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The effect of acute caffeine ingestion on upper and lower body anaerobic exercise performance

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Running Head: Caffeine ingestion and anaerobic exercise

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Abstract

The current study examined the effect of acute caffeine ingestion on mean and peak power production, fatigue index and rating of perceived exertion (RPE) during upper body and lower body Wingate anaerobic test (WANT) performance. Using a double-blind design, 22 males undertook one upper body and one lower body WANT, 60 min following ingestion of caffeine (5 $mg*kg^{-1}$) and one upper body and one lower body WANT following ingestion of placebo (5 $mg*kg^{-1}$ Dextrose). Peak power was significantly higher (P=.001) following caffeine ingestion in both upper and lower body WANT. Peak power and mean power was also significantly higher during lower body, compared to upper body WANTs irrespective of substance ingested. However, caffeine ingestion did not enhance mean power neither in upper nor lower-body WANT. There were no significant differences in mean fatigue index as a consequence of substance ingested or mode of exercise (all P>0.05). For RPE there was also a significant substance ingested X mode interaction (P = .001) where there were no differences in RPE between caffeine and placebo conditions in lower body WANTs but significantly lower RPE during upper body WANT in the presence of caffeine compared to placebo (P = .014). This is the first study to compare the effects of caffeine ingestion on upper and lower body 30-second WANT performance and suggests that caffeine ingestion in the dose of 5 $mg*kg^{-1}$ ingested 60 min prior to exercise significantly enhances peak power when data from upper and lower body WANTs are combined.

Keywords: Wingate test; high-intensity exercise; cognition; ergogenic aid; nutrition.

Introduction

Caffeine is a widely used supplement as a means to enhance exercise performance and the beneficial effects of ingesting this substance are well reported (Graham, 2001; Astorino & Roberson, 2010). The majority of this prior work supports the beneficial effects of caffeine ingestion on tasks that are predominantly aerobic in nature whereas, there is greater equivocality with respect to tests requiring anaerobic components of performance (Davis & Green, 2009). This has resulted in an increasing interest in caffeine responses to tests requiring maximal strength and power (Grgic & Mikulic, 2017), resistance exercise to failure (Astorino & Roberson, 2010) and the Wingate anaerobic test (WANT; Duncan, Dobell, Caygill, Eyre, & Tallis, 2018; Greer, McLean, & Graham, 1998; Salinero et al., 2017). The WANT test is widely used due to its simplicity, validity to estimate anaerobic performance, and high reliability (Bar-Or, 1987). In the context of WANT performance, studies have reported ergolytic effects (Greer et al., 1998), whilst others have reported significantly increased peak and mean power output following caffeine ingestion (Salinero et al., 2017).

Grgic (2018), recognising the equivocality on this topic, recently presented meta-analytical data examining the effects of caffeine ingestion on anaerobic exercise. This meta-analysis of 16 studies concluded that acute caffeine ingestion augments lower body peak and mean power produced during the WANT. One limitation of the studies included in the meta-analysis by Grgic (2018) is that none of them examined the effectiveness of the blinding to the caffeine and placebo conditions. This limitation may be relevant given that correct supplement identification may impact the exercise outcome and therefore present a source of bias in studies investigating the effects of caffeine ingestion on exercise performance (Saunders et al., 2017). The inclusion of studies that did not examine the efficacy of the blinding to caffeine and placebo trials in the analysis might have confounded the pooled meta-analytical results by Grgic (2018). This limitation highlights the need for future studies exploring the effects of caffeine on WANT performance whilst addressing this methodological limitation.

