Paracanoe: particularities of functional classes in the structuring of the sports' training

Paracanotaje: particularidades de las clases funcionales en la estructuración del entrenamiento deportivo

Paracanoagem: particularidades das classes funcionais na estruturação do treinamento esportivo

Luiz Gustavo Teixeira Fabricio dos Santos [1], Maria Florencia Sierra [2], Luis Felipe Correia Castelli de Campos [3], Edison Duarte [4], Cristian Rocha Luarte [5], Paulo Cesar Montagner [6], Joao Paulo Borin [7]

Santos, L., Sierra, M. F., Castelli, L. F., Edison Duarte, E., Rocha, C., Paulo Cesar Montagner, P. C., Borin, J. P. (2023). Paracanoe: particularities of functional classes in the structuring of the sports' training. *Revista Ciencias de la Actividad Física UCM, 24*(1), enero-junio, 1-10. https://doi.org/10.29035/rcaf.24.1.3

ABSTRACT

The performance of paracanoists is characterized by the ability of the athlete to advance at maximum speed, through a technically optimal paddling motion. It`s important to consider that in the case of para-athletes, the application of forces towards paddling is compromised by physical deficiencies. Thus, this study aims to assess the performance of athletes in the KL1, KL2 and KL3 sport classes, during a paralympic paracanoe event. The sample was composed of athletes from the Brazilian male paracanoe team, with a representative of each sport class: KL1, KL2, KL3 For performance analysis, we used a kayak ergometer (KayakPro®, Miami Beach, FL, USA) to simulate a 200-meter trial, during Rio 2016 Paralympic Games Road. The variables were evaluated: time trial, stroke frequency, mean speed, number of strokes, stroke length, stroke index, and power. According to results: I) the athlete KL3 had the lowest number of strokes, the longest stroke length and the highest stroke rate index; II) the athlete KL1 had the highest number of strokes, the lowest stroke length and the stroke rate index. This study puts into perspective the distinct characteristics of a paracanoe trial, analyzed in consideration to each sport class.

Key words: Paracanoe; Training; Physical performance.

.

[1] School of Pedagogy in Physical Education Department of Education Sciences. University of Bío-Bío, Chillán, Chile. https://orcid.org/0000-0002-3762-551X | ltfsantos@ubiobio.cl

[2] Master degree (Biodinâmica do movimento e esporte). Postgraduate Program of the Faculty of Physical Education of the State University of Campinas, São Paulo, Brasil. https://orcid.org/0000-0001-9467-1320 | mflorencia.sierra93@gmail.com

[3] Doutorado em Atividade Fisica Adaptada. School of Pedagogy in Physical Education Department of Education Sciences. University of Bío-Bío, Chillán, Chile. https://orcid.org/0000-0001-7771-6486 | lcastelli@ubiobio.cl

[4] Professor of the Department of Adapted Physical Activity Studies at the Faculty of Physical Education of the State University of Campinas, São Paulo, Brasil. https://orcid.org/0000-0003-4337-8065 | edison@fef.unicamp.br

[5] Physical Education, Faculty of Education Sciences - San Sebastian University. Concepción, Chile. https://orcid.org/0000-0002-1172-8692 | cristian.luarte@uss.cl

[6] Department of Sports Science at the Faculty of Physical Education of the State University of Campinas, São Paulo. State University of Campinas, Brasil. https://orcid.org/0000-0002-5764-8022 | paulocesar@unicamp.br

[7] Department of Sports Science at the Faculty of Physical Education of the State University of Campinas, São Paulo, Brasil. https://orcid.org/0000-0002-7393-4053 | joao.borin@unicamp.br

