ISSN: 2230-9926

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

IJDR

International Journal of Development Research
Vol. 07, Issue, 08, pp.14599-14603, August, 2017

REVIEW ARTICLE

Open Access

RESISTANCE EXERCISE TRAINING AND THE CONTROL OF BLOOD PRESSURE IN HYPERTENSIVE HUMANS

[*1]Cleberson Dias Lima, , [1]Valdir Aragão do Nascimento, [2]Valter Aragão do Nascimento, [1]Paula Felippe Matinez and [1]Silvio Assis de Oliveira Júnior

[1]Post-graduate Program in Health and Development in the Mid-West Region, Federal University of Mato Grosso do Sul, 79070–900, Campo Grande, MS, Brazil

[2]Group of Spectroscopy and Bioinformatics Applied to Biodiversity and Health, School of Medicine, Postgraduation Program in Health and Development in the Middle West Region, Federal University of Mato Grosso do Sul, Brazil, Zipcode: 79070900, Campo Grande, MS, Brazil

ARTICLE INFO

Article History:

Received 10th May, 2017
Received in revised form
15th June, 2017
Accepted 23rd July, 2017
Published online 30th August, 2017

Keywords:

Resistance exercises training,
Control of blood pressure

ABSTRACT

The present manuscript is focused on the use of resistance exercises as measure in order to control of blood pressure, and to demonstrate that moderate physical exercise is not a risk factor for health of hypertensive humans. As methodology, bibliographical and documentary analyses were performed with basis on scientific literature. As result, resistance exercises have presented different cardiovascular effects depending on their intensity. Generally, low-intensity exercises have improved localized muscular resistance, and have increased blood pressure values during its execution, but reduced arterial pressure after its accomplishment; in the long term, low-intensity resistance training may promote a small drop in the blood pressure of hypertensives. On the other hand, high intensity resistance exercises, which aim to improve muscle strength / hypertrophy, have promoted an extremely large increase in blood pressure during its execution, with important risks to the rupture of preexisting cerebral aneurysms in hypertensive patients. Also, those exercises have not been presenting a chronic hypertensive effect, despite reducing blood pressure after its completion. Thus, low-intensity resistance training has been indicated for hypertensive patients in addition to aerobic exercises, but high-intensity resistance exercises should be avoided in these patients.

Corresponding author

Citation: Cleberson Dias Lima, Valdir Aragão do Nascimento, Valter Aragão do Nascimento, Paula Felippe Matinez and Silvio Assis de Oliveira Júnior 2017. "Counter-resistance exercises and the control of blood pressure in hypertensions", *International Journal of Development Research*, 7, (08), 14599-14603.

INTRODUCTION

As the decrease of muscle mass evolves, expected event with advancing age and physical inactivity, it is observed the fall in basal and rest metabolic level, leading to greater accumulation of fat and consequent development of obesity and arterial hypertension respectively. In order to prevent such framework, the American College Sports Medicine / ACSM recommends performing aerobic exercises predominantly associated with the American College Sports Medicine / ACSM recommends performing aerobic exercises predominantly associated with resistance and flexibility exercise training for hypertensive humans (AMERICAN COLLEGE OF SPORTS MEDICINE, 2010). Prospective epidemiological studies have demonstrated that regular aerobic physical exercises reduce blood pressure levels, decreasing excess body weight and dyslipidemia, as well as insulin resistance and stress (BARRETTO; NEGRÃO, 2006). In this context, as recommended by the American College Sports Medicine / ACSM - aerobic physical exercises are beneficial to hypertensive humans, especially as a supporting intervention in the non-pharmacological therapy of hypertension conditions. Regular practice of physical exercises in the prevention and treatment of hypertension has been sustained by the hypotensive capacity of the aerobic exercise,

which results low indexes risks to human health (FORJAZ et al., 2003). Since 1950s, publications of scientific effort such as the study by Morris et al. (1953), considering postmen who walks or using bicycles, and the other ones who performed bureaucratic functions, showed that the most active postmen had a lower incidence of cardiovascular diseases than their more sedentary colleagues (GHORAYEB, BARROS, 1999). In the 1960s, other studies showed a concern about the use of resistance exercises by hypertensive and cardiac patients, such as Humphreys and Lind (1963) and Lind and McNicol (1967). Thus, the results of these studies contributed to the insertion of the practice of resistance exercises (WHELTON et al, 2002) in international health guidelines, a practice that was absent until mid-1990 in the mentioned guideline. During the last decades, there has been an expressive increase in demand for the resistance training modality, specifically regarding the use of this expedient as a potential strategy in the primary and secondary prophylaxis of the various and variant cardiomyopathies. Likewise, when carried out in a correct way and supervised by a qualified professional, resistance exercise contributes to the maintenance of the good health of humans, especially with regard to muscular strength and well- being psychosocial.

