Effects of a Short Daytime Nap on Shooting and Sprint Performance in High-level Adolescent Athletes

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Abstract

Purpose: The purpose of the research was to investigate the sport-specific performance effect of a brief afternoon nap on high-level Asian adolescent student-athletes that were habitually short sleepers. **Methods:** In the studies, participants were randomly assigned to a nap or non-nap (reading) condition. In the first study, 12 male shooters (13.8 ± 1.0 yrs) performed a shooting assessment (20 competition shots) with heart rate variability monitored during the assessment. In the second study, 19 male track & field athletes (14.8 ± 1.1 yrs) performed a 20m sprint performance assessment. Subjective measures of sleepiness and alertness were obtained in both studies. **Results:** The brief nap had no effect on any measure of shooting performance ($p > 0.05$) and autonomic function ($p > 0.05$) in shooters. However, fastest 20m sprint times increased significantly ($p < 0.05$) from 3.385 ± 0.128 sec to 3.411 ± 0.143 sec, with mean 2m times trending towards significance ($p < 0.1$) amongst the track & field athletes. No significant differences were observed in any other measures. **Conclusions:** The results of the research indicate varying effects of naps between sport-specific performance measures. Napping had no effect on shooting performance while a negative effect existed in 20-m sprint performance, potentially due to sleep inertia. Considering these findings, some caution is warranted when advocating naps for adolescent athletes.

Keywords: Sleep; Adolescent; Athlete; Napping; Performance

Introduction

Sleep insufficiency amongst adolescents is a global phenomenon [1] influenced by multiple biologically governed factors, [2] alongside other external influences. [3] In addition, evidence shows a declining trend in worldwide sleep durations amongst adolescents over the last century, [4] with Asian adolescents sleeping significantly later, and lesser than their counterparts from North America and Europe. [5] The effects of sleep loss are shown to result in impaired metabolism, health, academic and psychological outcomes. [6,7] Apart from adolescents, high-level athletes are recognised to experience sub-optimal sleep characteristics due to training schedules, pre-competition anxiety, and training intensity. [8] In a review of 205 studies on the effects of sleep loss on athletic performance, Fullagar and colleagues [8] highlight the prevalence of inadequate sleep durations and quality amongst athletes worldwide. With this in mind, it is evident that high-level Asian adolescent athletes could be most predisposed to habitual sleep restriction, which is in agreement with research in high-level Asian adolescent bowlers and badminton players. [9] The need to address the unique sleep requirements of youth athletes has prompted the International Olympic Committee to emphasize the need for relevant stakeholders to adopt strategies to ensure sufficient sleep in this population. [10]

While the effect of sleep deprivation on sport and exercise performance is well documented, [11] it is only relatively recent that research has shown the converse effects of sleep extension on performance. [12] Despite the potential of nocturnal sleep extension on performance, the magnitude of nocturnal sleep duration increase required to elicit performance changes may be impractical for school-going youth athletes due to early morning training and academic commitments. Daytime napping may offer a viable alternative to assuage the effects of chronic sleep restriction. The research in support of napping for improved performance is well documented in the literature in areas of cognition, health, motor performance, and motor memory consolidation. [13] In a notable investigation into the effects of sleep extension, caffeine supplementation and brief daytime napping, Horne and colleagues [14] reported most marked reduction in objective daytime sleepiness after a 15-20 minute afternoon nap, insomuch that a timely nap can better compensate over an additional hour of nocturnal sleep. Brief daytime naps are reported to improve sprint performance outcomes in partially sleep deprived participants. In a randomised crossover experiment, Waterhouse and colleagues [15] investigated the effects of a brief afternoon nap following a 4-hour nocturnal sleep curtailment on performance measures in sprint time, short-term memory, visual choice reaction time, and handgrip strength. While these results highlight the performance benefits of a brief nap following experimentally induced sleep restriction in healthy adults, there is no research on the effects of a replacement nap on high-level athletes that experience chronic sleep restriction, despite its prevalence and advocacy in the literature. [16]

A caveat when considering the usage of napping in enhancing performance is the effect of sleep inertia which is defined as *a transitional state of lowered arousal occurring immediately after awakening from sleep and producing a temporary decrement in subsequent performance*. [17] In an investigation on the recuperative effects of varying durations of afternoon naps following moderate sleep restriction in which participants obtained only 5 hours of sleep, a 10-minute nap was suggested to be most beneficial due to the immediacy of performance improvements and lack of sleep inertia, [18] with benefits lasting for 155 minutes on measures of sleepiness, fatigue, vigour, and cognition. The 20 and 30-minute naps both elicited performance improvements only after 35 minutes of awakening, with the latter resulting in an initial period of poorer performance due to sleep inertia, but with improvements recorded up to 155 minutes after the nap.

