ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 10, Issue, 12, pp. 42990-42998, December, 2020
https://doi.org/10.37118/ijdr.20435.12.2020

RESEARCH ARTICLE OPEN ACCESS

MORPHOFUNCTIONAL EVALUATION OF THE HEART OF RATS SUBJECTED TO AQUATIC EXERCISES

[1]Juliana Mendes Medrado, [2]Paula de Paula Moreira Schmitz, [3]Marcelo Baptista Dohnert, [4]Rafaela de Carvalho Alves, [5]Andreia Kassia Lemosde Brito, [6]Márcio Araújo de Almeida and [7]Wataro Nelson Ogawa

[1,2]Student of the Physiotherapy Course at the University of Gurupi – UNIRG, TO – Brazil; [3]Doctorate Degree in Health Sciences, Professor of the Physiotherapy course at the University of Gurupi – UNIRG, TO – Brazil; [4]Master's in Health sciences, the Federal University of Tocantins- UFT, TO – Brazil, professor of the Physiotherapy course at the University of Gurupi – UNIRG, TO- Brazil; [5]Specialist in Health Sciences Federal University of Tocantins - UFT, TO - Brazil Professor of the Nursing course at the University of Gurupi – UNIRG, TO- Brazil; [6]Master's in Health Sciences Federal University of Tocantins – UFT, TO - Brazil, Professor of the Physiotherapy course at the University of Gurupi – UNIRG, TO – Brazil; [7]Doctorate Degree Human Physiology at the University of São Paulo USP, SP - Brazil/professor of the Medicine course at the University of Gurupi - UNIRG, TO – Brazil

ARTICLE INFO

Article History:

Received xxxxxx, 2020
Received in revised form xxxxxxxx, 2020
Accepted xxxxxxxxx, 2020
Published online xxxxx, 2020

Key Words:

Aquatic Exercises;
Cardiac Evaluation;
Electrocardiogram

Corresponding author:
Juliana Mendes Medrado,

ABSTRACT

Exercise programs in rats, such as aerobic exercise and swimming are widely used to identify the benefits of this therapy for the cardiovascular system, this condition implies the need for records that seek evidence of cardiovascular adaptations in animals submitted to physical training. The influence of aquatic therapy on morphological and structural alterations in cardiac my ocytes and electrophysiological and hemodynamic characteristics are not yet clarified in the literature. Having this as a starting point, this work aims to study the implications of aquatic activities on the morpho-functional activity of the heart of rats. This is an experimental study, in which 10 Wistar rats supplied by the central bioterium of the UnirG University Center subdivided into a control group (CG, n$^{=5}$) and in the experimental group (EG, n=5) were used, will be submitted to aquatic therapy at a temperature, 33ºC for 6 weeks with a load increment of 8% of body weight. Heart rate parameters, QRS amplitudes, and QT intervals will be evaluated in vivo by means of an electrocardiogram, and the data analyzed using the Student T-test at a significance level of 5% will be evaluated.

Citation: ***Juliana Mendes Medrado, Paula de Paula Moreira Schmitz, Marcelo Baptista Dohnert, Rafaela de Carvalho Alves, Andreia Kassia Lemosde Brito, Márcio Araújo de Almeida and Wataro Nelson Ogawa.*** "Morphofunctional evaluation of the heart of rats subjected to aquatic exercises*", International Journal of Development Research*, 10, (12), 42990-42998.

INTRODUCTION

Exercise programs in rats, such as aerobic exercise and swimming, are widely used to identify the benefits of this therapy for the cardiovascular system (JACOBSEN *et al*., 1993; BAPTISTA *et al*., 2008). The protocols of aquatic exercises for rats do not present cardiovascular parameters reported as occurs in humans, this condition implies the need for records that seek evidence of cardiovascular adaptations in animals submitted to physical training (TOTOU *et al*., 2015). The search for means that increase life expectancy and endless and challenging with regard to the prevention, treatment, and resolution of the numerous damages to health. Cardiovascular physiology, as well as cardiology, has advanced in the treatment of cardiovascular dysfunctions due to basic and clinical experimental research with animals in the last five decades of what has occurred over the centuries (CHRISTOFOLETTI *et al*., 2013). In animal experimentation, the Wistar rat, which is genetically similar to humans, is the animal with low costs, reduced size and easy handling and adaptation to the laboratory environment. In this environment, an electrocardiogram becomes a reliable technological resource for the measurement of cardiac behavior in the face of the stress circumstance of this animal (HAJJE *et al*., 2014; ROBERTO *et al*., 2018). The ECG parameters of healthy rats are related to the record obtained in humans. However, with some caveats such as the electrophysiological t-path, which is usually positive and follows in a continuous direction with the S wave, in addition to the Q wave that manifests itself absent or rudimentary (BORLOZ *et al*., 2010). In studies by Carregaro and Toledo (2008) and Gomes *et al*. (2016), there was significant evidence of functional improvements in aquatic rehabilitation of musculoskeletal injuries through the kinesiological and physiological benefits of submerging the body in water, however, the influence of aquatic exercises on the cardiovascular system is not yet fully understood. Physical exercise produces sufficient adaptation to improve cardiac functions, greatly increasing both venous return and cardiac output (HALL, 2017). During water immersion, hydrostatic pressure promotes the resizing of the blood volume of the lower limbs to each thoracic cavity, causing increased venous return (CHOI, *et al*., 2013). Physical exercise produces sufficient adaptation to improve cardiac functions, considerably increasing both venous return and cardiac production (HALL, 2017). During water immersion, hydrostatic pressure promotes the resizing of the blood volume of the lower limbs to each thoracic cavity, causing greater venous return (CHOI, *et al*., 2013). According to (KRUEL, 2013) this phenomenon is known as hypervolemia, an increase in blood volume in the center of the body, in which blood translocation can affect blood pressure (BP) and cardiac workload, generating physiological adaptation, including decreased heart rate during exercise, reduced activity (RODRIGUEZ, 2011).

In addition, aquatic exercise offers advantages over land exercise, as in less gravity effect on body mass, contributing to less impact on joints during exercise (EGLI,2015). Physiological, hormonal, cardiovascular and renal changes in rodents submitted to aquatic exercises in hot water are not yet fully understood by the literature. Therefore, swimming exercise in rats is a method often used in research in the field of exercise physiology and behavioral research. (NUNES *et al*., 2015). Swimming exercises in rats in an experimental environment do not require elaborate technique and sophisticated equipment, thus reducing the costs of the study, in addition, the animals have an innate ability to swim, requiring only the choice of the appropriate container, maintaining the temperature of the water. water and depth (NUNES *et al*., 2015). Laboratory analyzes of cardiac tissue, in particular, the histological investigation of cardiomyocyte, in animals submitted to aquatic exercises are tools used to safely design scientific research and significant variables that reveal the morphofunctional changes of the heart (ANTUNES, *et al*.2016). This study has as a starting point to understand the morphofunctional changes of the heart, aiming to observe the behavior of cardiac functions in rats submitted to aquatic exercises. The variables heart weight, myocardial trophism, heart rate, QT interval and QRS amplitude will be measured to observe cardiac dromotropism and chronotropism. The morphological changes will be evaluated through histological slides in which possible changes of the cardiomyocyte will be observed.

