Rev Bras Cineantropom Desempenho Hum

original article

https://doi.org/10.1590/1980-0037.2026v28e108674

Efeito do consumo agudo da erva-mate (Ilex paraguariensis) no desempenho anaeróbio de atletas com deficiência física: um ensaio clínico randomizado

Adriano Cañete Avalos[1]
https ://orcid.org/0009-0003-6782-0978
Guilherme de Lucas Barbosa[1]
https ://orcid.org/0009-0006-0710-3055
Raquel Medeiros Kaizer Rossignoli Barizon[1]
https ://orcid.org/0000-0003-2964-657X
Cassio Pinho dos Reis[1]
https ://orcid.org/0000-0002-2211-2295
Christianne de Faria Coelho-Ravagnani[1]
https ://orcid.org/0000-0002-9082-6521

1. Federal University of Mato Grosso do Sul. Integrated Health Institute. Campo Grande, MS. Brazil.

Received: September 21, 2025
Accepted: March 04, 2026

How to cite this article
Avalos AC, Barbosa GL, Barizon RMKR, Reis CP, Coelho-Ravagnani CF. Effect of acute consumption of yerba-mate (Ilex paraguariensis) on the anaerobic performance of athletes with physical disabilities: a randomized clinical trial. Rev Bras Cineantropom Desempenho Hum 2026, 28:e108674. DOI: https://doi.org/10.1590/1980-0037.2026v28e108674

Corresponding author
Adriano Cañete Avalos.
Federal University of Mato Grosso do Sul
Av. Costa e Silva, 79070-900, Campo Grande (MS), Brazil.
E-mail: professoradrianoavalos@gmail.com

Scientific Editor:
Diego Augusto Santos Silva

Abstract – The rise in competitive levels in Paralympic sports, has led to an increase in the consumption of supplements among athletes with disabilities, aiming for a competitive edge. Due to its caffeine content, Yerba-mate, the main ingredient of Tereré, presents ergogenic potential. However, to date, its effects have not been tested in athletes with physical disabilities. Therefore, this study aimed to investigate the acute effects of Tereré (yerba-mate infused in cold water) ingestion on the anaerobic performance of athletes with physical disabilities. Five male athletes (31.3±13.7 years) with varying physical disabilities, from different sport modalities, who actively participated in competitions (≥1 year), were selected. The protocol included three visits to the gym-school. In the first visit, a health history questionnaire was applied and participants received general instructions. In the final two visits, athletes were randomly allocated to either the TrrEX (traditional yerba mate) or TrrPL (decaffeinated yerba mate) condition and ingested the respective drinks 60 minutes before testing. Dietary and caffeine intake were assessed using specific questionnaires. Sixty minutes after supplementation, a three-attempt medicine ball throw test was performed, followed by an adapted 30-second Wingate test on an arm crank ergometer. The ingestion of TrrEX did not lead to a statistically significant change in peak power (p=0.96), mean power (p=0.97), minimum power (p=0.78), fatigue index (p=0.27), or the distance thrown by the upper limbs in the medicine ball test (p=0.98) compared to TrrPL. In conclusion, acute ingestion of Tereré did not demonstrate ergogenic effects on the anaerobic performance of athletes with physical disabilities.

Key words: Arm Ergometry Test; Jump test; Caffeine; Ilex paraguariensis; Para-Athletes.

Resumo - *O aumento do nível competitivo em esportes paralímpicos tem aumentado o consumo de suplementos entre atletas com deficiência, visando vantagem competitiva. A erva-mate, principal ingrediente do tereré, apresenta potencial ergogênico, devido à cafeína em sua composição. Contudo, até o momento, seus efeitos não foram testados em atletas com deficiência física. Portanto, este estudo teve como objetivo investigar os efeitos agudos da ingestão do tereré (erva-mate infusionada em água gelada) no desempenho anaeróbio de atletas com deficiência física. Foram selecionados cinco atletas do sexo masculino (31,3 ±13,7 anos), com variadas deficiências físicas, de diferentes modalidades esportivas, que participavam ativamente de competições (≥1 ano). O protocolo incluiu três visitas à academia. Na primeira visita, foram aplicadas anamnese e orientações gerais. Nas duas últimas visitas, os atletas foram randomicamente alocados para a condição TrrEX (erva-mate tradicional) ou TrrPL (erva-mate descafeinada), e ingeriram as respectivas bebidas 60 minutos antes do teste. A ingestão dietética e de cafeína foi avaliada por meio de questionários específicos. Após 60 minutos,*