Grgic (2018) also noted that none of the included studies examined the effect of caffeine ingestion on upper body WANT performance and no studies compared upper versus lower body WANT performance in the presence of caffeine (Grgic, 2018). Despite previous work demonstrating caffeine induced increases in upper body strength (Bazzucchi, Felici, Montini, Figura, & Sacchetti, 2011), there is evidence to suggest that the effects of caffeine may not be uniform across the upper and lower body (Grgic & Mikulic, 2017; Tallis & Yavuz, 2018). It has been suggested that in smaller muscles, such as those of the upper arm, there may be a limited ability for increased motor unit recruitment associated with caffeine ingestion (Warren, Park, Maresca, McKibans, & Millard-Stafford, 2010). Therefore, the evidence on the acute performance-enhancing effects of caffeine in the lower body WANT cannot necessarily be generalised to the upper body musculature. Whilst meta-analyses suggest that caffeine ingestion may have a greater ergogenic effect on the lower body than upper body musculature, these results are generally obtained by pooling studies that examined the effects of caffeine on either upper or lower body exercise performance (Grgic & Pickering, 2018; Warren et al., 2010). In other words, currently, there is a lack of studies using tests for both upper and lower body in the same group of participants which is an avenue requiring further scientific attention.

Recently, Duncan et al. (2018) examined the effects of acute caffeine ingestion on power output during the upper body WANT following the ingestion of $5mg*kg^{-1}$ of caffeine in a sample of 12 males. They reported that caffeine ingestion, as compared to placebo, resulted in: (1) increased peak power (but not mean power); (2) higher fatigue rate; and (3) lower rating of perceived exertion (RPE). While these results support similar studies that have been conducted using lower body WANT, there are few studies that have examined whether caffeine ingestion has a differential effect on upper or lower body WANT exercise performance.

Understanding if caffeine influences perceptual responses to upper body exercise compared to lower body exercise is important in exercise prescription and planning training programmes. Perception of exertion may be amplified during upper body exercise (Kang, Chaloupka, Mastrangelo, & Angelucci, 1999) as less extraneous sensory information is processed when using a smaller muscle mass (Pandolf, Billings, Drolet, Pimental, & Sawka, 1984) and cerebral blood flow is greater for upper body, compared to lower body exercise (Thomas, Schroeder, Secher, & Mitchell, 1989).

The current study sought to address a key gap in the literature by comparing the effect of acute caffeine ingestion on mean and peak power production and RPE during upper body and lower body WANT performance. We hypothesised that caffeine ingestion would enhance both mean and peak power both in the lower and upper body WANT.

Methods

Participants

Following institutional ethics approval and informed consent, 23 males agreed to participate. Of that sample, one participant withdrew midway through the testing period due to illness, resulting in a sample of 22 males (aged 18-30; 22.4±3.7 years; height 174±0.7cm; body mass 76.0±12.2kg; mean±SD) who completed the testing sessions. All participants habitually ingested caffeine although none were heavy caffeine users (mean ± SD of caffeine consumption = 141.6 ± 35.8 mg/day, range = 90-240 mg/day). Caffeine intake was established using a 24-hour recall questionnaire (Maughan, 1999). All participants completed a health history questionnaire to ensure that they were “apparently healthy” and accustomed to regular high-intensity exercise. Participants were excluded if they had a musculoskeletal injury or cardiovascular condition that restricted exercise performance or were a heavy habitual caffeine user (>300mg/day). One volunteer was excluded on expressing interest in taking part in the project based on heavy caffeine habitual consumption and was not included in the initial sample taking part in the study. Male participants were specifically recruited as, in women, the use of oral contraceptives and menstrual cycle phases can alter caffeine metabolisation speeds (Rietveld, Broekman, Houben, Eskes, & Van Rossum, 1984). In turn, these factors may affect the ergogenic effects of caffeine. Therefore, to eliminate any confounding effects due to the inclusion of both sexes, we opted to explore the effects of caffeine on WANT performance while only including men.

