

Enhanced Physical and Cognitive Performance, and Mood States After Nap Opportunity Following a Sleep Restriction Night in Female Athletes: A Randomized Controlled Trial.

Abstract

This study examined the effects of different nap durations on sleepiness, attention and performance as well as mood states, pain perception (PP), perceived exertion (RPE), recovery (PRS) and delayed onset muscle soreness (DOMS) in well-trained women. Fourteen female bouxeuses (age 20 ± 2 years, height 166 ± 6 cm, weight 64 ± 6 kg) performed a 5 m shuttle run and digit cancellation test (i.e. attention) after one nap (N0) and 40 minutes (N40) and 90 minutes (N90) of nap opportunities after one night of normal sleep (NSN) and one night of sleep restriction (SRN). Subjective measurement of mood states, PP, RPE, PRS and DOMS were determined. TD was higher in N40 ($p = 0.035$, $d = 0.84$) and N90 ($p = 0.002$, $d = 1.34$) following NSN than SRN. HD was higher in N0 ($p < 0.001$, $d = 0.3$), N40 ($p < 0.001$, $d = 0.7$) and N90 ($p < 0.001$, $d = 0.98$) following NSN than SRN. After NSN, FI was lower in N40 and N90 than in N0 (N40: $p = 0.037$, $d = 0.47$; N90: $p = 0.004$, $d = 1.03$), and in N90 than in N40 ($p = 0.002$, $d = 0.48$). Furthermore, after NSN and SRN, the RPE score was higher in N0 compared with N40 (NSN: $p < 0.001$, $d = 2.51$; SRN: $p < 0.001$, $d = 2.04$) and N90 (NSN: $p < 0.001$, $d = 3.3$; SRN: $p < 0.001$, $d = 5.69$). Furthermore, after NSN and SRN, the PP score was higher in N0 compared with N40 (NSN: $p < 0.001$, $d = 2.78$; SRN: $p < 0.001$, $d = 2.73$) and N90 (NSN: $p < 0.001$, $d = 3.97$; SRN: $p < 0.001$, $d = 6.84$). Total mood scores were better after N40 and N90 compared with N0 ($p < 0.05$), with lower scores after N90 compared with N40 after NSN and SRN ($p < 0.05$). DOMS and RPE scores were significantly lower and PRS was significantly higher after N40 and N90 compared with N0 and after N90 compared with N40 after NSN and SRN ($p < 0.05$). Although both opportunity naps durations were beneficial, N90 was better than N40 for improving physical performance and attention as well as recovery, reducing perceived exertion, pain perception, delayed onset muscle soreness and negative mood states after NSN and SRN. In conclusion, the opportunity of two nap durations (i.e. 40 min and 90 min) helps counteract the negative effect of SRN on mood states as well as physical and cognitive performance.

Keywords: sleep ; siesta; sport; recovery; fatigue muscle soreness; mood; attention