Copyright: This is an Open Access article distributed under the terms of the Creative Commons Attribution license (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.Effect of acute consumption of yerba-mate (Ilex paraguariensis) on the anaerobic perfo

foi realizado o teste de medicine ball em três tentativas, seguido do teste de Wingate adaptado de 30 segundos em um cicloergômetro de braço. A ingestão do TrrEX não promoveu alteração estatisticamente significante nas variáveis potência máxima (p= 0,96), potência média (p= 0,97), potência mínima (p= 0,78), índice de fadiga (p= 0,27) e na distância arremessada pelos membros superiores no teste de medicine ball (p= 0,98) em comparação com o TrrPL. Conclui-se que a ingestão aguda de tereré não apresentou efeitos ergogênicos sobre o desempenho anaeróbio de atletas com deficiência física.

Palavras-chave: *Teste de Ergometria de Braço; Teste de salto; Cafeína; Ilex Paraguariensis; Paratletas.*

INTRODUCTION

The pursuit of competitive advantage through ergogenic aids, including nutritional supplements, is quite common among athletes with disabilities. In a study conducted by Graham-Paulson et al.[1], the authors observed that 58% of athletes used dietary supplements, with caffeine (5%) standing out in 9th place. Recovery, energy supply, and increased strength/power were among the reasons athletes reported for using these products[1].

According to Guest et al.[2], in recent decades, caffeine has dominated scientific research on ergogenic aids and sports supplements. Caffeine exerts its effects on the central nervous system (CNS) through antagonism of adenosine receptors, reducing fatigue and increasing the excitability of motor neurons, leading to faster muscle contraction. Furthermore, peripheral mechanisms have also been proposed as a possible explanation for the ergogenic effects of caffeine, including increased myofibrillar calcium release and availability[2].

These metabolic effects could help athletes with physical disabilities to perform physical efforts with more strength and speed, and consequently more anaerobic power. The lower number of muscles recruited for locomotion also implies a lower need for energy intake, which can lead to protein deficiencies and a reduction in the capacity for muscle repair and synthesis, affecting gains in strength and anaerobic performance[1]. Thus, the use of ergogenic foods or supplements containing caffeine could be useful for athletes with physical disabilities, particularly in sports that require high-intensity, short-duration efforts[3].

Another common challenge to the physical performance of athletes with disabilities, especially spinal cord injuries, concerns hydration, due to its negative effects on thermoregulatory function[4]. In individuals with spinal cord injury (SCI), disruption of communication between the periphery and the hypothalamic thermoregulatory center results in deficits in efferent output. This dysfunction manifests as reduced cutaneous vasodilation, impaired sweat gland activation, and decreased thirst perception. Therefore, adequate hydration and thermal management strategies are essential for the performance and safety of these athletes.

Tereré is a typical drink from Paraguay and the Central-West region of Brazil, whose main ingredient is yerba mate. The drink is consumed with cold water by sucking it through a silver pipe called a "bombilla", which has a flat disc with holes at its end that is immersed in the infusion, acting as a filter[5]. The drink is popular among consumers as a form of hydration, with a consumption rate of over 1 liter/day by thousands of people[6] in addition to providing caffeine naturally, making it a potentially ergogenic food.

Despite its ergogenic claims, no studies have tested the effects of yerba mate, in the form of Tereré, on the physical performance of athletes with disabilities.

Therefore, the aim of the current study was to evaluate the acute effects of Tereré (yerba mate) ingestion on the anaerobic performance of athletes with physical disabilities.

METHOD

Study characteristics

This randomized, double-blind, crossover, placebo-controlled study was approved by the Research Ethics Committee of the Federal University of Mato Grosso do Sul (UFMS), (No. 6010210). The Universal Trial Number (UTN) is U1111-1328-0760. Data collection was carried out at the University Hospital (HU) and the UFMS gym-school.