RESUMEN

El rendimiento de los paracanoistas se caracteriza por la capacidad del atleta para avanzar a la máxima velocidad, mediante un movimiento técnicamente óptimo. Es importante considerar que en el caso de los para atletas, la aplicación de fuerzas hacia el remo se ve comprometida por la discapacidad. Por lo tanto, este estudio tiene como objetivo evaluar el rendimiento de los atletas en las clases deportivas KL1, KL2 y KL3. La muestra estuvo compuesta por atletas de la selección brasileña masculina de paracanotaje, con un representante de cada clase deportiva. Para el análisis del rendimiento, utilizamos un ergómetro de kayak (KayakPro®, Miami Beach, FL, EE. UU.) para simular una prueba de 200 metros. Las variables monitoreadas fueran: tiempo, frecuencia de remada, velocidad media, número de remada, longitud de remada, índice de remada y potencia. Según los resultados: I) el atleta de la clase KL3 realizó el menor número de remadas, mayor longitud de remada y el mayor índice de remada.; II) el atleta de la clase KL1 realizó el mayor número de remadas, menor longitud de remada y índice de remada. Este estudio pone en perspectiva las distintas características de una prueba de paracanotaje, analizadas en consideración a cada clase deportiva.

Palabras clave: Paracanotaje, Capacitación, Desempeño físico.

RESUMO

O desempenho dos paracanoistas é caracterizado pela capacidade do atleta de avançar em velocidade máxima, através do movimento tecnicamente ideal. É importante considerar que no caso de para atletas, a aplicação de forças na remada é comprometida devido a deficiências apresentada. Assim, este estudo tem como objetivo avaliar o desempenho de atletas das classes esportivas KL1, KL2 e KL3, durante uma prova paralímpica de paracanoagem. A amostra foi composta por atletas da equipe brasileira de paracanoagem masculina, com um representante de cada classe esportiva. Para a análises do rendimento, foi utilizado o ergómetro de kayak (KayakPro®, Miami Beach, FL, EUA.) para simular uma prova de 200 metros. As variáveis avaliadas foram: tempo, frequência de remada, velocidade média, número de remada, comprimento de remada, índice de remada e potência. De acordo com os resultados: I) o atleta KL3 teve o menor número de remadas, o maior comprimento de remada e a maior índice de remada; II) o atleta KL1 teve o maior número de remadas, o maior comprimento de remada e índice de remada. Este estudo coloca em perspectiva as características de uma prova de paracanoagem, respeitando a especificidade de cada classe esportiva.

Palavras chave: Paracanoagem, Treinamento, Desempenho.

INTRODUCTION

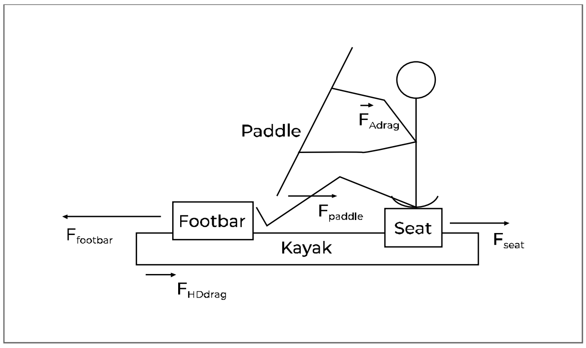
From the very first sports event dedicated to people with disabilities –the Stoke Mandeville Games organized by Sir Luwig Guttman in 1948, on the premises of the Stoke Mandeville Hospital in England (involving only 16 athletes with spinal cord injury)– to the opening ceremony of the 2016 Summer Paralympics in Rio (involving 4328 athletes) (Comité Paralímpico Internacional, 2021; Wilson & Ramchandani, 2017). The paralympic sport underwent several regulatory changes, aiming to achieve increasing numbers of participants and spectators. The 2012 Summer Paralympics in London achieved worldwide television coverage, winning the rank of the 3rd largest sporting event in the world, surpassed only by the Olympic Games and by the FIFA® Soccer World Cup (Duarte et al., 2017).

Paracanoe is considered a cyclical sport, characterized by trials at the 200-meter distances. Athletes with impairment of both sexes, using one-person kayaks (K1) or va'a one-person canoes (V1). It became a paralympic sport in the Rio 2016 Summer Paralympics, although only the 200-meter modality, for both men and women, was included (International Canoe Federation, 2022).

In a 200-meter race, optimal performance is judged by the ability of the athlete to advance at maximum speed, overcoming water resistance through a technically precise forward stroke action (Figure 1). The forward stroke has an aquatic phase –during which the paddle enters the water, is drawn and exits, propelling the canoe –and an aerial phase– during which the paddle prepares to repeat the paddling action at the opposite side (Mcdonnell et al., 2012, 2013).

