# INFLUENCE OF CUPPING TREATMENT ON HIGH-INTENSITY ANAEROBIC PERFORMANCE

**Ramzi A. Al-Horani[1], Khaled M. Alsays[1], and Mohammed Ihsan[2]**

*[1]Department of Exercise Science, Yarmouk University, Irbid, Jordan*
*[2]Human Potential Translational Research Program, Yong Loo Lin School of Medicine, National University of Singapore, Republic of Singapore*

Original scientific paper
DOI 10.26582/k.54.2.6

## Abstract:

The use of cupping therapy prior to sports events has increased in popularity, with limited evidence to support its efficacy. The purpose of this study was to evaluate the efficacy of dry and wet cupping therapy on subsequent Wingate anaerobic test (WAnT) performance. Twelve trained men participated in this repeated-measures randomized crossover study (age 24.9 ± 4.8 years; body mass index 27.6 ± 14.3 kg.m$^{-2}$). Participants were familiarized with the ergometer and the Wingate anaerobic test on three separate occasions. They then randomly performed three experimental Wingate tests separated by 48-72 h after either dry cupping (DRY), wet cupping (WET), or no treatment (CON). Repeated measures ANOVA and Pearson's correlation coefficient were used to analyze data and determine the relationships between WAnT and peak lactate and heart rate (HR). Peak power (PP), mean power (MP), and fatigue index (FI) were similar in all treatments (p=.47-.72). Heart rate (HR) and lactate increased similarly at all time points in all treatments (p<.001 for all comparisons). Post-WAnT peak HR was moderately negatively correlated with PP in all treatments and MP in CON only (p<.05 for all correlations). No other significant correlations were detected. The present findings demonstrate no beneficial effects of wet and dry cupping therapy, and hence do not support its use prior to high-intensity anaerobic sports events.

***Key words:*** *Wingate test, anaerobic power, fatigue, sprint cycling, all-out exercise performance, bloodletting cupping*

## Introduction

Cupping is a complementary and alternative therapy used worldwide in various clinical conditions for the management of pain and wellbeing (Al Bedah, et al., 2016). The main forms of this therapy include dry and wet cupping, and both involve negative pressure applied through a vacuum mechanism at selected skin sites. The negative pressure causes upward distraction of the skin and the underlying tissues. Additionally, wet cupping involves prior incisions to the superficial skin, which will be followed by cups suction for bloodletting (Al Bedah, et al., 2016; Stephens, Selkow, & Hoffman, 2020; Wang, et al., 2020). Recently, cupping treatment has become more popular in athletic populations as a sports medicine treatment for musculoskeletal disorders, and purportedly for enhancing recovery and maximal effort performance (Bridgett, Klose, Duffield, Mydock, & Lauche, 2018; Cao, Li, & Liu, 2012; Chiu, Manousakas, Kuo, Shiao, & Chen, 2020; Ekrami, Ahmadian, Nourshahi, & Shakouri, 2021). Despite the use of cupping by some athletes in the 2016 Rio Olympics and other sports events, there has been limited evidence to support its efficacy in improving the high intensity exercise performance (Bridgett, et al., 2018).

Cupping is traditionally considered a recovery modality, given that it has been shown to reduce post-exercise inflammatory response and systemic oxidative stress (Ekrami, et al., 2021; Tagil, et al., 2014). The use of cupping is growing as a pre-event strategy, where studies have examined the effects2153 of dry cupping on indices of aerobic fitness, isokinetic strength, balance, and flexibility parameters (Antush, Brilla, Suprak, Watson, & Olinger, 2020; Becerra, Wang, VanNess, & Jensen, 2021; Stoner, Petrizzo, Wygand, & Otto, 2017). Although providing limited benefits on the above performance parameters, cupping has been suggested to improve movement biomechanics through manipulating the fibrous adhesiveness of fascia layers, widely known as myofascial decompression (Okamoto, Masuhara, & Ikuta, 2014; Warren, LaCross, Volberding, & O'Brien, 2020).

