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Section: Original Investigation

Article Title: The Influence of Match-Day Napping in Elite Female Netball Athletes

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Journal: *International Journal of Sports Physiology and Performance*

Acceptance Date: February 26, 2018

DOI: https://doi.org/10.1123/ijspp.2017-0793

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Running head: Match-day napping of elite female athletes

Abstract word count: 235

Text-only word count: 2912

Number of figures: 2

Number of tables: 3

Abstract

Purpose: To assess the effect of match-day napping and duration of naps on perceptual and performance indices in elite female netball players over two consecutive netball seasons. **Methods:** Fourteen elite female netball athletes (mean ± SD; age = 23 ± 6 yr) participated in an observational study over 26 competition matches. On each match day, athletes provided information on their napping habits, perceived energy levels, and then performed 3 countermovement jumps (CMJ) 3h30 prior to the start of the match. One hour following the match, subjective player performance ratings from the players and two members of the coaching staff were obtained. Naps were characterized into 3 conditions for analysis; No Nap (NN), <20 min Nap (SHORT), and ≥20 min Nap (LONG). **Results**: A significant difference in peak jump velocity was observed between the SHORT and the NN condition in favor of the shorter nap (3.23 ± 0.26 and 3.07 ± 0.36 $m.s^{-1}$, respectively, d = 0.34, $p < 0.05$). A *moderate*, significant difference (d = 0.85; $p < 0.05$) was observed for the coach rating of performance (out of 10) between the SHORT and the NN condition (7.2 ± 0.8 and 6.4 ± 0.9, respectively) in favor of SHORT. **Conclusion**: The findings from the study would suggest that a short nap (<20 min) on the day of competition can enhance jump velocity and improve subjective performance in elite netball players, as assessed by coaching staff.

Keywords: Team-sports, performance indices, competition, perceptual indices, gender

Introduction

Elite athletes are exposed to a high level of both physiological and psychological stress leading up to and on the day of competition, and therefore look to utilize a range of different strategies to gain and maintain a competitive edge.[1] One strategy that elite athletes use to counteract slept debt and sleepiness in the training and competition environment is a daytime nap.[2-4] Napping has been defined as a sleep period less than 50% of an individuals average nocturnal sleep duration.[5-7] Although well-documented in the training setting,[4,8] at present, there is no research to evaluate the use of a pre match/competition nap on subsequent performance measures and the effect in elite athletes. There are a number of contributing factors that have an effect on both sleep and performance in elite athletes. Some of these factors include travel, match scheduling, media commitments, athlete compliance and a range of other psychological and physiological variables that highlight the difficulty in assessing the relationship between performance and napping. Furthermore, applied research in the elite sport setting can be somewhat difficult, with some coaches being reluctant to add any distractions, especially around competition and important phases of the season.

Previous studies have reported that poor sleep is common in elite athletes.[9-11] According to Lastella, Lovell and Sargent[9], 68% of athletes in their survey experienced poorer than normal sleep on the night prior to competition, resulting in 5 hours and 51 minutes of total sleep time, well below the daily recommendation.[12] Furthermore, Juliff, Halson and Peiffer[10] reported both female athletes and team sport athletes have lower sleep durations (7:36 h:m) than male and individual sport counterparts (7:48 h:m). The reduction in sleep quantity could be proposed as a potential reason for athletes utilizing naps on the day of competition to alleviate the sleep debt and sleepiness from the previous night [13] and in order to be re-energized and ready to perform. Anecdotal evidence also suggests that when athletes compete at night, naps are often used to attenuate the boredom associated with waiting for the event. It has been highlighted in previous research, in particular by Davies et al[14] and Petit et al[15], that there are two 'ideal' time durations of a nap. The nap duration of less than 20 minutes is considered optimal to avoid slow-wave sleep (deep sleep).[15] Alternatively, 90 minutes is also considered optimal as this allows a complete sleep cycle (NREM and REM) to occur, reducing the effects of sleep inertia.[14] Sleep inertia is a temporary reduction in arousal and performance, which is associated with slow-wave sleep in NREM.[16,17] Naps are likely to occur in the mid-afternoon, when there is a dip in the circadian rhythm following lunch, which is a period of time when attention and alertness is reduced.[18]