DIFFICULT: Cardiovascular disorders have the highest mortality rate in the world. With this knowledge, this research aims to understand the morphofunctional changes in the heart of animals submitted to aquatic exercises. Knowledge about cardiovascular physiology in experimental animals provides support for new research in humans.

HYPOTHESIS: Swimming exercises in rats cause adaptations such as myocardial hypertrophy, changes in chronotropism evidenced by heart rate and changes in cardiac dromotropism through the observation of the QT interval and inotropism through changes in the QRS amplitude. Aquatic exercises can promote adaptations in one or all cardiac electrophysiological parameters in cardiomyocyte trophism.

JUSTIFICATION: Cardiovascular diseases are the main causes of mortality and morbidity worldwide. The heart is among the organs most responsive to physical exercise therapies, being a great resource to prevent dysfunctions such as reduced heart rate, decreased contractility strength, myocardial relaxation speed decreased venous return and increased total peripheral vascular resistance. In this work, therefore, the evaluation of the cardiac performance of rats submitted to swimming exercises is justified by providing valuable information about cardiovascular physiology, and in which electrophysiological parameters and cardiac trophism, aquatic therapy can influence.

RESEARCH OBJECTIVES: Evaluate the cardiac and morphological activity of the heart of rats submitted to aquatic exercises. Accordingly:

Compare the heart weight of rats submitted to exercise and the control sample.

Evaluate by heart electrocardiograph, heart rate, QT interval and QRS amplitude.

Identify changes in cardiac trophism in the experimental group through histological analysis.

LITERATURE REVISION

Structure and physiology of the cardiac muscle: The histological study of the heart shows the complexity of an organ that has different cell types working in a common denominator. Among these cell types, we highlight the cardiomyocyte, found in greater quantity - they are responsible for more than half of the organ's cell volume - exhibiting the fundamental capacity of contractility (THOMAL, 2007). In adulthood, about 80% of the myocardium corresponds to cardiomyocyte, with the remaining 20% composed of the extracellular matrix, connective tissue and blood vessels (ÁGUILA; MANDARIM-DE-LACERDA & APFEL, 1998). These cells are made up of myofibrils, proteins of transcriptional and post-transcriptional regulation, which give rise to sarcomeres, calcium-dependent structures responsible for contraction. Myofibrils can change their dynamics, according to factors such as age and endocrine changes (MOHRMAN &HELLER, 2007; THOMAL, 2007). The contractility of cardiomyocytes is related to the homeostatic regulation of the calcium ion (Ca2 +), which participates in the excitation-contraction coupling at different moments in the process, namely: in the excitation of cardiac myocytes and in the final work of filaments, which leads to contraction (QUINTÃO-JUNIOR *et al*., 2012).

Myofibrillar protein complex: The proteins responsible for contractile regulation act through mechanisms that include various types of biomolecular interactions that require the participation of the calcium ion. Among these proteins, we can highlight actin, myosin, tropomyosin, troponin and titin (GORDON; HOMSHER; REGNIER, 2000).

Actin: A protein consisting of a long polymer (actin F) and a pair of globular monomer chains (actin G), of a globular character, giving rise to helical chains. It acts together with myosin in the sarcomere shortening process and acts on cardiac activity through the regulation of ion channels (BOFF, 2008; ALDENUCCI, 2010).

Myosin: Consisting of a pair of heavy chains (MHC - myosin heavy chain), which has two isoforms, α-MHC and β-MHC, in addition to two pairs of light chains (MLC - myosin light chain), MLC1 and MPLC2. Three isoenzymes V1, V2, V3 are found inactivity in the cardiac muscle of several species, having the same types of light chains and differing in the constitution of heavy chains: αα in V1, αβ in V2 and ββ in V3. In heavy chains, the active site of ATPase is found (FRANCHINI, 2001). MHC is the most important participating and regulating protein in cardiac contractility. The proportion of α-MHC and β-MHC varies with the stage of development, and variations in the regulation of these isoforms are detrimental to the activity of the heart. Hypothyroidism can trigger increased expression of β-MCP (YOUSEFZADEH; JEDDI; ALIPOUR, 2016).

Troponin: The regulatory protein present in the thin filaments of the myocyte and to a lesser extent in the cytosol (LOZOVOY, 2008). Composed of three subunits (TnC, TnI and TnT) that form a complex in the skeletal muscle that regulates the actin-myosin interaction. Troponin C bonds with calcium is a fundamental process in coupling with myosin. Troponin T binds to tropomyosin (BOFF, 2008). The troponin C subunit has the same constitution in skeletal and cardiac muscle, however, the genes responsible for coding subtypes I and T have differences, and this information is fundamental and widely used in the diagnosis of acute myocardial infarction. (GODOY; BRAILE; PURINI NETO, 1998).

Tropomyosin: The long and thin molecule, whose pair of polypeptide chains have a double helix shape and can be found in one of two forms: α, with fast and slow subtypes; and β found between actin filaments (BOFF, 2008). It is part of a protein complex present in the sarcomeres of striated muscles responsible for contractility - troponin-tropomyosin complex (YONEZAWA, 2009). In cardiac myocytes, the calcium ion promotes structural change in the position of tropomyosin that reaches the actin-myosin binding site (GORDON; HOMSHER e REGNIER, 2000).

Titin: The largest protein present in mammals, sarcomeric, with great elasticity, is found from the Z line to the M line. It acts in maintaining the sarcomere structure, regulating its length and adjusting the tension when there are conformational changes, and its positioning favors this biological function. Thus, titin has a primary role in systolic and diastolic functions in the Frank-Starling mechanism, in addition to promoting ventricular stiffness (FERREIRA *et al.*, 2010).

General aspects of animal experimentation: It is important to highlight the conditions in which the animals are subjected during the entire procedure, from their acquisition from animal houses to experimental measures. Stressing agents such as excessive noise, constant cage changes, intense lighting, sudden temperature changes and overcrowding in the cages, can significantly influence the results obtained. Variations in the circadian cycle, metabolic and hormonal are the frequent factors that cause bias, which impair the measurements and the interpretation of the data (SCHANAIDER; SILVA, 2016). Another aspect of great relevance is related to disease control. These, in addition to hurting the bioethical requirements of the research, spread throughout the colony and put the viability of the experiment at risk. The exhaled ammonia smell must be an aspect frequently observed, alerting to inappropriate hygiene measures (SCHANAIDER; SILVA, 2017). Inadequate ventilation, associated with high demographic density and poor hygienic cages, leads to increased concentrations of ammonia in the breath, causing irritation in the lining epithelium of the upper airways and the animal's vulnerability to contracting infectious diseases (DAMY*et al.*, 2010).

