0 ± 10
Body Mass (kg)	63.8 ± 9.0
Skeletal Muscle Mass (kg)	31.06 ± 6.18
Percent Body Fat (%)	14.8 ± 5.9
VO2max (mL·kg·min-1)	60.6 ± 7.4

Table 1: Mean (±SD) participant anthropometric data

Methods

Visit Format



Conditions

PAPE	NoPAPE
10 Minute Standardized warmup	10 Minute Standardized warmup
Dynamic Stretching	Dynamic Stretching
4 x 15s strides, 30s jog in between	4 x 15s strides, 30s jog in between
PAPE: 2 (10 ankle hops + 5 squat jumps) – in succession	11-minute rest period
8-minute rest period	3k time trial commences
3k time trial commences	

Data Analysis

- Data was analyzed using a 2 × 3 repeated-measures ANOVA (condition × time) with post-hoc t-tests when necessary
- Paired samples T-tests were used to determine the differences between the dependent variables (SR and CT) across time points (1k, 2k, 3 k)
- Significance was set to $P < 0.05$
- Software: SPSS 30 (IBM Inc, NY)

Figure 1: The technology used to record and assess gait variables, RunScribe 500Hz IMU footpods

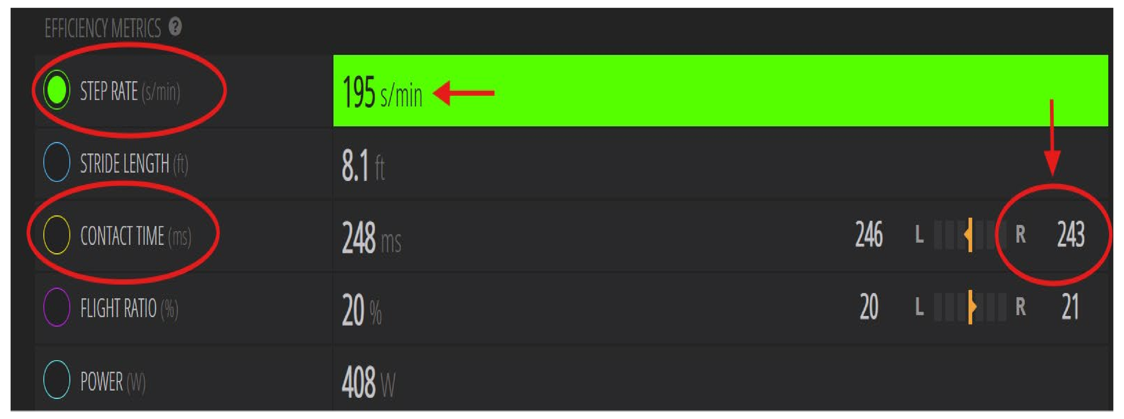
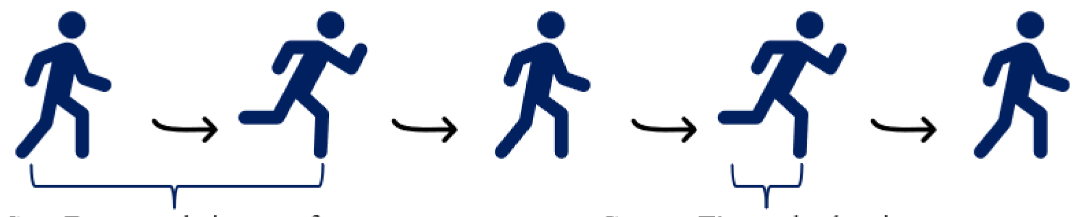


Figure 2: RunScribe Data Output

3k Time Trial Protocol

- Each participant completed two 3k treadmill time trials at 1% grade.
- Participants were blinded to speed, distance, and time, and could only increase or decrease treadmill speed using a single control
- Informed only when they reached 1k, 2k, and when 200 m remained
- No verbal encouragement was provided during testing
- 48 – 72 hours between visits