Moreover, cupping has been shown to modulate metabolic acidosis, improve muscle oxygenation, blood flow and indices of vascular function (Arce-Esquivel, Cage, Tulloch, & Ballard, 2020; Stephens, et al., 2020; Wang, et al., 2020), and hence demonstrates potential to improve anaerobic exercise performance where metabolic acidosis and inadequate oxygen supply may be limiting factors. Anaerobic capacity is critical for athletic performance in power and team sports including soccer, football, sprinting, speed skating, basketball, lacrosse – and for endurance events particularly at the start- and end-spurts (Noordhof, Skiba, & De Koning, 2013; Scott, Roby, Lohman, & Bunt, 1991). Yet, the authors are unaware of research examining the influence of cupping treatment on anaerobic capacity. Given the emerging use and potential to benefit, it is important to assess the impact of cupping on this type of physical performance.

The aim of this study is to evaluate the effect of wet and dry cupping treatment on the anaerobic function of physically active participants using the Wingate anaerobic test (WAnT). According to the potential positive effects of cupping, we hypothesized that prior cupping treatment would improve subsequent performance and the associated physiological responses during the WAnT.

## Methods

### Participants

Twelve healthy participants completed all procedures of the study (age 24.9 ± 4.8 years; body height 174.8 ± 5.8 cm; body mass 72.9 ± 7.7 kg; body mass index 27.6 ± 14.3 kg.m$^{-2}$; % body fat estimated from seven skinfold sites 9.2 ± 2.6%; waist-to-hip ratio 0.8 ± 0.02). Due to the global lockdowns, this was the maximum sample size that could be recruited under the severe pandemic restrictions. A *post-hoc* power analysis for within-factor repeated measures ANOVA revealed a power of 0.83 for the current sample size with a calculated effect size f(V) 1, $\alpha = 0.05$, and nonsphericity correction 1 using G*Power (version 3.1 Kiel, Germany). Participants were involved in high-intensity (3 – 4 days per week, 75 ± 27.9 min per day) and moderate-intensity physical activities (3 – 5 days per week, 63.4 ± 31.1 min per day). Participants were competitive (n = 3) and recreational (n = 7) soccer players, a competitive distance runner (n = 1), and a concurrent training recreational athlete (n = 1). Participants were first screened for cardiovascular, metabolic, and respiratory diseases and/or the associated symptoms and were informed of the benefits and risks of the study before providing a written informed consent. The institutional review board of King Abdullah University Hospital approved the study procedures (GM7601).

### Experimental design

The present study utilized a randomized cross-over design to investigate the effect of dry and wet cupping on anaerobic exercise performance test. Participants visited the laboratory on seven separate occasions at the same time of the day; three familiarization sessions, three experimental trials, and a session for wet cupping procedure which was performed 24 h prior to its respective experimental trial (Fig. 1). All participants were familiarized with the cycle ergometer, laboratory setting, and the WAnT during three separate familiarization trials. The 1$^{st}$ familiarization trial included pre-participation health and physical activity screening, as well as body composition examination. This was followed by a 30-min cycling at 70 – 75% HRmax and WAnT. The 2$^{nd}$ familiarization trial included a 30-min cycling at 70 – 75% HRmax followed by the WAnT. The purpose of the 30-min cycling sessions were to extensively familiarize the participants to cycling, due to their limited experience with this exercise modality. The third trial consisted of a single WAnT effort performed with full experimental procedures and measurements. In total, participants performed two 30-min cycling sessions at 70 – 75% HRmax on the 1$^{st}$ and 2$^{nd}$ familiarization trials, and three WAnTs on the 1$^{st}$, 2$^{nd}$, and 3$^{rd}$ familiarization trials. Following 72 h from the last familiarization trial, participants were randomly assigned to perform three experimental WAnT trials preceded either by: 1) no treatment, which served as the control trial (CON); 2) dry cupping (DRY); or 3) wet cupping (WET) (Fig. 1). All familiarization and experimental trials were carried out at 22 – 23 ºC between 10:00 and 13:00 a.m., with 48 – 72 h separating each trial. Participants were required to refrain from caffeine, alcohol, and supplements consumption, as well as strenuous exercise 24 h before the day of testing. Further, they were instructed to maintain same sleeping hours, and to replicate food and liquid intake the night before each day of testing. Participants were asked to consume 500 ml of water about 30 min and same type and quantity of fruits at least 2 h prior to reporting to the laboratory.

