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A Comparison of Three Different Warm-Ups on 800-Meter Running Performance in Elite Division I Track Athletes – A Pilot Study

ROGER KEESLING†[1], ANDREAS N. KAVAZIS‡[2], BENJAMIN WAX‡[1], MATTHEW W. MILLER‡[2], and BRAD VICKERS‡[1]

[1]Department of Kinesiology, Mississippi State University, Mississippi State, Mississippi, United States; [2]School of Kinesiology, Auburn University, Auburn, Alabama, United States

†Denotes graduate student author, ‡Denotes professional author

ABSTRACT

International Journal of Exercise Science 14(6): 1400-1407, 2021. Track and Field athletes perform different types of warm-ups at varying levels of volume and/or intensity prior to competition. Theoretically, this prepares sport specific muscles for activity by increasing muscle temperature, thus mitigating the chance for injury. There is a paucity of information regarding the optimum level for warm-ups regarding maximizing performance in middle distance events. The aim of this study was to examine the effects of three different warm-ups on 800-meter performance. Thirteen Division I student-athletes (seven males and six females) from the Southeastern Conference (SEC) who were middle distance runners participated in this study. We utilized a randomized, cross-over study design to test low, medium, and high-volume warm-up protocols on 800-meter performance. Trials were conducted over a span of three weeks on a SEC University outdoor track. We used a 2 (Sex) x 3 (Warm-Up Protocol) mixed-factor ANOVA, and our results show a main effect of warm-up volume that is not moderated by sex. Post-hoc tests reveal a high-volume warm-up yields superior results for the 800-meter run in comparison to a medium volume warm-up, which provides better results than a low-volume warm-up. These findings may be of value in providing information in program design for coaches on the most effective warm-up protocols for 800-meter runners. Identifying the best warm-up protocol to prime an 800-meter runner for peak performance may not only assist in preventing injury, but enhance performance thus leading to an increased of achievement, and confidence in personal ability.

KEY WORDS: Track and field, racing, team sports

INTRODUCTION

Athletes generally perform warm-ups to prepare their body for performance both physiologically and psychologically (1, 5). Traditionally, these warm-ups range from general to more sport specific exercises (19). Benefits of warm-ups include mitigated muscle and joint viscous resistance (17), increased oxygen kinetics (14), increased nerve conduction (22), and enhanced muscle metabolism (8). Fradkin et al. (9) meta-analysis of 32 studies examined the effects of warm-up on performance in different athletic events and found that warm-ups improved performance in 79% of studies, led to no change in 3% of studies, and negatively affected performance in 17% of studies. While several studies have examined physiological responses to warm-ups (15, 16), fewer studies have assessed changes in performance following different warm-up volumes (9). Skof and Strojnik (21) reported that a warm-up for middle distance runners that included slow running, stretching, sprinting, and bounding increased muscle activation more than a warm-up that included slow running and stretching only. Additionally, Ingham, Fudge, Pringle, and Jones (12) concluded that a high intensity and volume warm-ups may improve 800-meter performance.

Numerous studies have assessed performance following warm-ups on single sprint performance or continuous exercise (10, 20, 23); however, there is a paucity of well-documented studies assessing low, medium, and high-volume warm-up protocols on 800-meter performance found in the literature (9). In a study of 800-meter runners, researchers reported that higher volume and intensity warm-ups resulted in better performance (12). Despite the positive findings, the study's main weakness was that all testing was done on a treadmill. While laboratory setting helps control for issues related to the environment, this greatly diminishes the ecological value (environmental influences) of the findings (24). Additionally, athletes do not perform their personal best times on a treadmill due to the inability to make subtle pace adjustments and have lower motivation in comparison to performing in their competitive elements (11).

Therefore, the purpose of this study was to identify an appropriate warm-up protocol for NCAA Division I Southeastern Conference (SEC) 800-meter middle distance runners that results in optimal outcomes in a peak performance, i.e., 800-meter time trial performed on an outdoor track. We hypothesized that the high-volume warm-up protocol would result in the best (i.e., lowest) time trial completion for elite college age athletes in the 800-meter running performance.