Participants

The study included five male athletes with a mean age of 31.2±13.7 years and body weight of 73.6±20.8 kg. The athletes were recruited by convenience, through contact with coaches and visits to training centers in Campo Grande, MS. Eligibility criteria were: age ≥16 years, active participation in national competitions for at least one year, and a minimum frequency of three training sessions per week. Athletes with cardiovascular or respiratory diseases, hypertension, neuropathies (such as Charcot-Marie-Tooth syndrome), or any injury that prevented them from performing the tests were excluded. During the initial recruitment, 16 individuals agreed to participate in the study, however, when the collection date was set, six track and field athletes and two swimmers withdrew due to scheduling conflicts, and three others participated in the first visit but missed the last due to personal reasons. Thus, there was a loss of 11 athletes, and the final sample consisted of five athletes.

Experimental procedures

Three visits to the gym-school were held, each lasting an average of 1 hour and 20 minutes. In visit 1 (V1), participants signed the Informed Consent Form (ICF), completed the medical history, their body weight was measured, and they received a standardized food kit. The athletes were also advised to avoid caffeine and strenuous exercise in the 48 hours prior to visits 2 and 3. The standardized breakfast kit contained approximately 0.9 g of carbohydrate/kg of body mass and were advised to be consumed two hours before the visits at the gym-school.

In visit 2 (V2), participants were randomized by a specific researcher, using the software www.sealedenvelope.com, which generates random codes to provide a 50% chance of ingesting traditional yerba mate as Tereré (TrrEx) or decaffeinated yerba mate as placebo Tereré (TrrPL). Blood pressure, heart rate, and height were then measured. Each participant received TrrEx or TrrPL and rested for 60 minutes. During the rest period, a 24-hour dietary recall and a habitual caffeine consumption questionnaire were applied, developed by Monte[7]. After resting, clinical parameters were repeated, and participants performed the Medicine Ball Throw Test (three attempts with a 2-minute interval) and the Wingate Exercise

Test (WAnT_30s). At the end of the session, they were asked what they thought about the condition consumed (caffeine, placebo, or I don't know).

Visit 3 (V3) followed the same protocol as visit 2, with the difference being the drink administered (Figure 1)[8].

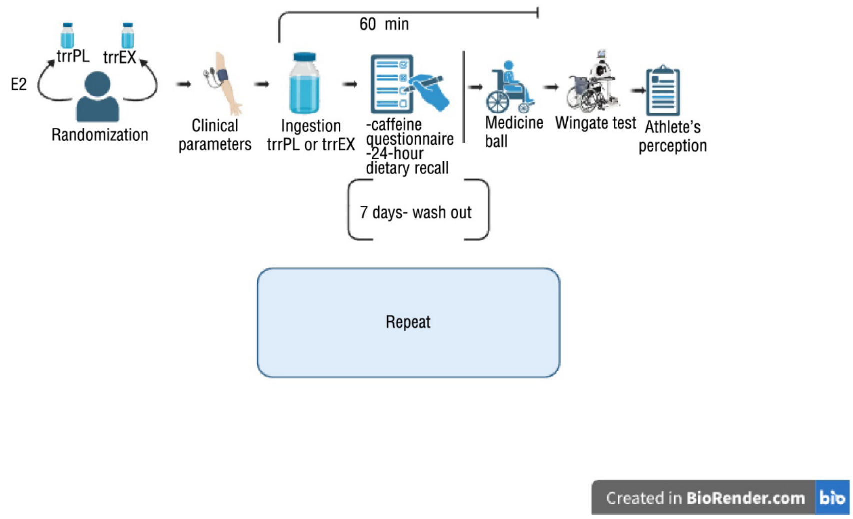

Figure 1. Schematic drawing of the order of the experimental procedures.
Note: TrrEX=Traditional yerba mate; TrrPL=Decaffeinated yerba mate. Created in[8] BioRender.

Drink administration

The TrrEX contained 50g of yerba mate, served in an aluminum cup. Portions of 60 to 100mL of chilled filtered water (approx. 11°C) were infused for each round of suction, using a pump, in order to reach the quantity of 6mL of water/kg of the athlete's body mass. The same amount of ice water was provided in the TrrPL condition, but using 50g of a washed (decaffeinated) yerba mate, with visual and organoleptic properties similar to the traditional yerba mate. Participants were instructed to consume the beverages within 10 minutes and, after receiving them, not to comment on the taste or perceived physiological effects with other participants.

Anthropometric measurements

The body mass of the athletes with spinal cord injuries was measured using a Líder scale (LD1050). The weight of the wheelchair was subtracted from the total weight to obtain the athlete's body weight. Height was estimated using the recumbent height method, with the athlete positioned on a stretcher in the supine position. Measurements were taken using a set square and a tape measure to mark the distance between the top of the head and the sole of the foot[9].