The animal's immobilization during the experiment should be done safely so as not to injure the animal, around the chest cavity, or by the tail in a smooth way. During handling, it is important to ensure that the animal is not frightened or afraid, to avoid accidents such as bites to the researcher. In order to be transferred from one cage to another or to be weighed, it can be wrapped in both hands, making a type of shell, being securely contained or with only one hand around your body, preferably at the level of the chest (TRAMONTE; SANTOS, 2012). Animals that will be submitted to electrocardiogram procedures will be anesthetized in order to guarantee a large safety margin for both the animal and the operator. It requires knowledge of the mechanisms of action and the different access routes. In addition to the cost, feasibility and probable interference of the drugs administered, the researcher must master the animal's immobilization. Ether, used for many years in preparations with rats, has been progressively replaced by other drugs due to adverse effects such as the risk of respiratory depression.

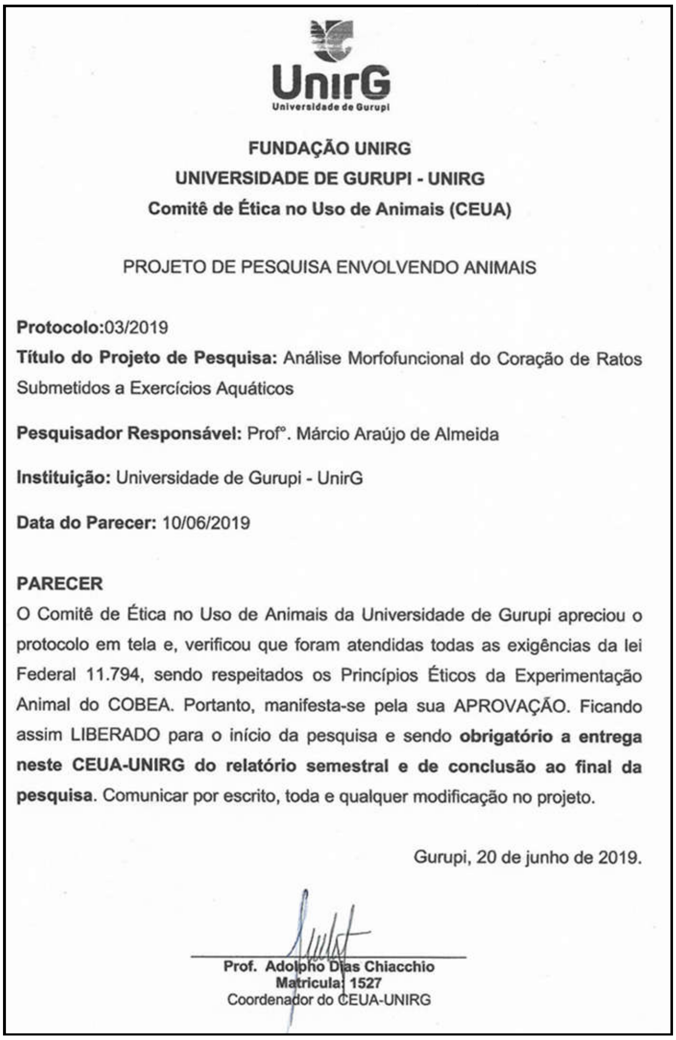
Sodium thiopental has been widely used with a greater safety margin in vivo research models. It is a barbiturate of short duration (5 to 15 minutes) that depresses the sensory cortex, decreases motor activity, alters cerebellar function, produces drowsiness and sedation (PRADO FILHO, 2000). Studies reveal that this anesthetic produces hypotension and reduced cardiac output, in addition to inhibiting aortic and carotid baroreceptors, worsening cardiovascular depression (CARREGARO *et al*., 2005). Euthanasia should guarantee a minimum of pain, fear and anxiety, when provided for in the experimental protocol. It is a legal and moral obligation to ensure the animal's well-being and minimize its discomfort, with any clinical changes, such as weight loss, physical deterioration and positive signs in the pain score, being constantly observed to identify and determine serious conditions and even an early euthanasia thus avoiding unnecessary suffering (DAMY *et al*., 2010). The scientist's ethical stance is essential in all stages of experimentation and further research. Thus, the considerations of experimentation must be based on several approaches and, among them, on the importance of the study, the responsibility with regard to the welfare of the animal exposed to the research and the experience of the researcher and the entire team involved (TOLAZZI, 2015).

METHODOLOGY

RESEARCH MODEL: This research is of an experimental nature where rats from the vivarium of the UNIRG University

Center will be used, with due authorization and approval from the Ethics Committee of the UNIRG institution.

CEUA - ETHICS COMMITTEE ON THE USE OF ANIMALS



UnirG
Universidade de Gurupi

FUNDAÇÃO UNIRG
UNIVERSIDADE DE GURUPI - UNIRG
Comitê de Ética no Uso de Animais (CEUA)

PROJETO DE PESQUISA ENVOLVENDO ANIMAIS

Protocolo:03/2019

Título do Projeto de Pesquisa: Análise Morfofuncional do Coração de Ratos Submetidos a Exercícios Aquáticos

Pesquisador Responsável: Profº. Márcio Araújo de Almeida

Instituição: Universidade de Gurupi - UnirG

Data do Parecer: 10/06/2019

PARECER

O Comitê de Ética no Uso de Animais da Universidade de Gurupi apreciou o protocolo em tela e, verificou que foram atendidas todas as exigências da lei Federal 11.794, sendo respeitados os Princípios Éticos da Experimentação Animal do COBEA. Portanto, manifesta-se pela sua APROVAÇÃO. Ficando assim LIBERADO para o início da pesquisa e sendo **obrigatório a entrega neste CEUA-UNIRG do relatório semestral e de conclusão ao final da pesquisa**. Comunicar por escrito, toda e qualquer modificação no projeto.

Gurupi, 20 de junho de 2019.

Prof. Adolpho Dias Chiacchio
Matrícula: 1527
Coordenador do CEUA-UNIRG

Figure1: Letter of approval from CEUA - Ethics Committee on the Use of Animals - UNIRG.

RESEARCH LABORATORY

All experiments will be designed, conducted and carried out in partnership with the Biophysics and Physiology Laboratory at Campus II UNIRG University in Gurupi - TO.

ANIMALS USED: 10 rats of the *Wistar* variety (male and/or female) supplied by the central vivarium of the UNIRG University Center will be used, clinically normal, fed with standard feed and water *ad libitum*. They will be kept for at least seven days in the new environment, for the purpose of setting and will be housed in polypropylene boxes with dimensions 41 x 34 x 16 cm, lined with dry rice straw, in the number of five per box, in an environment with the monitored temperature around 25^{o}C. To control the circadian rhythm, they will be kept in a room with twelve-hour light / dark cycles. The average level of noise intensity from the place where the rats will be stored and from the experimentation laboratory is on average 54,7 DB, measured by means of a digital decibel meter (IMPAC model IP-130) below the noise considered stressful for these animals Figure 2. The storage box is cleaned two to three times a week. Throughout the outlined experiment, the animals will be evaluated daily through visual inspections for clinical aspects such as mobility, weight, water and food intake, eyes, coat, behavior, possible wounds, etc. The animal weighing scale (CE mark, model SF-400) can weigh up to 7 kg with an accuracy of 1 gFigure2.

