

## Effects of aquatic therapy on gait and balance in patients with brain vascular accident: a literature review

Efeito da fisioterapia aquática na marcha e no equilíbrio em pacientes com acidente vascular cerebral: uma revisão de literatura

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### ABSTRACT

Stroke is one of the leading causes of death and physical disabilities in Brazil and worldwide. Being caused by an interruption of vascular cerebral flow, it is able to lead the individual to death or generate functional disabilities. Aquatic physiotherapy has shown great results for the rehabilitation of these patients, which is provided by the physical properties of water, which are able to provide pain relief and muscle relaxation, thus facilitating ambulation. Thus, this study aimed to review published articles in order to report the effects of hydrotherapy as a physical therapy resource on gait and the balance of stroke patients. For this, a review of articles was performed in the electronic databases PubMed and PEDro and eight articles were chosen, after considering the inclusion and exclusion criteria. The results showed that this physical therapy resource provides benefits in functional aspects, gait quality, speed, and static and dynamic balance. Also, the bibliographic research allowed observing that the technique has effects when used to replace or add to conventional methods of soil therapy. Given the good results obtained, it appears that the technique can be used to treat a patient with a stroke.

**Keywords:** Aquatic environment. Balance. March. Stroke.

### RESUMO

O acidente vascular cerebral (AVC) é uma das principais causas de óbitos e incapacidades físicas no Brasil e no mundo. Sendo causada por uma interrupção do fluxo cerebral vascular, é capaz de levar o indivíduo a óbito ou gerar quadros de incapacidades funcionais. A fisioterapia aquática vem demonstrando grandes resultados para a reabilitação desses pacientes, o que é propiciado pelas propriedades físicas da água, que são capazes de proporcionar alívio de dores e relaxamento muscular, facilitando assim a deambulação. Desta forma, este trabalho teve como objetivo revisar artigos publicados a fim de relatar os efeitos da terapia aquática como um recurso fisioterapêutico na marcha e o equilíbrio de pacientes com AVC. Para tal, foi realizada uma revisão de artigos nas bases de dados eletrônicas PubMed e PEDro e oito artigos foram escolhidos, após considerar os critérios de inclusão e exclusão. Os resultados mostraram que este recurso fisioterapêutico proporciona benefícios nos aspectos funcionais, qualidade da marcha, velocidade, equilíbrio estático e dinâmico de pacientes com AVC, comprovando a eficácia da hidroterapia nesses indivíduos. Ainda, a pesquisa bibliográfica permitiu observar que a técnica surte efeitos quando utilizada de forma a substituir ou adicional aos métodos convencionais de terapia de solo. Diante dos bons resultados obtidos, verifica-se que a técnica pode ser utilizada para tratar um paciente com AVC.

**Palavras-chave:** Ambiente aquático. AVC. Equilíbrio. Marcha.

## INTRODUCTION

A stroke is a medical emergency resulting from an interruption of cerebral blood flow that can cause sudden loss of neurological function, leading to temporary or permanent brain damage, ranging from mild to severe (Wolfe, 2000). As it is one of the main causes of death and physical disability in Brazil and the world, an emergency closely related to public health must be faced and, therefore, there is a need to prepare health professionals to deal with the compromises that can be the result of stroke (Pereira et al., 2009).

In the state of Paraná alone, in the period between 2008 and 2017, approximately 62,739 deaths from cerebrovascular diseases were recorded. These figures, in addition to being expressive, allow us to analyze the distribution of the disease in the population according to sex and age group: approximately 53.1% of the victims were male and 35.5% of the registered deaths were among those over 80 years old (Hata et al., 2019).

Stroke can be categorized as ischemic if it results from an obstruction of the blood vessel that makes it difficult for the supply of oxygen to the brain tissue, and hemorrhagic, when there is an extravasation of blood in nervous system structures (Chaves, 2000). Depending on the location and level of the injury, the complications of a stroke affect a hemibody, generating total or partial paralysis, which, in most cases, results in changes in the patient's motor, cognitive, sensory, communicative, and emotional functions (Barros, Passos & Nunes, 2013). Among the main impairments that negatively impact the quality of life of these patients is the motor control deficit, which is reflected in the difficulty of planning and performing movement, directly impacting the individual's quality of life (Matsunono et al., 2016). More specifically, the individual with CVA may have extensor hypertonia in the lower limb, which may result in gait restrictions, leaving it misaligned so that the individual needs to abduct the hip to perform balance, which is characterized as a reaping march. Still, there is difficulty in performing the stance phase, from the difficulty of performing dorsiflexion of the foot, which is capable of generating changes in the distribution of body weight on the ground, and, consequently, can compromise balance and proprioception of the same (Nunes & Quevedo, 2004; Zuge & Manfra, 2017).