Actually, changes in the sedentary lifestyle, with regular practice of physical exercises, reduces by 40% the risk of death from cardiovascular diseases, among them hypertension. Physical exercise promotes positive physiological adaptations, reducing risks for development of cardiovascular diseases, and promoting greater autonomic control of the heart rate and reduction in blood pressure levels (HASKELL et al., 2007; MONTEIRO, 1996). There are many types of exercise such as isometric, isotonic and isokinetic. Isometric exercise integrates maintained muscle contraction without joint motion, while isotonic modality involves muscle contraction accompanied of joint movement. Instead, isokinetic exercise realizes joint motion in a constant speed. The use of some terms such as resistance exercise or strength training has classically been referring to an exercise by which the movement of the body's segment is performed against the opposition of an external force usually offered by some type of equipment. However, unanimity regarding the benefits of using aerobic exercises to control blood pressure does not reach the sphere of resistance exercises, and over the last decades there has been a visible increase in the scientific interest regarding the analysis of cardiovascular effects of the practice of high impact resistance exercises (FORJAZ et al., 2003).

BENEFICIAL AND DETRIMENTAL EVIDENCES RELATIVE TO RESISTANCE EXERCISE TRAINING

Relative to the use of resistance exercises and the possibility of harmful results, several hypotheses have been raised, among them the most serious are the excessive elevation of blood pressure leading to rupture of arterial aneurysms, or repeated pressure overload resulting abnormal hypertrophy concentric myocardium. Despite the efforts made to sustain these risks and effects, research has shown satisfactory results with respect to use of resistance exercises, including cardiovascular benefits (Graves et al., 2001; STEIN, 2007). From the point of view of those benefits, there has been an increase in the indication of bodybuilding for the recovery process in different cardiovascular conditions - stroke, peripheral obstructive vascular disease, acute myocardial infarction, heart transplantation, congestive heart failure (CAMERA, SANTARÉN, JACOB FILHO, 2008). On the other hand, there are indirect forms (equations) and direct measures of exercise intensity in order to prescript physical exercise; classically, these diverse methods have lower or greater precision, as well as the risk of complications during the exercise execution (LANCHA JÚNIOR; LANCHA, 2016). In general, predictive equations are developed from regressive statistical methods, which makes them imprecise and with a high standard error of estimation. As a consequence, prediction methods may be associated to bias of measurement. Comparative study has reported acute cardiovascular effects in response to leg-press exercises performed with various intensities (1, 6 and 20 RM) and continuous aerobic cycle ergometer (75-80% of reserve heart rate) (POLITO, 2003). Accordingly, when performed with high loads and few repetitions, leg-press exercise resulted lower cardiac work (double-product) than exercises involving smaller loads and with a high number of repetitions. Exercises with 1 RM and 6 RM would offer lower cardiac risk than exercises 20 RM. Importantly, lower cardiac risk does not mean that there is not cardiovascular risk. The extent of the possible injury will always depend on the patient's level of effort when performing the exercise. With basis on a methodology of resistance exercise of different body segments, Bataglin *et al.* (2010) concluded that there was a safe increase of systolic blood pressure levels in patients submitted to resistance exercises. However, involvement of large muscle groups and high loads resulted a tendency to increase systolic blood pressure levels. Thus, this elevation does not imply an immediate threat to the patients' health, but serves as an alert for the possible complications with regard to the practice of high-load exercises. Also, Focht and Koltyn (1999) have showed that high-intensity exercises unchanged blood pressure levels, both systolic and diastolic. Other studies (REZK et al., 2006; SIMAO et al., 2005) have postulated a reduction of systolic blood pressure measures in humans submitted to very intense exercises - an effect not described in previous investigations (RAGLIN; TURNER; EKSTEN, 1993).