SAMPLING

Inclusion and exclusion criteria: 10 *Wistar* rats (male and/or female) will be used, clinically healthy, about three months old, weighing 300g to 400g, with good mobility and normal hair Figure 3. Obese animals, offspring, animals older than three and a half months with suspicious clinical conditions will be excluded.

DESIGN AND PROCEDURES: The rats will be divided by gender into two groups: control (five male rats, in one box) and experimental (five female rats, in another box) Figure 2. Before starting studies, the adaptation protocol consisting of 3 consecutive days will be applied to keep the animals for 10 minutes in shallow water at 30°C to reduce the stress of the animal's behavior, related to contact with water.(TOTOU *et al.*,2015) Figure 4.

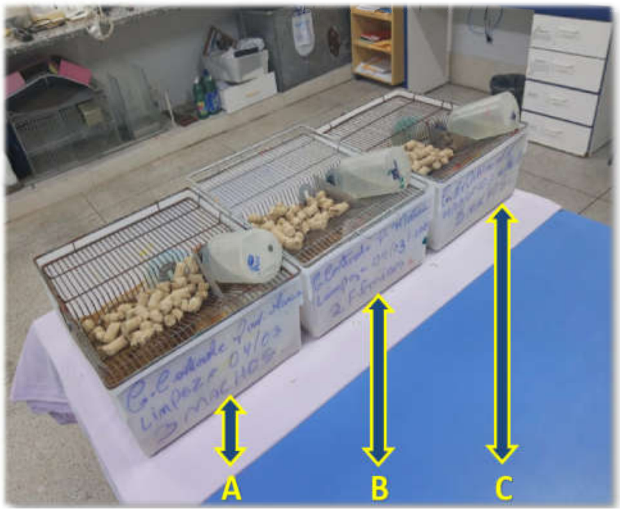


Figure 2. Rats, Feed, Water and Straw Storage Cages, 3Males (A), 2 Females (B), 5Males (C)/ Physiology Laboratory University of Gurupi, 2020

The aquatic therapy, as in Figure 4, was carried out in a plastic container (PVC) measuring 100 cm long, 70 wide, and 60 cm high with a 40 cm water column to prevent the rats from supporting the tail at the bottom of the container, at a temperature of 33ºC. The swimming exercises will be carried out in the morning period, for 25 minutes in the first week with an increase of load to 5% of the bodyweight to avoid fluctuation, this short period will be used initially as an adaptation phase to the aquatic exercise. Subsequently, the aquatic exercise protocol with an increase in load to 8% of the weight will be applied, as shown in Figure 3, to avoid fluctuation, for 5 weeks, in the frequency of five times a week, lasting 60 minutes during the morning shift, according to Table 1 of the Aquatic Therapy Protocol. Said describes the swimming time, exercise schedule and percentage of load in relation to body weight (GONÇALVES; LUCIANO, 1999; NUNES *et al*. 2015; GOMES *et al.*, 2016).

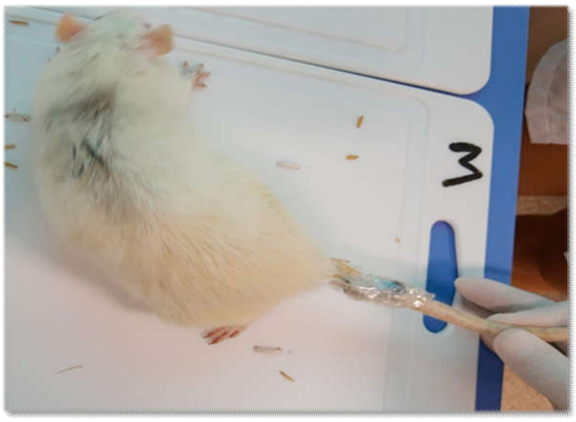


Figure 3. Fixing the load on the syrup's proximal branch - Physiology Laboratory University of Gurupi, 2020

Figure 4. Aquatic Therapy - Laboratory of Physiology University of Gurupi, 2020

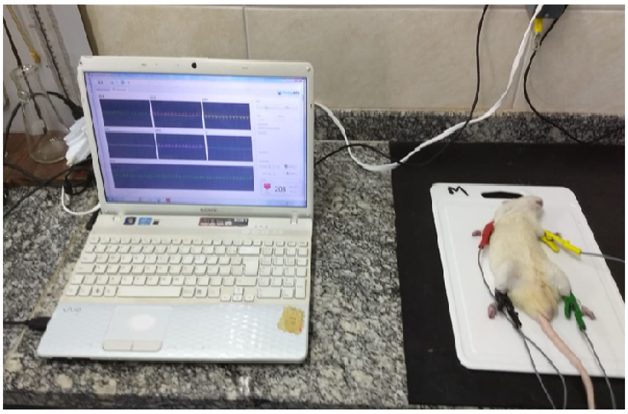


Figure 5. Electrocardiogram exam - Laboratory of Physiology University of Gurupi, 2020

In experiments with animals in vivo anesthetized with sodium thiopental (50mg/kg), these will be placed in the supine

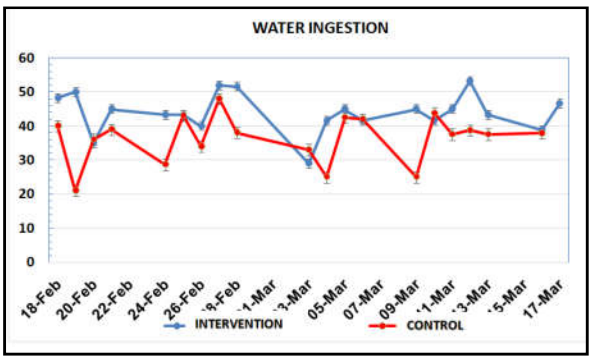


Figure 6. Median values of daily water intake in the study groups.Laboratory of Physiology University of Gurupi, 2020.