A study by Waterhouse et al[7] investigated the effect of a lunchtime nap following a partial (4 hour) sleep deprivation on cognitive, motor, and sprint performance in 10 untrained participants. On two separate occasions, participants performed either a 30-minute nap or no nap condition following partial sleep deprivation. The results showed a significant improvement in both the 2-m and 20 m sprint times following the 30-minute nap when compared to no nap. Participant's alertness and visual short-term memory also showed significant improvements in the 30-minute nap condition ($p < 0.01$, & $p = 0.01$, respectively). At present there is limited knowledge on the benefit of napping a sporting environment. However, Lastella et al[2] investigated the differences in sleep behaviors across a range of individual and team sport athletes, reporting the nap frequency over a 7 night period for team sport athletes was 11% with a mean duration of 0:59 ± 01:02 h:min, which would suggest it is an area that requires further investigation.

Given many professional athletes compete later at night, the anecdotal reports of napping by athletes on match day is common, however objective measures on the effects of napping on performance are currently lacking. Indeed, the majority of professional level netball matches are played at 19:30 at night as the requirements of television coverage has shifted the scheduling of professional team sport fixtures from the day to the evening,[19] creating a prolonged match-day period, therefore, promoting the need for napping. Therefore, the aim of the current study was to assess the effect of pre game napping behaviors on perceived energy levels, neuromuscular performance, and ratings of match performance in elite female athletes over two professional netball seasons.

Methods

Participants

A total of 14 professional female netball athletes (mean ± SD; age = 23 ± 6 yrs) volunteered to participate in the current study. Athletes were of international and/or national representative standard (11 and 3, respectively) and the study took place over two seasons during the Trans-Tasman (Australia/New Zealand) netball competition, which is widely regarded as the top domestic netball competition in the world given the number one and two International Netball Federation rankings of Australia and New Zealand. The status of the athletes involved in this study is reflected in the fact that the team made the semi-finals during both seasons during data collection for this study. All participants provided informed written consent before taking part in this study. Ethical approval for the study was obtained through the institutions Human Research Ethics Committee.

Study Design

The present study incorporates an observational, longitudinal design. All athletes were familiarised with the study protocols prior to the collection of data. The data was obtained over a 26-week collection period of two ANZ championship competitive seasons (13 weeks for each season), which comprised of a total of 26 matches (played once per week). The team being studied won the National Championship in both seasons. Measures were obtained on the day of competition, approximately four hours prior to match commencement, and one-hour following the conclusion of the netball match (Figure 1).

On each match day, six hours prior to the commencement of the match, athletes were required to have two-hours of 'downtime.' During this period, athletes were asked to remain in their hotel rooms and were instructed to use this time to relax and prepare for competition using their own pre-match routines. Athletes individually decided how to use this time (e.g. napping, reading, watching TV). If a nap was taken, athletes were asked to keep track of the estimated duration by the time at which sleep was initiated and the time at which they awoke. At the conclusion of the two-hour downtime period athletes completed a 15-minute walk outside as a team before commencement of their pre-match primer exercises (Table 1) that lasted approximately 15 minutes, followed by jump tests and perceptual measures.

Performance Measures

Thirty minutes following the allocated downtime period (and after the primer exercises), athletes were required to perform countermovement jumps (CMJ) to determine mean velocity, peak velocity and jump height. It has been recommended that a period of 30 minutes following waking from a nap be given prior to commencement of testing, to minimize the effects of sleep inertia.[7] CMJ were performed using a linear position transducer device (LPT) (GymAware, Kinetic Performance Technology, Canberra, Australia). The LPT was connected to a tablet computer (iPad 3, Apple Inc., USA) and the manufacturers software (GymAware Lite v2.10, GymAware, Kinetic Performance Technology, Canberra, Australia) via a Bluetooth connection. Athletes performed 3 standing CMJ with three seconds rest allowed between each jump. The CMJ's were performed from an upright position, making a downward movement to a self-selected depth of their squat and simultaneously beginning to push off, whilst hands were places upon hips. The reliability of the CMJ protocol in this same population has been reported previously, with coefficient of variations of 6.2% for jump height, 4.7% for peak velocity and 6.7% for mean velocity.[20]

Perceptual Measures

On completion of the CMJ’s, athletes provided a rating between 1 and 5 on an energy level scale to rate their current perceived energy level (1=very low, 2=low, 3=average, 4=high and 5=very high). Athletes were also asked if they had taken a nap in the prescribed downtime period, if the athlete answered yes, the duration of the nap was recorded.