Among the different approaches and methods that have been studied as alternatives for the treatment of changes in the motor system of these patients is aquatic physical therapy. This resource has been achieving good results and provides, based on physical principles of water such as buoyancy, density, viscosity, hydrostatic pressure, pain relief, and muscle relaxation, thus facilitating ambulation (Caromano, 2002; Santos, Teixeira & Santos, 2018). While buoyancy and density act by facilitating or providing resistance to the movement of the body in the aquatic environment, viscosity and hydrostatic pressure assist in the discharge of weight, promoting stability and support for a body that demands balance, reducing the fear of falling. and providing greater confidence to perform activities (Becker, 2009; Roper et al., 2013).

## MATERIAL AND METHODS

Data collection for this work was carried out from a selection of articles. The search was carried out in June 2021, using the PubMed and PEDro platforms. The descriptors used for the research were: Hydrotherapy in stroke, gait, and balance.

Based on the descriptors, 60 articles were initially found, 5 from PubMed and 55 from PEDro. Then, the titles and abstracts of these articles were read. At this stage, articles that aimed to study the effects of hydrotherapy on gait and balance in stroke patients were included. Afterward, the full texts were read to apply the inclusion and exclusion criteria. The inclusion criteria used for the selection of articles were: publications carried out between 2015 and 2021, in Portuguese and English that addressed the effects of hydrotherapy on gait and balance in individuals with stroke sequelae, through clinical trials. After a careful reading, articles that were older than 2015 were excluded, as well as bibliographic reviews and clinical trials that were unavailable or incomplete for online reading.

After reading these works in full and using the inclusion and exclusion criteria, eight articles were selected for this study. The step of selecting the articles used for the preparation of this work is summarized in Figure 1.

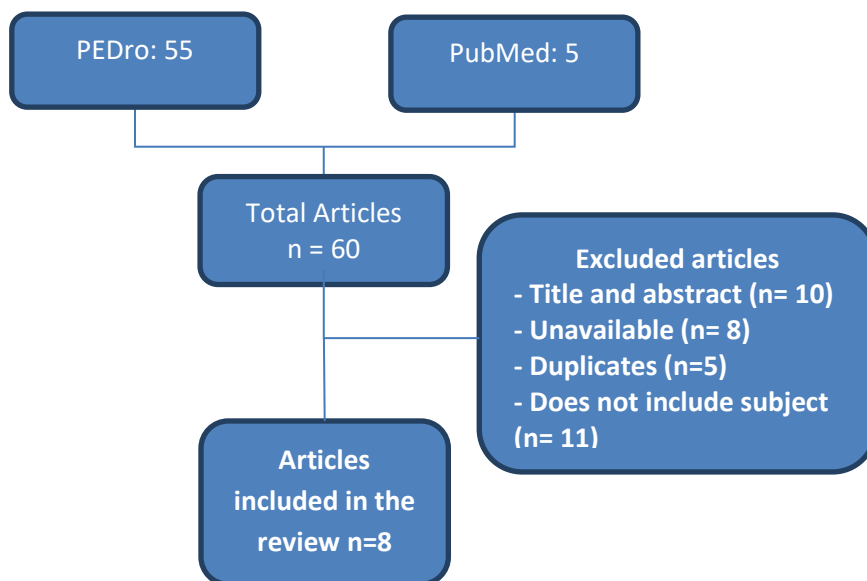


Figure 1. Steps inserted in the electronic search were used to select the articles for this bibliographic review.

Source: The authors.

## RESULTS AND DISCUSSION

Eight articles were selected to carry out the work, with the objective of identifying the effects of aquatic therapy on gait and balance in patients with stroke sequelae. To facilitate the visualization and comparison of the selected studies, a table was prepared, containing: the year of publication, author's name, sampling, interventions, and results (Table 1).

From the reading of the selected articles, it was possible to perceive that aquatic therapy has been widely used and studied as a physical therapy resource in post-stroke patients. This practice can be used as a complement to traditional physical therapy performed on the ground or exclusively since several new aquatic techniques have been developed.