These findings highlight the inconsistencies in performance declines after awakening following naps, and similar irregularities in optimal "windows of opportunity" for performance enhancement following replacement naps that ensue periods of sleep loss. In light of the current dearth of research on the effects of napping on sport performance, with no literature on its effects on youth athletes, the current series of two studies examined the effects of a brief afternoon nap on shooting, sprint and cognitive performance amongst high-level adolescent student-athletes. The objective of these studies was to ascertain if an acute short-nap can elicit sport-specific performance changes after a night of sleep restriction.

Methods

Subjects-Study 1

In the first study, a sample of 16 high-level pistol and rifle shooters from a high-performance youth development shooting academy were recruited for this study. Exclusion criteria included factors such as age >19, injury or illness and on any medications during the period of the study, not living in the academy's boarding facilities on school-nights during the study, and those with a known history of sleep disorders. None of the participants were habitual nappers (one or more times per week for at least 2 years [19] due to their training and academic schedules. Of the recruited, a final number of 12 performed all the requisite experimental protocols and sleep monitoring for the study. Participant demographics can be found in Table 1. The participants and their parents were duly informed about the nature of the study and its associated risks verbally and in information sheets. As participants were all under the age of 21, a written informed consent was obtained from all participants' parents or guardians, as well as assent from the participant. Ethical approval for the study was obtained from a university Institutional Review Board (IRB-2014-01-005).

Design-Study 1

This study was conducted outside periods of major sport competitions and school academic examinations to control for the effects of competition and academic stress on sleep quality. Participants were asked to refrain from caffeine-containing food and drinks during the study, and to refrain from napping before the experimental conditions. Participants resided in boarding facilities during the experimental period and followed a fixed sleep/wake schedule of 22:15 – 06:00 hours (7 hours 45 minutes). This schedule had to be adhered to due to their daily school/training schedule. Prior to the main experimental sessions, all participants underwent one habituation session in a laboratory to familiarise them with the various assessments, equipment, as well as the provision of a nap.

Participants were reminded to maintain a regular sleep/wake schedule during the main experimental period of the study. On the night prior to each experimental session, participants wore GT3X activity monitors (Actigraph, FL, USA) to objectively record their sleep patterns to ensure that a consistent sleep-wake schedule was adhered to. The data were scored and analysed using ActiLife 6.9.2 and using the Sadeh algorithm which has been validated in an adolescent population and shown to have an overall high accuracy to that of polysomnography. [20] A randomised crossover design was adopted for this study. On the days of the main experiment, participants were required to report to a laboratory on two separate days, at least one week apart, between 1430 – 1600 hours as this coincided with the end of the school day and a drop in circadian rhythms of alertness and increased sleepiness amongst adolescents. [21] Upon arrival at the laboratory, participants were randomly assigned to either a nap, or no-nap condition. For the nap condition, participants wore a wireless dry electroencephalographic (EEG) sensor (Zeo, MA, USA) which was configured to obtain real-time objective sleep measures. [22] This system has been validated against an in-laboratory PSG [23]. For the nap, participants were ushered into a darkened room and allowed to nap with the assistance of ear-plugs and eye-masks, to reduce environmental light and noise. A researcher was in an adjacent room during the nap monitoring the participant's sleep patterns. Sleep inertia presents following naps with deep sleep. [18] For this reason, the participants were awakened after 1 minute elapsed from the occurrence of deep sleep to minimise these effects. Additionally, a 30-

minute time limit was set as the nap termination criteria if the participant was not able to sleep, or no deep sleep was obtained to prevent the participant from obtaining greater durations of deep sleep. [24] In the no-nap condition, participants performed 30 minutes of quiet reading under the supervision of a researcher. Ratings of alertness and sleepiness were obtained prior to, and after both conditions. For both conditions, after awakening from the nap or following quiet reading, each participant proceeded to perform a shooting performance test which commenced 45 minutes after awakening or quiet reading.