One hour following the match, athletes were sent an electronic survey link (Survey Monkey Inc., California, USA) to rate their perceived performance from the match (0=very poor, 5=average, 10=excellent). The same survey was also given to two members of the coaching staff to rate each players performance from the match. The two coaches were blinded to the napping conditions of the athletes.

Statistical Analysis

Nap duration was characterized into 3 conditions; No Nap (NN), <20 min Nap (SHORT), and ≥20 min Nap (LONG). All data is presented as means ± SD unless stated otherwise. Statistical analyses were performed with the Statistical Package for the Social Sciences (V. 22.0, SPSS Inc., Chicago, IL). A one-way analysis of variance (ANOVA) was performed to determine if there was a significant difference on the measured variables of peak velocity, mean velocity, and jump height between nap conditions. Games-Howell post-hoc t-tests were performed to locate differences where main effects were evident, with statistical significance set at $p \leq 0.05$. A Kruskal-Wallis test was conducted to determine if there were differences on the ordinal measured variables of energy level, coach rating and player rating between nap conditions. Pairwise comparisons were performed using Dunn’s (1964) procedure. Magnitudes of the standardized effects were calculated using Cohen’s *d* and interpreted using thresholds of 0.2, 0.6, 1.2 and 2.0 for *small, moderate, large and very large,* respectively.[21] An effect size of < 0.2 was considered to be *trivial* and the effect was deemed *unclear* if its 90% confidence interval overlapped the thresholds for both small positive and negative effects.[22]

Results

The data set was distributed across the nap conditions as; NN (*n* = 92), SHORT (*n* = 38), and LONG (*n* = 129). The average nap duration of the SHORT and LONG nap conditions were 14.6 and 57.3 minutes, respectively. On average seven athletes napped prior to each game, and the average nap duration was 41.5 minutes. Across the entirety of the study, on at least one occasion, all athletes completed all three conditions.

The values for the comparison of variables between NN, SHORT and LONG can be observed in Tables 2 and 3. As shown in Figure 2, Games-Howell post-hoc analysis revealed a significant difference in peak jump velocity between the SHORT to the NN condition (3.23 ± 0.26 and 3.07 ± 0.36 $m \cdot s^{-1}$, respectively, $p < 0.03$), which was associated with a *small* effect size (*d* = 0.34, Table 3).

Figure 2 shows a significant difference observed in coach rating from the NN to the SHORT condition (6.4 ± 0.9 to 7.2 ± 0.8, $p < 0.01$) in favor of SHORT, which was associated with a *moderate* effect size (*d* = 0.85, Table 3). Pairwise comparisons showed a significant difference in coach rating between LONG and SHORT conditions (6.8 ± 0.8 and 7.2 ± 0.8, respectively, $p < 0.01$), which was associated with a *small* effect size (*d* = -0.44). There were no significant differences ($p > 0.05$) in player rating, energy levels and jump height between any of the nap conditions.

Discussion

The findings from the current study show that when athletes napped for less than 20-miutes on the day of competition, neuromuscular jump performance and perceived netball performance was observed to be higher in comparison to when athletes did not nap. The current study is the first to assess the effect of a pre-match nap in a competitive setting on energy and performance variables in elite female athletes in a competition setting. The findings provide evidence that varying nap durations may have a positive effect on athletic performance. However, a large standard deviation was observed for all of the results, indicating that multiple outside variables may influence the individual athlete, resulting in the effectiveness of the napping durations being highly individual.

The results from the current study are consistent with the results reported by Waterhouse et al[7], who showed a significant improvement in the physical performance variables of both 2-m and 20-m sprint times following a similar time period of 30-minute nap compared to a no nap condition. Although the current study differs in the type of physical performance measures used (CMJ v sprint time), we contend that these are both neuromuscular power tests. Therefore, results are comparable between the two studies, with significant improvements found in similar nap duration conditions. In both of the studies the napping period occurred in the mid-afternoon, a time that is associated with a dip in the circadian cycle.[18,23] It has been reported that alertness and attention is often reduced during this period, but no previous research to our knowledge has reported physiological performance effects, which makes it difficult to draw decisive conclusions or compare the two studies to others.