Procedures

All testing took place between 9.00 am and 12.00 noon with each condition taking place at the same time of day for each participant. The half-life of caffeine is generally 4 to 6 hours (Graham, 2001); therefore this time of caffeine abstinence should be sufficient to eliminate any confounding effects of prior caffeine consumption. Participants were asked to refrain from vigorous exercise, maintain normal dietary patterns in the 48 h prior to testing and were asked not to consume caffeine after 6:00 pm the night before testing (Marlat & Rosenhow, 1980). Each participant undertook five visits to the human performance laboratory. In the first visit they were familiarised with the equipment and procedures involved in the study. All of the participants had prior experience of undertaking both upper and lower body WANTs within the preceding 3 months to engaging in the current study and were familiar with the protocols being employed. However, this first visit also comprised a habituation to the WANTs and verification of maximal cadence to be used in the subsequent experimental trials. In the following four experimental trials participants undertook either an upper body WANT, 60 minutes following ingestion of either caffeine or placebo or a lower body WANT following ingestion of either caffeine or placebo. Order of exercise trial was randomised using GraphPad randomisation software (GraphPad, San Diego, USA) freely available at: https://www.graphpad.com/quickcalcs/randomize1.cfm.

Prior to the experimental trials, participants ingested either 5 $mg*kg^{-1}$ body mass of caffeine (Myprotein, UK) or a placebo (5 $mg*kg^{-1}$ dextrose, Myprotein, UK) administered in gelatine capsules with 200 ml water. Substances were presented double blind and in a counterbalanced order. Substances were consumed 60 minutes before each exercise trial as plasma caffeine concentration is maximal approximately 1 hour after ingestion of caffeine (Graham, 2000).

Exercise Protocol and Performance Measures

The exercise tests consisted of 30 second upper or lower body WANTs completed on a Monark Peak bike (Ergomedic 894E, Vansbro, Sweden) and executed following recommended guidelines (Peterson, 2012). The ergometer was calibrated prior to any testing being conducted. A fly wheel braking force corresponding to 0.05kg/per kg body mass (Nindl, Mahar, Harman, & Patton, 1995) was used for upper body WANT and 0.075kg/per kg body mass for lower body WANTs. Prior to each test commencing, participants completed a standardised, 4-minute warm up at a load against a load of 1 kg, followed by 3 × 2 s maximal cycling against a load of 7.5% (lower body) or 5% (upper body) body mass, interspersed with 45 s easy cycling following the procedure reported by Kavaliauskas and Phillips (2016). After a short gap (standardised to 1 minute), the participant was then asked to begin cranking or cycling at maximal cadence against no load. Once the participant was at maximal cadence the external load was applied for 30 seconds. Care was made to ensure participants remained seated throughout. The peak power output mean power output, and fatigue index (%) were calculated during the WANT using custom software sampling data at 0.5 second intervals. Peak power was defined as the highest power output achieved during any 0.5 second interval and mean power was defined as the average power over the 30 second test. Using a WANT protocol the same as that reported here, Kavaliauskas and Phillips (2016) reported that the test-retest reliability of peak and mean power in the WANT is very high (intraclass correlation coefficient: 0.93 and 0.99, respectively).

During each WANT, peak heart rate (PHR) was assessed using heart rate telemetry, sampling at 5Hz (RS400 Polar Electro Oy, Kempele, Finland) and on completion of each test RPE for the active musculature was determined using the Borg 6-20 RPE scale (Borg, 1970). This is in accordance with protocols used to assess RPE following WANT testing and nutritional manipulation including caffeine ingestion (Woolf, Bidwell, & Carlson, 2008). Post exercise blood lactate (Bla) was also determined 2 minutes after each test using a capillary blood sample from the earlobe (Lactate Plus, Nova Biomedical, USA).

Assessment of Blinding

After completion of all trials, participants were asked which trial they thought was the caffeine and which the placebo trial. They were also asked to outline why they identified which trial as which. These responses were noted down by the researchers to address criticisms of past studies on the effect of caffeine which have not assessed the efficacy of blinding (Grgic, 2018). The efficacy of blinding was then determined using Bang's Blinding Index (Bang, Ni, & Davis, 2004) to provide a standardised measure of participants guessing which substance was ingested over chance.