1. Results

1.1. 5-m Shuttle Run Test

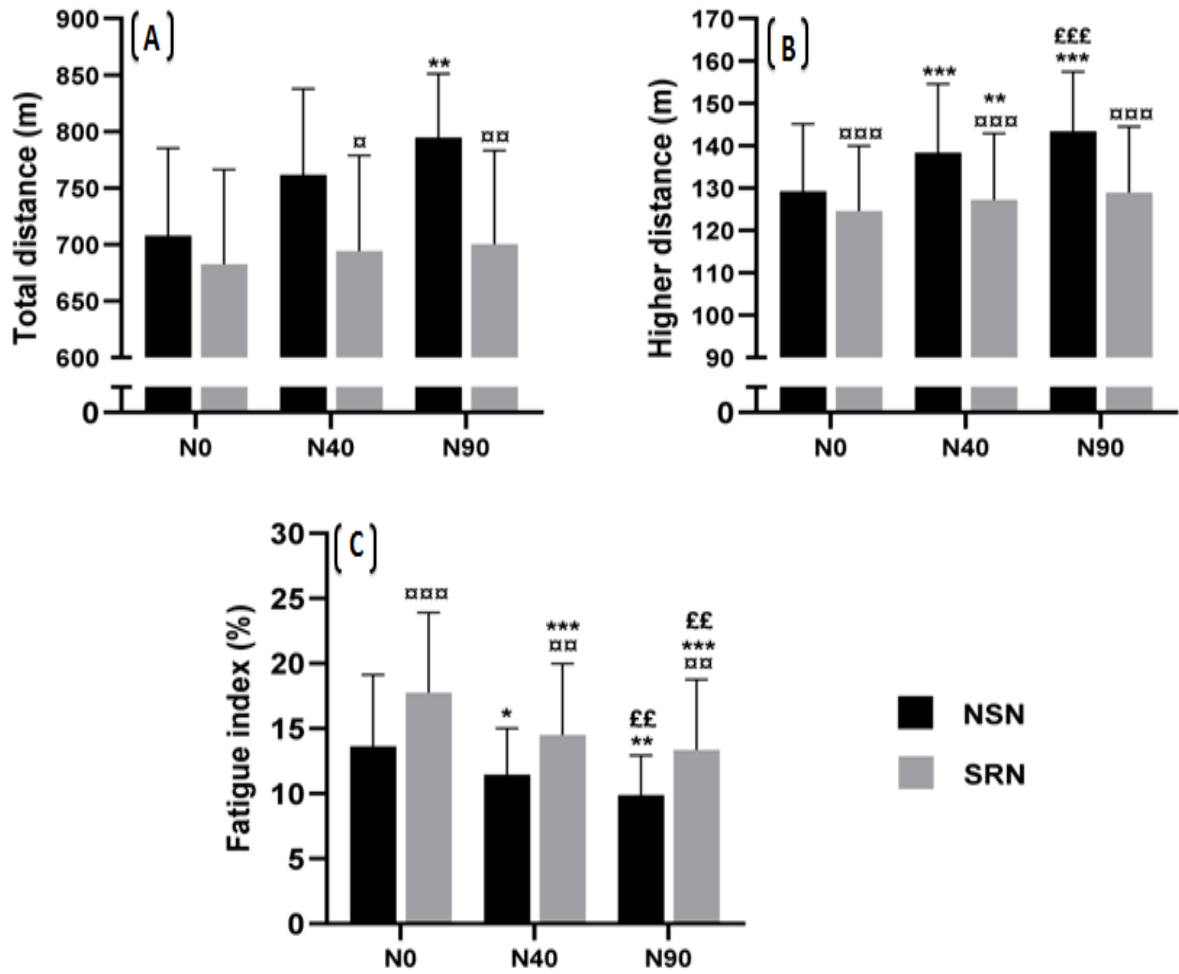
Total distance (TD), higher distance (HD), fatigue index (FI), and percentage decrement (PD) results are presented in Figure X.

The LD.F2 model showed a significant effect of Sleep $\times$ Nap interaction ($F_{ATS}(1.19, \infty) = 24.71$; $p < 0.001$; $\eta_p^2 = 0.66$), where TD was higher in N40 ($p = 0.035$, $d = 0.84$) and N90 ($p = 0.002$, $d = 1.34$) following NSN compared to SRN. Additionally, TD was higher in N90 compared to N0 following NSN ($p = 0.006$, $d = 1.42$).

For HD, the two-way ANOVA showed a significant effect of Sleep $\times$ Nap interaction ($F(1.77, 23.06) = 18.88$, $p < 0.001$, $\eta_p^2 = 0.59$), where HD was higher in N0 ($p < 0.001$, $d = 0.3$), N40 ($p < 0.001$, $d = 0.7$), and N90 ($p < 0.001$, $d = 0.98$) following NSN compared to SRN. Additionally, HD was higher in N40 ($p < 0.001$, $d = 0.57$) and N90 ($p < 0.001$, $d = 0.99$) compared to N0, and in N90 compared to N40 ($p = 0.002$, $d = 0.34$) following NSN. HD was higher in N90 compared to N0 and N40 (N0: $p = 0.016$, $d = 0.17$; N40: $p = 0.044$, $d = 0.28$) following SRN.

Regarding the FI, there was no significant effect of Sleep $\times$ Nap interaction ($F(1.22, 15.84) = 1.32$, $p = 0.277$, $\eta_p^2 = 0.09$). However, a significant effect of sleep and nap were found (Sleep: $F(1, 13) = 44.5$, $p < 0.001$, $\eta_p^2 = 0.77$; Nap: $F(1.27, 16.5) = 46.94$, $p < 0.001$, $\eta_p^2 = 0.78$). The pairwise comparisons revealed that the FI was lower in N0 ($p < 0.001$, $d = 0.71$), N40 ($p = 0.001$, $d = 0.66$), and N90 ($p = 0.003$, $d = 0.79$) following NSN compared to SRN. Following NSN, FI was lower in N40 and N90 compared to N0 (N40: $p = 0.037$, $d = 0.47$; N90: $p = 0.004$, $d = 1.03$), and in N90 compared to N40 ($p = 0.002$, $d = 0.48$). as well as following SRN, FI was lower in N40 and N90 compared to N0 (N40: $p < 0.001$, $d = 0.56$; N90: $p < 0.001$, $d = 0.76$), as well as in N90 compared to N0 ($p = 0.009$, $d = 0.21$).

