The Effect of Caffeine on Wingate Performance and Blood Lactate Levels for Anaerobic Track and Field Athletes

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ABSTRACT

Caffeine is a common supplement used by athletes to aid and enhance their competition performance in a number of different ways. The purpose of this study was to examine the effect that caffeine has on college-aged anaerobic track and field athletes' performance on a wingate test as well as changes in blood lactate. The participants in the study included 4 males and 3 females. Among these 7 participants, 4 of them did not consume caffeine on a regular basis, and 3 of them considered themselves habitual caffeine users. There were two testing days, and participants were randomly assigned a caffeine supplement or a placebo, dosed 3 mg per 1 kg of body mass. After 30 minutes had passed from the time of ingestion, they completed a wingate test, and multiple lactate values were also recorded. Lactate values were taken using the Lactate Plus blood lactate analyzer prior to the start of the wingate test, 30 seconds post-completion, and then again 3 minutes after. The Velotron Wingate Software Version 1.0 software recorded the wattage output (minimum, maximum, and average), revolutions per minute (minimum, maximum, and average), anaerobic capacity, anaerobic power, and fatigue index. No significant difference was found between wingate results with or without caffeine consumption. However, there were significant differences in fatigue index between conditions across the different event groups ($p = 0.01$). The null hypothesis was accepted. Overall, caffeine supplementation did not result in any significant improvements on wingate performance for anaerobic track athletes.

BACKGROUND

Improved physical performance, perceived exertion, information processing, and increased muscle fiber contractility are just a few of the ways that caffeine can give athletes an edge over their competition. Caffeine has been shown to enhance endurance performance, but has not been reviewed as extensively for its effects on anaerobic activities. Previous studies have seen a relationship between muscle fiber type contribution and caffeine effectiveness, concluding that caffeine is more effective for aerobic activities because of the energy systems used (Herbe et al. 2019). However, research with highly-trained athletes showed a significant increase in power on the wingate test with caffeine compared to the placebo (Ghazaleh et al. 2024). Improved performance on a wingate test with caffeine supplementation suggests that ingesting caffeine before other anaerobic activities could also improve performance in those activities.

Definitions

- **College-age.** 19 to 22-year-old D1 student-athletes in track and field.
- **Division 1 (D1).** Holds the greatest number of students, biggest athletic budgets, and offers the greatest amount of athlete scholarships (NCAA).
- **Wingate test.** An effective tool in measuring both muscular power and anaerobic capacity in a 30-second time period (Zupan et al. 2009). Consists of pedaling with maximal effort for 30 seconds against a constant force.
- **Lactate.** Lactate is a by-product constantly produced in the body during normal metabolism and exercise. Blood lactate levels serve as an indirect marker for biochemical events such as fatigue within exercising muscle.
- **Mechanical ergometer.** An apparatus for measuring the work performed by exercising.
- **Pedal revolutions.** The number of rotations that the pedal makes on the stationary bike.
- **Caffeine.** A crystalline compound that is a stimulant of the central nervous system. It is a popular ergogenic aid that athletes use widely at all levels to improve sports performance (Ghazaleh et al. 2024).
- **Anaerobic.** Relating to or denoting exercise that does not improve the efficiency of the body's cardiovascular system in absorbing and transporting oxygen.

PURPOSE

The purpose of this study was to examine the effect that caffeine has on anaerobic track and field athletes' performance on a wingate test as well as changes in blood lactate. The hypothesis was that caffeine should increase maximal anaerobic power and blood lactate concentration.

METHODS

Setting

- The study took place at Valparaiso University in the campus Fitlab
- March 2024

Participants

- 7 participants, 4 males and 3 females

Procedures

- Eat two hours before the test; no caffeine 12 hours prior.
- Randomly assign a caffeine pill or a placebo to ingest upon arrival.
- 5-10 minute general warm-up, followed by a five-minute bike warm up.
- Wait 30 minutes, then record blood lactate.
- Perform wingate test with the traditional resistance level. The Velotron Wingate Software Version 1.0 collected all wingate data.
- Record blood lactate within 30 seconds of completion of wingate.
- Rest 3 minutes then record blood lactate again. All demographic and lactate data was recorded on the data collection sheet.
- Rate perceived exertion on a scale from 1-10.

Table 1.

Participant Demographics

Participant	Age	HT (in)	WT (lbs.)	HCU	Injury
1	21	80	313	Y	N
2	19	71	173	Y	N
3	19	68	146	Y	N
4	19	65	165	N	N
6	22	71	196	N	N
7	20	71	160	N	N
8	21	73	191	N	N
$\bar{x}$	20.14285714	71.28571429	192		

HT = height; in = inches; WT = weight; lbs. = pounds; HCU = habitual caffeiene user; Y = yes; N = no

RESULTS

Table 2.