Figure 1

Dynamics of forces acting to generate kayak propulsion during paddling.



Note: (Michael et al., 2009, p. 171). FAdrag: Air friction force; Fpaddle; Paddle force; Fseat: Seat force; FHDdrag: Hydrodynamic drag force of water; Ffootbar: Footbar force.

Certain performance variables have been identified as significant efficiency indicators for canoists: Mechanical power (Watts); Mean speed (meters/second or kilometers/hour); Number of strokes; Stroke Frequency (cycles/minute or cycles/second); Stroke Length (centimeters); Stroke Time (milliseconds); and Stroke index (m2.[cycles.s]-1), according to the following formula: SI = S2/SF (Begon et al., 2010; Bjerkefors et al., 2019; Carneiro & Castro, 2009; Limonta et al., 2010; Lok, 2013; Michael et al., 2009; Vaquero-Cristóbal et al., 2013; Calvo et al., 2020).

These variables can be used by coaches as performance evaluation parameters, since they are related to the technical characteristics of the paddling; optimizing these parameters will allow for the most efficient application of force.

Particularly in the paralympic context, there is an interest in studies pertaining the effects of kayak ergometer training in the motor performance of recreational athletes and the influence of prostheses on the performance of athletes belonging to the KL3 (Bjerkefors et al., 2015, 2018; Ellis et al., 2017; Grigorenko et al., 2004; Norrbrink et al., 2012; Ribeiro et al., 2022; Rosen et al., 2022).Their results demonstrate that there are actual performance differences within sport classes themselves, a conclusion with direct implications over training prescriptions. However, the lack in the literature is perceived in the absence of studies comparing the different sports classes in locu condition or in a kayak ergometer simulation. Nevertheless, there is a lack of information regarding the performance standards of athletes within each sport class (Bjerkefors et al., 2019; Ribeiro et al., 2022; Rosen et al., 2022).

In this sense, this study aims to analyze KL1, KL2 and KL3 athlete's performance in a paralympic male paracanoe event, specifically regarding the variables total time, stroke frequency, mean speed, number of strokes, stroke length, stroke index, and power.

METHODS

All procedures in this study were respected Helsinki Declaration. This research followed all the guidelines of Law 510/2016 of the National Council of Ethics in Research Involving Human Beings. The participants provided the term of free and informed consent. This project was submitted and approved by the Research Ethics Committee of the Faculty of Medical Sciences of the State University of Campinas, number 1997113.

Sample-size

The sample-size was comprised of three voluntaries, paracanoe athletes from the Brazilian Male Paracanoe Team, including a male representative of each sport class: KL1 (1.76 m height, 77 kg body weight, injury to the tenth thoracic segment); KL2 (1.20 m height, 78 kg body weight, bilateral transfemoral amputation); KL3 (1.86 m height, 73 kg body weight, unilateral transfemoral amputation).

Body weight and height

Body weight measurements employed the 2180® (Toledo®, Brazil) scale, with a precision of 0.1 kg. Height measurements employed a wooden stadiometer with centimeter-level precision; athletes were measured in supinated and cephalocaudal positions.

Experimental protocol

During the preparatory period for the Rio 2016 Paralympic Games, a familiarization routine—in which all athletes used the same kayak ergometer (KayakPro®, Miami Beach, FL, USA) for 7 days—was carried out. During the familiarization sessions and evaluation protocol it was necessary to calibrate the ergometer for each individual athlete, according to body weight. For the familiarization and testing sessions to take place under suitable environmental conditions, an air-conditioned room at a temperature of approximately 25 °C was used. The command to start the race simulation followed the international standard (International Canoe Federation, 2022), minimizing variations in the starting signals provided by evaluators.

The familiarization session protocol consisted of two stages: the first was a free paddling section with a duration of 20 minutes, and the second a maximum performance simulation of a 200-meter race. All familiarization sessions and maximum performance simulations occurred at the same time of day.