Wingate upper limb test

An EB4100 arm cycle ergometer (Cefise) was adapted to an adjustable table so that wheelchair athletes could perform the test in their own chair. The Wingate upper limb test (WAnT_30s) was applied according to the protocol of Jacobs, Mahoney, Johnson [10]. The warm-up consisted of 3 minutes of no load at low rpm, followed by 2 minutes of no load at 100 RPM. A load of 3.5% of body weight was then applied, and participants were encouraged to crank at maximum speed for 30 seconds. After the test, the load was removed for a 3-minute cool-down. The anaerobic power measurement was determined using Ergometric 6.0 software (Cefise), which calculated Maximum Power (PMax), Mean Power (PMe), Minimum Power (PMin), and the Fatigue Index (FI)[3,10,11].

Medicine ball test

The medicine ball throwing test was conducted according to the protocol of Costa et al[12] to assess upper-body power (Figure 2). Participants, seated in wheelchair, threw a 3-kg medicine ball with both hands, starting from a stationary position and raising the ball above their shoulders. The distance thrown was measured in meters, from the point of release to the ball's first contact with the ground.

Figure 2. Representations of the medicine ball and Wingate tests.

Statistical analysis

Data are expressed as mean ± standard deviation and were initially analyzed using the Shapiro-Wilk test to verify normality. The Student's t-test for dependent samples was used to compare physical performance variables between conditions. A p-value <0.05 was adopted for statistical significance. R (version 4.5.1) statistical software was used.

RESULTS

Five male athletes, with previous experience in the sport and participation in national competitions, in the modalities of swimming, wheelchair basketball, amputee football, and canoeing, participated in the study. Regarding the type of physical disability, myelomeningocele, cerebral palsy, lower limb amputation (above the knee), total spinal cord injury above T6 (T3-T6), and total injury at T11-T12 make up the sample, with one athlete for each disability. Other general characteristics of the sample are shown in Table 1.

Table 1. General characteristics of participants.

Variables	Mean	Standard Deviation	Minimum	Maximum
Age	31.2	13.7	16	49.0
Height (cm)	173.0	8.46	165.0	185.0
Weight (kg)	73.6	20.8	50.0	96.2
SBP rest (mmHg)	126.0	12.6	106.0	153.0
DBP rest (mmHg)	78.9	9.86	61.0	93.0
HR rest (bpm)	75.1	9.95	62.0	96.0
Experience in the sport (years)	7.8	9.08	1.0	24.0
Weekly training in the sport (hours)	6.7	2.1	4.0	10.0
Daily caffeine (mg)	261.0	194.0	14.8	531.0
Daily caffeine (mg/kg)	3.32	2.46	0.29	6.81

Note. Data are presented as mean and standard deviation, minimum and maximum. SBP rest = Resting systolic blood pressure; DBP rest = Resting diastolic blood pressure; HR rest = Resting heart rate.

Table 2 presents the mean, standard deviation, and p-value of the physical performance tests in the TrrEX and TrrPL conditions. Tereré intake did not promote statistically significant changes in the variables PMax, PMe, PMin, and FI, or in the distance thrown in the medicine ball test, as observed in Figure 3.

Table 2. Anaerobic performance of athletes in the TrrEX and TrrPL conditions.

Variables	TrrPL	TrrEX	P valor
Maximum Power (W)	465.9 ± 156.2	461.2 ± 144.9	0.96
Mean Power (W)	376 ± 121.6	373.3 ± 133.1	0.97
Minimum Power (W)	341 ± 117	318.8 ± 123.5	0.78
Fatigue Index (%)	26.37 ± 7.112	31.85 ± 7.498	0.27
Medicine Ball (m)	3.814 ± 1.733	3.784 ± 1.567	0.98

Note. Data are presented as mean ± standard deviation. TrrEX = traditional yerba mate. TrrPL = decaffeinated yerba mate. m = meters.