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5. **Figure 2.** The total distance (A), greatest distance (B), and fatigue index (C) recorded post the 90-min nap, 40-min nap opportunity conditions (NAP) and the no-nap condition (N0), after a night of normal sleep (NSN) and a night of sleep restriction (SRN). AU: Arbitrary unit; * ($p < 0.05$), ** ($p < 0.01$), *** ($p < 0.001$): significantly different compared to N0. ££ ($p < 0.01$), £££ ($p < 0.001$): significantly different compared to N40; □ ($p < 0.05$), □□ ($p < 0.01$), □□□ ($p < 0.001$): significantly different compared to NSN; ANOVA: Analysis of variance. F_{ATS} : F-value of ANOVA-type test statistic calculated by LD.F2 model. Bars represent mean values and error bars represent SD.

5.1. Rating of Perceived Exertion

The two-way ANOVA showed a significant effect of sleep, nap, and Sleep $\times$ Nap interaction for RPE (Table 1), where RPE score was lower in N0, N40, and N90 (N0: $p < 0.001$, $d = 2.69$; N40: $p < 0.001$, $d = 3.34$; N90: $p = 0.004$, $d = 0.98$) following NSN compared to SRN. Additionally, following both NSN and SRN, RPE score was higher in N0 compared to N40 (NSN: $p < 0.001$, $d = 2.51$; SRN: $p < 0.001$, $d = 2.04$) and N90 (NSN: $p < 0.001$, $d = 3.3$;

SRN: $p < 0.001$, $d = 5.69$), and in N40 compared to N90 (NSN: $p = 0.004$, $d = 1.07$; SRN: $p < 0.001$, $d = 3.45$).

5.2. Pain perception

For PP, the LD.F2 model revealed a significant effect of sleep, nap, and Sleep $\times$ Nap interaction for RPE (Table 1). The pairwise comparisons showed that PP score was lower in N0, N40, and N90 (N0: $p < 0.001$, $d = 2.98$; N40: $p < 0.001$, $d = 3.34$; N90: $p = 0.002$, $d = 1.28$) following NSN compared to SRN. Additionally, following both NSN and SRN, PP score was higher in N0 compared to N40 (NSN: $p < 0.001$, $d = 2.78$; SRN: $p < 0.001$, $d = 2.73$) and N90 (NSN: $p < 0.001$, $d = 3.97$; SRN: $p < 0.001$, $d = 6.84$), and in N40 compared to N90 (NSN: $p = 0.002$, $d = 1.37$; SRN: $p < 0.001$, $d = 3.45$).

5.3. Delayed onset of muscle soreness

The LD.F2 model revealed no significant effect of Sleep $\times$ Nap interaction for DOMS (Table 1). However, a significant effect of sleep and nap was found (Table 1), where DOMS score was lower in N0, N40, and N90 (N0: $p < 0.001$, $d = 1.73$; N40: $p < 0.001$, $d = 2.14$; N90: $p = 0.003$, $d = 1.33$) following NSN compared to SRN. Following NSN, DOMS score was higher in N0 compared to N40 ($p = 0.012$, $d = 1.04$) and N90 ($p < 0.001$, $d = 2.52$), and in N40 compared to N90 ($p = 0.012$, $d = 1.47$). Lastly, DOMS score following SRN was lower in N40 compared to N0 ($p < 0.001$, $d = 0.88$) and higher in N40 compared to N90 ($p < 0.001$, $d = 1.75$).

5.4. Perceived recovery status

Regarding to PRS scores, the LD.F2 model revealed a significant effect of sleep and nap, but not a significant effect of Sleep $\times$ Nap interaction (Table 1). The pairwise comparisons revealed that PRS score was higher in N0, N40, and N90 (N0: $p = 0.008$, $d = 1.09$; N40: $p =$

0.002, $d = 1.29$; N90: $p = 0.002$, $d = 1.29$) following NSN compared to SRN. RPE score was higher, for both NSN and SRN, in N0 compared to N40 (NSN: $p = 0.001$, $d = 1.4$; SRN: $p = 0.005$, $d = 1.15$) and N90 (NSN: $p < 0.001$, $d = 2.85$; SRN: $p < 0.001$, $d = 2.9$), and in N40 compared to N90 (NSN: $p = 0.004$, $d = 1.4$; SRN: $p = 0.001$, $d = 1.51$).

5.5. Digit cancelation test

The LD.F2 model revealed a significant effect of sleep and nap for DCT scores, but not a significant effect of Sleep $\times$ Nap interaction (Table 1). However, DCT score was higher following NSN in N40 ($p = 0.043$, $d = 0.8$) compared to SRN. Additionally, DCT score was higher in N90 compared to N0 following both NSN ($p = 0.021$, $d = 1.17$) and SRN ($p = 0.008$, $d = 1.24$).