### Wingate test

The WAnT is a reliable 30-second all-out test widely used to assess anaerobic power of athletes in a variety of sports (Ramírez-Vélez, et al., 2016; Zupan, et al., 2009). The WAnT was performed on a mechanically braked cycle ergometer (894 E, Monark, Sweden), with seat and handlebar heights recorded at the most comfortable position and replicated throughout the experimental trials for each participant. The test was preceded by a standard

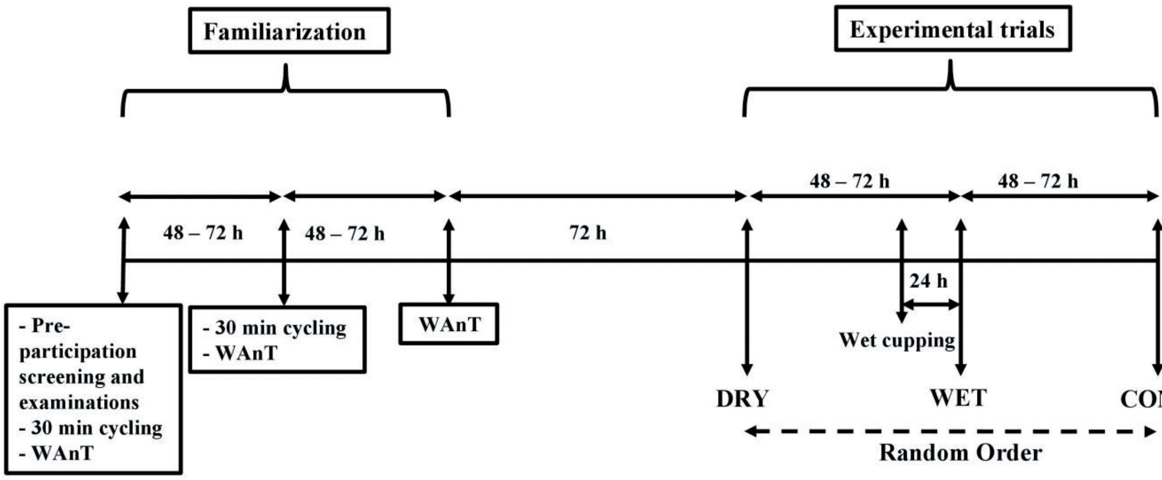


*Fig. 1. A summary of the study design.*

warm-up protocol of 8-min at 70 – 75% HRmax interspersed by three 5-second sprints at the 3rd, 5th, and 7th minute. Participants rested for 3-min after the warm-up, during which they were free to walk within the laboratory. The WAnT commenced with flying starts, while the participant accelerating for approximately five seconds (unloaded) to achieve maximum cadence before performing an all-out 30-second effort against a braking load corresponding to 7.5% of individual body mass. Strong verbal encouragement was given throughout the test. The resistance was immediately lifted following the 30-second effort, and participants continued pedaling for 1 – 2 min at low intensity. The test was video recorded and analyzed using Kinovea 0.8.15 (Kinovea.org, France) for pedal revolutions. Peak power output (PP), mean power output (MP), and fatigue index (FI) were calculated. PP was identified from the highest mechanical power produced during five consecutive seconds, which was attained during the first five seconds for all the participants. MP was identified as the average power produced during the entire 30-second performance. FI was identified as the percentage drop-off from the PP to the lowest power produced in the last five seconds.

## HR and lactate measurements

HR measurement was obtained using a chest belt placed at the xiphoid process level linked to a GPS watch (Polar V800, Polar Electro Oy, Finland). HR was monitored throughout the familiarization trials and warm-up, and recorded at pre-, immediately post-, and 3-min-post WAnT. Capillary blood was collected through a finger prick and analyzed for lactate determination using a hand-held system (Lactate Scout+, SensLab GmbH, Germany) at pre-warm-up, pre-WAnT and at 3-min post-WAnT. All HR and blood lactate measurements were taken with participants seated on the cycle ergometer.

