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ORIGINAL ARTICLE

How recovery postures influence performance during multiple sprint shuttles

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ABSTRACT

Recovery from exercise is arguably one of the most essential traits in training and competition to reduce fatigue and improve performance. Therefore, individuals should utilize the best short- and long-term recovery strategies to improve their physiological and psychological abilities. This study aimed to examine the effects of two different standing recovery postures, Hands on the Knees (HK) and Hands on the Head (HH), in between performing three 150-yard (150-YD) sprint shuttles. Heart rate recovery (HRR) was collected, along with shuttle completion times for comparison. There were no significant differences between trials 1, 2, 3, and average shuttle completion times between the HK and HH recovery methods. However, significant differences occurred in trials 1, 2, 3, and average recovery heart rates (p = .03 - .00), with small to moderate effect sizes. The data indicates that the HK posture may be more beneficial than the HH position due to its enhanced HRR capabilities during high-intensity sprinting. Future expansive research is needed to determine how recovery positions can impact higher volume high-intensity sprinting bouts from both recovery and performance perspectives in field settings.

Keywords: Performance analysis, High-Intensity, Recovery posture, Sports performance, Heart rate recovery.

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INTRODUCTION

Acute recovery from an exercise bout is arguably one of the essential traits during training and competition for reducing fatigue and improving subsequent performance (Burnley & Jones, 2016; Halson, 2014). The capability to recover mainly depends on the cardiovascular and neuromuscular systems' synchronized ability to produce and sustain appropriate responses to the demands of exercise, with heavy and severe intensity exercise producing substantially more central and peripheral fatigue than moderate intensity modes (Burnley & Jones, 2016). The coordination of these systems helps buffer metabolic by-products from exercise, such as hydrogen ions (H^+), carbon dioxide (CO_2), and inorganic phosphate (Pi), which can disrupt skeletal muscle functionality and induce greater levels of fatigue (Hureau et al., 2002; Michaelson et al., 2019). Individuals who can recover rapidly during exercise can typically outperform their opponents by expressing higher and longer amounts of high-intensity work, all of which are likely to positively influence the outcomes of competition (Burnley & Jones, 2016; Halson, 2014). Therefore, in addition to appropriate and progressive exercise training programs, individuals should utilize the best recovery strategies to enhance their physiological responses to the demands of training and competition.

There are three primary passive positions that individuals can utilize to recover between exercise bouts: supine, seated, or upright, and each can have different effects on the body (Michaelson et al., 2019). For example, a study by Hwangbo et al. (2019) examined fifteen male university students and their ability to recover from a maximal treadmill running protocol while either in a supine, seated, or standing spinal flexed position with hands on the knees (HK). The HK position displayed significantly ($p < .05$) lower minute ventilation after five minutes of recovery compared to the sitting and supine positions (20.0 ± 2.8 vs. 29.9 ± 7.0 and 32.4 ± 13.5 L/min), demonstrating improved oxygen delivery and metabolic by-product recycling due to fewer demands imposed on the cardiovascular system (Hwangbo et al., 2019). Another investigation by Charry et al. (2023) had sixteen adults perform four randomized high-intensity interval tests lasting twenty seconds, followed by four minutes of recovery, either standing upright with hands on the head (HH), HK, slow walking with hands on hips, or supine. Peak power significantly ($p < .05$) declined after each twenty-second cycle trial without significant differences between postures; however, heart rate recovery (HRR) was significantly ($p < .001$) faster in the supine position compared to the HH, HK, and slow walking positions (53 ± 9 vs. 39 ± 15, 42 ± 10, 39 ± 9 beats per minute), indicating that the supine posture is best for recovery between intervals since a greater HRR between exercise intervals reflects an improvement in aerobic capacity, while a delayed HRR results in adverse performance outcomes and greater changes in fatigue (Burnley & Jones, 2016; Charry et al., 2023; Michaelson et al., 2019). Based on the limited literature examining recovery postures from different exercise intervals and modes, the best position may depend on objective, subjective, or a combination of measurements to determine which will facilitate recovery for each individual, with more research needed to confirm whether one position outperforms the others.