Table 1. Rating of Perceived Exertion (RPE), Pain perception (PP), Delayed onset of muscle soreness (DOMS), Perceived recovery status (PRS), and Digit cancellation test (DCT) recorded after no nap (N0), 40-minute nap (N40), and 90-minute nap opportunity.

Variable	Sleep Condition	Nap Duration			ANOVA
		N0	N40	N90	
PRE (AU)	NSN	5.58 $\pm$ 0.62	4.05 $\pm$ 0.61 ***	3.34 $\pm$ 0.7 ***££	S: F (1, 13) = 240.45; $p < 0.001$; $\eta_p^2 = 0.95$ N: F (1.31, 16.98) = 190.85; $p < 0.001$; $\eta_p^2 = 0.94$ S $\times$ N: F (1.73, 22.49) = 13.18; $p < 0.001$; $\eta_p^2 = 0.5$
	SRN	7.03 $\pm$ 0.45 □□□	6 $\pm$ 0.56 □□□ ***	3.99 $\pm$ 0.61 □□□ *** £££	
PP (AU)	NSN	5.76 $\pm$ 0.63	4.05 $\pm$ 0.61 ***	3.18 $\pm$ 0.66 ***££	S: F _{ATS} (1, ∞) = 212.46; $p < 0.001$; $\eta_p^2 = 0.94$ N: F _{ATS} (1.41, ∞) = 259.11; $p < 0.001$; $\eta_p^2 = 0.95$ S $\times$ N: F _{ATS} (1.73, ∞) = 8.02; $p < 0.001$; $\eta_p^2 = 0.38$
	SRN	7.19 $\pm$ 0.26 □□□	6 $\pm$ 0.56 □□□ ***	3.99 $\pm$ 0.61 □□ ***£££	
DOMS (AU)	NSN	6 $\pm$ 1.18	5 $\pm$ 0.68 *	4 $\pm$ 0.68 ***£	S: F _{ATS} (1, ∞) = 98.17; $p < 0.001$; $\eta_p^2 = 0.88$ N: F _{ATS} (1.51, ∞) = 221.51; $p < 0.001$; $\eta_p^2 = 0.94$ S $\times$ N: F _{ATS} (1.14, ∞) = 2.66; $p = 0.098$; $\eta_p^2 = 0.17$
	SRN	8 $\pm$ 1.18 □□□	7 $\pm$ 1.18 □□□	5.07 $\pm$ 1 □□ ***£££	
PRS (AU)	NSN	4.07 $\pm$ 0.92	5.21 $\pm$ 0.7 **	6.21 $\pm$ 0.7 ***££	S: F _{ATS} (1, ∞) = 154.52; $p < 0.001$; $\eta_p^2 = 0.92$ N: F _{ATS} (1.85, ∞) = 374.47; $p < 0.001$; $\eta_p^2 = 0.97$
	SRN	3.07 $\pm$ 0.92	4.14 $\pm$ 0.95	5.36 $\pm$ 0.63	

		□□	□□**	□□***££	S×N: $F_{ATS}(1.73, \infty) = 2.53$; $p = 0.088$; $\eta_p^2 = 0.16$
DCT (AU)	NSN	81.43 ± 9.61	87.21 ± 8.12	90.21 ± 6.9 *	S: $F_{ATS}(1, \infty) = 70.27$; $p < 0.001$; $\eta_p^2 = 0.84$ N: $F_{ATS}(1, \infty) = 71.24$; $p < 0.001$; $\eta_p^2 = 0.85$ S×N: $F_{ATS}(2.8, \infty) = 2.67$; $p = 0.071$; $\eta_p^2 = 0.17$
	SRN	76.71 ± 9.24	80.21 ± 9.28 □	87.07 ± 7.33 **	

1.1. AU: Arbitrary unit; * ($p < 0.05$), ** ($p < 0.01$), *** ($p < 0.001$): significantly different

compared to N0. £ ($p < 0.05$), ££ ($p < 0.01$), £££ ($p < 0.001$): significantly different compared

to N40; □ ($p < 0.05$), □□ ($p < 0.01$), □□□ ($p < 0.001$): significantly different compared to NSN;

ANOVA: Analysis of variance. F_{ATS} : F-value of ANOVA-type test statistic calculated by

LD.F2 model. **Profile of mood states**

The two-way ANOVA revealed a significant effect of sleep and nap for vigour score, but not a significant effect of Sleep × Nap interaction (Table 2). However, Vigour score following NSN was higher than SRN in N0, N40, and N90 (N0: $p < 0.001$, $d = 0.85$; N40: $p < 0.001$, $d = 0.82$; N90: $p < 0.001$, $d = 0.83$). Vigour score, following both NSN and SRN, was lower in N0 compared to N40 (NSN: $p < 0.001$, $d = 0.67$; SRN: $p < 0.001$, $d = 0.82$) and N90 (NSN: $p < 0.001$, $d = 1.19$; SRN: $p < 0.001$, $d = 1.37$), and in N40 compared to N90 (NSN: $p < 0.001$, $d = 0.52$; SRN: $p = 0.002$, $d = 0.51$).