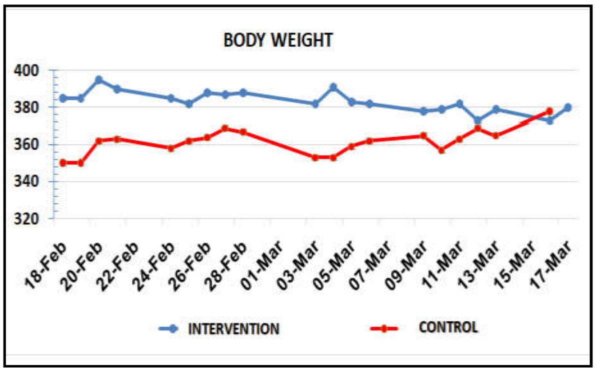


Figure 7. Values of median body weight daily in the study groups. Laboratory of Physiology University of Gurupi, 2020

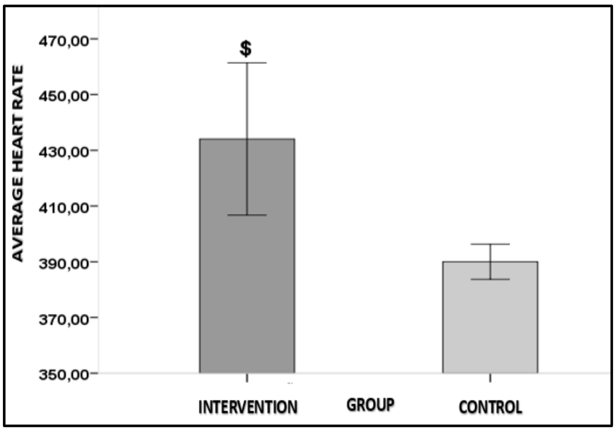


Figure 8. Média final da frequência cardíaca nos grupos de estudo.$ p<0.05. Teste t de Student. Laboratory of Physiology University of Gurupi, 2020

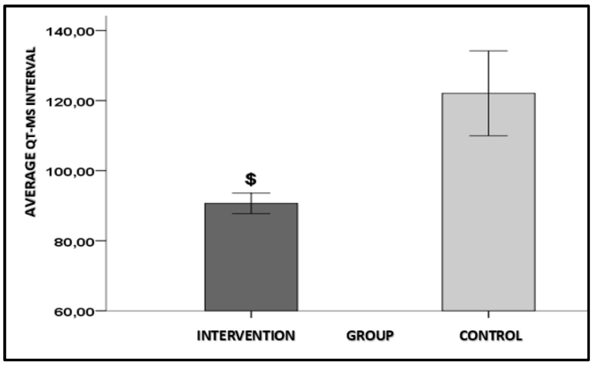


Figure 9. Média final do intervalo QT-MS nos grupos de estudo.$ p<0.05. Teste t de Student. Laboratory of Physiology University of Gurupi, 2020

position on surgical clipboards, the four electrodes proper to the ECG will be fixed by means of claws on the feet (trichotomized pulses) previously lubricated with electrolytic gel (Carbogel®) and connected to the DL 660 model electrocardiograph, Delta Life brand. The electrocardiogram with the isoelectric signal will be collected without interference in Figure 5. At the end of the experimental period, the animals will be anesthetized with sodium thiopental 50mg/kg according to body mass, then a thoracotomy will be performed to dry the heart, which will be weighed by a precision scale (0,01g) and later slides were prepared for histological analysis.

Variables: The variables analyzed both in control rats and in rats submitted to aquatic exercises were: heart rate, QRS

Table 1. Aquatic Therapy Protocol

	Monday	Tuesday	Fourth	Fifth	Friday	Saturday
1ª Week	25 Min. 8 h / 5%	25 Min. 8 h/ 5%	25 Min. 8h/5%	25Min. 8h/5%	25 Min. 8h / 5%	25Min. 8h/5%
2ª Week	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%
3ª Week	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%
4ª Week	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%
5ª Week	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%
6ª Week	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%	60 Min. 8h/ 8%

Source: Gomes et al., 2016.

complex (amplitude), QT interval duration, signs of changes in cardiomyocyte trophism and heart weight, observing rats from the group of intervention, started the experiment with an average body weight of 400mg and rats in the control group an average of 350mg, thus evolving at the end of the experiment with the reduction of body weight in the intervention group to an average of 380mg and control rats increased their food intake for each day of the test performed.

Data collection instruments, application strategies, data analysis and presentation: For the analysis and description of sample data in this study, measures of central tendency and dispersion of variability inherent to the samples (standard deviation, standard error of the mean and coefficient of variation) will be used. Student's t-test will be used for the inductive analysis of all variables together, with the level of significance adopted for 5%, that is, all probabilities below 0,05 will be considered significant. For the descriptive statistical treatment such as means, standard deviation, coefficient of variation, Tables and graphs, the Microsoft Office Excel 2007 program will be used and, for inductive analysis, the Bioestat-5 program will be used.

ETHICAL ASPECTS: All treatment, manipulation and euthanasia procedures will be carried out in strict compliance with the resolutions of the specific Brazilian norms of Bioethics in Animal Experiments, Law Procedures for the Scientific Use of Animals, N0 11794 - sanctioned on October 8, 2008 - of the National Council of Animal Experimentation Control - CONCEA. This project will be submitted to the Animal Use Ethics Committee (CEUA) of the University of Gurupi. According to the Health Waste Management Manual (2006), hospital waste (RSS) is classified according to its function, characteristics and risks that it can cause to the environment and health. Therefore, the National Health Surveillance Agency (ANVISA) No. 306/04 and the National Environment Council - CONAMA, Resolution No.358/05 classify RSS into five groups: A, B, C, D and E. The residues of this study are inserted in Group A, which are those that present biological agents and risks of infection, such as anatomical pieces, carcasses, among others. These materials need to be treated through physical, hemical or other validated processes to later be sent to the authorized landfill for the final deposition of RSS. In this way, the carcasses of the animals of the present study will be stored in appropriate bags and frozen at -1ºC in the Consul brand refrigerator with a capacity of 380 liters in the Physiology laboratory, after which they will be disposed of in the biological waste of the University of Gurupi. The carcasses are collected on Mondays, Wednesdays and Fridays and are then deposited in the hospital landfill in charge of the collection by the city hall's automobiles. However, this research may pose risks for animals, researchers and the scientific community. Animals can suffer if there is an error in the dosage of the anesthetic and scientists are attentive and well trained to avoid this suffering. Scientists are at risk of being bitten by animals when handling them under anesthesia. Personal protective equipment, handling techniques and protection from rats from reliable sources were used to prevent any type of injury or contamination. As for the risks to the scientific community, these could be caused by the publication of incomplete data, inconsistent that could be due to methodological errors. There is a guarantee that the researchers are sufficiently trained so that these types of errors do not occur and due to ethical composure in the publication of the results.

RESULTS

During the study, the experimental group, throughout the study, evolved with water intake with an average of 48.33 ml daily. Proceeding with values of 50 ml; 36 ml; 45 ml; 43,33 ml; 43 ml; 40 ml; 52 ml; 51,66 ml; 29 ml; 41,66 ml; 45 ml; 42 ml; 45 ml; 43,77 ml; 45 ml; 53,33 ml; 43,33 ml; 37,9 ml and 46,66 ml. Thus, it is possible to observe that the values remained constant, with a significant difference only on March 5th, as consumption was only 29 ml. Thus, the animals presented the necessary intake for the development of the experiment. At the end of the experimental period, the animals will be anesthetized with sodium thiopental 50mg/kg according to body mass, then a thoracotomy will be performed to dry the heart, which will be weighed by a precision scale (0,01g) and later slides were prepared for histological analysis.

Variables: The variables analyzed both in control rats and in rats submitted to aquatic exercises were: heart rate, QRS complex (amplitude), QT interval duration, signs of changes in cardiomyocyte trophism and heart weight, observing rats from the group of intervention, started the experiment with an average body weight of 400mg and rats in the control group an average of 350mg, thus evolving at the end of the experiment with the reduction of body weight in the intervention group to an average of 380mg and control rats increased their food intake for each day of the test performed.