## Cupping

Wet cupping (i.e., WET trial) was performed 24 h prior to the WAnT (Fig. 1). Wet cupping procedure followed the three-steps method: cupping, puncturing and cupping (CPC) as previously described in detail (El Sayed, Mahmoud, & Nabo, 2013). Participants first cycled for 10 min at low-moderate intensity before starting the cupping procedure. This short exercise was aimed at increasing blood flow and providing a gradient for the infiltration from blood capillaries at the sites of cupping (Goto, et al., 2007; Pober & Sessa, 2014). The cupping sites were thoroughly disinfected by 70% ethanol. During step 1 of the CPC, five disposable plastic cups were placed on the back of the participant: one cup below the C7 at between the two middle trapezius muscles (Cu1), two cups below the T12 each at the middle part of the latissimus dorsi muscle (Cu2 and Cu3), and two cups at the lower back each above the iliac crest at between the lower part of the latissimus dorsi and the thoracolumbar fascia (Cu4 and Cu5). Suction pressure was first applied at each site using a handpump gun for 5-min. The negative pressure was able to raise the skin surface 2 – 2.5 cm within each cup. During step 2 of the CPC, negative pressure was released and multiple superficial skin incisions, each 6 – 8 mm in length were applied within the diameter of each cup using a stainless steel sterile surgical blade (No. 15). Step 3 of the CPC included the application of suction pressure again as previously described in step 1 for another 10 min for bloodletting. The cupping sites were then cleaned and disinfected with 10% povidone-iodine and left to air dry. A total of 109.2 ± 37 ml of blood was collected during wet cupping and was distributed as follows: Cu1 32.6 ± 13.5; Cu2 32.6 ± 13.5; Cu3 19.6 ± 6.6; Cu4 20.1 ± 11.2; and Cu5 16.6 ± 8.8 ml. The collected blood was discarded once volume was determined.

The dry cupping procedure was similar to the wet cupping procedure, except that the dry cupping did not include skin incisions and bloodletting, i.e., it included only step 1 of the CPC. The suction pressure was applied for 15 min to parallel the total suction duration performed during the wet cupping. Cupping sites were cleaned, and participants immediately started the pre-WAnT warm-up. The participants were seated during both the wet and dry cupping on bar chair without back support. Participants received neutral recommendation towards both cupping procedures, i.e., might positively or negatively impact performance, to avoid any psychological effect of either procedure.

## Statistical analysis

Data are presented as mean ± SD. Shapiro-Wilk test was performed to determine normality, to which all variables conformed to normal distributions. One-way repeated measures ANOVA followed by the Tukey's *post-hoc* test was used to detect differences in WAnT performance outcomes between the three trials (CON, DRY, and WET). A two-way (trial and time) repeated measures ANOVA was used for analyzing the HR and lactate results at the allotted measurement time points. When time × trial interaction and omnibus main effects were detected, Student paired *t*-tests were utilized to find the differences at the individual time points. Sphericity assumption was evaluated using Mauchly's *W*. Pearson's correlation coefficient was used to determine the relationship between WAnT performance (PP and MP) and peak lactate at 3-min post-WAnT and maximum HR immediately post-WAnT. The strength of the relationships were classified according to the Pearson's coefficient (r) value as very strong (r ≥ 0.8), moderately strong (r = 0.6 – 0.8), fair (r = 0.3 – 0.5), and poor (r < 0.3) (Chan, 2003). The Statistical Package for Social Sciences (SPSS, Inc., Chicago, IL, USA) was used for all analysis. Significance was set at p<.05. In addition, effect sizes (Cohen's d) were calculated where appropriate to indicate trivial, small, moderate, large, and very large effect when the obtained d was < 0.2, 0.2 – 0.6, 0.6 – 1.2, 1.2 – 2.0, and >2.0, respectively (Al-Horani, Wingo, Ng, Bishop, & Richardson, 2018; Cohen, 1992).

## Results

The WAnT performance outcomes for the three conditions are presented in Table 1. There were no significant differences between the conditions for PP (p=.47), MP (p=.72), and FI (p=.53). The effect sizes of treatments were trivial for PP (Cohen's d = 0.05 – 0.13), and MP (Cohen's d = 0.006 – 0.08), and trivial to small for FI (0.06 – 0.2) between any two trials.

*Table 1. WAnT performance outcomes (mean ± SD), peak power (PP), mean power (MP), and fatigue index (FI), following control (CON), dry cupping (DRY), and wet cupping (WET)*

| | CON | DRY | WET |
|---|---|---|---|
| PP (W) | 772 ± 86 | 767 ± 91 | 778 ± 76 |
| MP (W) | 565 ± 56 | 565 ± 65 | 570± 63 |
| FI (%) | 48 ± 5 | 45 ± 11 | 47 ± 7 |

The HR responses at the pre-warm-up, pre-WAnT test, immediately post-WAnT, and 3-min post-WAnT were similar for all the trials (Fig. 2). There was no significant effect of treatment (p=.06) and treatment x time interaction (p=.3) on HR responses. Not surprisingly, there was a significant increase in HR across time in all the trials (p<.001) where HR was similar at the pre-warm-up for all the trials (p=.2) and increased similarly at all the time points during and following WAnT (p<.001 for all comparisons). The effect size of treatments was trivial to small at the pre-warm-up (d = 0.05 – 0.6), and small at the pre-WAnT (d = 0.3 – 0.6), post-WAnT (d = 0.2 – 0.6), and 3-min post-WAnT (d = 0.2 – 0.5) for all the between treatments comparisons.