Pre-test protocol

The athlete was allowed to select an adapted seat with a high back (20 cm) and a wider base (50 cm), or the training device's original seat, which has the same dimensions as an official competition seat. This possibility was offered to the athlete for the test to better reproduce sport class-specific and competitive conditions. After selecting the necessary adaptations, evaluators collected information to fill out the specific values requested by E-Monitor® software: body weight, height, and age. Properly filling out the software's input form allows for an adequate load during the test's execution. Regarding the positioning of the lower limbs, the evaluators directed the athletes to seek a position similar to that used during an official trial. The athlete was allowed to perform a 10-minute warm-up on the Kayak Ergometer, with free load settings.

Test procedure

During the test, evaluators were allowed to verbally motivate athletes. As soon as the requested distance of 200 meters was completed, athletes were instructed to perform a low-effort lap for 5 minutes. On the day of the maximum performance evaluation, evaluators instructed all athletes to perform the usual pre-competition procedures. The following variables were evaluated: trial time (TT), stroke number (SN), stroke frequency (SF) corresponds to the number of paddling cycles performed per minute and points to the intensity at which the athlete performed the test, mean speed (S_Km/h), stroke length at the right side (SL_R), stroke length at the left side (SL_L), stroke index (SI), and the mean power produced by the athletes corresponds to the sum of the work done in each stroke divided by the total number of strokes performed throughout the trial's 200 meters. Since the stroke is the main canoe propulsion action, SN is directly related to its efficiency, defined by the SI, which in turn is the product of speed multiplied by stroke length (SL) –the distance covered by the canoe during a stroke cycle.

Statistic analysis

Trial performance data were collected through the E-Monitor® online software and stored in a computer database. The statistical program GraphPad Prism 7 was used to analyze the data according to the following variables: stroke frequency, mean speed, power, right stroke length, left stroke length, and stroke index. Variables were presented as means (Mean ± Standard Deviation), representing 25-meter sections of the total trial distance.

RESULTS

Results are presented in Table 1, according to the studied variables, concerning the characterization of individual performance in the different sport classes. Graph 1 shows stroke frequency, mean speed, and stroke index for the KL1, KL2 and KL3 athletes, measured every 25 meters.

Unsurprisingly, Table 1 in particular shows that variable trial time (TT), considered the main performance indicator in paracanoeing trials, is directly related to mean speed. In fact, the shortest time, 36.6 seconds, achieved by the KL3 athlete, corresponds to the highest recorded mean speed: 20.15 ± 1.81 km/h. The KL1 athlete obtained a 43.80 second TT, corresponding to a mean speed of 16.38 ± 1.4 km/h; while the KL2 athlete had the longest TT, 44.1 seconds, corresponding to a mean speed of 16.34 ± 1.15 km/h.

Mean stroke frequencies for the KL1, KL2 and KL3 athletes were 150, 130 and 155 strokes/min, respectively.

The highest mean power was achieved by the KL3 athlete, with 501.56 Watts, followed by the KL1 athlete, with 269.69 Watts, the latter hardly differing from the KL2 athlete, who achieved a mean power of 269.14 Watts.

The athlete in the KL1 finished the race with 101 strokes; their mean length was 1.79 ± 0.17 m, and the athlete's SI was 7.91 m2. [cycles.s]-1. The KL2 athlete completed 48 stroke cycles; their mean length was 2.09 ± 0.09 m and the athlete's SI was 9.52 m2. [cycles.s]-1. The KL3 athlete completed 43 stroke cycles; their mean length was 2.14 ± 0.09 m and the athlete's SI was 11.97 m2. [cycles.s]-1.

Table 1

Performance characterization for each sport class, according to studied variables (Mean ± SD).