Statistical analysis

In order to examine whether there were any differences in peak power, mean power, fatigue index, Bla, PHR and RPE between caffeine and placebo conditions in upper and lower body conditions a series of 2 (substance ingested) X 2 (mode; upper vs lower body) ways repeated measures analysis of variance (ANOVA) were carried out. Where any significant differences were found Bonferroni post-hoc pairwise comparisons were used to indicate where the differences lay. Partial eta^2 (Pη^2) was also used as a measure of effect size. The Bang's Blinding Index was used for exploring the effectiveness of the blinding to the caffeine and placebo conditions (Bang, Ni, & Davis, 2004). Given the limitations of data presentation using bar graphs (Weissgerber, Milic, Winham, & Garovic, 2015), data were visually presented following procedures advocated by Weissgerber et al. (2015) by presenting data distribution in figures to ensure more complete presentation of data. The statistical package for social sciences (SPSS Version 25) was used for all analysis.

Results

Mean ± SD and 95% CIs for peak power, mean power, fatigue index, Bla, PHR and RPE in caffeine and placebo conditions for each repetition of the upper and lower body WANT are presented in Table 1.

Table 1 here

Peak Power

For peak power there was no significant substance X mode interaction (P = .244). There were, however, significant main effects for substance ingested (P = .001, Pη^2 = .541) and mode of exercise (P = .0001, Pη^2 = .900). Bonferroni post-hoc pairwise comparisons indicated that WANT performance was significantly higher for upper and lower body combined following caffeine ingestion compared to placebo (mean diff = 59.4, P = .001) irrespective of mode of exercise and that peak power was significantly higher during lower body WANTs compared to upper body WANTs (mean diff = 322.9, P = .0001). Subsequent planned comparisons revealed no significant difference between caffeine and placebo conditions in the lower body (P = .193) or upper body (P = .104) WANTs. In both cases peak power was higher in the presence of caffeine compared to placebo. A scatterplot showing the data distribution for peak power for each trial of the WANT in caffeine and placebo conditions is presented in Figure 1.

Figure 1 here

Mean Power

For mean power there were no significant substance X mode interactions (P = .814, Pη^2= .003) nor was there a significant main effect for substance ingested (P = .114, Pη^2=

.120). There was a significant main effect for mode of exercise (P = .0001, $P\eta^2$= .864) where mean power was significantly lower in upper body compared to lower body WANT. A scatterplot showing the data distribution for mean power for each trial of the WANT in caffeine and placebo conditions is presented in Figure 2.

Figure 2 here

Fatigue Index

Data for fatigue index indicated no significant substance ingested X mode interaction (P = .08), nor was there a significant main effect for substance ingested (P = .941) or mode of exercise (P =.639).

Blood Lactate and Peak Heart Rate

For Bla there was no significant substance ingested X mode interaction (P = .091), nor was there a significant main effect for substance ingested (P = .204) or mode of exercise (P =.183). The results for PHR followed a similar trend to those for Bla. There was no significant substance ingested X mode interaction (P = .521), nor was there a significant main effect for substance ingested (P = .099) or mode of exercise (P =.109).

Rating of Perceived Exertion

For RPE there was also a significant substance ingested X mode interaction (P = .001, $P\eta^2$ = .458). Post-hoc analysis indicated no significant difference in RPE between caffeine and placebo in lower body WANT (P = .634, $P\eta^2$ = .012) but significantly lower RPE during upper body WANT in the presence of caffeine compared to placebo (P = .014, $P\eta^2$ = .253). Mean ±

SD and 95% CIs of RPE for each trial of the WANT in caffeine and placebo conditions is presented in Table1.