METHODS

Participants

Thirteen (seven males and six females) SEC Division I Track and Field student-athletes who competed in middle distance (800-meter) running events were recruited to participate in this study. Track and Field athletes who competed in other events (e.g., 100-meter, 200-meter, jumping and throwing events) were excluded from participation. Further exclusionary criteria of the study included: (a) musculoskeletal problems, (b) cardiorespiratory ailments, (c) metabolic disorders, (d) blood disorders, (e) history of psychological disorders, (f) use of tobacco products, (g) consuming more than ten alcoholic beverages per week, and (h) use of supplements or other medications. Athletes' academic classification ranged from freshmen to junior. This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (18). The study's procedures were reviewed and approved by the University Institutional Review Board prior to the initiation of the study and all athletes provided their written consent prior to participation. Additionally, permission was granted by the athletic administration and team coaches. Table 1 displays means and standard deviations for athletes' characteristics.

Table 1. Athlete demographics.

Age (y)	Height (m)	Body mass (kg)	Body Mass Index
Males (n = 7)			
20.0 ± 1.8	1.76 ± 0.05	62.1 ± 3.8	20.0 ± 0.8
Females (n = 6)			
20.0 ± 1.1	1.66 ± 0.05	57.7 ± 3.2	20.9 ± 0.7

Protocol

A study design incorporating low, medium, and high-volume warm-up protocols (independent variable) were utilized in this study. Testing occurred on an SEC University 400-meter International Amateur Athletic Federation certified synthetic rubber outdoor track over a three-week period, with each athlete testing one day each week. The warm-up protocols (low, medium, and high volume) were applied in a random counterbalanced manner over the three-week period.

During the initial meeting, the Principal Investigator met with student-athletes who met the inclusion criteria and explained the purpose of the investigation, provided an overview of the study and addressed any initial questions. Consent forms were given to those who were interested in participating to review and consider on their own. A second group meeting was held approximately one-week later to answer any additional questions and collect signed consent forms from participating athletes. To reduce threats to internal validity, athletes were asked to follow the same physical activity and dietary behavior routine for 48 hours before subsequent testing times. Physical activity items were modified from the National Health and Nutrition Examination Survey (NHANES; Centers for Disease Control and Prevention, 2013) (6).

On the first testing day, participating student-athletes met in the Training Room. Each athlete completed Diet and Physical Activity Log to document physical exertion and dietary behaviors during the 48 hours prior to the first testing date. Demographic information was also collected during this session. Athletes completed the Physical Activity Readiness Questionnaire (PAR-Q) to determine if there were any potential risks associated with physical activity (25). All physical documents (other than consent forms) used ID numbers only (i.e., no names) to identify/track athletes across testing dates. Athletes were reminded that participation was completely voluntary and they could cease their involvement at any time without negative consequences.

Athletes then moved outdoors to the University Track, where the three warm-up protocols (low, medium, and high intensity) were tested based on assignment for that day. To control for physical risks associated with this study (e.g., muscle pulls, strains, sprains; fainting; breathing difficulties; bumps, scrapes, or bruises; or other risks that could typically result from physical exertion), at least one SEC Track and Field athletic trainer was present during all testing sessions. Each athlete completed their assigned warm-up protocol for the testing date. A standard 60 second rest period was incorporated in between all activates within the warm-up protocol. Table 2 outlines the sequence of warm-up activities for each protocol's level of intensity.

After finishing the warm-up protocol, the participant put back on their warm-up suit and was encouraged to sit quietly for 15 minutes. During this period, the participants were permitted fluids and to stand or walk in order to maintain their ecological pre-run ritual. No additional activity was permitted during this period. Following the rest period, the participant took off their suit and reported to the starting line. Five minutes elapsed between undressing and starting the 800-meter time trial. All trials were conducted individually. During the 800-meter time trials, the SEC Track and Field Coaches and trainers recorded the timed 800-meter checkpoints using a standard digital stopwatch (Seiko SVAS003 Tokyo, Japan). Total time was also documented. Athletes were encouraged to perform up to their maximum potential for each session. The subsequent two sessions followed a similar testing format and were conducted on the same day and time of the week.