SC	TT	SN	SN_R	SN_L	S	Power	SF	SL	SL_R	SL_L	SI
KL1	43.80	101	51	50	16.38 (± 1.4)	269.69 (± 43.15)	150 (± 15.57)	1.79 (± 0.17)	1.75 (± 0.21)	1.83 (± 0.09)	7.91 (± 1.06)
KL2	44.1	95	48	47	16.34 (± 1.15)	269.14 (± 47.61)	130 (± 8.43)	2.09 (± 0.09)	2.11 (± 0.23)	2.08 (± 0.08)	9.52 (± 1.19)
KL3	36.6	86	43	43	20.15 (± 1.81)	501.56 (± 102.66)	155 (± 6.38)	2.14 (± 0.09)	2.13 (± 0.26)	2.15 (± 0.10)	11.97 (± 1.66)

Note: **SC**: Sport Class; **TT**: Trial Time(s); **SN**: Stroke Number; **SN_ R**: Stroke Number at the Right Side; **SN_ L**: Stroke Number at the Left Side; S_ Speed(Km/h:); **P**: Power(Watss) **SF**: Stroke Frequency(strokes/min); **SL**: Stroke Length(m); **SL_R:** Stroke Length at the Right Side(m); **SL_L:** Stroke Length at the Left Side(m); **SI**: Stroke Index[m2. cycles. s]-1.

In order to understand the development of athletes' individual performance throughout the race, the 25m, 100m and 200-meters points were selected for analysis, representing the beginning, middle and end of the race, as shown in Table 2.

Table 2

Individual performance of athletes throughout the test (Mean ± SD).

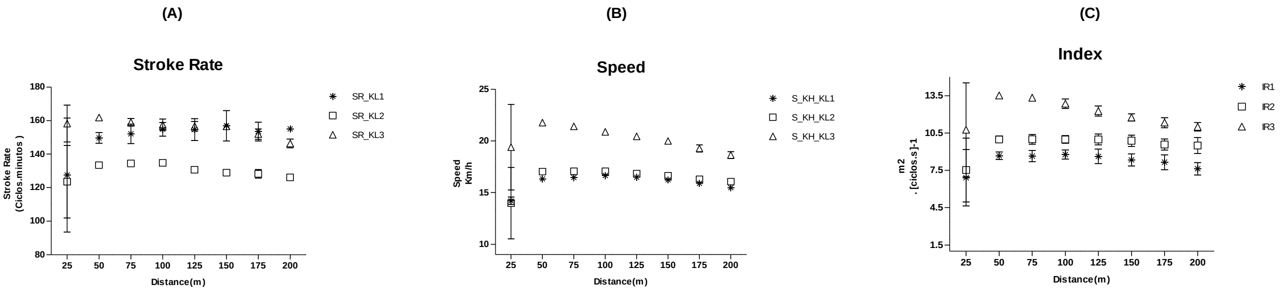
CAT	25 meters			100 meters			200 meters		
	SF	S	SI	SF	S	SI	SF	S	SI
KL1	127.5 (± 33.93)	14.21 (± 0.37)	6.90 (± 2.26)	154.8 (± 4.08)	16.64 (± 0.08)	8.77 (± 0.37)	155.08 (± 1.37)	15.47 (± 0.11)	7.62 (± 0.49)
KL2	123.58 (± 21.61)	13.97 (± 3.46)	7.52 (± 2.56)	134.83 (± 1.40)	17.07 (± 0.12)	9.99 (± 0.30)	126.09 (± 1.8)	16.05 (± 0.14)	9.49 (± 0.64)
KL3	158.33 (± 10.98)	19.39 (± 4.14)	10.76 (± 3.78)	157.54 (± 3.33)	20.88 (±0.28)	12.85 (± 0.38)	146.45 (± 2.58)	18.62 (± 0.33)	11.00 (± 0.33)

Note: **SF**: Stroke Frequency; **S**: Speed; **SI**: Stroke Index

Figure 2 presents stroke frequency, speed, and stroke index results (mean and standard deviation), for sport class KL1, KL2 and KL3. Results were obtained every 25 meters.

Figure 2

Performance variables during a 200-meter race.



Note: **SN_ R:** Stroke Number at the Right Side; **SN_ L:** Stroke Number at the Left Side; S_Km/h: Speed; **SI:** Stroke Index.