Results

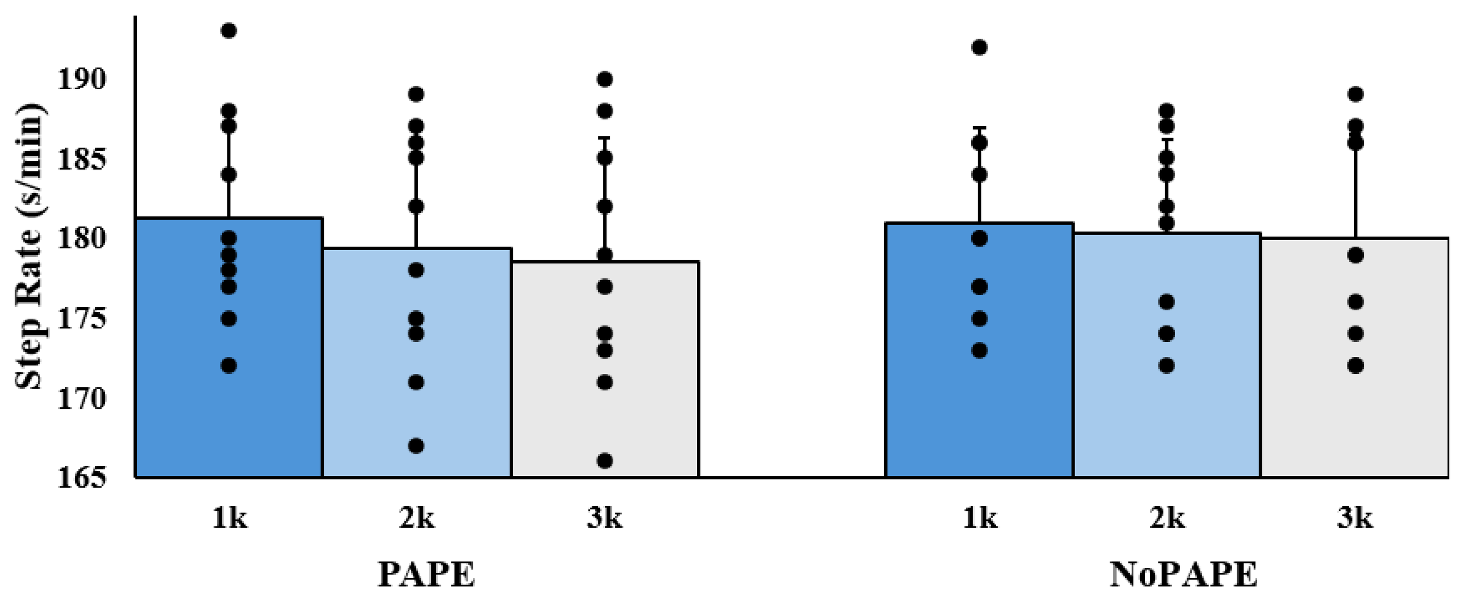


Figure 3: Mean (±SD) kilometer step rates across time points in both conditions. Individual participant data represented