Previous research has reported improvements in mood, subjective sleepiness, alertness, and vigor [24-26] following naps of 10 to 20 minutes. Although not directly related, the current study assessed the athletes' energy levels following the allocated nap period. The results of the current study are in contrast to the previous research, with no significant differences found between the three nap conditions; NN, SHORT and LONG. It is postulated that athletes already feel extremely motivated on game day and it is possible that napping or not napping would not influence their motivation levels to perform, due to a ceiling effect. Therefore, this may be a potential reason for the lack of differences in the energy level results, as energy levels are likely to be related to motivation. A study by Tietzel and Lack[25] reported a significant improvement in alertness and cognitive performance following a 10-minute nap compared to a no nap condition. Furthermore, Waterhouse et al[7] reported similar significant improvements in alertness, short-term memory, and accuracy in an 8-choice reaction time test following a 30-minute nap versus no nap condition. Although the current study did not aim to assess cognitive performance following different nap conditions, elite sport requires high levels of mental processing, which may be influenced by differing nap conditions.[19] Therefore, the findings of the two previous studies, warrants future research on cognitive performance and decision making following naps in the professional sport environment.

Previous research [25,26] has shown the ideal nap duration to be between 10 to 20 minutes, where the ability to perform upon waking is required. The results from the current study offer support to the previous research on the optimal nap duration, with higher performance jump velocity and coach perceptual measures found in the <20 minute nap condition. Brooks and Lack[27] have supported the shorter nap duration with their findings indicating shorter nap times can improve performance and alertness, whilst acting as a countermeasure to sleep debt. A point highlighted within previous research, was the possible effect of sleep inertia and the negative effects it may have on performance and functioning post a nap. Sleep inertia has been described as a reduction in the ability to think and impaired performance upon awakening from sleep.[16-18] A total period of 30 minutes (15 minute walk and 15 minute primer exercises) before testing began, was implemented in the current study to avoid sleep inertia.

There were several limitations to the present study that require clarification in future research. As this was a field based study, there were multiple variables that were unable to be controlled for, which could have had an impact on performance and the overall results of the study. The athletes were exposed to many different sleeping environments over the two seasons (hotel rooms and home environments). The athletes were exposed to different pressures to perform that were dependent on the time of the season, team selections, media, win/loss record and general expectations. A study of this magnitude over two competitive seasons in a professional team needed to be minimally invasive on the athletes and coaching staff. Therefore, while there are some factors that could have better controlled, the aim was to produce an ecologically valid piece of research in an applied setting. The use of objective sleep measurements would have provided more in-depth information on the sleep quantity and quality of the naps. The monitoring of sleep on the night prior to competition would have been useful to provide athletes sleeping patterns and potential reasoning for the naps. Furthermore, monitoring sleep on the night of the competition would have allowed for analysis on whether a nap has an effect on subsequent sleep quality and quantity. Given this was an observational study, further intervention studies are also warranted in the athletic population. Such interventions may involve the use of prescribed napping durations on the day of competition in athletes with the aim of determining the optimal duration for performance.

Practical Applications

- Nap durations of <20 minutes on match-day may be beneficial for athletic performance.
- Match-day napping may be used to alleviate sleep debt and sleepiness that can occur from the night prior to competition.

Conclusion

The findings of this study are the first to show the effects of match day napping in an elite athletic environment, suggesting that a SHORT nap on the day of competition is effective in enhancing jump velocity measures and improves subjective performance as assessed by coach player ratings. It has been established in previous research and through the current study, that both physical and cognitive measures are improved following a ~20 minute nap. Moreover, given the importance of optimal performance in competition, the ability to utilize naps may be an effective tool for elite athletes, not just for recovery, but for performance enhancement.

Acknowledgments

The authors would like to thank each of the athletes and coaching staff for their time and participation during this study. There was no funding provided for this research, and there are no conflicts of interest.

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International Journal of Sports Physiology and Performance