Methodology-Study 1

All participants participated in a 20-shot simulated competition in 20 minutes. Guns and ammunition used complied with the International Shooting Sport Federation (ISSF) specifications and rules for rifles and pistols. Rifle shooters were permitted to use non-variable sights with a maximum of four power magnification. Participants were required to fire at a target which was at a distance of 10 metres. An electronic paper target complying with the specification of the ISSF target standards for decimal ring scores was used. [25] For the rifle target, the centre of the target (ten ring) measured 0.5 mm in diameter, with the outermost circle (1 ring) measuring 45.5 mm in diameter. For the pistol target, the centre of the target (ten ring) measured 11.5 mm in diameter, with the outermost circle (1 ring) measuring 155.5 mm in diameter. Both guns used pellets of 4.5 mm in diameter. Shooting score was recorded using a computerised optical shooting simulator unit (SCATT Shooter Training Systems, Russia). The shooting competition commenced 1 minute after a 10-minute period of sighting-in.

During the shooting performance test, heart rate variability (HRV) was monitored to evaluate physiological changes of the autonomic nervous system (ANS). [26] Before starting the shooting performance tests, participants wore an elastic electrode belt (Polar Team 2, Polar Electro Oy, Kempele, Finland) for the collection of HRV measures. Data were time tagged in real-time using the Polar Team2 Pro software from the start of the simulated shooting competition till the final shot performed by each shooter for analysis. Data processing of HRV parameters was conducted using Kubios HRV Analysis software 2.2 (Biosignal Analysis and Medical Imaging Group, Department of Applied Physics, University of Eastern Finland). Frequency bands were defined as default: Low-Frequency (LF, 0.04-0.15 Hz), and High-Frequency (HF, 0.15-.04 Hz).

Subjects-Study 2

In the second study, a sample of 23 high-level track & field athletes from a high-performance youth development track & field academy were recruited. Participants met the same inclusion criteria as those in the first study and had similar schedules. Of the recruited, a final number of 19 performed all the requisite experimental protocols and sleep monitoring for the study. Participant demographics can be found in Table 1. The participants and their parents were duly informed about the nature of the study and its associated risks verbally and in information sheets. As participants were all under the age of 21, a written informed consent was obtained from all participants' parents or guardians, as well as assent from the participant. Ethical approval for the study was obtained from a university Institutional Review Board (IRB-2014-01-006).

Design-Study 2

The design of this study was identical to the first study and was conducted during the same period. The sprint performance test was conducted 45 minutes after awakening or quiet reading. Before the sprint test, the starting block was set to the requirements of the participants, with the identical configuration used during both performance tests.

Methodology-Study 2

Participants were made to start behind a starting line on an International Association of Athletics Federations (IAAF) approved starting block. The starting block was fitted with an integrated reaction time sensor (Smartshoxx, FusionSport Pty Ltd, Australia) that was synchronised with timing lights (Smartspeed, FusionSport Pty Ltd, Australia) to measure reaction time, 2, 10, and 20-m sprint timing on an indoor running track. A three-command start, in line with IAAF guidelines for 400m and shorter events, was used. When participants were settled and still, the verbal command "Set" required participants to assume a final set position. This was followed by an auditory tone provided by the Smartspeed system, which was placed 0.5 metres behind the starting block, to simulate the starting gun. The delay in this auditory stimulus following the previous verbal command was set to 1.8 to 2.4 seconds to prevent anticipation of the start signal.

Statistical Analyses

Paired t-tests were performed to evaluate differences in sleep and performance measures. A two-way within-subjects ANOVA was employed to compare the differences in subjective measures of sleepiness and alertness, prior to and after both experimental conditions. The changes in shooting performance variables (Integer and Fractional result) between conditions (No nap vs. Nap) were standardized and expressed as a factor of the smallest worthwhile change, which was based on a small standardized effect based on Cohen effect-size principle (0.2 × between-athletes SD) for performance measures. ES between <0.2, 0.2–0.6, 0.6–1.2, 1.2–2and 2.0–4.0 were considered trivial, small, moderate, large and very large, respectively. Quantitative chances of higher or lower differences were evaluated qualitatively as follows: <1%, almost certainly not; 1−5%, very unlikely; 5−25%, unlikely; 25−75%, possible; 75−95%, likely; 95−99%, very likely; >99%, almost certain. If the chance of having higher or lower values than the smallest worthwhile difference was >5%, the true difference was assessed as unclear. Statistical significance was set at $p < 0.05$. Statistical analysis was done using IBM SPSS 20 for windows.