The LD.F2 model revealed a significant effect of sleep and nap, but not a significant effect of Sleep × Nap interaction for confusion, anxiety, fatigue and anger scores (Table 2). The pairwise comparisons showed that confusion score following NSN was lower than SRN in N0, N40, and N90 (N0: $p < 0.001$, $d = 1.55$; N40: $p = 0.001$, $d = 1.36$; N90: $p = 0.003$, $d = 1.27$). Further, confusion score was higher in N0 compared to N90 following NSN ($p = 0.009$, $d = 1.35$) and in N0 compared to N40 and N90 following SRN (N40: $p = 0.015$, $d = 1.11$; N90: $p < 0.001$, $d = 1.91$). Moreover, anxiety score following NSN was lower than SRN in N0, N40, and N90 (N0: $p = 0.001$, $d = 1.41$; N40: $p = 0.004$, $d = 1.21$; N90: $p = 0.003$, $d = 1.26$). Also, anxiety score was higher in N0 compared to N40 and N90 following both NSN

(N40: $p = 0.006$, $d = 1.13$; N90: $p < 0.001$, $d = 2.45$) and SRN (N40: $p = 0.021$, $d = 0.99$; N90: $p < 0.001$, $d = 2.09$). Lastly, fatigue and anger scores following NSN were higher than SRN in N40 ($p = 0.044$, $d = 0.80$) and N0 ($p = 0.041$, $d = 0.81$), respectively. Additionally, fatigue and anger scores were higher in N0 compared to N90 following NSN (Fatigue: $p = 0.041$, $d = 1.02$; Anger: $p = 0.035$, $d = 0.98$) and SRN (Fatigue: $p = 0.048$, $d = 0.89$; Anger: $p = 0.098$, $d = 1.27$).

Regarding to depression and TMD score, the two-way ANOVA showed a significant effect of sleep, nap, and Sleep $\times$ Nap interaction (Table X). Depression score was lower following NSN compared to SRN in N0, N40, and N90 (N0: $p < 0.001$, $d = 0.7$; N40: $p < 0.001$, $d = 0.47$; N90: $p < 0.001$, $d = 0.47$). Also, Depression score was higher following NSN in N0 compared to N40 and N90 (N40: $p < 0.001$, $d = 0.41$; N90: $p < 0.001$, $d = 0.84$), also in N40 compared to N90 ($p < 0.001$, $d = 0.38$). As well as following SRN, Depression score was higher in N0 compared to N40 and N90 (N40: $p < 0.001$, $d = 0.67$; N90: $p < 0.001$, $d = 1.21$), also in N40 compared to N90 ($p < 0.001$, $d = 0.53$).

Further, TMD score was lower following NSN compared to SRN in N0, N40, and N90 (N0: $p < 0.001$, $d = 1.48$; N40: $p < 0.001$, $d = 1.4$; N90: $p < 0.001$, $d = 1.3$). Also, TMD score was higher following NSN in N0 compared to N40 and N90 (N40: $p < 0.001$, $d = 0.95$; N90: $p < 0.001$, $d = 1.72$), also in N40 compared to N90 ($p < 0.001$, $d = 0.79$). also,, TMD score was higher in N0 compared to N40 and N90 (N40: $p < 0.001$, $d = 1.25$; N90: $p < 0.001$, $d = 2.39$), also in N40 compared to N90 ($p < 0.001$, $d = 1.07$).

1.2. Stanford sleepiness scale

The three-way ANOVA showed a significant effect of sleep ($F(1, 13) = 452.98$, $p < 0.001$, $\eta_p^2 = 0.97$), nap ($F(1.77, 23.95) = 60.2$, $p < 0.001$, $\eta_p^2 = 0.82$), and time ($F(1, 13) = 113.99$, $p < 0.001$, $\eta_p^2 = 0.9$) for SSS. Also, a significant effect of Nap $\times$ Time interaction was found