Figure 3 shows the lactate responses to the three trials. There was no significant treatment (p=.46) or treatment x time interaction (p=.99) effect on lactate responses; however, there was a significant time effect (p<.001). Blood lactate was significantly elevated after the warm-up and peaked at the 3-min post-WAnT compared to baseline (p<.001 for all the trials at pre-WAnT and 3-min post-WAnT). The effect size of treatment was trivial to small at the pre-warm-up (d = 0 – 0.5), and trivial at the pre-WAnT and 3-min post-WAnT (d = 0.05 – 0.1) for all the comparisons.

A moderate negative correlation was detected between PP and post-WAnT HR during all the trials (Table 2). However, only CON demonstrated

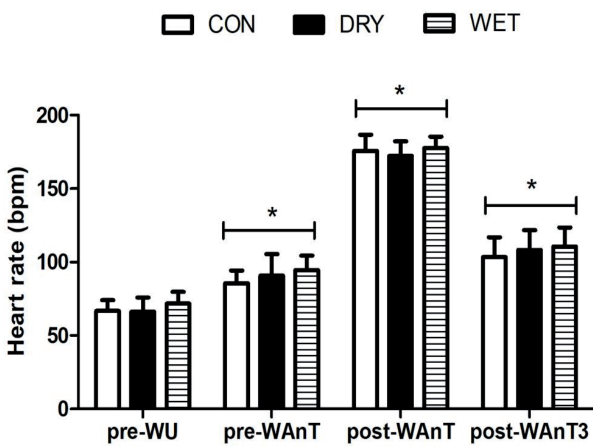


*Fig. 2. Heart rate changes from prior to warm-up (pre-WU) to immediately before commencing the WANT (pre-WAnT), immediately after the WAnT (post-WAnT), and to 3-min after finishing the WAnT (post-WAnT3) during control (CON), dry cupping (DRY), and wet cupping (WET) trials. * Significant difference from pre-WU in all conditions at p<.05.*

*Table 2. The Pearson's correlation coefficients (r) for WAnT outcomes, peak power (PP) and mean power (MP), and the HR immediately post- and lactate 3-min post-WAnT for control (CON), dry cupping (DRY), and wet cupping (WET)*

| | CON | | DRY | | WET | |
|---|---|---|---|---|---|---|
| | PP (W) | MP (W) | PP (W) | MP (W) | PP (W) | MP (W) |
| Heart rate (bpm) | -0.77* | -0.66* | -0.62* | -0.21 | -0.65* | -0.51 |
| Lactate (mmol/L) | -0.15 | -0.18 | 0.30 | -0.51 | 0.40 | 0.43 |

* Significant correlation at p<.05

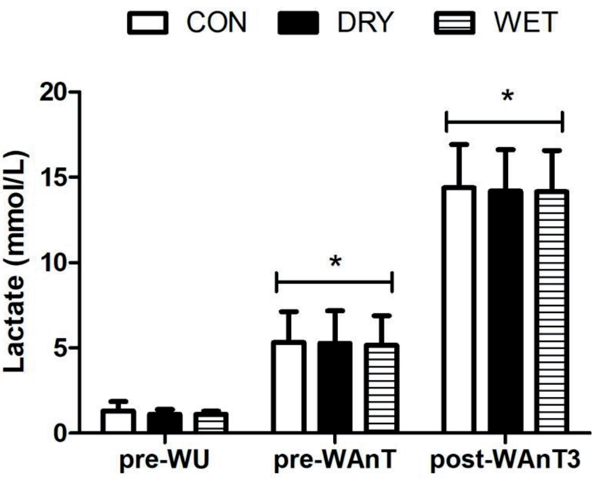


*Fig. 3. Blood lactate changes prior to warm-up (pre-WU) to immediately before commencing the WAnT (pre-WAnT), and to 3-min after finishing the WAnT (post-WAnT3) during control (CON), dry cupping (DRY), and wet cupping (WET) trials. * Significant difference from pre-WU in all conditions at p<.05.*

a significant moderate negative correlation between MP and post-WAnT HR. No significant correlations were observed for lactate with PP and MP.