Resistance exercises produce an equivalent or greater increase of the arterial pressure in relation to the continuous aerobic exercises, but a smaller heart rate increase (FORJAZ, 2003). Consequently, double-product values have been lower than 30,000, which would be the score for angina. However, blood pressure values have been directly and linearly associated with the amount of recruited muscle mass in order to contract during resistance exercise. These circumstances has resulted important peripheral vascular resistance and health risks (FLECK; KRAEMER , 2006). Actually, the pressure load is related with the required resistance, as well as duration of muscle contraction and rest period (CASTINHEIRAS; COSTA FILHO; FARINATTI, 2010). Although the 1 RM test is considered a gold standard for the prescription of the intensity of resistance exercises, some authors have pointed the possibility of injury in the 1 RM test application. However, no author has related occurrence of accidents due execution of these tests (REYNOLDS; GORDON; ROBERGS, 2006). It is noteworthy that the Valsalva maneuver contributes to elevate blood pressure measures during resistance exercises; with intensity equal to or greater than 80% of 1 RM, the present maneuver is inevitable during the resistance exercises (BARRETTO, NEGRÃO, 2006). The maneuver in question, created by the Italian physician Antonio María Valsalva and very widespread nowadays, consists of forcing the air against closed lips and a stuffy nose, that is, any attempt to emit air

with the closed glottis or with the mouth and the nose closed (CASTIGLIONI, 1947). Physical exercise has been widely used for prevention and for treatment of cardiovascular and metabolic diseases. Brazilian organizations such as the Brazilian Society of Sports and Exercise Medicine (SBMEE), Brazilian Society of Cardiology (SBC), as well as international societies such as American College of Sports Medicine (ACSM) and the International Federation of Sports Medicine (FIMS) have recommended physical activity with adequate dose and orientation (BARRETTO; NEGRÃO, 2006; SANTOS et al., 2008). Accordingly, respective guidelines support predominant practice of aerobic physical exercise by hypertensive humans, combined to resistance and flexibility exercise training (AMERICAN COLLEGE SPORTS MEDICINE, 2010; SOCIEDADE BRASILEIRA DE CARDIOLOGIA, 2015; FÉDÉRATION INTERNACIONALE MÉDECINE DU SPORT, 2001).

With respect to the recommendation of intensity levels for resistance exercises and the use of predictive equations, the statistical methods are regressive, making it with a high standard error of estimation. In this way, those methods are imprecise to indicate the intensity of the resistance exercise (MOURA; PERIPOLLI; ZINN, 2002). Regarding the application of the method by perceived subjective exertion (PSE), although they are widespread, these recommendations are based on few experimental studies in which their effective use has been tested. Tiggemann (2012) has achieved a satisfactory relationship between PSE and 1 RM, without changes in blood pressure. Other studies suggest that PSE may be an indicator of the intensity of resistance exercise (RE), but it cannot indicate cardiovascular overload with the multiple series of RE because there is no association between PSE and cardiovascular variables (SOUSA; PINHEIRO; MONGE, 2010). Thus, for a better reproducibility of the 1 RM test, it is recommended to follow well established protocols, in which the predictive methods are used in order to reduce the number of attempts to find the maximum load (BRZYCKI, 1993).