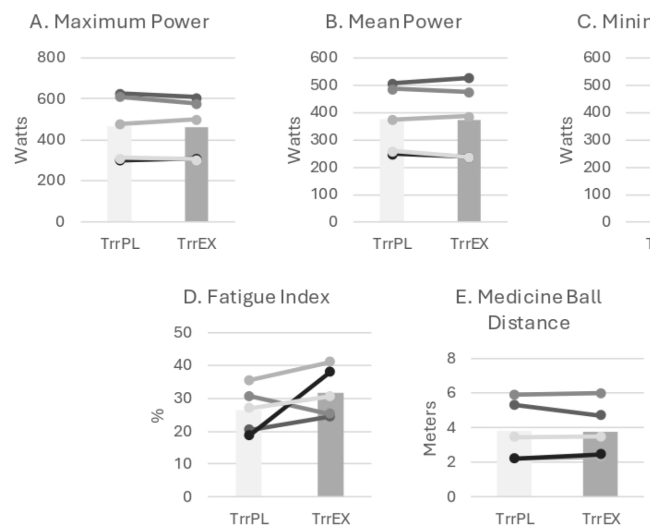

Figure 3. Individual performance in the physical tests according to the experimental conditions. Note. The mean values of Maximum Power (A), Mean Power (B), Minimum Power (C), Fatigue Index (D), and Medicine Ball Distance (E) are presented in the columns. The individual values of the athletes in the TrrEX (yerba mate) and TrrPL (decaffeinated yerba mate) conditions are presented in the rows.

DISCUSSION

Acute consumption of Tereré in its traditional form, compared with the decaffeinated washed yerba mate, did not result in positive effects on the anaerobic performance of athletes with physical disabilities. Parameters such as PMax, PMe, PMin, FI, and medicine ball throwing distance did not differ between conditions, contrasting with the previously established hypothesis.

No comparative studies were found on the effects of yerba mate on the anaerobic performance of athletes with physical disabilities. However, some studies evaluated the effects of caffeine (one of the main bioactive compounds in yerba mate) on the anaerobic performance of athletes with disabilities[3,13-15] which, although the authors used different tests, are similar in the nature of the efforts performed.

Flueck et al.[3] evaluated the acute effects of 6 mg/kg of pure caffeine on the physical performance of 34 physically active men in the 3-minute upper limb test. Among them, 17 had no disability (ND), 10 were paraplegic, and 7 were tetraplegic. The mean power (PMe) in the first 30 and 60 seconds improved significantly with caffeine consumption in paraplegic individuals, but not in tetraplegic individuals or ND. The maximum power (PMax) improved (+21 W) in paraplegic individuals and ND (+46 W) with caffeine, when compared to placebo, but without statistical significance. No difference was observed in tetraplegic individuals[3]. The authors highlight the wide variability of effects, with some being very strong and others having no effect, especially in tetraplegic individuals. Despite this, they recommended caffeine for paraplegic athletes during intense efforts lasting 30 to 60 seconds. One of the reasons for the more significant effect on paraplegic participants was that these athletes were not elite competitors. Individuals with lower training status tend to experience larger ergogenic benefits from caffeine than high-performance athletes who are already closer to their performance limits and generally show smaller relative improvements.

In the current study, the athletes were mainly amateurs, although with good experience in the sport (7.8 ± 9.1 years), yet, despite this, they did not show positive effects of Tereré on power variables, leading us to raise other hypotheses.

In the randomized, double-blind, crossover study conducted by Graham-Paulson et al.[15], twelve experienced wheelchair rugby athletes (6.7 ± 6.0 years), with varying disabilities, ingested anhydrous caffeine capsules (CAF - 4mg/kg) or placebo (PLA - 4mg/kg dextrose) prior to performing repeated 20-meter sprints at maximum speed (RSP). The mean RSP times were significantly shorter in the CAF condition compared to the PLA in both RSP1 and RSP2[15]. The same effect was not repeated in the current study, with no statistically significant difference between TrrEX and TrrPL in PMax, PMin, and FI.

As in the study by Flueck et al.[3], in the study by Parada-Rivera et al.[14], the positive effects of caffeine were observed during the efforts and/or initial moments of the tests. In the same sense, four wheelchair rugby athletes (3 men) were subjected to physical tests, seeking to evaluate the acute effects of caffeine on muscular performance and repeated sprint capacity. Maximum power - determined by the maximum rim propulsion test (MRP) and sprint time - determined in the 10-meter test - were not different between the Caffeine (CAF 4 mg/kg) and Placebo groups, although slightly better performance in the MRP was observed in the CAF group (251.7±220.4 W) compared to the placebo (244.30±219.3 W). The authors concluded that ingesting 4 mg/kg of caffeine 45 minutes before warming up can slightly improve the performance of para-athletes[14].