Results

The results indicated no significant differences in nap durations (20.5 ± 6.4 vs. 19.68 ± 6.9 mins; *M* = -0.82, 95% CI [-5.88, 4.25], t(29) = -.33, *p* = .66) and sleep onset latency for the nap (3.42 ± 2.71 vs. 7.53 ± 7.68; *M* = 4.11, 95% CI [-.62, 8.84], t(29) = 1.78, *p* = .06) between shooting and track & field athletes.

The results indicated no significant differences in bedtime (*M* = 00:01:15, 95% CI [-00:12:55, 00:15:25], t(11) = .19, *p* = .85), waketime (*M* = -00:01:25, 95% CI [-00:10:18, 00:07:28], t(11) = -.35, *p* = .73), TIB (*M* = -2.67, 95% CI [-18.30, 12.97], t(11) = -.35, *p* = .71), WASO (*M* = 10.08, 95% CI [-17.94, 38.11], t(11) = .72, *p* = .24), SE (*M* = -2.43, 95% CI [-8.73, 3.87], t(11) = -.85, *p* = .41) and TST (*M* = -10.67, 95% CI [-37.50, 16.17], t(11) = -.88, *p* = .40) amongst shooting athletes. These details are reported in Table 2.

The results indicated no significant differences in shooting performance and HRV variables. When comparing conditions (No nap vs. Nap), shooting performance differences during the napping condition were found to be possibly trivial. Specifically, differences in shooting performance (No Nap vs. Nap) were possibly (8/51/41) and trivial (ES=0.15 ± 0.41) in integer scores, and possibly (6/51/43) and trivial (ES=0.16 ± 0.38) in fractional scores. These details are reported in Tables 3 and 4.

There were no two-way interactions on subjective measures of sleepiness, $F(1, 11) = 0.51$, $p < 0.49$ amongst shooting athletes. Main effect analyses of time showed significant differences on sleepiness before and after, $F(1, 11) = 4.802$, $p < .051$. Post-hoc analysis with Bonferroni adjustment revealed a statistically significant increase in sleepiness scores (i.e.

more sleepy) from pre (*M* = 5.00, *SE* = 0.45) to post intervention (*M* = 5.79, *SE* = 0.42), $p < 0.05$.

There were also no statistically significant two-way interactions on subjective measures of alertness, $F(1, 11) = 0.75$, $p < 0.41$. Main effect analyses of time showed a trend towards significance for alertness levels before and after the experimental conditions, $F(1, 11) = 3.77$, $p < .08$ with post hoc analysis revealing a reduction in alertness levels (i.e. less alert) from pre (*M* = 5.88, *SE* = 0.36) to post (*M* = 5.29, *SE* = 0.43) experimental conditions.

The results indicated no significant differences in bedtime (*M* = 00:00:37, 95% CI [-00:11:09, 00:12:25], t(18) = .11, *p* = .91), waketime (*M* = -00:05:34, 95% CI [-00:16:06, 00:04:57], t(18) = -1.11, *p* = .28), TIB (*M* = -4.79, 95% CI [-16.03, 6.45], t(18) = -.90, *p* = .38), WASO (*M* = 1.84, 95% CI [-11.47, 15.15], t(18) = .29, *p* = .78), SE (*M* = -1.59, 95% CI [-4.73, 1.56], t(18) = -1.10, *p* = .30) and TST (*M* = -7.42, 95% CI [-22.11, 7.27], t(18) = -1.06, *p* = .30) amongst track & field athletes. These details are reported in Table 2.

The results indicated a significant deterioration in the sprint performance variable of fastest 20m sprint time (*M* = 0.025, 95% CI [0.001, 0.049], t(18) = 2.21, *p* = .04. There was a trend towards statistical significance for the deterioration of mean 2m sprint time (*M* = 0.012, 95% CI [-0.003, 0.028], t(18) = 1.75, *p* = .098. These details are reported in Table 5.