DISCUSSION

The paddling action is a motor action that requires a high level of body control, since it involves complex coordination of upper limbs, trunk, hip and lower limbs under constant interaction, with reaction forces towards different directions, resulting in a forward propulsive force (Bjerkefors et al., 2019; Bjerkefors et al., 2018; Ribeiro et al., 2022; Rosen et al., 2022). However, Figure 1 is not a perfect reproduction of force dynamics in paracanoe. Para-athletes present specific physical deficiencies that compromise the application of forces during the coordination of the paddling action. For this reason, in official paracanoe events, athletes are classified into three sport class (KL1, KL2 and KL3), defined by their impairment and the type of canoe in which they compete, aiming at a fairer and more equitable competition (International Canoe Federation, 2022).

The variables stroke frequency, speed and stroke index have been pointed out in the literature as significant indicators of efficiency, providing practical information to configure loads and monitor the performance of athletes during water training(Bjerkefors et al., 2015, 2018; Ellis et al., 2017; Grigorenko et al., 2004; Norrbrink et al., 2012; Rosen et al., 2022).

The efficiency of an athlete is associated with the ability to achieve the highest speed along with the highest energy saving during stroke cycles. In this sense, the coaches must understand the relationship between stroke frequency and speed, as well as the direct influence of the stroke length variable, in order to identify the efficiency of the athlete's technique, expressed as a stroke index value.

At the 25-meter mark, we can see an overlap of results between KL1 and KL2, which have lower values when compared to KL3 (Table 2). Considering that, due to their deficiencies, the KL1 and KL2 athletes have lower active muscle mass and less efficiency in paddling force transmission, there is a compromise phase of acceleration. These athletes need to make a greater effort to place the canoe in motion.

At the half-way mark (Table 2), we observe an approximation between KL1 and KL3 in terms of stroke frequency, and a decrease of that same variable for the KL2 and KL3 athletes. The KL1 athlete maintains a constant increase in stroke frequency until the 150-meter mark (156.92 ± 9.0). In spite of this approximation, in terms of the speed variable, the overall performance of the KL1 athlete is lower than that of the KL3 athlete. This conclusion is corroborated by SI values.

At the finish mark (Table 2), unlike at the starting point, there was no overlap of results between the sport classes. However, the athlete belonging to KL3 presented the highest paddling efficiency, followed by the KL2 and KL1 athletes, respectively.

When analyzing the test in its entirety, the athlete who performed the least number of strokes and had the longest stroke length (KL3) also obtained the highest SI; the athlete who performed the highest number of strokes and had the lowest stroke length (KL1) obtained the lowest SI. This demonstrates the close relationship between sport class, stroke index, and the athlete's technical efficiency, evidencing efficiency differences between the functional classes.

Another important aspect is the symmetry of the stroke action between right and left sides, as a symmetrical propulsion force helps maintaining a constant speed(Bjerkefors et al., 2019; Bjerkefors et al., 2018; Ellis et al., 2017; Michael et al., 2012). The three evaluated athletes presented minimal differences in their stroke length results when comparing the right and left sides.

The observed asymmetry in stroke length for the KL1 (Table 1) is related to the fact that, usually, during official trials, athletes need to correct the steering of the canoe –as they must use a fixed rudder (keel), instead of a free rudder system. It is very important to note that athletes belonging to the KL2 and KL3 do not have any impairment of the trunk musculature, eliminating the possibility of stroke asymmetry as a result of deficiency. The KL3 athlete presented the smallest difference of stroke length between each side: 0.02 m (Table 1). His left arm had a longer reach this is possibly related to the technical quality developed because of using the free rudder, making the correction of the canoe's direction through paddling unnecessary. Therefore, for the KL1 and KL2, steering control must happen through symmetrical paddling, characterizing, thus, a specific training that must be developed by the trainer.

According to Verkhoshansky (2001), sports performance is a result of the development of the body's work capacity, which in turn reflects the athlete's motor potential and his/her ability to use this potential effectively. This is achieved through adequate technical, tactical, physical, and psychological preparation. In analyzing these study's performance variables according to each paracanoe sport classes, we observed that each functional class presents performance characteristics. Therefore, the athlete's individuality, as a function of their disability, is a determining factor in acquiring the ability to fulfill his/her performance potential.

CONCLUSION

Results found in this study in respect to stroke frequency, mean speed, and stroke index, show the different characteristics of paracanoe trials which, when analyzed according to each sport class, indicate the need for specific training adaptations.