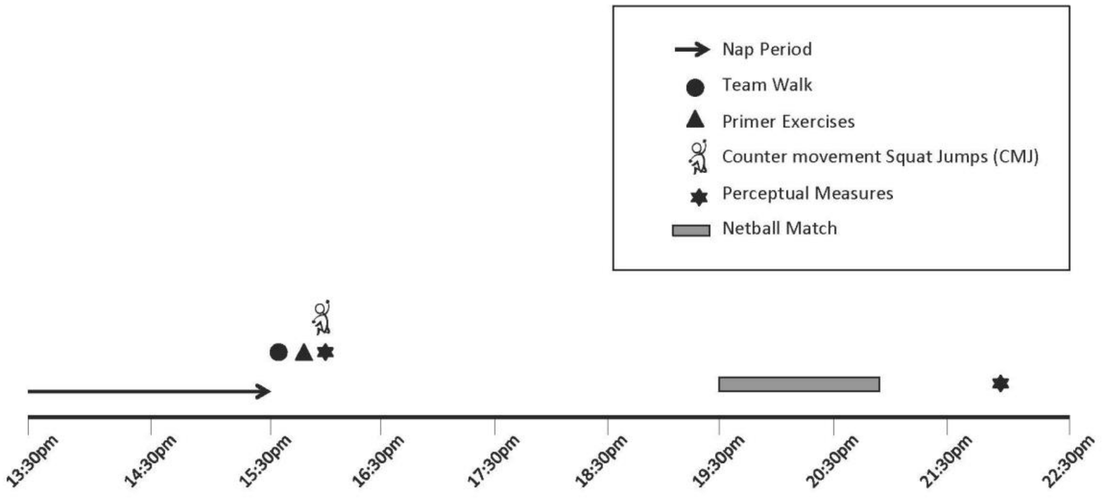

Figure 1. Study design timeline.

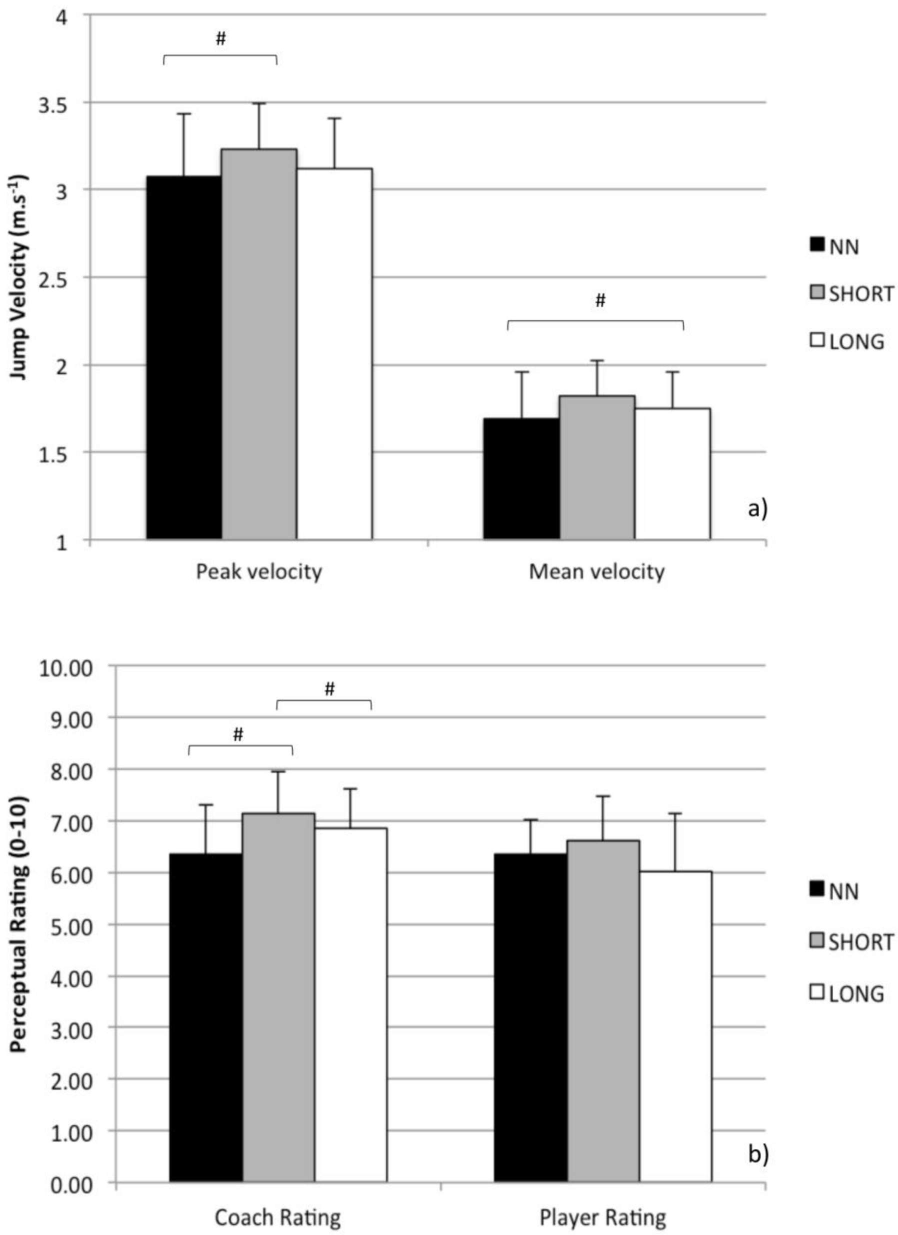

Figure 2. Mean data from No nap, SHORT and LONG for a) Peak velocity and mean velocity (m.s^{-1}) and b) Coach rating and player rating (0-10). # indicates significant difference between conditions ($p < 0.05$).