Efficacy of Blinding

Post experiment responses in regard to participant awareness of which trial involved caffeine and which placebo indicated 41% (*n* = 9) of participants correctly identified the upper body caffeine or placebo trial, 45% (*n* = 10) incorrectly identified the correct trial. Reasons for identification of trial as containing caffeine (irrespective of whether it was identified correctly or not) were because participants felt “more alert”, “more aware”, “ready to go”. Three participants (14%) suggested they could not discern which upper body trial was which. In regard to the lower body trials, 55% (*n* = 12) of participants correctly identified the caffeine or placebo trial and 36% (*n* = 8) incorrectly identified the correct trial. Similar reasons were identified as with the upper body trials for which contained which alongside participants stating “I just know” which trial contained caffeine and “I could feel it”. In the case of the former this statement was made by participants who guessed correctly and incorrectly in terms of which substance contained caffeine and which placebo. Two participants (9%) stated they did not know which lower body trial contained caffeine and which placebo. Results from the Bang Blinding Index indicated that, for upper body trials, 5.8% and 5.2% of participants correctly guessed the caffeine and placebo trials beyond chance respectively. This figure was 5.8% and 9% for guessing caffeine and placebo trials beyond chance respectively in the lower body trials. 95% confidence intervals were -0.05 – 0.24 for upper body trials and -0.2 – 0.26 for lower body trials. As the confidence intervals overlap the null this is indicative that blinding was highly effective and participants’ decisions as to which trial was which were more likely to be due to random guessing by the participants (Bang, Ni, & Davis, 2004).

Additional a posteriori analysis was conducted using independent samples t-tests to examine any differences in the caffeine trials and placebo trials for those who correctly guessed which substance they ingested versus those who incorrectly guessed. For lower body and upper body WANTs there were no significant differences in peak power or mean power (all $P>0.05$) for those who correctly identified the caffeine trial and those who did not. Mean ± SD for peak power during lower body WANT was 930 ± 215 Watts (4.1% improvement) versus 893 ± 156 Watts and mean power was 580 ± 107 Watts (4.5% improvement) versus 555 ± 120 Watts for those correctly identifying the caffeine trial compared to those who did not respectively. For upper body trials mean ± SD was 604 ± 160 Watts (4.2% improvement) versus 590 ± 122 Watts for peak power and 351 ± 130 Watts (3.2% improvement) versus 340 ± 68 Watts for mean power for those who correctly identified the caffeine trial compared to those who did not.

Discussion

This study examined the efficacy of acute caffeine ingestion on upper and lower body WANT anaerobic test performance. The results of the current study suggest that, when upper and lower body exercise data are combined (i.e. a main effect), caffeine ingestion enhances peak power production compared to placebo. This is the first study to compare the effects of caffeine ingestion on upper and lower body 30 second WANT test performance and, as such, this work makes an original contribution to the literature. Caffeine ingestion significantly enhanced peak power in both upper and lower body WANTs. Caffeine ingestion also dampened RPE; however, this effect was noted only for upper body exercise. Mean power and fatigue index were not significantly different as a consequence of substance ingested or the mode of exercise. Blinding of the participants was generally effective and thus did not confound the results.

The ability to generate greater peak power during a 30-second exercise period is important in a number of cases. Notably, in BMX racing where peak power achieved within the first five seconds of a race is indicative of overall race performance, lasting approximately