The work carried out by the author Zhu et al. (2016) studies aquatic therapy as an alternative to ground treatment, so in their study, patients were divided according to the type of therapy applied. After treatment, the authors report a statistical improvement in both groups, but, in particular, there is a significant improvement in the walking test of the group that performed water activities in relation to the other. This improvement expressed in the test suggests that water-based exercises can improve the mobility of patients seen.

Complementarily, good results were obtained by the authors Kim et al. (2016). In their study, the authors compared how patients progress when aquatic therapy is applied in a complementary way to soil therapy and demonstrated that an aquatic intervention associated with conventional therapy, evidenced a relevant change in balance and gait in an experimental group when it was compared with a control group. These results corroborate the research by the authors Jeon et al. (2019), who, when evaluating the effects of training of oriented tasks in water, in a short period, verified a significant improvement in the gait and balance of hemiplegic patients. Still, the authors realized that the training when complementary is more effective in some cases, for example, in the balance gain.

Table 1

Summary of objectives and main results found in the studies selected for the research.

Author/ Year	Objective	Sampling	Interventions	Assessments Instruments	Results
Zhu et al. (2016)	Investigate the effects of stroke therapy on patients and stroke gait	- 28 patients, divided into control and study groups; - 6 months post-stroke and with difficulties walking and controlling balance.	- 4 weeks of interventions 5 days a week. - Sessions of 45 minutes. - initial 5 minutes were stretching on the floor; - 40 minutes of aquatic therapy.	- Tests: Berg Scale, 2-minute walk test, and Timed Up and Go (TUG) test.	Aquatic therapy improved motor function and balance. The improvement was statistically significant in the 2-minute walk test of the aquatic group compared to the control group ( $p<0.01$ ).
Kim et al. (2016)	To determine the effects of aquatic activity on gait and balance in stroke patients.	- 20 patients were divided between control and experimental groups; - Post-stroke (6 months of diagnosis).	- 6 weeks of interventions, 5 days a week; - 30-minute sessions; - The study group was additionally submitted to water activities using the hands for the dual task.	- Tests: 10-meter walk, TUG, and Functional Gait Assessment (FGA).	- The dual-task aquatic treatment generated positive results in balance and gait ( $p=0.05$ ).
Cha et al. (2017)	Evaluate the effects of the Bad Ragaz rings method	- 22 patients were divided between experimental and control groups - Individuals affected by chronic stroke.	- Control group: 18 physical therapy sessions (3 days a week for 4 weeks); - The experimental group: conventional rehabilitation therapy + Bad Ragaz method.	- Timed Up and Go.	- The Bad Ragaz method provided statistically better benefits ( $p<0.05$ ), showing better muscle activation of lower limbs and balance in patients.
Park et al. (2018)	To investigate the effects of exercises on land and in water for balance and control in day-to-day activities of the stroke patient.	-29 patients were divided between the study and control groups; - Individuals with sequel e resulting from chronic stroke.	- 4 weeks with 5 days per week; - 30 minutes per session. - Conventional therapy; - The experimental group performed, in addition to conventional physiotherapy, aquatic therapy based on the Halliwick method.	- Strength and control in the trunk, posture, balance, and functionality of patients in everyday activities.	The conventional treatment associated with the aquatic treatment statistically improved the evaluated parameters ( $p<0.05$ ), showing gains in trunk control, balance, and the activities of daily living of these patients.
Jeon et al. (2019)	Verify the effect of aquatic therapy on the gait and balance of the analyzed patients.	- 31 patients, were allocated into three groups: (1) conventional therapeutic exercise; (2) single-task training; (3) dual-task training; - Individuals with hemiplegia.	- 4 weeks of interventions, 5 times a week, with a 30-minute session; - The conventional group performed general exercises. The single-task and dual-task groups underwent training in a therapeutic swimming pool.	- Tests: TUG, Berg scale, FGA.	The groups showed a statistically significant improvement in the tests ( $p>0.05$ ); - On the Berg scale, the dual-task group presented a superior result.bb

(To be continued)

(Continuing)