Data collection instruments, application strategies, data analysis and presentation: For the analysis and description of sample data in this study, measures of central tendency and dispersion of variability inherent to the samples (standard deviation, standard error of the mean and coefficient of variation) will be used. Student's t-test will be used for the

inductive analysis of all variables together, with the level of significance adopted for 5%, that is, all probabilities below 0,05 will be considered significant. For the descriptive statistical treatment such as means, standard deviation, coefficient of variation, Tables and graphs, the Microsoft Office Excel 2007 program will be used and, for inductive analysis, the Bioestat-5 program will be used.

ETHICAL ASPECTS

All treatment, manipulation and euthanasia procedures will be carried out in strict compliance with the resolutions of the specific Brazilian norms of Bioethics in Animal Experiments, Law Procedures for the Scientific Use of Animals, N0 11794 - sanctioned on October 8, 2008 - of the National Council of Animal Experimentation Control - CONCEA. This project will be submitted to the Animal Use Ethics Committee (CEUA) of the University of Gurupi. According to the Health Waste Management Manual (2006), hospital waste (RSS) is classified according to its function, characteristics and risks that it can cause to the environment and health. Therefore, the National Health Surveillance Agency (ANVISA) No. 306/04 and the National Environment Council - CONAMA, Resolution No.358/05 classify RSS into five groups: A, B, C, D and E.

The residues of this study are inserted in Group A, which are those that present biological agents and risks of infection, such as anatomical pieces, carcasses, among others. These materials need to be treated through physical, hemical or other validated processes to later be sent to the authorized landfill for the final deposition of RSS. In this way, the carcasses of the animals of the present study will be stored in appropriate bags and frozen at -1ºC in the Consul brand refrigerator with a capacity of 380 liters in the Physiology laboratory, after which they will be disposed of in the biological waste of the University of Gurupi. The carcasses are collected on Mondays, Wednesdays and Fridays and are then deposited in the hospital landfill in charge of the collection by the city hall's automobiles. However, this research may pose risks for animals, researchers and the scientific community. Animals can suffer if there is an error in the dosage of the anesthetic and scientists are attentive and well trained to avoid this suffering. Scientists are at risk of being bitten by animals when handling them under anesthesia. Personal protective equipment, handling techniques and protection from rats from reliable sources were used to prevent any type of injury or contamination. As for the risks to the scientific community, these could be caused by the publication of incomplete data, inconsistent that could be due to methodological errors. There is a guarantee that the researchers are sufficiently trained so that these types of errors do not occur and due to ethical composure in the publication of the results.

RESULTS

During the study, the experimental group, throughout the study, evolved with water intake with an average of 48.33 ml daily. Proceeding with values of 50 ml; 36 ml; 45 ml; 43,33 ml; 43 ml; 40 ml; 52 ml; 51,66 ml; 29 ml; 41,66 ml; 45 ml; 42 ml; 45 ml; 43,77 ml; 45 ml; 53,33 ml; 43,33 ml; 37,9 ml and 46,66 ml. Thus, it is possible to observe that the values remained constant, with a significant difference only on March 5th, as consumption was only 29 ml. Thus, the animals presented the necessary intake for the development of the experiment. In this study, from the variable bodyweight of the analyzed group, it was possible to infer that the intervention group had a higher weight than the control group. Despite this, the condition of exposure to physical exercise did not significantly influence the weight of the animals, thus showing that the training does not interfere with the weight of the kidneys of these animals. In this sense, at the beginning of the treatment, the average weight of the animals was 385mg in the experimental group to 350mg in the control group. At the end of the experiment, the intervention group was at 385mg and the control at 378mg. In the evaluation of chronotropism, the heart rate of the intervention and control groups had significant differences, demonstrating that physical exercise can significantly change the HR of the animals analyzed ($p < 0.05$). In this bias, it is possible to understand the values presented as strong health indicators. In addition, the significant increase in heart rate is a strong indicator of morpho-functional changes in the heart, with an increase in heart rate as a sign of physiological adaptation to exposure to aquatic exercises. In this work, the evaluation of cardiac chronotropism at the mean of the QT-MS interval in the study groups, the results showed an average of 120ms for the values obtained in the QT interval of the control group and 90ms for the experimental group. In this situation, the QT interval varies inversely in relation to HR. This corroborates the explanation for the increase in heart rate since there was an increase in the speed with which the stimulus propagates through the myocyte.

DISCUSSION

In this line of reasoning, the practice of physical exercises has been gaining more and more highlights for acting both in the prevention and treatment of various diseases, as well as for providing a better quality of life to the population, besides, the practice of resistance exercises produces an increase in endorphin and brain levels. The behavior observed in this study showed positive results, as the intervention group reaching a significantly higher heart rate compared to the control group. During the QT interval, which is defined as the measurement from the beginning of the QRS complex to the end of the T wave, this interval represents the total duration of ventricular electrical activity. (DE OLIVEIRA JUNIOR, 2004). According to the data found, it is possible to infer that during physical exercise there is an increase in blood flow, with a consequent increase in venous capacitance, which generates an increase in the shear stress of blood flow in the vessel wall, which stimulates the release of nitric oxide (GOTO, *et al*., 2003). In addition to nitric oxide, other substances such as prostaglandins, adenosine, ATP, potassium, lactate, bradykinin and vasopressin, vasodilators can modify the alpha-adrenergic vasoconstrictor response (HALLIWILL; 2001; PONTES *et al*., 2008) and possibly contribute to changes in cardiovascular parameters. Physical training has been advocated as an excellent preventive factor for cardiovascular diseases as it promotes hemodynamic and autonomic adaptations, structural changes in the walls of arterial vessels and decreased sympathetic tone. Maux *et al*. (2009), did not observe changes in the arterial wall of the horizontal aorta of rats submitted to protein malnutrition during pregnancy and lactation who underwent physical training from the age of 60 days, for eight weeks. Likewise, Huonker *et al*. (2003), using athletes from different sports, demonstrated that there were no dimensional changes in the aortic artery, possibly due to the predominance of elastic fibers in this artery. According to the same authors, the aortic artery is a central vessel responsible for capturing the blood flow ejected from the left ventricle, through a passive dilation caused by the expansion of the elastic structures of the artery. Such expansion allows an elastic recoil of the vessel wall during ventricular diastole. Because it is highly elastic, the arterial wall of the aorta may not yield to increased blood flow due to cardiac adaptations resulting from physical exercise.

Conclusion

In short, from the results presented here, it was possible to infer that aquatic exercises generated morphofunctional adaptation due to left ventricular hypertrophy with increased cardiac weight. Thus, there were significant changes in the cardiac parameters analyzed in the rats in the experimental group compared to the control group. Continuity is necessary for new findings to be reported.