35 seconds (Rylands, Roberts, Hurst, & Bently, 2017). This is also the case for upper body peak power in grinders within America's Cup sailing where peak power production is key to sailing performance (Neville, Pain, & Folland, 2009). The results of the current study align with assertions made by Duncan et al. (2018) that reported increased peak power in the presence of caffeine during upper body WANT performance. The results of the current study in respect to lower body WANT performance are also in agreement with some prior research examining this topic (Duncan, 2009; Grgic, 2018, Salinero et al., 2017) but do not agree with studies (Greer et al., 1998; Pereira et al., 2010) that reported caffeine to have an ergolytic effect on lower body WANT performance. One study examined the effects of caffeine on upper and lower body WANT performance using a repeated effort protocol (6 x 15 seconds). In the study by Andre, Green, Gann, O'Neal, and Coates (2015) a caffeine dose of 7 $mg*kg^{-1}$ ingested one hour before the testing commenced, was effective for acute increases in peak and mean power output in the upper but not lower body. However, in this study, the participants completed both the upper and lower body WANTs in the same sessions (with the upper body test always preceding the lower body WANT) while in our study, the performance in these tests was examined on different testing days. It remains possible that caffeine was not ergogenic for lower body in the study by Andre et al. (2015) due to the accumulated fatigue from the upper body WANT given that in some cases, caffeine may become ergolytic as fatigue develops (Bishop, 2010). Furthermore, the use of a repeated effort protocol (i.e., 6 x 15 seconds) and the differences in caffeine doses (7 vs. 5 $mg*kg^{-1}$) limit any further comparison with the results observed herein.

We did not observe significant effects of caffeine on mean power. However, the percent differences between the placebo and caffeine conditions showed a ~5% favouring of the caffeine conditions (both in the upper and lower body WANT). Therefore, it might be that these results did not reach statistical significance due to the wide variation in responses to caffeine ingestion (Pickering & Kiely, 2018). Future studies are needed to explore the reasons for this variation in responses between individuals. While the improvement in performance following caffeine ingestion is small and could be questioned from a practical significance standpoint, these results may be relevant for individuals interested in maximising their power performance, for example, those participating in sports such as BMX. It is also important to note that, following sub analysis of peak and mean power for participants who correctly guessed which substance was ingested, correctly guessing caffeine had been ingested in the caffeine trials resulted in small (in the region 2.3-4.5%), but non-significant, improvements in peak and mean power in both lower and upper body WANT.

Previous studies examining upper and lower body exercise performance have suggested that caffeine's effects on exercise performance predominantly manifest in the large muscles of the lower body (e.g., knee extensors) but not in smaller muscles of the upper body such as the arm flexors (Warren et al., 2010). However, such claims have been made in relation to measures of upper body muscular strength and endurance using different resistance exercises that may not hold true for the upper body WANT. By virtue of the requirements of the upper body WANT there is a likely greater contribution to the exercise of the abdominals, back, and chest as well as the arms which are not seen in upper body resistance exercise. The greater amount of muscle mass activated during WANT might provide an explanation why caffeine is ergogenic for this type of a test—a finding in contrast to some of the suggested different responses to caffeine between the upper and lower body (Warren et al., 2010). Aside from caffeine, somewhat surprisingly and given the range of ergogenic substances that have been studied in the context of improving human performance, very few studies have compared the effects of ingestion of ergogenic aids on upper vs lower body anaerobic performance. Such information would be useful in demonstrating if such aids elicit region differences in performance of the upper and lower body. Only one other study appears to have examined whether ingestion of an ergogenic aid, in this case, creatine monohydrate, influenced upper vs lower body WANT performance (Green, McLester, Smith, & Mansfield, 2001). In their study Green et al (2001) reported no differences in mean or peak power as a consequence of creatine ingestion on upper or lower body WANT performance.

The present study also suggests that caffeine ingestion dampens RPE compared to placebo. Such a finding is apparent in the literature across aerobic and anaerobically based exercise modalities (Doherty, Smith, Hughes, & Davison 2004; Doherty & Smith, 2005; Duncan, Stanley, Parkhouse, Cook, & Smith, 2013). However, RPE was only dampened for upper body exercise and not lower body exercise. It remains unclear why we observed these differences in responses. Therefore, additional research is needed to explore why caffeine may have a RPE reducing effect during upper, but not lower body WANT.