In team sports, most individuals and coaches prefer an upright position since this more closely reflects what occurs during competition (Buchheit et al., 2009; Michaelson et al., 2019). The choice of the HK or HH position may stem from the coach's or individual's preference; however, the HK position may be more advantageous for immediate recovery compared to HH, as it optimizes the diaphragm's capabilities to influence ribcage elevation and the subsequent ability to expand the lungs, thus promoting greater gas and nutrient exchange, which aids recovery (Buchheit et al., 2009; Michaelson et al., 2019). For example, in a study by Michaelson et al. (2019), twenty female athletes completed two exercise sessions comprising four rounds of four-minute intervals at 90-95% of their maximum heart rate, followed by three minutes of either HK or HH passive recovery between each interval. The HK posture significantly outperformed the HH posture regarding HRR (53 ± 10.9 vs. 31 ± 11.3 beats per minute, $p < .001$), tidal volume (1.44 ± 0.2 vs. 1.34 ± 0.2 L/min, $p = .008$), and carbon dioxide volume (1.13 ± 0.2 vs. 1.03 L/min, *p* = .049), indicating greater physiological recovery capabilities that would likely enhance performance during competition (Michaelson et al., 2019). Despite the current understanding of maximizing the diaphragm's capabilities in the standing recovery position, investigations into their roles within different forms of exercise are limited, especially in practical settings. Due to the limited information on various standing recovery postures in practical environments, this study was conducted to determine the effects of using HH and HK in a non-laboratory setting and to examine how standing recovery positions influence heart rate responses and performance capabilities.

MATERIALS AND METHODS

Participants

The study sample consisted of 13 male and 7 female subjects (n = 20, age = 20.2 ± 2.2 years) representing various sports teams associated with the National Association of Intercollegiate Athletics (NAIA). The sample size of 20 participants, along with the descriptive statistics, mirrored the research conducted by Michaelson et al. (2019), which investigated passive recovery postures in 20 collegiate athletes during high-intensity exercise intervals. For this study, eligible participants needed to engage in physical activity at least 3 days per week and must have been able to perform sprint/agility shuttle tests without any physical or psychological limitations. All participating individuals were required to complete their testing trials separated by a minimum of 48 hours and to finish trials 1 and 2 within one calendar week of each other. Study protocols and materials were approved by the Institutional Review Board at Siena Heights University.

Measurements

High-intensity anaerobic capacity was measured through 150-yard shuttle runs (150-YD), which mimic the exact parameters of the 300-yard shuttle runs, albeit at half the distance. The 300-yard shuttle run is a reliable field test (r = .84; ICC = 0.83) for assessing high-intensity capacities, and the acceleration, deceleration, and change of direction demands reflect similar aspects encountered in many sports and activities (Hoffman, 2012; White, 2015). The 150-YD tests were conducted on an indoor basketball court with appropriate markings and cones spaced 25 yards apart. Individuals sprinted as fast as possible for 25 yards and then returned to the starting line for three rounds (6 x 25 yards = 150 yards), touching the end lines with their right and left legs, respectively (Hoffman, 2012). Time was measured with a stopwatch, and each individual's time was recorded after each 150-YD trial was completed, resulting in three total time trials for each testing day. Each individual's heart rate was monitored throughout each trial using a Polar H9 heart rate sensor (Polar Electro Oy, Kempele, Finland). Heart rates were recorded after one minute of recovery using the HH or HK method, yielding three total heart rate measurements for each testing day. When performing similar shuttles that assess sprinting and anaerobic performance, coaches require their athletes to complete two trials, separated by five minutes of recovery time, with the best performance between both trials used for record-keeping (Hoffman, 2012). However, these testing standards examine how well athletes perform this test, not necessarily how they manage the demands of repeated high-intensity sessions encountered during competition. Therefore, this study aimed to investigate the effectiveness of the HK and HH recovery positions when performing three consecutive 150-YD trials separated by two-minute recovery windows.

Protocol

Each individual completed two testing days consisting of three 150-YD tests, separated by two-minute recovery periods. Before the first testing day began, the individual's recovery method was randomly selected, either HK for day one followed by HH for day two, or vice versa. Individuals completed a walk-through and adequate warm-up of their choice before beginning trial one. During the test, individuals ran as fast as possible for 25 yards, touched the end line, ran another 25 yards back to the starting line, and then repeated this sequence two additional times, covering a total of 150 yards (Hoffman, 2012; White, 2015). Once the first 150-YD trial was complete, the subject passively recovered for two minutes, then repeated this process for a total of three 150-YD trials and three recovery periods. When all trials and recovery periods were completed, the first testing day was finished. The subject returned between two and seven calendar days later to complete the second testing day, following the same protocol but using the other recovery period that they had not used during the first testing day.