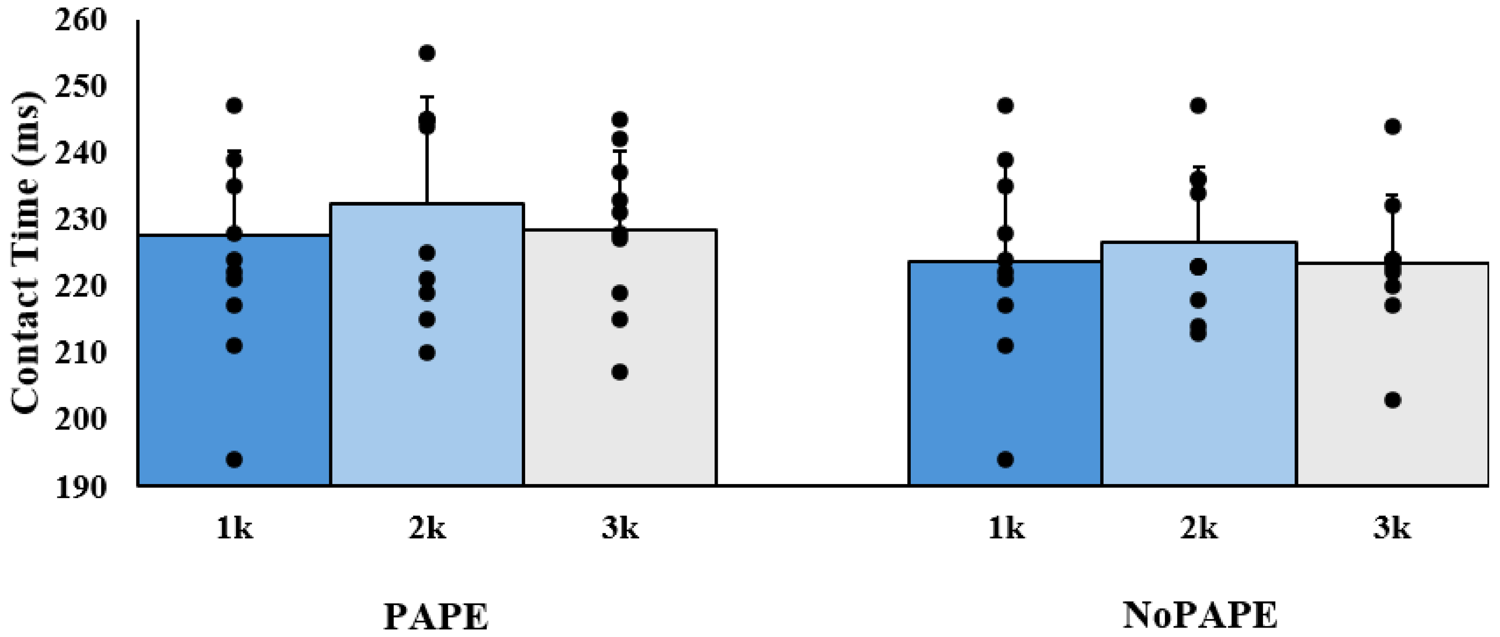


Figure 4: Mean (±SD) kilometer contact time across time points in both conditions. Individual participant data represented

	1k Time	2k Time	3k Time	Total Time
PAPE	3:38±35s	3:52±36s	3:54±31s	11:24±96
NoPAPE	3:41±34s	3:46±33s	3:51±27s	11:19±89
Combined Average	3:40±34s	3:49±33s *	3:53±28s *	11:22±90

Table 2: Mean (±SD) kilometer split and trial times across PAPE, NoPAPE and collapsed conditions. * denotes significant differences in average kilometer time from 1 km (p<.05).

Discussion

- The PAPE protocol did not improve 3k time trial performance or alter SR or CT, suggesting the conditioning stimulus was insufficient to elicit measurable performance enhancement[1]
- These findings align with prior work showing limited PAPE effects during endurance tasks, where sustained effort may override short-term neuromuscular benefits[1]
- Gait enhancement from PAPE may be protocol-dependent[2], with previous studies reporting improvements when using higher-intensity or more targeted conditioning activities such as heavy calf-dominant exercises or intense plyometrics[2]
- Across both conditions, progressive pace slowing was observed and is likely attributable to fatigue-related pacing strategies rather than any influence of PAPE[4]

Limitations

- Participants may have experienced pacing bias, as performing a second 3k trial could improve pacing regardless of condition
- Small sample size and disproportionate representation of males and females limits statistical power and generalizability

Conclusion

- PAPE protocol did not improve 3k running performance or alter gait variables (SR or CT); runners progressively slowed across kilometer splits in both conditions, indicating fatigue-driven slowing
- Future studies should examine the effectiveness of other PAPE protocols as some studies with different protocols suggest that a conditioning activity does elicit gait enhancements

References

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Acknowledgements

Supported by University of New Hampshire's 2025 Research Experience and Apprenticeship Program (REAP) from the Hamel Center for Undergraduate Research