It is worth noting that in paralympic sports, although the functional classification has the objective of guaranteeing a fairer competition, there is a maximum and minimum range of performance among the athletes of each functional class, bringing them closer to the classes above or below the ones to which they officially belong: this approximation characterizes a 'borderline' athlete. In functional systems, the main factors that determine the class they are not diagnosis and medical evaluation, but how much a athlete's disability affects sports performance, highlighting the importance of maximizing training sessions and the specificity of the sport class.

As such, in elaborating training processes, technical committee members, in addition to considering the general characteristics of each sport class, for example speed, stroke frequency and stroke index. The characteristics presented must be analyzed individually for the elaboration of the specific training should also consider the individuality of the athletes within the same sport class.

In this sense, the present research brings to light techniques variables dearly in the Paracanoe, which can help in the determination of the sport's evolution and highlighting the need to carry out training sessions with athletes from the same sport class, eradicating multiclass training.

ACKNOWLEDGEMENTS

The authors thank the Brazilian Confederation of Canoeing and the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for funding this study.

BIBLIOGRAPHIC REFERENCES

Begon, M., Colloud, F., & Sardain, P. (2010). Lower limb contribution in kayak performance: Modelling, simulation and analysis. *Multibody System Dynamics*, *23*(4), 387–400. https://doi.org/10.1007/s11044-010-9189-8

Bjerkefors, A., Rosén, J. S., Tarassova, O., & Arndt, A. (2019). Three-Dimensional Kinematics and Power Output in Elite Para-Kayakers and Elite Able-Bodied Flat-Water Kayakers. *Journal of Applied Biomechanics*, *35*(2), 93-100. https://doi.org/10.1123/jab.2017-0102

Bjerkefors, A., Tarassova, O., Rosén, J. S., Zakaria, P., & Arndt, A. (2018). Three-dimensional kinematic analysis and power output of elite flat-water kayakers. *Sports Biomechanics,* *17*(3), 414-427. https://doi.org/10.1080/14763141.2017.1359330

Bjerkefors, A., Squair, J., Chua, R., Lam, T., Chen, Z., & Carpenter, M. (2015). Assessment of abdominal muscle function in individuals with motor-complete spinal cord injury above T6 in response to transcranial magnetic stimulation. *Journal of Rehabilitation Medicine*, *47*(2), 138–146. https://doi.org/10.2340/16501977-1901

Calvo, J., de Fuentes, M., Torralba, M. A., & Braz, M. (2020). Estudio cinemático de la carrera de 100 m en atletas con discapacidad. *Revista Ciencias de la Actividad Física UCM*, *21*(1), 1–15. https://doi.org/10.29035/rcaf.21.1.8

Carneiro, L. M., & Castro, F. (2009). Cinemática da canoagem: revisão- Canoe kinematics: a review. *Mov*, *17*(3), 114–122. https://portalrevistas.ucb.br/index.php/rbcm/article/view/1034

Comité Paralímpico Internacional. (2021). *Paralympic Games - All Editions*. https://www.paralympic.org/paralympic-games

Duarte, T., Culver, D. M., Trudel, P., & Milistetd, M. (2017). Desenvolvimento profissional de treinadores paralímpicos:evidências do contexto canadense. In L. R. Galatti, A. J. Scaglia, P. C. Montagner, & R. R. Paes (Eds.), *Desenvolvimento de treina`dores e atletas: pedagogia do esporte* (1st ed., p. 298). Editora da Unicamp.

Ellis, S., Callaway, A., & Dyer, B. (2017). The influence of lower-limb prostheses technology on Paracanoeing time-trial performance. *Disability and Rehabilitation: Assistive Technology*, *13*(6), 1–7. https://doi.org/10.1080/17483107.2017.1357052

Grigorenko, A., Bjerkefors, A., Rosdahl, H., Hultling, C., Alm, M., & Thorstensson, A. (2004). Sitting balance and effects of kayak training in paraplegics. *Journal of Rehabilitation Medicine*, *36*(3), 110–116. https://doi.org/10.1080/16501970310020401