($F(1.77, 23.95) = 60.2, p < 0.001, \eta_p^2 = 0.82$). There was no significant effect of Sleep $\times$ Nap interaction ($F(1.96, 25.44) = 2.32, p = 0.12, \eta_p^2 = 0.15$), Sleep $\times$ Time interaction ($F(1, 13) = 0.03, p = 0.869, \eta_p^2 = 0.002$), or Sleep $\times$ Nap $\times$ Time interaction ($F(1.85, 24.05) = 2.37, p = 0.119, \eta_p^2 = 0.154$). However, the pairwise comparisons showed that SSS score following NSN was lower than SRN at Pre- and Post-Nap in N0 (Pre-Nap: $p < 0.001, d = 3.34$; Post-Nap: $p < 0.001, d = 3.41$), N40 (Pre-Nap: $p < 0.001, d = 5.26$; Post-Nap: $p < 0.001, d = 4.41$), N90 (Pre-Nap: $p < 0.001, d = 4.05$; Post-Nap: $p < 0.001, d = 6.04$). Additionally, SSS score, following both NSN and SRN, was increased from pre- to post-Nap in N0 (NSN: $p < 0.001, d = 1.86$; SRN: $p = 0.033, d = 0.98$), and decreased in N40 (NSN: $p < 0.001, d = 2.4$; SRN: $p < 0.001, d = 2.08$) and N90 (NSN: $p < 0.001, d = 3.94$; SRN: $p < 0.001, d = 3.48$). Moreover, SSS score Post-Nap was higher in N0 compared to N40 and N90 following NSN (N40: $p < 0.001, d = 3.46$; N90: $p < 0.001, d = 5.25$) and SRN (N40: $p < 0.001, d = 2.44$; N90: $p < 0.001, d = 5.41$), as well as SSS score was lower Post-Nap in N90 compared to N40 following NSN ($p = 0.019, d = 1.35$) and SRN ($p = 0.007, d = 1.36$).

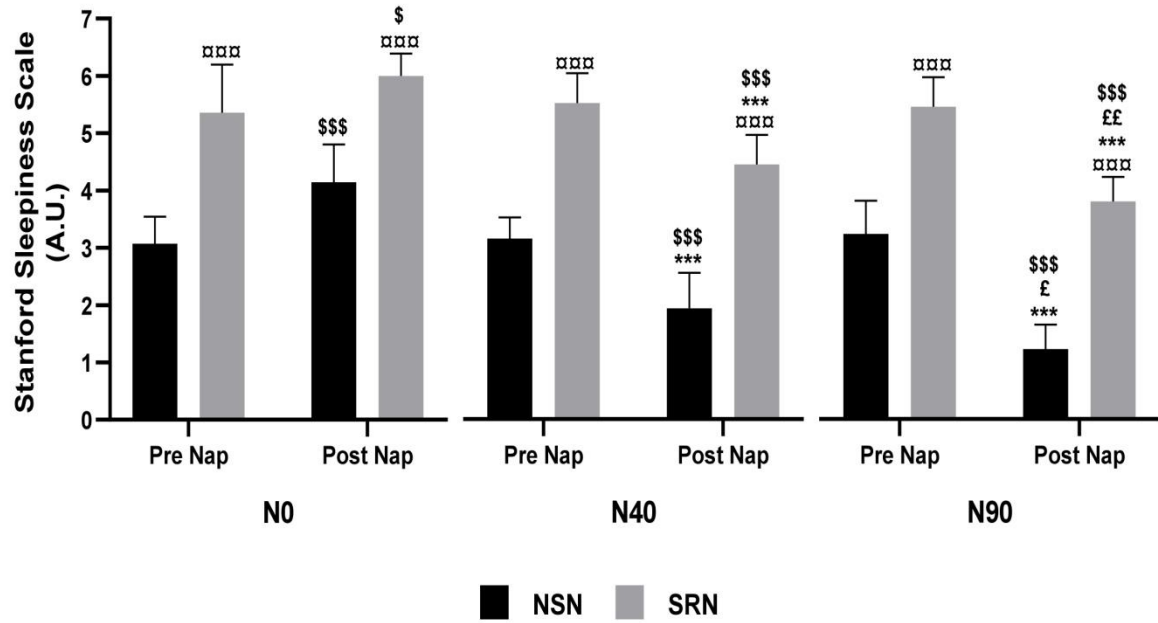


Figure 3 The Stanford Sleepiness Scale (SSS) scores recorded pre and post the 90-min nap, 40-min nap opportunity conditions (NAP) and the no-nap condition (N0), after a night of normal sleep (NSN) and a night of sleep restriction (SRN). AU: Arbitrary unit; *** ($p < 0.001$): significantly different compared to N0. £ ($p < 0.05$), ££ ($p < 0.01$): significantly different compared to N40; □□□ ($p < 0.001$): significantly different compared to NSN; \$ ($p < 0.05$), \$\$\$ ($p < 0.001$): significantly different compared to pre Nap; ANOVA: Analysis of variance. F_{ATS} : F-value of ANOVA-type test statistic calculated by LD.F2 model.