There are some limitations to the current study. Prior work (e.g., Greer et al., 1998) has employed a protocol involving four repeated WANTs. In the current study, we sought to compare WANT performance with and without caffeine ingestion using upper and lower body "all out" WANT versions, acting on suggestions for future research made in the recent meta-analysis by Grgic (2018). Given the employed WANT version, any generalisation to repeat effort protocols is limited and this area would be beneficial for future research to investigate. We also acknowledge that blood sampling 2 minutes post exercise is more a reflection of post exercise values rather than peak blood lactate. The current study also included young males as participants who were involved in regular exercise but not specifically athletes. Therefore, future work examining if caffeine has the same effect on the upper body and lower body WANT performance in females and athletes competing in anaerobic-based sports would also be useful. Future studies are also needed using different doses of caffeine in order to establish an "optimal" dose of caffeine for acute ergogenic effects.

Conclusion

To conclude, ingestion of 5 mg*kg^{-1} body mass caffeine enhances peak power production during the upper body and lower body WANT in non-specifically trained males when data from upper and lower body trials are combined. Such results have application for sports where there may be anaerobic power demands such as wheelchair sports, boxing, rowing, and other sports that include all-out sprinting activities.

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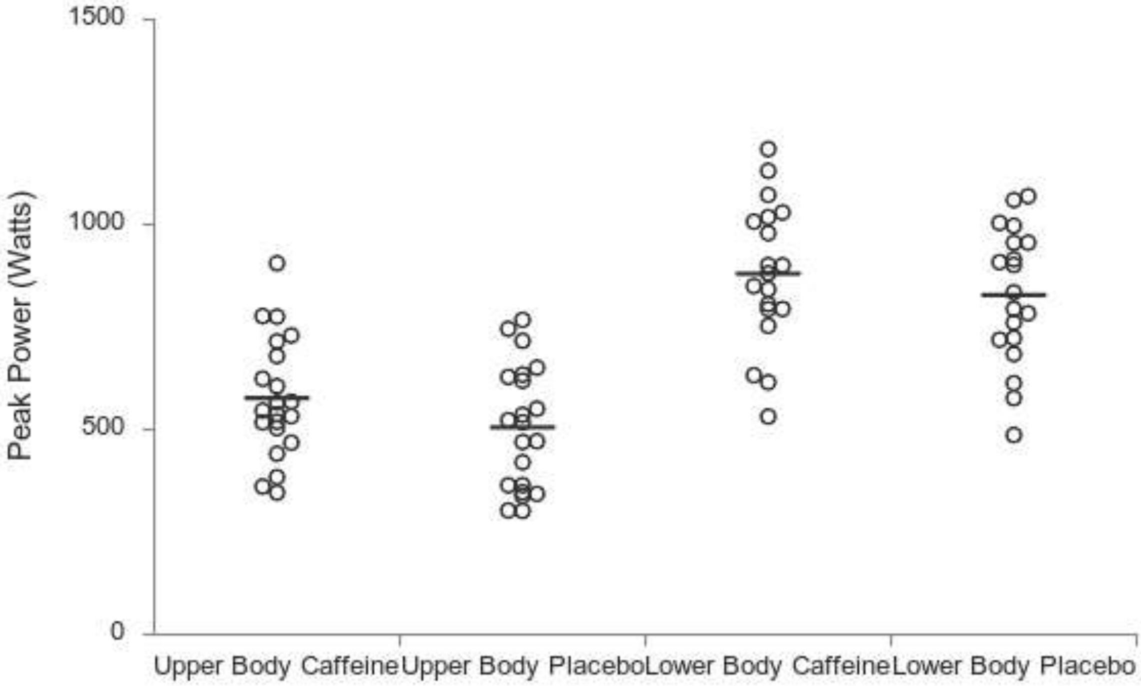

Figure 1. Scatterplot showing the data distribution (circles) and mean (horizontal bar) for peak power (watts) for the Wingate test in caffeine and placebo conditions.