International Canoe Federation. (2022). *Paracanoe Rules*. https://www.canoeicf.com/disciplines/paracanoe

Limonta, E., Squadrone, R., Rodano, R., Marzegan, A., Veicsteinas, A., Merati, G., & Sacchi, M. (2010). Tridimensional kinematic analysis on a kayaking simulator: Key factors to successful performance. *Sport Sciences for Health*, *6*(1), 27–34. https://doi.org/10.1007/s11332-010-0093-7

Lok, Y. L. (2013). *Biomechanics Study in Sprint Kayaking using Simulator and On-water Measurement Instrumentation: An Overview.* 3rd Malaysian Postgraduate Conference (MPC2013), 216-223. https://research.usq.edu.au/download/accb19131dfc4e8ae71b38d4c30c363bc245e9638141a539fe714d1498d1d66c/12964559/Noor_Rahman_MPC2013_Full%20Proceedings_PV.pdf

Mcdonnell, L. K., Hume, P. A., & Nolte, V. (2012). An observational model for biomechanical assessment of sprint kayaking technique. *Sports Biomechanics*, *11*(4), 507–523. https://doi.org/10.1080/14763141.2012.724701

Mcdonnell, L. K., Hume, P. A., & Nolte, V. (2013). Place time consistency and stroke rates required for success in K1 200-m sprint kayaking elite competition. *International Journal of Performance Analysis in Sport*, *13*(1), 38–50. https://doi.org/10.1080/24748668.2013.11868630

Michael, J. S., Rooney, K. B., & Smith, R. M. (2012). The dynamics of elite paddling on a kayak simulator. *Journal of Sports Sciences*, *30*(7), 661–668. https://doi.org/10.1080/02640414.2012.655303

Michael, J. S., Smith, R., & Rooney, K. B. (2009). Determinants of kayak paddling performance. *Sports Biomechanics*, *8*(2), 167–179. https://doi.org/10.1080/14763140902745019

Norrbrink, C., Lindberg, T., Wahman, K., & Bjerkefors, A. (2012). Effects of an exercise programme on musculoskeletal and neuropathic pain after spinal cord injury—results from a seated double-poling ergometer study. *Spinal Cord*, *50*(6), 457–461. https://doi.org/10.1038/sc.2011.160

Ribeiro Neto, F., Alsamir Tibana, R., Rodrigues Dorneles, J., & Gomes Costa, R. R. (2022). Internal and External Training Workload Quantification in 4 Experienced Paracanoeing Athletes. *Journal of Sport Rehabilitation*, *31*(2), 239–245. https://doi.org/10.1123/jsr.2020-0499

Rosen, J. S., Arndt, A., Nilsson, J., Rosdahl, H., Victoria, L., Bjerkefors, A., Rosen, J. S., Arndt, A., Nilsson, J., Rosdahl, H., & Victoria, L. (2022). Kinematic and kinetic performance variables during paddling among para-kayak athletes with unilateral above or below knee amputation. *Sports Biomechanics*, 1–15. https://doi.org/10.1080/14763141.2022.2067074

Vaquero-Cristóbal, R., Alacid, F., López-Plaza, D., Muyor, J. M., & López-Miñarro, P. A. (2013). Kinematic Variables Evolution During a 200-m Maximum Test in Young Paddlers. *Journal of Human Kinetics*, *38*(2013), 15–22. https://doi.org/10.2478/hukin-2013-0041

Verkhoshansky, Y. (2001). *Teoría y Metodología del Entrenamiento Deportivo* (1st ed.). Paidotribo.

Wilson, D., & Ramchandani, G. (2017). Home advantage in the Winter Paralympic Games 1976–2014. *Sport Sciences for Health*, *13*(2), 355–363. https://doi.org/10.1007/s11332-017-0365-6

Dirección para correspondencia

Luiz Gustavo Teixeira Fabricio dos Santos
PhD in Physical Education
School of Pedagogy in Physical Education
Department of Education Sciences
University of Bío-Bío
Chillán, Chile

ORCID: https://orcid.org/ 0000-0002-3762-551X

Contacto: ltfsantos@ubiobio.cl

Recibido: 01-07-2022

Aceptado: 21-12-2022