Acute ingestion of Acetaminophen improves physical and cognitive performance in well-trained female athletes: A double-blind randomized crossover trial .

Abstract

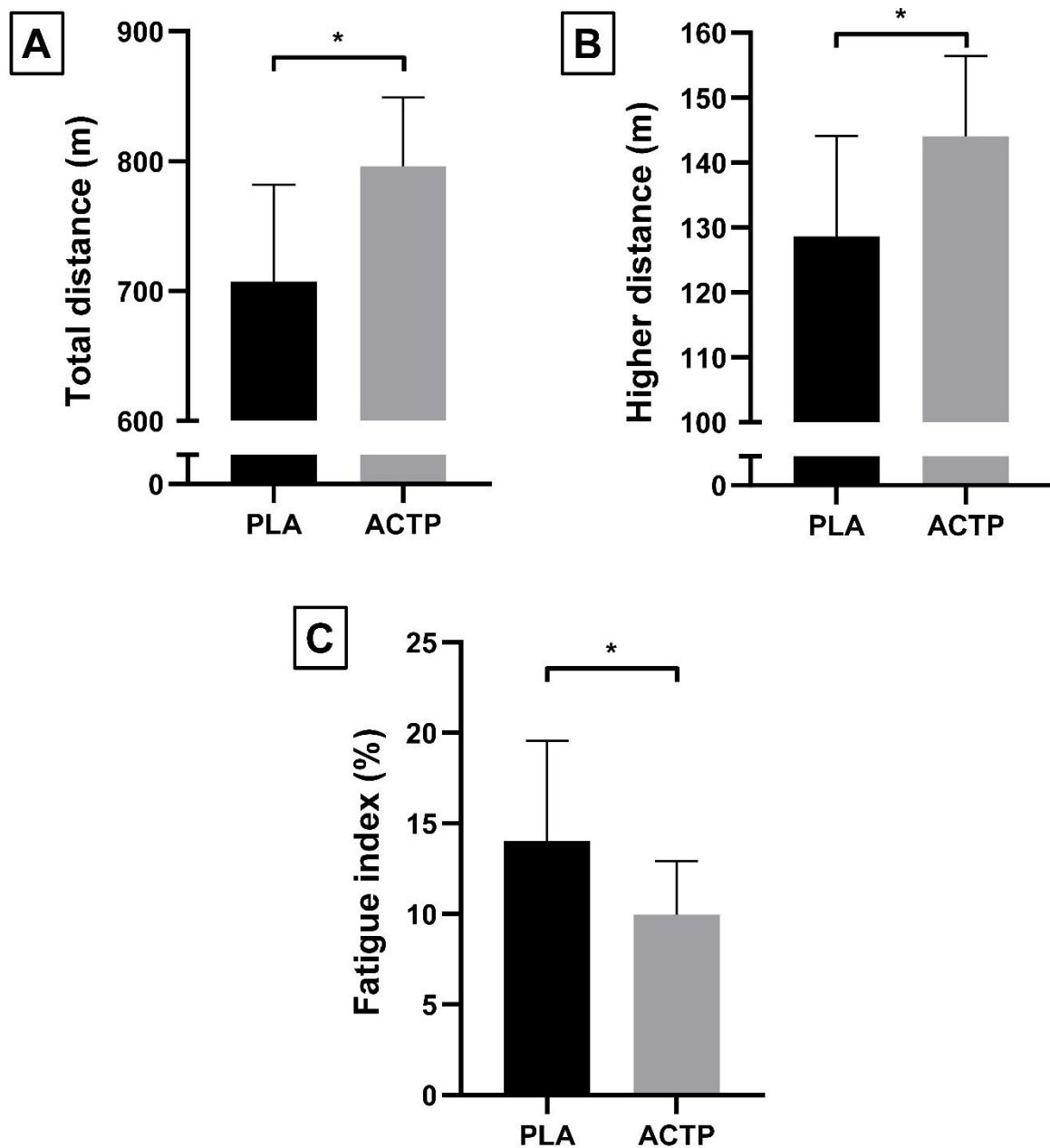
This study examined the effect of acute acetaminophen (ACTP) ingestion on physical performance during the 5m Shuttle Run Test (5mSRT), attention, mood states, and the perception of perceived exertion (RPE), pain (PP), recovery (PRS), and delayed onset of muscle soreness (DOMS) in well-trained female athletes. In a randomized, placebo-controlled, double-blind, crossover trial, fifteen well-trained female athletes (age 21 ± 2 years, height 165 ± 6 cm, body mass 62 ± 5 kg) swallowed either 1.5 g of ACTP or 1.5 g of placebo. The profile of mood states (POMS) and digit-cancellation (DCT) were assessed 45 min post-ingestion and the 5mSRT was performed 60 min post-ingestion. The RPE and PP were determined immediately after each 30-s repetition of the 5mSRT and the PRS; DOMS were recorded at 5 min post-5mSRT. For the 5mSRT, ACTP ingestion improved greatest distance (+10.88%, $p < 0.001$), total distance (+ 11.33%, $p = 0.0007$) and fatigue index (+21.43%, $p = 0.0003$) compared to PLA. Likewise, DCT score was better in ACTP ($p = 0.0007$) compared to PLA. RPE, PP, PRS, and DOMS scores were improved after ACTP ingestion ($p < 0.0001$, $p < 0.0001$, $p = 0.0007$, and $p = 0.001$) compared to PLA. POMS scores were enhanced with ACTP ingestion compared to PLA ($p < 0.01$). In conclusion, acute ACTP ingestion enhanced high intensity short-term maximal performance and improved the perception of fatigue, recovery, muscle soreness and mood states.