## Discussion and conclusions

The present study investigated the effect of pre-exercise dry and wet cupping on the anaerobic performance during a 30-second all-out Wingate anaerobic test. There was no influence of dry or wet cupping on PP, MP, FI, or lactate and HR responses during WAnT performance. We hence conclude that cupping therapy prior to short-term all-out high-intensity exercise confers no ergogenic effects.

Cupping has been purported to enhance exercise performance through facilitating myofascial decompression, increased vascular function and tissue oxygenation, and reduced inflammatory response and oxidative stress (Antush, et al., 2020; Becerra, et al., 2021; Ekrami, et al., 2021; Stephens, et al., 2020; Stoner, et al., 2017; Tagil, et al., 2014). Accordingly, despite the increasing use of cupping therapy prior to sports events (Bridgett, et al., 2018; Musumeci, 2016), there is limited research examining of the efficacy of this modality on anaerobic exercise performance. The present study demonstrates no performance or physiological benefit when dry or wet cupping therapy is performed prior to a WAnT effort. Our findings contribute to the literature demonstrating minimal beneficial effects of dry cupping on various physical performance indices such as muscle strength and power, running economy, maximal oxygen uptake and range of motion (Antush, et al., 2020; Becerra, et al., 2021; Stoner, et al., 2017; Wygand, Stoner, Petrizzo, & Otto, 2017). In addition, the effect of wet cupping on subsequent anaerobic performance was lacking within the literature, to which we have provided preliminary evidence.

Blood lactate and HR responses to WAnT were not altered following cupping treatment compared to the control. Our findings somewhat contrast the purported physiological mechanisms surrounding cupping therapy, including modulating metabolic acidosis, decreased oxidative stress, enhanced mitochondrial function, and increased oxygen availability and utilization (Arce-Esquivel, et al., 2020; Dun, et al., 2015; Ekrami, et al., 2021; Hofmann, et al., 2007; Powers & Jackson, 2008; Tagil, et al., 2014). Consequently, these were plausible mechanisms that could modify the physiological responses to the anaerobic exercise, to which the present study reports no beneficial effects based on HR and lactate responses. Possibly, these suggested mechanisms underpinning cupping therapy are either rapidly transient or site specific. More investigations are highly warranted to further explore the physiological impacts of cupping therapy.

The correlation coefficients analysis revealed an inverse relationship between MP and peak HR only within CON during WAnT. It is unclear yet why the peak HR – MP relationship remained significantly negative without treatment compared to the cupping therapy. It is likely that cupping might have contributed to changing this relationship through differentially redistributing blood flow during exercise compared with no treatment, since cupping has been shown to induce reactive hyperemia and increase skin blood flow by more than 16 folds (Wang, et al., 2020). Peak blood lactate and WAnT performance outcomes were not related in all the trials. Moreover, negative associations between PP and peak HR were observed for all the trials. In contrast to our findings, lactate and HR were previously found to positively relate to power output during a repeated force-velocity exercise (Temfemo, Carling, & Ahmaidi, 2011). However, the repeated force-velocity exercise involved repeated 6-second sprints with increasing load every repetition, and every two repetitions were interspersed with a long recovery period (5 min). Thus, comparison between these responses with the responses during a single 30-second all-out sprint performed under constant load during the WAnT is not appropriate. Therefore, establishing relationship patterns between the physiological responses and performance outcomes in a single all-out anaerobic sprint are warranted in different athletic populations.