Table 1. Outline of Primer Exercises

Warm Up	**Reps**	**Rest (seconds)**
Body Weight Squat	12	60
Body Weight Good Mornings	12	60
Reverse Lunge	10 each side	60
Lateral Lunge	10 each side	60
Press-ups	10	60
Ballistic Preparation	**Reps**	**Rest (seconds)**
Double Leg Squat Drop	5	60
Single Leg Squat Drop	5 each side	60
Double Leg Pogo's	10	60
Double Leg Squat Drop – Tap – Jump	5	60
Single Leg Squat Drop – Tap – Jump	5	60
Banded Counter Movement Jumps	5	60

Table 2. Measured variables over 26 competition days in 14 elite athletes following No Nap, <20 minute Nap and ≥20 minute Nap. Data presented as means ± SD.

Variable	No Nap (Mean ± SD)	<20 min Nap (Mean ± SD)	≥20 min Nap (Mean ± SD)
Energy Levels (0-5 AU)	3.6 ± 0.5	3.5 ± 0.4	3.4 ± 0.5
Peak Jump Velocity ($m.s^{-1}$)	3.07 ± 0.36	3.23 ± 0.26[#]	3.12 ± 0.29
Mean Jump Velocity ($m.s^{-1}$)	1.69 ± 0.27	1.82 ± 0.20	1.75 ± 0.20[%]
Jump Height (cm)	38.5 ± 7.4	38.3 ± 7.6	38.2 ± 6.7
Coaches Rating (0-10 AU)	6.4 ± 0.9	7.2 ± 0.8[#]	6.8 ± 0.8[^]
Player Rating (0-10 AU)	6.4 ± 0.7	6.6 ± 0.6	6.0 ± 1.1

Significant difference between <20min Nap and No Nap ($p < 0.05$)

% Significant difference between ≥20min Nap and No Nap ($p < 0.05$)

^ Significant difference between <20min Nap and ≥20 min Nap ($p < 0.05$)

AU = arbitrary units

Table 3. Mean ± SD data for differences between No Nap, <20 minute Nap and ≥20 minute Nap, including effect sizes (*d*) for comparison between conditions.

Variable	<20 min Nap v ≥20 min Nap Effect Size	<20 min Nap v No Nap Effect Size	≥20 min Nap v No Nap Effect Size
Energy Levels (0-5 AU)	-0.10 ± 0.37 ES = -0.22 *Unclear*	-0.11 ± 0.45 ES = -0.22 *Unclear*	-0.22 ± 0.58 ES = -0.47 *Small*
Peak Jump Velocity ($m.s^{-1}$)	-0.06 ± 0.09 ES = -0.20 *Small*	0.11 ± 0.19[#] ES = 0.34 *Small*	0.04 ± 0.16 ES = 0.13 *Trivial*
Mean Jump Velocity ($m.s^{-1}$)	-0.03 ± 0.10 ES = -0.13 *Trivial*	0.08 ± 0.16 ES = 0.34 *Small*	0.06 ± 0.10[#] ES = 0.26 *Small*
Jump Height (cm)	0.01 ± 0.04 ES = 0.19 *Trivial*	-0.02 ± 0.04 ES = -0.22 *Small*	0.00 ± 0.03 ES = -0.03 *Trivial*
Coaches Rating (0-10 AU)	-0.44 ± 0.65[#] ES = -0.49 *Small*	0.76 ± 0.68[#] ES = 0.85 *Moderate*	0.50 ± 0.97 ES = 0.55 *Small*
Player Rating (0-10 AU)	-0.75 ± 1.36 ES = -0.75 *Moderate*	-0.03 ± 0.73 ES = -0.03 *Unclear*	-0.23 ± 1.24 ES = -0.23 *Unclear*

Significant difference between conditions ($p < 0.05$)

AU = arbitrary units