Lim (2020)	Determine the effects of underwater treadmill gait in stroke patients by comparing training with water jets and ankle weights.	- 22 patients with chronic stroke were separated into two groups.	- 4 weeks of interventions, 5 days per week with 30 minutes per session; - Both groups performed gait training on an underwater treadmill, with one group using ankle weights and the other receiving resistance with a water jet.	- Static and dynamic balance and gait evolution.	The group that received resistance with water jet had better results in the static and dynamic balance skill scores, gait speed, cadence, step length ( $p < 0.00$ , respectively), and swing phase ( $p = 0.02$ ).
Ku et al. (2020)	Investigate the effectiveness of the Ai Chi method compared to the conventional method of aquatic therapy.	- 20 patients suffering from chronic stroke were divided into two groups: control and experimental.	- 6 weeks of interventions, 3 times a week lasting 60 minutes per session; - Control group received the Ai Chi technique and the experimental group received conventional exercises in an aquatic environment.	- Berg scale and gait evolution.	- The group that received the intervention of the Ai chi technique obtained statistically more significant results in balance ( $p = 0.025$ ).
Pérez-De-La-Cruz (2021)	Compare the effectiveness of three different techniques in improving posture, control, and balance.	- 45 stroke patients with more than one year of diagnosis were divided into three groups: control, experimental and mixed;	- The three groups underwent 12 weeks of interventions, twice a week, lasting 45 minutes; - The experimental group performed aquatic therapy using the Ai Chi method; - Control group performed earth therapy, consisting mostly of strength and aerobic exercises; - The mixed group received both ground and Ai Chi therapy.	- Tests: Berg scale, TGU, how long they took to sit and stand up five times, and how many seconds they remained in an upright position;	- Combination therapy promoted statistically superior results; - Good results were also found for the Ai Chi method; - The statistical test applied was ANOVA and a result with $p < 0.05$ was considered significant.

Source: The authors.

This gain in mobility and gait reported by the studies is very important since, according to Benvegna et al. (2008), the main complaint of stroke patients is the difficulty in resuming independent gait, which makes the recovery of balance and locomotion capacity an important factor for rehabilitation.

According to Marinho-Buzelli et al. (2017), carrying out interventions in an aquatic environment is beneficial since this environment promotes an influence on weight bearing, providing inertia to movement, and favoring the completion of gait phases, which facilitates gait training and gain. of balance.

Still, on the effects of water concerning gait, a method that is being widely used is treadmill gait training (Lopes, Aguiar & Carvalho, 2019). This fact can be substantiated by the study by Lim

(2020), who evaluated a rehabilitation protocol in an aquatic environment with the use of aquatic treadmills. In their work, it is reported that the use of this equipment with a water jet resistance is efficient to contribute to gait rehabilitation and balance gain in individuals with chronic stroke.

Several methods fall under the name aquatic therapy of which the methods stand out: the Bad Ragaz, Halliwick, and Aichi rings. These techniques aim to decrease muscle tone, gain range of motion, normalize neurological patterns in the lower and upper limbs, usually acquired due to spasticity, as well as prepare these lower limbs to support body weight. These techniques provide different results and reactions to individuals with motor dysfunctions (Santos et al., 2018).

The Bad Ragaz rings method consists of floating exercises in heated water characterized by spiral and diagonal patterns to reduce tone, relax, increase range of motion and promote muscle reeducation (Cha et al., 2017). In this technique, the patient is supported by floating points and the physical therapist acts as a fixation point in the water. The authors Cha et al. (2017) studied the effects of this technique by comparing the results obtained by patients who were treated with aquatic therapy with another control group, which received conventional therapy. When evaluating the effects of the Bad Ragaz method, they realized that this intervention brought beneficial effects on muscle activation of the lower limbs and balance gain in these patients. The Bad Ragaz ring method provided statistically better benefits ( $p < 0.05$ ) in the evaluated tests, which is reflected in better muscle activation of lower limbs and balance in patients.

In the Halliwick method, exercises are highlighted in a more individual way for balance control, and rotations are performed in the different axes of the human body, dealing with the turbulence of the water. Park et al. (2018) carried out a comparative study between a group that was treated only with soil therapy and another that, in an additional way, received aquatic therapy using the Halliwick method. Statistically significant results for the combined treatment (conventional and aquatic) with  $P < 0.05$ , compared to the control group, which shows gains in trunk control, balance, and activities of daily living in patients with chronic stroke.

Still, another technique that can be cited is Ai Chi, characterized by slow and wide coordinated movements that promote balance and relaxation (Kuet al., 2020; Perez-De-La-Cruz., 2021). In studies carried out by the authors Kuet al. (2020) and Pérez-de la Cruz (2021), who sought to investigate the effect of the Ai Chi technique, concluded that the group with the intervention of this method showed considerably better results compared to the group that received conventional exercises in the aquatic environment. The benefits were reflected in the significant gain in functional balance, lower limb control, and gait of individuals with stroke.