Statistical analysis

Each individual's 150-YD trial time and corresponding heart rates were analysed using paired samples t-tests to examine the performance and heart rates of trials 1, 2, and 3 from both testing days. The level of significance for all tests was set at α = .05. The effect size for interactions between conditions was calculated using Cohen's d, defined as >0.2 (small), >0.5 (medium), and >0.8 (large) (Thomas et al., 2015).

RESULTS

All 20 individuals completed both testing days, which consisted of three 150-YD trials separated by three recovery periods, each utilizing either an HH or HK recovery method. The data from each individual's performance for both testing days are outlined in Table 1.

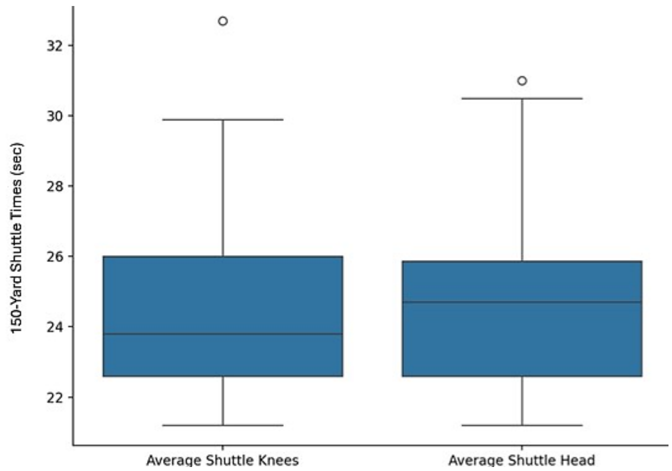
Table 1. Descriptive statistics for each individual's trials.

Test	Timing group	M (SD)	Range
150-YD (sec)	Trial 1 HK	24.5 (2.81)	9.1
	Trial 2 HK	24.9 (2.99)	11.2
	Trial 3 HK	25.4 (3.51)	14.3
	Trial 1 HH	24.6 (2.89)	9.6
	Trial 2 HH	25.2 (3.0)	10.1
	Trial 3 HH	25.1 (2.91)	10.5
HR (bpm)	Trial 1 HK	142.2 (18.66)	67.0
	Trial 2 HK	149.0 (18.66)	45.0
	Trial 3 HK	152.5 (12.37)	41.0
	Trial 1 HH	147.7 (19.32)	74.0
	Trail 2 HH	157.2 (16.02)	61.0
	Trial 3 HH	162.4 (13.69)	55.0

Note. 150-YD = 150 Yard Shuttle Test, HR = Heart Rate, sec = seconds, bpm = beats per minute.

Paired-sample t-tests were performed to investigate any differences in performance times between trials 1, 2, and 3 using the HK and HH recovery methods. There was not a significant difference in performance times for trial 1 HK (M = 24.5, SD = 2.81) and HH (M = 24.6, SD = 2.89) conditions, t(19) = -0.27, *p* = .78, *d* = 0.04; trial 2 HK (M = 24.9, SD = 2.99) and HH (M = 25.2, SD = 3.0) conditions, t(19) = -0.70, *p* = .49, *d* = 0.10; and trial 3 HK (M = 25.4, SD = 3.51) and HH (M = 25.1, SD = 2.91) conditions, t(19) = 0.84, *p* = .41, *d* = 0.09. There was not a significant difference in average performance times for all trials between HK (M = 24.96, SD = 3.03) and HH (M = 24.96, SD = 2.84) conditions; t(19) = -0.02, *p* = .98, *d* = 0.00. The distribution of averages between 150-YD times is outlined in Figure 1.

Paired-sample t-tests were performed to investigate any differences in heart rates after one minute of recovery between trials 1, 2, and 3 using the HK and HH recovery methods. There was a significant difference in heart rate responses for trial 1 HK (M = 142.2, SD = 3.03) and HH (M = 147.7, SD = 19.32) conditions, t(19) = -2.29, *p* = .03, *d* = 0.29; trial 2 HK (M = 149.0, SD = 12.73) and HH (M = 157.2, SD = 19.32) conditions, t(19) = -3.02, *p* = .00, *d* = 0.57; and trial 3 HK (M = 152.5, SD = 12.37) and HH (M = 162.4, SD = 13.69) conditions, t(19) = -4.83, *p* = .00, *d* = 0.76. There was a significant difference in average heart rates for all trials between HK (M = 147.88, SD = 13.49) and HH (M = 155.8, SD = 16.04) conditions; t(19) = -4.12, *p* = .00, *d* = 0.53. The distribution of average heart rates recorded during the first minute of recovery is outlined in Figure 2.



Note. sec = seconds.