[Table 5 here]

There were no statistically significant two-way interactions on subjective measures of sleepiness $F(1, 18) = 3.08$, $p < 0.10$ amongst track & field athletes. Main effect analyses of time showed a trend towards significance on sleepiness before and after, $F(1, 18) = 3.87$, $p < .07$. Post hoc analysis with Bonferroni adjustment revealed a statistically significant increase in sleepiness scores (i.e. more sleepy) from pre a*M* = 4.79, *SE* = 0.36) to post intervention (*M* = 5.37, *SE* = 0.34), $p < 0.05$.

There were also no statistically significant two-way interactions on subjective measures of alertness, $F(1, 18) = 2.68$, $p < 0.12$. Main effect analyses of time showed a significant difference in alertness levels before and after the experimental conditions, $F(1, 18) = 5.84$, $p < .03$ with post hoc analysis revealing a reduction in alertness levels (i.e. less alert) from pre ($M = 5.82$, $SE = 0.3$) to post ($M = 5.24$, $SE = 0.34$) experimental conditions.

Discussion

The key findings of the first study are as follows: (i) an acute afternoon nap in adolescent shooting student-athletes resulted in no significant changes in shooting performance and autonomic function when compared to a no-nap condition. In Study 2: (i) an acute afternoon nap in adolescent track & field student-athletes resulted in significant deterioration in 20 metre sprint performance when compared to a no-nap condition.

The most notable finding in the studies was the negative effect of a brief afternoon nap on 20-metre sprint performance, with a significant slowing of 20-metre sprint time, and a trend towards significance at 2 metres. This finding is in contrast to that of Waterhouse and colleagues [15] who reported significant improvements in 2 and 20 metre sprint times after a brief nap. In their study, the performance test was performed 30 minutes after awakening from the nap, while the current study administered the sprint performance test 45 minutes after awakening. Therefore, the temporal difference of the assessment post-nap would have had minimal effect on sprint performance. However, several other key differences between the studies could explain these conflicting results. In the current investigation, participants were high-level Asian youth athletes who were routinely trained for sprint events, and are known to experience chronically shortened sleep durations, [9] therefore potentially carrying a greater sleep debt. The truncated sleep durations have previously been shown to be due to later sleep times due to a complex interplay of intrinsically occurring maturational changes of biological sleep processes, extrinsic factors such as social pressures, societal needs, electronic device and online social media usage, as well as the distinct cultural attitudes towards sleep in Asian societies. [3,27-31] This is reflected in the discrepancy between the fixed bedtime prescribed by the boarding environment and the actual bedtime of the participants in both arms of this study, as similarly reported in previous studies in similar populations. [32,33] In comparison to the current findings on sprint performance, the study by Waterhouse and colleagues employed adult participants who were healthy and reported to obtain ideal sleep durations prior to a single night of partial sleep restriction. The results could also have been attributed to sleep inertia, which occurs when the brain re-establishes full consciousness at different rates, and involves a functional reorganization of brain activity, evident in the prefrontal cortex, upon awakening for full alertness to occur. [34]

In contrast to the negative effects of the nap on sprint performance, there were no effects of napping on shooting performance amongst high-level adolescent shooters. This is further supported by only possibly trivial improvement in shooting scores after a nap. Perhaps more importantly, the brief nap also did not elicit any performance or physiological benefits as monitored by HRV. It has been reported that insufficient sleep alters autonomic function, specifically the sympathetic/parasympathetic balance, as determined by measures of HRV [35]. Awareness of HRV responses following exposure to a nap is salient to athletes as moderation of sympathetic activity (as indicated by greater high frequency HRV values) is reported to be associated with improved basketball shooting, passing and dribbling performance [36]. The lack of changes in physiological HRV profiles may be attributed to the relatively short nap durations employed in the current investigation. Recent evidence highlights the ability of an extended 80-minute nap to improve autonomic regulation by way of increased vagal activity and high frequency power, potentially due to the increased durations of non-rapid eye movement sleep [37]. Our current findings on shooting performance could also be attributed to a temporal decay of effects following the nap which has been reported previously on measures of cognitive performance. [18] In their study, Brooks and Lack [18] reported that performance on a Letter Cancellation Task only exhibited improvements after 35 minutes upon awakening from a 30-minute nap, with the beneficial effects tapering beyond this point. Also, Santhi and colleagues [38] have highlighted the inconsistency of effects of sleep inertia on several cognitive performance domains, with tasks requiring lower cognitive processes, such as attention, impacted upon more than tasks requiring higher cognitive engagement, such as working memory. Thus, the varying performance effect of sleep inertia on sprint and shooting performance could be attributed to the differential effects of sleep inertia on two very different sport performance measures. However, as the current study did not directly test the temporal effects of sleep inertia at multiple time points post-nap on the respective sport performance measures, it is uncertain how long such an effect exists on both sport-specific outcome measures. Another potential interpretation of the lack of positive effects of a brief nap on sport performance measures might be the differential effects of a nap on habitual versus non-habitual nappers. The current evidence comparing the effects of napping between these apparently distinct groups highlight the ability of habitual nappers to remain in the lighter stages of sleep when compared to non-nappers. [39] Separately, Milner and colleagues [40] highlight that napping was able to elicit greater performance improvements in a task of motor performance, and that these gains were highly associated with the number of sleep spindles in stage 2 sleep. Sleep spindles are a hallmark of stage 2 sleep and are reflected as an EEG event reflecting a mechanism involved in the consolidation of memory during sleep and occurs from the firing of the thalamic and corticothalamic networks. [41,42] However, these beneficial effects were found to only apply to habitual nappers, with the nap having an adverse effect on motor performance in non-habitual nappers. [40] In light of these uncertainties, sport scientists need to be cognizant of the transient impairment that occurs following awakening when recommending the use of nap breaks due to sleep inertia.