Despite of exercise types, aerobic or resistance modality, systolic blood pressure has progressively increased, while diastolic blood pressure remains or is slightly reduced with 20% to 30% of maximum voluntary contraction (CVM). In response to superior overload, muscular pressure becomes greater than the intravascular pressure of the vessels of the contracted muscle, leading to an increase in SBP, DBP and PVP (peripheral vascular resistance) (TAKARADA et al., 2000; FLECK; KRAEMER, 2006). There is scientific evidence that indicates that a single session of aerobic exercise induces the reduction in blood pressure levels in both normotensive and hypertensive patients. However, in the case of resistance exercises it is still not well understood, although adaptive alterations of diastolic blood pressure is evidenced (FOCHT; KOLTYN, 1999; FORJAZ et al., 2006). Therefore, there is a possibility of alteration in SBP due to the use of resistance exercises, supporting the importance of SBP for the prescription and execution of resistance exercises for hypertensive humans presenting high risks for cardiovascular complications (COLLIER *et al.*, 2008). The direct method of measuring blood pressure would be through intra-arterial catheterization, because it is considered gold standard; however, it is an invasive method, and hasn't been indicated to evaluate asymptomatic individuals (CASTINHEIRAS *et al.*, 2012). Recently, the indirect auscultatory method has been used in researches on hemodynamic behavior during sessions of resistance exercises (SOCIEDADE BRASILEIRA DE CARDIOLOGIA, 2015). Oscillometric method produces absolute values of blood pressure capable of comparing blood pressure responses in resistance exercises performed with multiple series and different loads, although this must be done at the end of the exercise (CASTINHEIRAS *et al.*, 2012). Relative to the 1 RM test, oscillometric method would be used immediately after completing the eccentric phase of the exercise, as recommended by the VI Brazilian Hypertension Guideline that requires the validation of the device by the British Hypertension Society (BHS) and Brazilian Institute of Metrology, Standardization and Industrial Quality (INMETRO) (POLITO *et al.*, 2007; SOCIEDADE BRASILEIRA DE CARDIOLOGIA, 2015). On the other hand, the autonomic nervous system is divided in sympathetic and parasympathetic, which in turn acts on the modulation of heart rate, which is increased in response to sympathetic action, and is decreased when there is predominance of vagal action. Elevated heart rate variability (HR) has been associated to greater efficiency of autonomic mechanisms (VANDERLEI *et al.*, 2009). Differentially, there is a relationship between increased sympathetic activity, lower heart rate variability and cardiovascular adverse events, such as hypertension, heart failure and acute myocardial infarction (FERREIRA *et al.*, 2013).

Conclusion

Aerobic physical training promotes an important hypotensive effect in hypertensive patients and, therefore, has been recommended for the treatment of hypertension. However, there is now a growing scientific interest in the cardiovascular effects of another type of exercise, the resistance exercise training. These exercises are characterized by contractions of specific muscles against an external resistance. Low intensity resistance exercises are indicated for hypertensive humans, in combination to aerobic exercises, but high intensity resistance exercises should be dosed and monitored in these patients.

REFERENCES

AMERICAN COLLEGE OF SPORTS MEDICINE. DIRETRIZES DO ACSM PARA OS TESTES DE ESFORÇO E SUA PRESCRIÇÃO. RIO DE JANEIRO: *GUANABARA KOOGAN*, 2010.

AMERICAN COLLEGE OF SPORTS MEDICINE. EXERCISE AND HYPERTENSION. MEDICINE SCIENCE SPORTS EXERCISE, V. 36, N. 3, P. 533-553, MAR. 2004.

BARRETTO, A. C. P., NEGRÃO, C. E. CARDIOLOGIA DO EXERCÍCIO: DO ATLETA AO CARDIOPATA. 2 ED., SÃO PAULO: MANOLE, 2006.

BATTAGIN, A. M., DAL CORSO S., SOARES, C. L. R., FERREIRA, S., LETÍCIA, A., SOUZA, C. DE. MALAGUTI, C. RESPOSTA PRESSÓRICA APÓS EXERCÍCIO RESISTIDO DE DIFERENTES

SEGMENTOS CORPORAIS EM HIPERTENSOS. ARQ BRAS CARDIOL, 95(3), P. 405-411, 2010. DISPONÍVEL EM: HTTP://WWW.SCIELO.BR/PDF/ABC/V95N3/AOP11310 ACESSO EM: 18 MAR. 2017.

BRZYCKI, M. STRENGTH TESTING: PREDICTING A ONE-REP MAX FROM REPETITIONS TO FATIGUE. JOPERD-Journal of Physical Education, Recreation and Dance, v. 64, n. 1, p. 88-90, Jan.1993.

CÂMARA L. C., SANTARÉM, M., JACOB FILHO W. Atualização de conhecimentos sobre a prática de exercícios resistidos por indivíduos idosos. ACTA FISIATR 2008; 15(4): 257 – 262. Disponível em: http://www.revistas.usp.br/actafisiatrica/article/view/10300 8/101288 Acesso em 28 maio 2017.

CASTINHEIRAS, NETO A. G., COSTA FILHO, I. R., FARINATTI, P. T. Respostas cardiovasculares ao exercício resistido são afetadas pela carga e intervalos entre séries. Arquivo Brasileiro de Cardiologia, v.95, n. 4, p. 493-501, out. 2010.