It should be noted that the three studies cited above have in common the high concentration of caffeine used prior to exercise, ≥ 4mg/kg, while in the current study, the dose of caffeine consumed by athletes through yerba mate varied between 1 and 1.92 mg/kg (1.41 ±0.45 mg/kg), which is well below that recommended in the literature to produce ergogenic effects (3 - 6 mg/kg)[2].

Furthermore, given the limited number of participants, the results of the current study, as well as those of previous studies, should be interpreted with caution. Perhaps a larger number of athletes could have demonstrated more significant improvements in performance tests.

Another common aspect of the cited studies is the time between caffeine administration and the execution of the tests, which was 60 minutes, as in our study. In athletes with spinal cord injuries, the ideal time for caffeine ingestion before physical exertion appears to be slightly longer compared to that of healthy individuals, due to the autonomic disturbance of the gastrointestinal system and limitations in the digestive process imposed by the deficiency, with a recommended interval of between 60 and 80 minutes before exertion[3,16,17]. The time to reach peak plasma caffeine concentration was approximately 80 minutes for the ingestion of 3 mg/kg of caffeine in athletes with spinal cord injury[17], and therefore greater than the 60 minutes adopted in the current study.

The main limitations of the study include the size and heterogeneity of the sample, composed of varied disabilities, with different physiological and biomechanical demands, making it difficult to interpret the results. In addition, only five athletes participated in the study, reducing the statistical power of the tests. However, low participant numbers are common in studies involving athletes with disabilities[3,13,14,18]. Furthermore, the lack of caffeine measurement in plasma after ingestion of the beverages is another limiting factor in the analysis of the results, as we do not know for sure whether the substance was adequately absorbed by the athletes. Despite these limitations, the current study provides unprecedented data on a yerba mate popular in South America. To our knowledge, this study is the first to investigate the effect of yerba mate on the physical performance of athletes with disabilities.

Additional studies are needed to deepen our understanding of the effects of Tereré and other caffeine-containing beverages on the anaerobic performance of para-athletes. Furthermore, it is important to carry out investigations that address the pharmacokinetics of ergogenic substances, considering the different types of deficiency, as well as the inclusion of more representative samples, including a greater number of participants, especially women.

CONCLUSION

The results of the current study allow us to conclude that the acute ingestion of Tereré did not present ergogenic effects on the anaerobic performance of athletes with physical disabilities.

ACKNOWLEDGEMENTS

The Federal University of Mato Grosso do Sul, and the PENSARE study group (Research on Exercise and Nutrition in Health and Sports Performance).

Barão Erva-mate e Chás (Barão de Cotegipe) - for the donation of traditional yerba mate. A special thanks to the people who assisted with data collection: Arilson Barbosa; Yuhri Moraes Kosloski; Pedro Soares Junqueira; Aparecida de Fátima dos Santos Santana; Silvia Feiten; Juan Luna Carolino; Raphael de Jesus Brittes; Sander Fric Zanatto; Weverton Valerio da Silva.

Compliance with ethical standards

Funding

Federal University of Mato Grosso do Sul (UFMS), Coordination for the Improvement of Higher Education Personnel (CAPES), National Council for Scientific and Technological Development (Proc. 407000/2023-2 CNPq).

Data Availability Statement

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Ethical approval

Ethical approval was obtained from the local Human Research Ethics Committee – Federal University of Mato Grosso do Sul (no. 6.010.210). The project was written in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed the experiments: ACA, CFCR. Performed the experiments: ACA, GLB, RMKRB. Analyzed the data: CPR. Contributed materials/analysis tools: ACA, GLB, CFCR. Wrote the paper: ACA, CFCR.

REFERENCES

1. Graham-Paulson TS, Perret C, Smith B, Crosland J, Goosey-Tolfrey VL. Nutritional supplement habits of athletes with an impairment and their sources of information. Int J Sport Nutr Exerc Metab. 2015;25(4):387-95. https://doi.org/10.1123/ijsnem.2014-0155. PMid:25811415.
2. Guest NS, VanDusseldorp TA, Nelson MT, Grgic J, Schoenfeld BJ, Jenkins NDM, et al. International society of sports nutrition position stand: caffeine and exercise performance. J Int Soc Sports Nutr. 2021;18(1):1-37. PMid:33388079.
3. Flueck JL, Lienert M, Schaufelberger F, Krebs J, Perret C. Ergogenic effects of caffeine consumption in a 3-Min all-Out arm crank test in paraplegic and tetraplegic compared with able-Bodied individuals. Int J Sport Nutr Exerc Metab. 2015;25(6):584-93. https://doi.org/10.1123/ijsnem.2015-0090. PMid:26132642.