BIBLIOGRAPHIC REFERENCES

AGUILA, M. B.; RODRIGUES-APFEL, M. I.; MANDARIM-DE-LACERDA, C. A. Stereology of the myocardium and blood biochemistry in aged rats fed with a cholesterol-rich and canola oil diet (n-3 fatty acid rich). Basic research in Cardiology, v. 93, n. 3, p. 182-191, jun. 1998. Disponível em: <https://www.ncbi.nlm.nih.gov/ pubmed/ 9689444>. Acesso em: 20 Out. 2019.

ALDENUCCI, B. G.; HOINASKI, L. F.; NUNES, E. A. The role of glycogen synthase kinase-3 on muscle hypertrophy pathways modulation and the influence of resistance exercise on this signaling/A participacao da glicogenio sintase cinase 3 na modulacao de vias hipertroficas musculares e as influencias exercidas pelo exercicio de forca nestas sinalizacoes. Revista Brasileira de Prescrição e Fisiologia do Exercício, v. 4, n. 19, p. 94-106, 2010. Disponível em:<http://go.galegroup.com/ps/anonymous?id=GALE%7CA389800903&sid=googleScholar&v=2.1&it=r&linkaccess=fulltext&issn=19819900&p=AONE&sw=w>. Acesso em: 20 Out. 2019.

ANTUNES, J. S. *et al*. Efeito do exercício físico resistido de subida em escada, sobre a regeneração nervosa periférica, em modelo experimental de ciatalgia. Tese de Doutorado. Universidade Estadual do Oeste do Paraná. Centro de Ciências Biológica, 2016. Disponível em: http://tede.unioeste.br/handle/tede/3230. Acesso em: 20 Out. 2019.

BAPTISTA, S. *et al*. Treadmill running and swimming imposes distinct cardiovascular physiological adaptations in the rat: Focus on serotonergic and sympathetic nervous systems modulation. Acta Physiologica Hungarica*,* v. 95, p. 365-381,2008. Disponível em:<https://www.ncbi.nlm.nih.gov/pubmed/19009912>. Acesso em: 15 Out. 2019.

BOFF, S. R. A fibra muscular e fatores que interferem no seu fenótipo. Acta fisiátrica, v. 15, n. 2, p. 111-116, 2008. Disponível em: <https://www.revistas.usp.br/ actafisiatrica/article/view/102923>.Acesso em: 20 Out. 2019.

BORLOZ, M. P. *et al*. Electrocardiographic differential diagnosis of narrow QRS complex tachycardia: an ED-oriented algorithmic approach. The American journal of emergency medicine, v. 28, n. 3, p. 378-381, 2010.Disponível em: <https://www.sciencedirect.com/ science/article/pii/S0735675708008668>.Acesso: 20 Out. 2019.

CARREGARO, A. B.; CASTRO, M. B.; MARTINS, F. S. Estudo da ação inflamatória aguda do tiopental intraperitoneal em ratos. Arquivo Brasileiro de Medicina Veterinária e Zootecnia, v.57, n.2, p. 191-195,2005.Disponível em: <http://www.scielo.br/pdf/%0D/abmvz/v57n2/a09v57n2.pdf.>Acesso em: 20 Out. 2019.

CARREGARO, R. L. *et al*. Efeitos fisiológicos e evidências científicas da eficácia dafisioterapia aquática. Revista Movimenta, v. 1, n. 1, p. 23-27, 2008. Disponível em: <https://www.revista.ueg.br/index.php/movimenta/article/view/7235>. Acesso em: 15 Out. 2019

CHOI, K. M. *et al*. The effects of caloric restriction on F etuin□A and cardiovascular risk factors in rats and humans: a randomized controlled trial. Clinical endocrinology, v. 79, n. 3, p. 356-363, 2013.

CHRISTOFOLETTI, D. C. *et al*. Eletrocardiografia: um método útil na seleção de animais de experimentação. Saúde em Revista, v. 13, n. 33, p. 39-46, 2013.Disponível em: https://www.metodista.br/revistas/revistas-unimep/index.php/sr/article/view/1689. Acesso em: 20 Nov. 2019.

DAMY, Sueli Blanes *et al*. Aspectos fundamentais da experimentação animal-aplicações em cirurgia experimental. Revista da Associação Médica Brasileira, v. 56, n. 1, p. 103-111, 2010. Disponível em: <http://producao.usp.br/handle/BDPI/8744>. Acesso em: 20 Out. 2019.

DE OLIVEIRA JUNIOR, Nilson Araújo *et al*. O Eletrocardiograma e a Síndrome de QT Longo. Revista da SOCERJ, p. 3, 2004.

EGLI, Cory N. The Effects of Land vs. Aquatic HIIT Treadmill Running on Aerobic and Anaerobic Performance – A Pilot Study. Honors Research Project, 2015. Disponível em:https://pdfs.semanticscholar.org/a8a6/d6f2faa04a9d7061e2d698a6d05a2cd6f0df.pdf. Acesso em: 20 Out. 2019.

FERREIRA, Anderson J. *et al*. Attenuation of isoproterenol-induced cardiac fibrosis in transgenic rats harboring an angiotensin-(1-7)-producing fusion protein in the heart. Therapeutic Advances in Cardiovascular Disease, v. 4, n. 2, p. 83-96, 2010.

FRANCHINI, K. G. Hipertrofia cardíaca: mecanismos moleculares. Revista Brasileira de Hipertensão, v. 8, n. 1, p. 125-42, 2001. Disponível em: <http://departamentos.cardiol.br/dha/revista/8-1/014.pdf>. Acesso em: 20 Out. 2019.

GODOY, M. F. de; BRAILE, D. M.; PURINI NETO, J. A troponina como marcador de injúria celular miocárdica. Arquivos Brasileiros de Cardiologia, v. 71, n. 4, p. 629-633, 1998. Disponível em: <http://www.scielo.br/scielo.php?pid=S0066-782X1998001000013 &script= sci_arttext>. Acesso em: 20 Out. 2019.

GOMES, Nívea Maria André *et al*. Aquatic therapy in bone mineral density in rats after paw disuse by Immobilization. Bone, v. 4, p. 11, 2016.

GONÇALVES, A. L.; LUCIANO, E. Respostas inflamatórias em ratos wistar submetidos a atividade física. Revista Brasileira de Atividade Física & Saúde, v. 4, n. 1, p. 39-46, 1999. Disponível em: <http://rbafs.org.br/RBAFS/article/view/1023>. Acesso em: 15 Out. 2019.

GORDON, A. M.; HOMSHER, E.; REGNIER, M. Regulation of contraction in striated muscle. Physiological Reviews, v. 80, n. 2, p. 853-924, 2000. Disponível em: <https:// www.physiology.org/doi/full/10.1152/physrev.2000.80.2.853>.Acesso em: 20 Out. 2019.

HAJJE, G. *et al*. Hypothyroidism and its rapid correction alter cardiac remodeling. JournalPLoS One, v. 9, n. 10, p. e109753, oct, 2014. Disponível em: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0109753>. Acesso em: 20 Out. 2019.