Thus, it is evident that when used individually or in conjunction with conventional therapies on the ground, aquatic therapies positively affect gait and balance. Regardless of the techniques used, several benefits are reported, which is evident, especially when observation and discussion are carried out with a control group that does not receive an aquatic intervention. Thus, because of the expressive results reported, it is recommended that when treating a patient with stroke, the use of aquatic therapy should be considered.

In addition, it should be noted that, in the face of a health emergency that generates a high degree of commitment in those affected, the participation of professionals from different areas of health is strictly essential so that physical recovery is possible that also culminates in the recovery of quality of life of the stroke patient. Thus, it is necessary for professionals, especially physical therapists, to be prepared to investigate the individual's situation and find the best treatment plan that best suits their needs and limitations, always seeking to improve the patient's quality of life.

Also, given the various techniques available, it is important that further research be carried out in order to categorize these techniques for specific patient groups, considering the recommendations and setbacks of each of these techniques.

## CONCLUSION

From the results obtained by this work, it is possible to conclude the importance of aquatic therapy in the rehabilitation of stroke patients and also the importance of updating the scientific evidence that demonstrates the positive effects of this technique.

According to the analyzed works, it is clear that aquatic physiotherapy is a physiotherapeutic resource that contributes positively to the gait and balance of patients, a fact that has been statistically proven by many studies. Still, it appears that such a technique can be used in conjunction with soil therapies, which also enhances its positive effects. Among the techniques that can be used with aquatic physical therapy, some authors have studied Bad Ragaz, Halliwick, and Ai Chi ring therapies, techniques that are applied in different ways, but which have the potential to present statistically positive effects to patients.

Finally, it is noteworthy that aquatic therapy provided an improvement in the clinical condition of patients and it is recommended to consider the possibility of applying this therapy in the treatment of patients with stroke, always in order to respect the indications of each method and the individuality of the patient.

## REFERENCES

- Barros, S. L. A., Passos, N. R. S., & Nunes, M. A. S. N. (2013). Breve estudo do estado da arte sobre acidente vascular cerebral e serious games para aplicação no projeto “AVC” do núcleo de tecnologia assistida da UFS. *Revista GEINTEC-Gestão, Inovação e Tecnologias*, 3(1), pp. 129-143. doi: 10.7198/s2237-0722201300010012
- Becker, B. E. (2009). Aquatictherapy: scientific foundations and clinical e habitation applications. *PM&R*, 1, p. 859- 872. doi: 10.1016/j.pmrj.2009.05.017
- Benvegnu, A. B., Gomes. L. A, Souza, C. T., Cuadros, T. B. B., Pavão, L. W, & Avila, N. W. (2008). Avaliação da medida de independência funcional de indivíduos com sequelas de acidente vascular encefálico (AVE). *Ciência & Saúde*, 1(2), pp. 71-77. doi: 10.15448/1983-652x.2008.4.4115
- Caromano, F.A. (2002). Princípios físicos que fundamentam a hidroterapia. *Fisioterapia Brasil*, 3(6), pp. 394-402. doi: 10.33233/fb.v3i6.2991
- Chaves, M. L. F. (2000). Acidente vascular encefálico: conceituação e fatores de risco. *Revista Brasileira de Hipertensão*, 7(4), pp. 372-382.
- Cha, H. G., Shin, Y. J., & Kim, M. K. (2017). Effects of the Bad Ragaz ring method on muscle activation of the lower limbs and balance ability in chronic stroke: a randomised controlled trial. *Hong Kong Physiotherapy Journal*, 37, pp. 39-45. doi: 10.1016/j.hkpj.2017.02.001
- Hata, M. M., Rodrigues, A. J. S., Quadros, A.C., Turmina, L., Iachinski, R. E., & Osório, A. P. S. (2019). Análise do perfil epidemiológico de óbitos por doenças cerebrovasculares em residentes do Estado do Paraná no período de 2008 a 2017. *Fag Journal of Health*, 1(3), pp. 209-215. doi:10.35984/fjh.v1i3.126
- Jeon, J. Y., Chang, W. N., &Hwang, B. Y. (2019). Effects of task-oriented training in water on balance and gait in patients with hemiplegia. *The Journal of Korean Society for Neurotherapy*, 23(1), pp. 15-23. doi: 10.17817.2019.01.29.111351