_____. Aferição da pressão arterial durante exercícios resistidos pelo método auscultatório. Revista Brasileira de Cardiologia, v. 25, n. 1, p. 59-66, jan./fev. 2012.

CASTIGLIONI, A. História da medicina. São Paulo, Cia. Editora nacional, 1947.

COLLIER, S. R., KANALEY, J. A., CARHART JÚNIOR. R., FRECHETTE, V., TOBIN, M. M., HALL, A. K., LUCKENBAUGH, A. N., FERNHALL, B.Effect of 4 weeks of aerobic or resistance exercise training on arterial stiffness, blood flow and blood pressure in pre- and stage-1 hypertensives. Journal of Human Hypertension, v. 22, n. 10, p. 678-686, Oct. 2008.

FARINATTI, P. T. V., ASSIS, B. F. C. B. Estudo da frequência cardíaca, pressão e duplo-produto em exercício contra-resistência e aeróbio contínuo. Revista Brasileira Atividade Física e Saúde, v. 5, n. 2, p. 5-16, maio/ago. 2000.

FERREIRA, L. L., DE SOUZA, N. M., BERNARDO, A. F. B., VITOR, A. L. R., VALENTI, V. E., VANDERLEI, L. C. M. Variabilidade da frequência cardíaca como recurso em fisioterapia: análise de periódicos nacionais. Revista Fisioterapia em Movimento, v. 26, n. 1, p. 25-36, jan./mar. 2013.

FLECK, S. J., KRAEMER, W. J. Fundamentos do Treinamento de Força Muscular. 3. ed. Porto Alegre: Artmed, 2006.

FOCHT, B. C., KOLTYN, K. F. Influence of resistance exercise of different intensities on state anxiety and blood pressure. Medicine Science Sports Exercise, v.31, n. 3 p. 456-463, mar. 1999.

FORJAZ, C. L. de M., REZK, C. C., MELO, C. M de., SANTOS, D. A. dos., NERY, L. T., SOUZA, S. de., TINUCCI, T. Exercício resistido para o paciente hipertenso: indicação ou contra-indicação. Revista Brasileira de Hipertensão, v. 10, n. 2, abr./jun. 2003.

GHORAYEB, N., BARROS, T. O exercício: preparação fisiológica, avaliação médica, aspectos especiais e preventivos. São Paulo: Atheneu, 1999.

GRAVES, J. E., FRANKLIN, B. A. Resistance training for health and rehabilitation. Champaign: Human Kinetics, 2001.

HASKELL, W. L., LEE, I., PATE, L. L., POWELL, K. E., BLAIR, S. N., FRANKLIN, B. A, *et al*. Physical activity and public health. updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Circulation. v. 116, n. 9, p.1081-93, 2007.

HUMPHREYS, P. W., LIND, A. R. The blood flow through active and inactive muscles of the forearm during sustained hand-grip contractions. J Physiol. 1963; 166: 120-35.

WORLD HEALTH ORGANIZATION. United Nations high-level meeting on noncommunicable disease prevention and control. World Health Organization 2011. Disponível em: http://www.who.int/nmh/events/un_ncd_summit2011/en/A cesso em: 16 dez. 2015.

INTERNATIONAL FEDERATION OF SPORTS MEDICINE – FIMS. Team physician manual. 1. ed., Harbour City: Lippincott Williams & Wilkins Asia Ltda, 2001.

KRAEMER, W. J., FLECK, S. J., DESCHENES, M. R. Fisiologia do exercício: teoria e prática. Rio de Janeiro: Guanabara Koogan, 2013.

LANCHA JÚNIOR, A. H., LANCHA, L. O. P. Avaliação e prescrição de exercícios físicos: normas e diretrizes. São Paulo: Manole Conteúdo, 2016.

LIND, A. R., MCNICOL G.W. Circulatory responses to sustained hand-grip contractions performed during other exercise, both rhythmic and static. J Physiol. 1967; 92 (3): 595-607.

MONTEIRO, W. D. Aspectos fisiológicos e metodológicos do condicionamento físico na promoção da saúde. Revista Brasileira de Atividade Física e Saúde. v. 1, n. 3, p. 44-58, 1996. Disponível em: https://periodicos.ufpel.edu.br/ojs2/index.php/RBAFS/artic le/view/503/506 Acesso em 11 set. 2015.