HALL, John E. Guyton e Hall tratado de fisiologia médica. Elsevier, 2017. <http://go. galeg roup.co m/ps/anonymous?id=GALE%7CA389800903&sid=googleScholar&v=2.1&it=r&linkaccess=fulltext&issn=19819900&p=AONE&sw=w>. Acesso em: 20 Out. 2019.

JACOBSEN, T. N. *et al*. Relative contributions of cardiopulmonary and sinoaortic baroreflexes in causing sympathetic activation in the human skeletal muscle circulation during orthostatic stress. Circulation Research, v.73, p. 367-378,1993. Disponível em: <https://www.ncbi.nlm.nih.gov/pubmed/8330379>. Acesso em: 14 Out. 2019.

KRUEL, L. F. M. *et al*. Cardiorespiratory responses to stationary running in water and on land. Journal of sports science & medicine, v. 12, n. 3, p. 594, 2013.

LOZOVOY, M. A. B.; PRIESNITZ, J. C.; SILVA, S. A. Infarto agudo do miocárdio: aspectos clínicos e laboratoriais. Interbio, v. 2, n. 1, p. 4-10, 2008. Disponível em: <http://www.unigran.br/interbio/paginas/ed_anteriores/vol2_num1/arquivos/artigo1.pdf>. Acesso em: 20 Out. 2019.

MOHRMAN, D. E.; HELLER, L. J.; ROJAS, A. M. G. Fisiologia cardiovascular. 6. ed. Rio de Janeiro: McGraw-Hill, 2007. Disponível em: <https://s3.amazonaws.com/academia.edu.documents/39621521/Fisiologia_Cardiovascular.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1552682951&Signature=6CQf7ZhKSiquQYsiacUhjbCPp84%3D&response-content-disposition=inline%3B%20filename%3DFisiologia_Cardiovascular.pdf>.Acesso em: 20 Out. 2019.

MARTINS JÚNIOR, Francisco de Assis Dias. Efeitos do treinamento físico em meio aquático e terrestre sobre respostas cardiovasculares em idosas hipertensas. 2018.

NUNES, R. B. *et al*. Hemodynamic responses during an incremental swimming exercise test in rats. Journal Exercise Physiology Online, v. 15, n. 3, p. 55-62, 2015. Disponível em: <https://www.researchgate.net/publication/290453459_Hemodynamic_responses_during_an_incremental_swimming_exercise_test_in_rats>. Acesso em: 14 Out. 2019.

PRADO FILHO, O. R. *et al*. Xilazina como pré-medicação para anestesia com tiopental sódico em cães. Acta Cirurgica Brasileira, v. 15, n. 2, p. 00-00, 2000. Disponível em: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0102-86502000000200007&lng=en&nrm=iso>. Acesso em: 14 Out. 2019

QUINTÃO-JÚNIOR, J.F. *et al*. Morphology and contractility in cardiomyocytes of rats with low exercise performance. ARQUIVOS BRASILEIROS de CARDIOLOGIA, v. 98, n. 5, p. 431-436, 2012. Disponível em: <http://www.scielo.br/scielo.php?pid=S0066-782X20120 00500 008&script=sci_arttext&tlng=pt>. Acesso em: 20 Out. 2019.

ROBERTO, J. V. B. *et al*. Parâmetros bioquímicos de referência de ratos wistar de diferentes faixas de peso, provenientes do biotério das faculdades Nova Esperança–PB. Revista de Ciências da Saúde Nova Esperança, v. 16, n. 1, p. 81-87, 2018.

RODRIGUEZ, Carlos J. *et al*. Association of annular calcification and aortic valve sclerosis with brain findings on magnetic resonance imaging in community dwelling older adults: the cardiovascular health study. Journal of the American College of Cardiology, v. 57, n. 21, p. 2172-2180, 2011.

SCHNAIDER, T. B.; SOUZA, C. de. Aspectos éticos da experimentação animal. Revista Brasileira de Anestesiologia, v. 53, n. 2, p. 278-85, 2003. Disponível em: https://editorarealize.com.br/revistas/conapesc/trabalhos/TRABALHO_EV058_MD1_SA94_ID287_05052016002950.pdf Acesso em: 20 Out. 2019.

Stagg NJ, Mata HP, Ibrahim MM, *et al*. Regular exercise reverses sensory hypersensitivity in a rat neu – ropathic pain model. Role of endogenous opioids. Antes- thesiology 2011;114(4):940-8

STAGG, Nicola J. *et al*. Regular exercise reverses sensory hypersensitivity in a rat neuropathic pain modelrole of endogenous opioids. Anesthesiology: The Journal of the American Society of Anesthesiologists, v. 114, n. 4, p. 940-948, 2011.

The Journal of Neuroscience, v. 36, n. 44, p11320–11330, 2016. Disponível em: http://www.jneurosci.org/content/36/44/11320.abstract Acesso em: 20 Out. 2017.

THOMAL, R. A. Avaliação da função cardíaca em modelo experimental de hipotireoidismo. 2007. 99 f. Tese (Doutorado em Saúde da Criança e do Adolescente), Programa de Pós-Graduação em Saúde da Criança e do Adolescente, Universidade Federal do Paraná, Curitiba, PR, 2007. Disponível em: <https://www.acervodigital. ufpr.br/bitstream/handle/1884/21552/Avaliacao%20da%20Funcao%20Cardiaca%20EM%20MODELO%20EXPERIMENTAL%20DE%20HIPOTIREOIDISMO.pdf?sequence=1>. Acesso em: 20 Out. 2019.

TOLAZZI, J. R.; GARCIA, R. D.; BEZERRA, A. S. Nutrição experimental: conceitos, aspectos éticos e dietas experimentais. Disciplinarum Scientia. Série: Ciências da Saúde, v. 16, n. 1, p. 147-162, 2015. Disponível em: <https://www.periodicos.ufn.edu.br/index.php/disciplinarumS/article/view/1121>. Acesso em: 20 Nov. 2019.

TOTOU, N. L. *et al*. Cardiopulmonary reflex and blood pressure response after swimming and treadmill exercise in hypertensive rats. Journal of Exercise Physiology Online, v. 18, n. 5, 2015. Disponível em: <https://www.asep.org/asep/asep/JEPonlineOCTOBER2015_Becker.pdf>. Acesso em: 14 Out. 2019.

YONEZAWA, H. *et al*. Outer membrane vesicles of Helicobacter pylori TK1402 are involved in biofilm formation. BMC Microbiology, v. 9, n. 1, p. 197, 2009. Disponível em: <https://bmcmicrobiol.biomedcentral.com/articles/10.1186/1471-2180-9-197>. Acesso em: 20 Out. 2019.

YOUSEFZADEH, N.; JEDDI, S.; ALIPOUR, M. R. O Efeito de Hipotireoidismo Fetal na Expressão da Miosina Cardíaca de Cadeia Pesada em Ratos Macho. Sociedade Brasileira de Cardiolpogia, v. 107, n. 2, p. 147-153, 2016. Disponível em: <http://www.scielo.br/pdf/abc/2016nahead/pt_0066-782X-abc-20160099.pdf>.Acesso em: 20 Out. 2019.

****