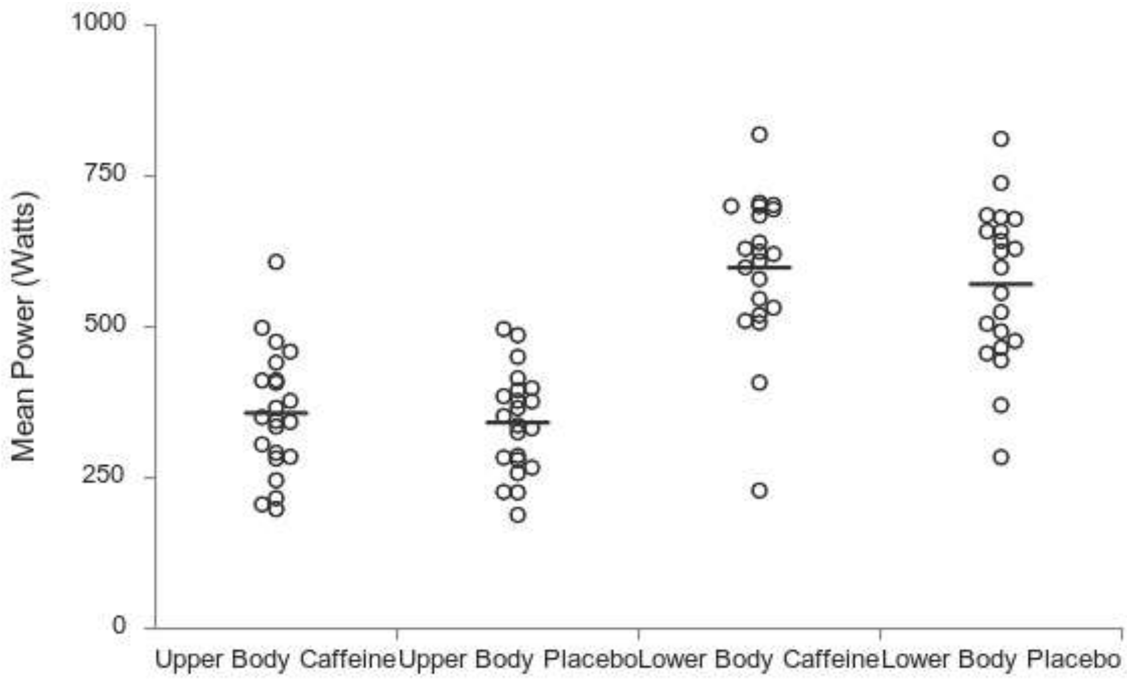

Figure 2. Scatterplot showing the data distribution (circles) and mean (horizontal bar) for mean power (watts) for the Wingate test in caffeine and placebo conditions.

	Caffeine						Placebo					
	Upper Body			Lower Body			Upper Body			Lower Body		
	M	SD	95% CI	M	SD	95% CI	M	SD	95% CI	M	SD	95% CI
Peak Power (Watts)	574	148	500-640	880	192	796-965	498	262	423-573	850	198	761-938
Mean Power (Watts)	357	101	313-408	598	126	541-655	341	84	301-378	570	129	512-629
Fatigue Index (%)	72.8	14.1	57.4-84.5	73.4	12.4	64.4-82.3	70.8	13.7	59.4-86.3	69.8	12.1	61.2-78.4
Peak Heart Rate (bpm)	160	15	152-167	164	13	158-171	152	14	147-160	161	14	154-169
Blood Lactate (mmol/L)	9.9	3.9	8.1-11.8	11.9	2.8	10.5-13.2	11.5	3.2	10.6-13.1	11.4	2.11	10.4-12.4
RPE (6-20)	13.2	1.4	12.4-14.1	14.1	1.3	13.5-14.7	14.0	1.4	13.4-14.5	14.3	1.7	13.5-15.1

M: mean
SD: standard deviation
RPE: rating of perceived exertion
CI: confidence interval