The following limitations need to be acknowledged with regards to this study. Due to time limitations, the shooting performance test protocol conducted in the current study was kept shorter than international match norms in order to fit into the schedules of the participants. Finally, the temporal effects of the nap on the various sport performance measures were not investigated beyond the single time point following awakening from the nap. Future research should employ a repeated measure design to ascertain these effects. Despite these limitations, the strength of this study lies in its randomised crossover design, and recruitment of high-level youth athletes that were subjected to an ecologically valid yet controlled environment during the study.

Practical implications

1. The divergent performance effects of a brief nap on sport performance measures of shooting and sprinting warrants more caution in recommending naps as a manner of performance enhancement.
2. Such advocations should be caveated by information on whether the athlete is a habitual napper and the known effects of sleep inertia on the athlete.
3. Individual responses should be understood, especially amongst athletes at the highest levels of sport performance to account for potential nefarious effects of sleep inertia.
4. The usage of naps chronically by athletes could indicate inadequate nocturnal sleep durations. Practitioners may need to document the employment of napping amongst their athletes to identify such ubiquitous usage, and also initiate educational interventions to advocate for extended nocturnal sleep bouts due to the known effects of night-time sleep curtailment on athlete skill acquisition and health.

Conclusions

The present findings from this series of studies suggest varying effects of a brief nap on measures of sprint and shooting performance, with no apparent effect on cognitive performance amongst high-level Asian adolescent student-athletes. Napping had no effect on shooting performance and autonomic function during the performance test, while a negative effect existed on 2 and 20 metre sprint performance. To further explore the influence of napping and post-nap sleep inertia on sport performance, its effects should be discriminated between habitual and non-habitual nappers. It would also be salient to investigate if sport-specific motor learning is altered with a nap amongst developmental adolescent athletes that are still acquiring the requisite skills for success in their respective sports.

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Table 1: Participant demographics.

	Shooting (n = 12)	Track & field (n = 19)
Age	13.76 ± 1.03	14.81 ± 1.14
Height (cm)	160.39 ± 9.36	168.10 ± 5.80
Weight (kg)	49.90 ± 9.68	60.25 ± 8.34

Data are mean ± SD.

Table 2: Sleep characteristics.

	Nap	No Nap	*P*
Shooting athletes			
Bedtime (hh:min)	23:23 ± 00:27	23:21± 00:30	0.85
Waketime (hh:min)	05:59 ± 00:15	06:01 ± 00:15	0.73
TIB (mins)	396.58 ± 36.85	399.25 ± 38.31	0.71
WASO (mins)	70.58 ± 41.59	60.50 ± 33.98	0.45
SE (%)	82.01 ± 9.15	84.44 ± 7.55	0.41
TST (mins)	324.00 ± 38.18	334.67 ± 12.82	0.40
Track & field athletes			
Bedtime (hh:min)	00:01 ± 01:03	00:01 ± 01:09	0.91
Waketime (hh:min)	06:46 ± 00:39	06:51 ± 00:44	0.28
TIB (mins)	405.89 ± 60.99	410.68 ± 61.70	0.38
WASO (mins)	80.26 ± 34.29	78.42 ± 41.40	0.78
SE (%)	79.03 ± 8.02	80.62 ± 9.33	0.30
TST (mins)	322.47 ± 62.63	329.89 ± 58.87	0.30

Data are mean ± SD. Bedtimes and waketimes are expressed in 24-hour clock format.