Table 2. Warm-up protocols.

Activity	Low Volume	Medium Volume	High Volume
10-minute jog	x	x	x
Dynamic stretching exercises (4-way leg swings, back to wall – wall touches (hip rotation), forward lunges, backward lunges, donkey kicks, glut bridges, cats to camel, iron crosses, sitting leg raises, side lunges, karaoke's, and side skips with overhead arm swings)	x	x	x
4 x 40-60m bounding/striding runs	x	x	x
4 x 60m acceleration sprints at race pace		x	
2-minute walking/jogging recovery		x	
100m sprint at race pace		x	x
100m, 200m, and 300m consecutive sprints at race pace with 60 second walking/jogging recovery in between each			x
15-minute rest period (e.g., sitting, walking, drinking water and/or Gatorade)	x	x	x

Statistical Analysis

Data were submitted to a 2 (Sex: male/female) x 3 (Warm-Up Protocol: low/medium/high) mixed-factor ANOVA with repeated-measures on the second factor. If a Sex x Warm-Up Protocol interaction occurred, we would conduct separate one-way (Warm-Up Protocol) repeated-measures ANOVAs for each sex. Effect sizes for significant ANOVAs are reported as η^2_p. For significant effects of warm-up protocol, we planned to conduct paired-sample *t*-tests between warm-up protocols. Effect sizes for significant paired-sample *t*-tests are reported as *dz*. Alpha level was set to 0.05, and the Greenhouse-Geisser correction was applied when sphericity was violated. Corrected degrees of freedom and *p*-values are reported when necessary.

RESULTS

Figure 1 summarizes the data as a function of sex and warm-up protocol. Results revealed main effects of sex ($F(1, 11) = 15.2$, $p = 0.002$, $\eta^2_p = 0.581$) and warm-up protocol ($F(2, 22) = 17.5$, $p < 0.001$, $\eta^2_p = 0.614$). Paired-sample *t*-tests revealed the high volume warm-up protocol was superior to the medium volume warm-up protocol ($t(12) = 3.67$, $p = 0.003$, $dz = 1.02$) and low volume warm-up protocol ($t(12) = 5.46$, $p < 0.001$, $dz = 1.51$). The medium volume warm-up protocol was better than the low volume warm-up protocol ($t(12) = 2.99$, $p = 0.011$, $dz = 0.828$).