Blood Lactate Levels

Participant	C Condition			P Condition		
(mmol/L)	Before	30s after	180s after	Before	30s after	180s after
1	2.4	9.5	10.5	1.2	7	16.7
2	2	4.4	8.5	2.1	4.6	13.4
3	0.8	2.5	9.3	2.4	5	10.2
4	2.1	7.6	12.9	1.8	10.5	12.9
6	1.7	6.8	7.4	1.7	10.3	11.5
7	3	9.4	12.3	2.7	12.4	13.1
8	2.8	9.5	15.6	3.4	12.1	13.4

C Condition = caffeine; P Condition = placebo; mmol/L = millimoles per liter; s = seconds

Table 3.

Wingate Results

Participant	1		2		3		4		6		7		8	
Condition	C	P	C	P	C	P	C	P	C	P	C	P	C	P
Min Watts	583	660	451	453	387	385	509	502	260	260	428	507	442	524
Max Watts	2004	1848	1004	1023	857	683	729	630	885	1045	1076	1094	1422	1275
Avg Watts	942	1080	741	735	584	534	643	579	460	471	776	828	864	906
Min RPM	56	63	78	79	79	79	93	90	40	39	80	94	69	82
Max RPM	192	176	178	178	176	140	132	113	135	158	202	202	223	199
Avg RPM	91	103	129	129	120	110	117	104	71	72	146	154	136	142
An Cap	6.63	7.65	9.45	9.42	8.82	8.06	8.6	7.7	5.2	5.24	10.7	11.3	9.97	10.4
An Pwr	14.1	12.9	12.8	13.1	12.9	10.3	9.7	8.3	10	11.6	14.8	14.9	16.4	14.6
Fatigue Index	48	40.1	18.9	20.2	16.1	10.3	7.5	4.3	21	26.4	23.4	21	33.9	26.9

RESULTS

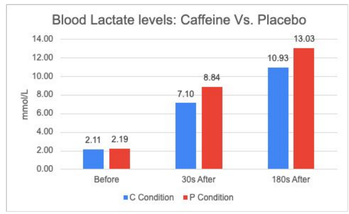

Figure 1. The average lactate levels for each timestamp are compared. Lactate values were always higher in the placebo condition than the caffeine condition.

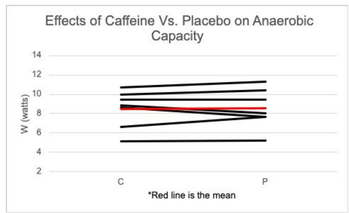

Figure 2. The anaerobic capacity for each participant is compared across conditions. The red line represents the mean across all participants. No significant difference was found between anaerobic capacity with or without caffeine consumption ($p = 0.85$). No significant difference in anaerobic capacity was found when comparing habitual caffeine users to non-habitual users (habitual: $p = 0.90$; non-habitual: $p = 0.92$).

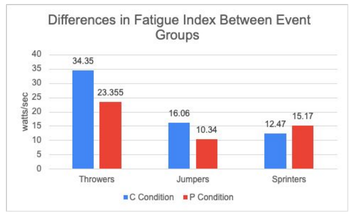

Figure 3. The difference in fatigue index between event groups was significant ($p = 0.01$). Throwers and jumpers had a higher fatigue index with the caffeine condition, whereas the sprinters had a lower fatigue index with the caffeine condition.

DISCUSSION

In conclusion, caffeine supplementation did not result in any significant improvements on wingate performance for anaerobic track athletes. No significant difference was found between wingate results with or without caffeine consumption. No significant difference was found when comparing habitual caffeine users to non-habitual users. In regards to blood lactate levels, caffeine did not increase blood lactate as hypothesized. However, there were significant differences in fatigue index between the different event groups ($p = 0.01$). In this case, the caffeine condition helped the sprinters achieve a lower fatigue index, whereas the throwers and jumpers recorded a higher fatigue index in the caffeine condition. This may be due to the throwers and jumpers' ability to achieve a higher wattage output than the sprinters, making the difference between the maximum and minimum output greater (fatigue index). Additionally, sprinters have the capacity to sustain their anaerobic energy for longer periods of time than throwers and jumpers can. This is because the time it takes to complete the throw or jump is 10 seconds or less, whereas the short sprinting events can last anywhere from 12 seconds to one minute. This study was limited by the participant's physical abilities, hydration, energy levels, and effort given. Additional limitations include the sample size, the reliability of equipment used, and the ability of researcher to correctly interpret data. Future research should be conducted with a larger sample size and multiple trials in each condition.

References

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