Table 3: Shooting performance.

Variable	T-value	Nap			No nap			Effect size (d_{Cohen} [95% CI])	*P*
				Shooting performance					
Integer	-0.63	181.83	±	10.14	183.25	±	9.13	0.15 [-0.99 - 1.28]	0.54
Fractional	-0.76	191.04	±	9.87	192.66	±	9.34	0.16 [-0.73 - 1.07]	0.46
Shot group result	-1.14	192.98	±	8.65	195.48	±	6.38	0.33 [-0.81 - 1.47]	0.28
Shot group deviation	-0.93	2.00	±	1.67	2.83	±	4.19	0.26 [-0.88 - 1.40]	0.38
Diametrical dispersion	0.81	27.77	±	22.47	24.61	±	18.90	-0.15 [-1.29 - 0.98]	0.44
Stability	-0.94	15.86	±	12.26	16.68	±	14.19	0.06 [-1.07 - 1.19]	0.37
Accuracy	0.45	3.10	±	3.05	2.75	±	2.45	-0.13 [-1.26 - 1.01]	0.66
Steadiness	-1.30	34.55	±	17.14	39.00	±	15.45	0.27 [-0.915 - 1.46]	0.22
Average length	0.70	98.32	±	97.72	95.85	±	93.39	-0.03 [-1.16 - 1.11]	0.50

Data expressed as mean ± SD.

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Table 4: HRV indices.

Variable	T-value	Nap			No nap			Effect size (d_{Cohen} [95% CI])	*P*
				HRV-Time domain					
MeanRR (ms)	-1.09	642.63	±	61.54	659.19	±	65.91	0.26 [-0.88 - 1.40]	0.30
RMSSD (ms)	-2.09	25.91	±	6.84	33.89	±	15.76	0.66 [-0.51 - 1.82]	0.06
				HRV-Frequency domain					
HF power (ms^2)	-1.58	207.94	±	106.39	565.27	±	862.83	0.58 [-0.57 - 1.74]	0.14
LF power (ms^2)	-0.95	1482.67	±	622.28	1673.50	±	722.64	0.28 [-0.85 - 1.42]	0.36
LF/HF	1.63	8.18	±	3.59	6.19	±	3.93	-0.53 [-1.68 - 0.62]	0.13

Data expressed as mean ± SD. MeanRR = Mean RR intervals; RMSSD =root mean square of successive differences between adjacent normal R-R intervals ; HF = high-frequency; LF = low-frequency

Table 5: Sprint performance.

Variable	T-value	Nap			No nap			Effect size (d_{Cohen} [95% CI])	*P*
Sprint performance									
Mean reaction time	1.16	0.302	±	0.126	0.273	±	0.097	-0.01 [-0.91 - 0.89]	0.26
Mean 2m sprint*	1.75	0.936	±	0.061	0.923	±	0.061	-0.21 [-1.12 - 0.69]	0.098
Mean 10m sprint	1.22	2.206	±	0.090	2.197	±	0.088	-0.10 [-1.00 - 0.80]	0.24
Mean 20m sprint	1.16	3.444	±	0.141	3.431	±	0.136	-0.09 [-0.99 - 0.81]	0.26
Fastest reaction time	1.32	0.246	±	0.113	0.214	±	0.058	-0.36 [-1.26 - 0.55]	0.21
Fastest 2m sprint	1.54	0.913	±	0.062	0.900	±	0.063	-0.21 [-1.11 - 0.69]	0.14
Fastest 10m sprint	1.26	2.177	±	0.092	2.168	±	0.085	-0.10 [-1.00 - 0.80]	0.22
Fastest 20m sprint**	2.21	3.411	±	0.143	3.385	±	0.128	-0.19 [-1.09 - 0.71]	0.04

** indicates significant differences at an alpha of level $P < 0.05$; * indicates significant differences at an alpha of level $P < 0.1$; Data expressed as mean ± SD