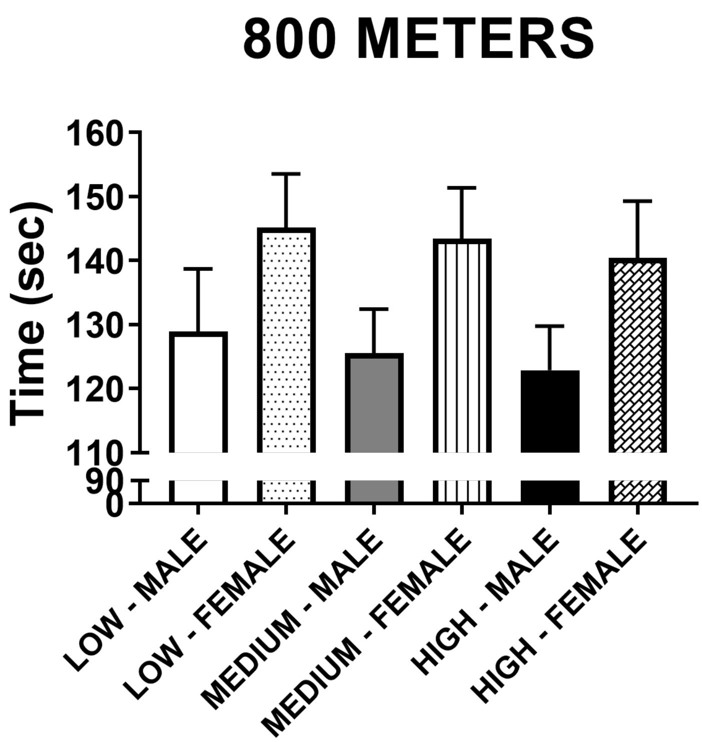

Figure 1. 800-meter time in seconds for each warm-up protocol. The time trials revealed a statistically significant difference ($p < 0.05$) in the protocols for males (low = 128.98 ± 9.72 seconds; moderate = 125.53 ± 6.92 seconds; high = 122.89 ± 6.91 seconds) and females (low = 145.20 ± 8.33 seconds; moderate = 143.39 ± 7.99 seconds; high = 140.46 ± 8.83 seconds.

DISCUSSION

Findings from the present study confirmed our hypothesis, suggesting that a high intensity warm-up may be more prudent for elite level athletes during 800-meter races. Results revealed a dose-dependent relationship between warm-up protocol and 800-meter performance such that a high-volume warm-up was superior to a medium volume warm-up, which was better than a low-volume warm-up. These effects were not significantly affected by the sex of the runner. For males, six of the seven improved their time when doing medium compared to low volume and six of seven improved their time when doing high compared to medium volume. For females, five of six improved their time when doing medium compared to low volume and all six improved their time when doing high compared to medium volume. These findings agree with a recent study, which reported that high volume warm-ups may improve 800-meter running performance (12). Note, the present study confirmed the finding by implementing three warm-up protocols (low, medium, and high volume), which allowed for additional distinctions regarding the most effective warm-up protocol for 800-meter runners.

In a prior study by Ingham et al. (12), treadmills were utilized to test running performance, in contrast to our study, which conducted running trials on an NCAA track. Hill (11) suggested that athletes do not perform their best on a treadmill due to lower motivation in the laboratory setting than in competition and the inability to make subtle pace adjustments. In the present study, temperatures, humidity, wind direction, and speed were relatively similar across testing days. Thus, conducting the present study in an outdoor setting may provide greater ecological value for practitioners and athletes.

Bishop (4) reported that different physiological responses to warm-up may be required to optimize performance for different tasks. Specifically, increasing nerve transmission velocity results in decreased reaction time via increased muscle contraction (26). The increased temperature resulting in an augmentation of performance has been previously established (2, 23), as long as the intensity does not result in high levels of blood lactate, resulting in decreased pH levels, increased inorganic phosphate, and inhibiting the energy systems (3, 4). Therefore, future studies should demonstrate the specific physiological changes that occur to prime the body for exertion (7), such as changes in muscle temperature and function, heart rate, oxygen kinetics, and energy systems; thus, mitigating the muscle’s viscous resistance (3, 26).

Finally, there are also general limitations in this study. First, due to maintaining the ecological integrity of the athlete’s environment, specific standardized intensity levels were not measured. Next, while the female athletes reported their menstrual cycles to the coaches and medical staff (trainers and team doctors), this information was not provided for this study. Additionally, due to the homogeneity of the athletes training and performance levels, prohibited a control group, which may limit the generalization of the findings to a limited population. Finally, despite using trained expert timers for this study, human error was still a slight possibility.

In conclusion, warm-ups are essential to prepare athletes for exertion and optimum performance (4). The findings of the present study suggest that high intensity warm-up may be most prudent for college age elite level male and female athletes preceding racing distances of 800-meters. Given the connection between warm-up protocols and performance, as well as knowing that warm-up protocols are often based on the coaches’ intuition (4), training on the most effective event-specific warm-up protocols could be developed and provided to coaches through certification courses which have been shown to be an effective way to communicate such information (13). Identifying the best warm-up protocol (e.g., intensity and volume) to prime an 800-meter runner for peak performance can help prevent injury, enhance performance and sense of achievement, and increase an athlete’s confidence in his or her personal skills and abilities.

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