Keywords. Paracetamol; Repeated sprints; Mood; Attention; Fatigue.

3. Results

5-m shuttle run test

The TD, HD, and FI during the 5mSRT are presented in Figure 2. Statistical analysis revealed TD (+11.33%) and HD (+10.83%) were significantly higher in ACTP condition compared to PLA ($Z = 3.41$, $p = 0.0007$, $d = 1.38$ and $t = 8.29$, $p < 0.0001$, $d = 1.1$, respectively). Additionally, FI was significantly lower by 21.44% in ACTP condition compared to PLA ($t = 4.77$, $p = 0.0003$, $d = 0.91$).



The digit-cancellation test (DCT)

Statistical analysis showed DCT scores were higher after ACTP ingestion compared with PLA (Table 1).

Rating of perceived exertion scale (RPE)

Statistical analysis showed RPE values were lower after ACTP ingestion compared with PLA (Table 1).

Rating of perceived pain (PP)

Statistical analysis showed PP values were lower after ACTP ingestion compared with PLA (Table 1).

Perceived recovery status (PRS)

Statistical analysis showed PRS values were higher after ACTP compared with PLA (Table 1).

Delayed onset muscle soreness (DOMS)

Statistical analysis showed that DOMS values were lower after ACTP compared with PLA (Table 1).

Table 1. Values are expressed as the mean $\pm$ SD. Digit cancelation test (DCT), delayed onset muscle soreness (DOMS), perceived recovery status scale (PRS), rating of perceived exertion scale (RPE), and perceived pain (PP) recorded after the consumption of the ACTP and the PLA.

PLA	ACTP	$\Delta\%$	t/Z	p-value	Cohen's d
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DCT (AU)	80.4 ± 10.08	89.7 ± 6.98	10,54	Z = 3.41	0.0007	1.09
RPE (AU)	5.6 ± 0.5	3.2 ± 0.6	-40,33	t = 10.56	< 0.0001	3.54
PP (AU)	5.8 ± 0.7	3 ± 0.5	-42,55	t = 12.66	< 0.0001	4.14
PRS (AU)	4 ± 0.9	6.9 ± 0.7	40,46	Z = 3.41	0.0007	3.40
DOMS (AU)	6 ± 1.1	4 ± 0.6	-31,76	Z = 3.29	0.001	2.3

AU: arbitrary units.

Profile of Mood States (POMS)

Analyses revealed a significant effect of ACTP ingestion compared to PLA for anxiety, anger, depression, fatigue; vigor, confusion, and TMD score. Anxiety, depression, anger, fatigue, confusion and TMD were reduced with ACTP compared to PLA. However, vigor was increased with ACTP compared to PLA (Table 2).

Table 2. Values of the profile of mood states scores recorded after ingestion of the ACTP and the PLA

	PLA	ACTP	t/Z	p-value	Cohen's d
Anxiety (AU)	9.7 ± 3	4 ± 1.9	t = 13.31	< 0.0001	2.29
Depression (AU)	10 ± 4	6 ± 4	t = 20.14	< 0.0001	0.86
Anger (AU)	10.5 ± 6.1	5.6 ± 4.5	Z = 3.41	0.0007	0.97
Vigor (AU)	16.4 ± 4.8	21.6 ± 3.9	Z = 3.41	0.0007	1.16
Fatigue (AU)	7 ± 4	3 ± 3	Z = 3.41	0.0007	0.95
Confusion (AU)	8 ± 3.4	4.5 ± 2.2	Z = 3.3	0.001	0.77
TMD (AU)	29 ± 16	7.9 ± 13	t = 19.63	< 0.0001	1.83

AU: Arbitrary units; TMD: Total mood disturbance.