Figure 1. Distribution of average 150-yard shuttle times between the Hands on Knees (HK) and Hands on Head (HH) recovery positions.

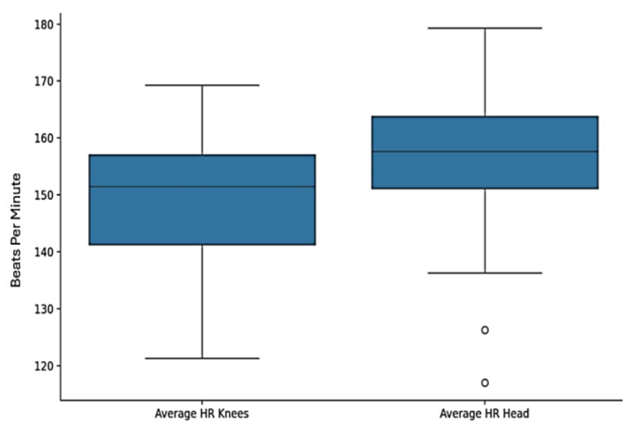


Figure 2. Distribution of average Heart Rates (HR) measured at the first minute of the Hands on Knees (HK) and Hands on Head (HH) recovery positions.

DISCUSSION

Overview of findings

As expected, the average times needed to complete each 150-YD trial increased as attempts progressed from trial 1 to trials 2 and 3, regardless of whether the individuals were utilizing HK or HH recovery methods. This indicates that the individuals were working to achieve their best 150-YD times with each trial, as instructed. However, these differences were modest, and there were no statistically significant changes in performance outcomes between trials 1, 2, and 3 when comparing HK to HH recovery methods, along with their average completion times for all three trials.

However, there were noteworthy differences in HRR responses between the HK and HH recovery methods. In trials 1, 2, and 3, as well as their collective averages, the HK recovery method resulted in significantly lower heart rates compared to the HH, with small to moderate effect sizes. Unexpectedly, the reduction in heart rate did not lead to successive performance improvements between trials when compared to the HH position. This can be attributed to several factors, such as the testing intervals not being long enough to create a substantial physiological demand and deficit between each trial or the recovery periods of 2 minutes being adequate to positively influence the ATP-PCr and glycolytic energy systems for the next 150-YD trial, regardless of which recovery position was used (Burnley & Jones, 2016). While HRR likely matters when performing multiple exercise bouts, it does not appear to be a significant factor concerning overall performance when the recovery periods are approximately four times the length of the exercise bouts, as observed in this study.

Study limitations and future research directions

The present study has several limitations that should be acknowledged. Based on an extensive search, this study appears to be the first of its kind to examine two different standing recovery postures after performing multiple high-intensity exercise bouts in the field, making its findings novel. This may potentially justify its small sample size; however, according to G*Power (Version 3.1.97; Heinrich Heine Universität, Düsseldorf, Germany), with an alpha level of .05 and a 0.5 effect size, a minimum of 54 participants is needed. This indicates that the study is underpowered, which could result in a type II error (Thomas et al., 2015).

While other studies have explored similar variables, they have all been conducted in laboratory settings where additional attributes can be measured in a more controlled environment. Since the subjects performed field tests, the number of variables was limited, making it unclear whether other measurements, such as O2 consumption and CO_2 production, would have provided additional insight into both the HK and HH recovery positions. Furthermore, the individuals tested were college-aged NAIA athletes from various sports, and it remains uncertain whether including individuals from different athletic backgrounds or ages would have influenced the results differently. Although the sample size achieved statistical significance, it is small; thus, follow-up studies would benefit from examining larger subject pools of varying backgrounds. Additionally, it would be advantageous to explore other speed, agility, and aerobic field test intervals to investigate further how the HK and HH recovery positions can influence performance and physiological variables. Future research should also consider more exhaustive field tests that impose greater and/or longer demands on the cardiovascular system to discover how the HK and HH recovery positions can affect subsequent performance.

CONCLUSION

The study's findings suggest that the HK posture facilitates greater HRR compared to the HH posture during high-intensity sprinting. Heart rate values were significantly different, with small to moderate effect sizes, between trials 1, 2, 3, and their averages, despite no training protocols being implemented. Performance times displayed minimal variability; however, the heart rate differences indicate that cardiovascular demands varied between recovery positions and could impact subsequent performance bouts. The results of the study support the use of HK posture during standing passive recovery and should be adopted by individuals and coaches to enhance athletic performance during training and competitions. Future research examining these effects in the field is necessary to confirm these findings and build upon the results obtained.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author.

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