MOURA, J. A. R., PERIPOLLI, J., ZINN, J. L. Comportamento da percepção subjetiva do esforço em função da força dinâmica submáxima em exercícios resistidos com pesos. Revista Brasileira de Fisiologia do Exercício, v. 2, p. 110-122, 1. sem. 2002.

MORRIS, J. N., HEADY J. A., RAFFLE, P. A. B., ROBERTS, C. G., PARKS, J. W. Coronary heart disease and physical activity of work. Lancet., n. 2, p. 1053-7, 1953.

POLITO, M. D., FARINATTI, P. T., LIRA, V. A., NÓBREGA, A. C. Blood pressure assessment during resistance exercise: comparison between auscultation and Finapres. Blood Pressure Monitoring, v. 12, n. 2, p. 81-6, apr. 2007.

_____ Considerações sobre a medida da pressão arterial em exercícios contra-resistência. Revista Brasileira Medicina do Esporte, v. 9, n. 1, p. 25-33, jan./fev. 2003.

RAGLIN, J. S., TURNER, P. E., EKSTEN, F. State anxiety and blood pressure following 30 min of leg ergometry or weight training. Med Sci Sports Exerc. 1993; 25(9): 1044-8. Disponível em: http://psycnet.apa.org/psycinfo/1994-12684-001 Acesso em: 22 abr. 2017.

REYNOLDS, J. M., GORDON T.J., ROBERGS, R. A. Prediction of one repetition maximum strength from multiple repetition maximum testing and anthropometry. Journal of Strength and Conditioning Research, v. 20, n. 3, p. 584-592, aug. 2006.

SANTOS, E. M. R. dos., GOMES, T. M., FARES, JÚNIOR R. S., NOVAES, J. da S. Respostas cardiovasculares agudas em diferentes exercícios de força. Revista SOCERJ-Sociedade de Cardiologia do Estado do Rio de Janeiro, v. 21, n. 3, p. 166-172, maio/jun. 2008.

SOCIEDADE BRASILEIRA DE CARDIOLOGIA. Valores de pressão arterial para o diagnóstico e metas: análise crítica das diretrizes mais recentes. Revista da Sociedade de Cardiologia do Estado de São Paulo - SOCESP, v. 25, n. 1, p. 19-22, jan./mar. 2015.

SOUSA, P. F. M., PINHEIRO, F., MONGE, D., PIRES F. O.

resistido de diferentes intensidades. Revista Brasileira Ciência e Movimento, v. 18, n. 4, p. 26-33, out./dez. 2010.

TAKARADA, Y., TAKAZAWA, H., SATO, Y., TAKEBAYASHI, S., TANAKA, Y., ISHII, N. Effects of

resistance exercise combined with moderate vascular occlusion on muscular function in humans. Journal of Applied Physiology,v. 88, n. 6, p. 2097-2106, June 2000.

TIGGEMANN, C. L. Comparação entre métodos de determinação da carga e de velocidade de execução do treinamento de força nas adaptações neuromusculares e no desempenho de capacidades funcionais em mulheres idosas: ensaio clínico randomizado. 2012. 115 f. Tese (Doutorado em Ciências do Movimento Humano) – Universidade Federal do Rio Grande do Sul/UFRGS, Porto Alegre, 2012.

UMPIERRE, D., STEIN R. Efeitos hemodinâmicos e vasculares do treinamento resistido: implicações na doença cardiovascular. Arq Bras Cardiol. 2007; 89(4): 256-62.

básicas de variabilidade da frequência cardíaca e sua aplicabilidade clínica. Revista Brasileira Cirurgia Cardiovascular, v. 24, n. 2, p. 205-217, abr./jun. 2009.

WHELTON, P. K., HE, J., APPEL, L. J., CUTLER, J. A., HAVAS, S. K. T. A., ROCCELLA, E. J., STOUT, R., VALLBONA, C., WINSTON, M. C. KARIMBAKAS, J. Primary prevention of hypertension: Clinical and public health advisory from The National High Blood Pressure Education Program. Journal of American Medical Association, v. 288, p. 1882-1888, Oct. 2002.

****

VANDERLEI, L. C. M., PASTRE, C. M., HOSHI, R. A., CARVALHO, T. D. de., GODOY, M. F. de. Noções