The authors are highly confident of the reliability and validity of the current findings, given that WAnT has been shown to retain a very high test-retest reliability (intraclass correlation coefficient > 0.98, > 0.97, > 0.95, 0.93, and 0.94% for PP, MP, FI, peak heart rate, and lactate responses, respectively) using a range of braking forces (7.5 – 11% of body mass) on mechanically- or electromagnetically-braked cycle ergometers (Bringhurst, Wagner, & Schwartz, 2020; Jaafar, et al., 2014; Watt, Hopkins, & Snow, 2002; Weinstein, Bediz, Dotan, & Falk, 1998). Reliability has been shown to improve further when adding a practice session prior to baseline measurement, suggesting that a minimum of one full familiarization trial is required to increase the reliability of power output (Barfield, Sells, Rowe, & Hannigan-Downs, 2002; Bringhurst, et al., 2020). In our study, there were three 30-second all-out cycling practice sessions, during which full experimental procedures were undertaken with one of them. Additionally, stringent measures were adhered to prior to all the experimental trials to determine and isolate whether cupping therapy will be an effective strategy to enhance anaerobic performance. These included replicating sleeping hours, food and liquid intake, the time-of-day of testing, abstinence from potential ergogenics, alcohol and intensive exercise, many of which have been shown to influence WAnT performance (Grgic & Mikulic, 2021; Souissi, Sesboüé, Gauthier, Larue, & Davenne, 2003). In addition, to eliminate the psychological effect of the cupping therapy, neutral feedback was given to the participants regarding the treatments' efficacy. Therefore, we are confident that dry and wet cupping treatment provided no beneficial performance effect on the Wingate anaerobic performance and associated physiological responses when administered within 24 h or less.

## Limitations

It might be argued that the cupping sites were not at the major muscle groups involved in cycling. While previous work have reported localized effects such as increased tissue oxygenation, hyperemia and myofascial decompression (Arce-Esquivel, et al., 2020; Stephens, et al., 2020; Warren, et al., 2020), it is not certain whether systemic effects are evident with cupping therapy. Nevertheless. previous reports have shown no additional effects of cupping therapy on a subsequent exercise performance compared to no treatment when cupping was applied at the major body sites involved during the exercise (Antush, et al., 2020; Becerra, et al., 2021; Stoner, et al., 2017). Further, this study did not measure the physiological biomarkers related to the potential mechanisms of cupping therapy, such as inflammatory cytokines, oxidative stress, and tissue oxygenation, which may assist in identifying future directions in cupping and exercise research. The current procedure, therefore, could not identify how long the effects of cupping lasted after the treatment on these biomarkers, if there were any. It might be speculated that the effects of cupping remained until the following trials, and the results could be confounding. The authors, however, are unaware of any study that determines the long-lasting effects of cupping on performance-related factors in healthy subjects. Nonetheless, the randomization of trials may have helped in ameliorating this suspicion and eliminating the bias that may result from treatments order. One more limitation that might be argued about was different time gaps between the cupping treatment and exercise testing in WET and DRY. Dry cupping has been shown to induce immediate effects on factors that might be related to performance such as increased blood flow and reduced muscle stiffness (Jan, et al., 2021; Wang, et al., 2020). It seemed appropriate that the performance task was undertaken soon after the cupping procedure. On the other hand, wet cupping has been reported to confer delayed effects that may last >12 hours post-treatment, such as increased arterial $O_2$ saturation (Hekmatpou, Moeini, & Haji-Nadali, 2013). Importantly, exercise immediately following the wet cupping was reportedly unwanted amongst our athletes during piloting due to the unpleasant marks, skin incisions and blood loss. Nevertheless, investigating the time gap effect between cupping treatment and exercise testing is warranted in future studies.

The present findings demonstrate no beneficial effect of pre-exercise dry and wet cupping therapies on anaerobic performance outcomes and the associated physiological responses. Anaerobic performance is critical for power and team sports including – soccer, football, sprinting, speed skating, basketball, lacrosse. Therefore, coaches and practitioners working with team or power athletes are not encouraged to use cupping therapy prior to sports events. However, athletes may still wish to use cupping treatment for recreational or therapeutic purposes before such events. Our findings demonstrated no detrimental effect resulting from cupping therapy, and hence athletes may opt to continue with this therapy if it is part of their standard routine procedure or if they perceive an ergogenic benefit.

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Submitted: February 4, 2022
Accepted: June 21, 2022
Published Online First: September 2, 2022

Correspondence to:
Ramzi A. Al-Horani
Department of Exercise Science, Yarmouk University, Irbid, Jordan
Postal code: 21163
Phone number: +962790201423
Email: raalhorani@yu.edu.jo

**Acknowledgments**

The authors are grateful to the participants who completely volunteered to be part of this study. We are also thankful for the master students who helped in the data collection and participants recruitment.