- Kim, K., Lee, D. K., & Kim, E. K. (2016). Effect of aquatic dual-task training on balance and gait in stroke patients. *Journal of Physical Therapy Science*, 28(7), pp. 2044-2047. doi: 10.1589/jpts.28.2044
- Ku, P. H., Chen, S. F., Yang, S. R., Lai, T. C., & Wang, R. Y. (2020). The effects of Ai Chi for balance in individuals with chronic stroke: a randomized controlled trial. *Scientific Reports*, 10(1), pp. 1201-1210. doi:10.1038/s41598.020.58098.0
- Lim, C. G. (2020). Effect of underwater treadmill gait training with water-jet resistance on balance and gait ability in patients with chronic stroke: a randomized controlled pilot trial. *Frontiers in Neurology*, 10, pp. 1246-1456. doi: 10.3389/fneur.2019.01246/S
- Lopes, N. M., Aguiar, R. N., & Carvalho, A. V. (2019). Ação fisioterapêutica na recuperação do paciente com acidente vascular encefálico: uma revisão bibliográfica. *Medicus*, 1(2), pp. 1-8. doi:10.6008/CBPC2674-6484.2019.002.0001
- Marinho-Buzelli, A. R., Rouhani, H., Masani, K., Verrier, M. C., & Popovic, M. R. (2017) The influence of the environment on the control of postural sway running title: postural sway in water and on land. *Gait & posture*, 58, pp. 469-475. doi: 10.1016/. gaitpost.2016.09.009
- Matsumoto, S., Uema, T., Ikeda, K., Miyara, K., Nishi, T., Noma, T., & Shimodozono, M. (2016). Effect of underwater exercise on lower-extremity function and quality of life in post-stroke patients: a pilot controlled clinical trial. *Journal of Alternative and Complementary Medicine*, 22, pp. 1-7. doi: 10.1089/acm.2015.0387
- Nunes, L. C. B. G., & Quevedo, A. A. F. (2004) Efeitos da eletroestimulação neuromuscular no músculo tibial anterior de pacientes hemi-paréticosespásticos (Dissertação). Campinas: Unicamp. doi: 10.1590/S1413-35552008000400011
- Park, H. K., Lee, H. J., Lee, S. J., & Lee, W. H. (2018). Land-based and aquatic trunk exercise program improve trunk control, balance and activities of daily living ability in stroke: a randomized clinical trial. *European Journal of Physical and Rehabilitation Medicine*, 55(6), pp. 687-694. doi: 10.23736/s1973-9087.18.05369-8
- Pereira, A. B. C. N. G., Alvarenga, H., Pereira, R. S., Jr. & Barbosa, M. T. S. (2009). Prevalência de acidente vascular cerebral em idosos no Município de Vassouras, Rio de Janeiro, Brasil, através do rastreamento de dados do Programa Saúde da Família. *Caderno de Saúde Pública*, 25(9), pp. 1929-1936. doi: 10.1590/S0102-311X2009000900007
- Pérez-de la Cruz, S. (2021). Comparison between three therapeutic options for the treatment of balance and gait in stroke: a randomized controlled trial. *International Journal of Environmental Research and Public Health*, 18(2), pp. 426-437. doi: 10.3390/ijerph18020426
- Roper, J. A., Bressel, E., & Tillman, M. D. (2013). Acute aquatic treadmill exercise improves gait and pain in people with knee osteoarthritis. *Archives of Physical Medicine and Rehabilitation*, 94, pp. 419-425. doi: 10.1016/j.apmr.2012.10.027
- Santos, J. M. P., Teixeira, R. S. A., & Santos, A. C. (2018). Revisão sobre benefícios da hidroterapia em pacientes com sequelas de acidente vascular cerebral. *Revista JRG de Estudos Acadêmicos*, 1(3), pp. 17-26. doi:10.5281/zenodo.4322021
- Wolfe, C. D. (2000). The impact of stroke. *Brazilian Medicine Bulletin*, 56(2), pp. 275-286.



- Zhu, Z., Cui, L., Yin, M., Yu, Y., Zhou, X., Wang, H., & Yan, H. (2016). Hydrotherapy vs. conventional land-based exercise for improving walking and balance after stroke: a randomized controlled trial. *Clinical Rehabilitation*, 30(6), pp. 587-593. doi: 10.1177/0269215515593392
- Zuge, R. W., & Manfra, E. F. (2017). Efeitos de uma intervenção cinesioterapêutica e eletroterapêutica na cinemática da marcha de indivíduos hemiparéticos. *Fisioterapia em Movimento*, 22(4), pp. 547-556.