4. Grossmann F, Perret C, Roelands B, Meeusen R, Flueck JL. Fluid Balance and Thermoregulatory Responses during Wheelchair Basketball Games in Hot vs. Temperate Conditions. Nutrients. 2022;14(14):2930. https://doi.org/10.3390/nu14142930. PMid:35889887.
5. Mazzafera P. Mate drinking: caffeine and phenolic acid intake. Food Chem. 1997;60(1):67-71. https://doi.org/10.1016/S0308-8146(96)00311-1.
6. Pamplona Mosimann AL, Wilhelm-Filho D, Da Silva EL. Aqueous extract of Ilex paraguariensis attenuates the progression of atherosclerosis in cholesterol-fed rabbits. Biofactors. 2006;26(1):59-70. https://doi.org/10.1002/biof.5520260106. PMid:16614483.
7. Monte MM. Validação e reprodutibilidade de um questionário para avaliação do consumo de cafeína em adultos [dissertação]. Maceió: Programa de Pós-graduação em Nutrição, Universidade Federal de Alagoas; 2021.
8. BioRender. [cited 2025 Jan 2]. Available from: https://www.biorender.com/
9. Calado LC. Manual de avaliação nutricional de adultos e idosos: técnicas de aferições antropométricas. São Luís: Editora da UFMA (EDUFMA); 2022.
10. Jacobs PL, Mahoney ET, Johnson B. Reliability of arm Wingate Anaerobic Testing in persons with complete paraplegia. J Spinal Cord Med. 2003;26(2):141-4. https://doi.org/10.1080/10790268.2003.11753674. PMid:12828291.
11. Bar-Or O. The wingate anaerobic test an update on methodology, reliability and validity. Sports Med. 1987;4(6):381-94. https://doi.org/10.2165/00007256-198704060-00001. PMid:3324256.
12. Costa RRG, Dorneles JR, Lopes GH, Gorla JI, Neto FR. Medicine Ball Throw Responsiveness to Measure Wheelchair Basketball Mobility in Male Players. J Sport Rehabil. 2021;30(8):1230-2. https://doi.org/10.1123/jsr.2020-0222. PMid:33883302.
13. Costa GDCT, Galvão L, Bottaro M, Mota JF, Pimentel GD, Gentil P. Effects of placebo on bench throw performance of Paralympic weightlifting athletes: a pilot study. J Int Soc Sports Nutr. 2019;16(1):9. https://doi.org/10.1186/s12970-019-0276-9. PMid:30782172.
14. Parada-Rivera I, Sánchez-Grau J, Ferrer-Ramos P, Toro-Román V, Illera-Domínguez V, Font R, et al. Acute effect of caffeine supplementation on neuromuscular performance and repeated-sprint ability in wheelchair rugby players. a case study. Retos. 2025;65:895-908. https://doi.org/10.47197/retos.v65.111739.
15. Graham-Paulson TS, Perret C, Watson P, Goosey-Tolfrey VL. Improvement of sprint performance in wheelchair sportsmen with caffeine supplementation. Int J Sports Physiol Perform. 2016;11(2):214-20. https://doi.org/10.1123/ijspp.2015-0073. PMid:26182441.
16. Shaw KA, Zello GA, Bandy B, Ko J, Bertrand L, Chilibeck PD. Dietary supplementation for para-athletes: a systematic review. Nutrients. 2021;13(6):1-17. https://doi.org/10.3390/nu13062016. PMid:34208239.
17. Graham-Paulson TS, Paulson TAW, Perret C, Tolfrey K, Cordery P, Goosey-Tolfrey VL. Spinal cord injury level influences acute plasma caffeine responses. Med Sci Sports Exerc. 2017;49(2):363-70. https://doi.org/10.1249/MSS.0000000000001108. PMid:27669443.
18. Flueck JL, Mettler S, Perret C. Influence of caffeine and sodium citrate ingestion on 1,500-m exercise performance in elite wheelchair athletes: a pilot study. Int J Sport Nutr Exerc Metab. 2014;24(3):296-304. https://doi.org/10.1123/ijsnem.2013-0127. PMid:24281893.