Journal of Physical Education and Sport ® (JPES), 18(1), Art 20., pp. 157 - 162, 2018
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Higher levels of physical activity reduce spending on medicines in the elderly

MARCIO ROBERTO DORO[1], BRUNO NASCIMENTO-CARVALHO[1], MARCIO RUARO[1], VINICIUS BARROSO HIROTA[2], BRUNO RODRIGUES[3], ANDRÉ RINALDI FUKUSHIMA[1], IRIS CALLADO SANCHES[1], ERICO CHAGAS CAPERUTO[1]
[1] Human Movement Lab, Universidade São Judas Tadeu (USJT) São Paulo, BRAZIL.
[2] Physical Education Department, Methodist University, São Bernardo do Campo, BRAZIL.
[3] Physical Education School, UNICAMP, Campinas, BRAZIL.

Published online: March 30, 2018
(Accepted for publication January 27, 2018
DOI:10.7752/jpes.2018.01020

Abstract:
Objective: to compare physiological variables and expenses with medicine between physically active elderly and sedentary elderly. Method: 35 elderlies residents on the metropolitan region São Paulo, were divided in 2 groups: Active group, 22 elderlies (10 men and 12 women) with average age of 67,09±5,92 years; Sedentary group, 13 elderlies (2 men and 11 women) with average age of 70,15±6,10 years. The subjects of the active group had 2 years of training, 2 times per week, with moderate intensity. We use Student´s T test and Pearson correlation. Significance was set to $p<0.05$. Results: The main results of this study were increased parasympathetic activity associated with a reduction in the pulse interval 911±122 ms for the active group compared to the sedentary group 2488±1732 ms and it also showed an increase in the variance of the pulse interval (2038±904 ms active group) in relation to the sedentary (936±126 ms). That was associated with a significant reduction in blood pressure values in the active group when compared to the sedentary (systolic blood pressure 126±8 mmHg active, 139±13 mmHg sedentary; diastolic blood pressure 79±3 mmHg active, 86±7 mmHg sedentary). Moreover, it observed a moderate correlation of reduced expenses with medicines with increased time of physical activity ($r= -0.6769$ and $p<0.0001$). Conclusion: regular moderate intensity physical activity is able to reduce blood pressure levels significantly and increase cardiac parasympathetic modulation. Moreover, more minutes per week of physical activity practice correlates with reduced expenses with medicines.
Key words: aging, physical activity, medicines, autonomic modulation, blood pressure.

Introduction

Aging population is a worldwide phenomenon, with a larger growth of the aging population compared to the other age groups. Between 2000 and 2050, the population over 60 will grow from 10 to 22% in world terms; from 6 to 19% in North Africa; from 8 to 22% in Latin America; from 6 to 18% in the Middle east; from 7 to 18% in East Asia and from 10 to 30% in China. As a reference, in the same period, it's estimated that in eastern Europe this population will pass from 20 to 35% (World Health Organization, 2011). The population over 60 years old will be larger than the population under 15 years and the population over 80 years will be multiplied by six (Lutz, W., Sanderson, W., & Scherbov, 2001).

This exponential increase is directly related to the development of new diagnostic techniques and therapeutic maneuvers to treat diseases that were once considered fatal. Nonetheless, not always the increase in life expectancy is associated to life quality. In order to the aging process to be a positive experience, it must come along lifelong health, participation and security opportunities. Although the aging population might be understood as a victory regarding health, most of the elderlies have some kind of disease or chronic condition that impairs the proper social living and consequently the practice of physical exercises (Verardi et al., 2014).

Chronic non-transmissible diseases represent a threat to health and development of all nations. Estimates that close to 36 million deaths per year are attributed to this group of diseases whose incidence is already very high in the low and medium income countries (World Health Organization, 2013). In Brazil, a very large number of deaths (close to 75%) are due to these kind of diseases, although there has been a reduction of 20% of heart and respiratory diseases (Schmidt, M. I., Duncan, B. B., Hoffmann, J. F., Moura, L. D., Malta, D. C., & Carvalho, 2009).

Normal changes of aging in the cardiovascular system are associated to risk factors such as smoking, obesity, systemic arterial hypertension, dyslipidemia, hyperglycemia and sedentary behavior. Surely there is an association between the advances of age and the appearance of cardiovascular diseases (Trombetta, I. C., Batalha, L. T., Halpern, A., Negrão, C. A., & Barreto, 2005).

Aging brings the stiffness and thickening of medium and large arteries, due to progressive loss of elastic tissue, connective tissue accumulation and calcium build up. That leads to artery complacency decrease. When

Corresponding Author BRUNO NASCIMENTO-CARVALHO, E-mail: brunonascimentoc@gmail.com

this is added to fat depots (i.e. atherosclerosis) and collagen increase it compromises cardiovascular function and its ability to elevate the heart rate in response to an effort or stimulus with consequent left ventricle diastolic disfunction and impaired ventricular ejection. These changes are associated with the pathological left ventricle hypertrophy (Lakatta, 2003). Moreover, there is a decrease in the response to catecholamines and in the vascular response to the baroreceptor reflex. All these changes reflect a higher systolic artery hypertension with greater risk of cardiovascular events (Bertagnolli et al., 2006).

There are several mechanisms that manage the heart and blood vessels in order to regulate arterial blood pressure in the organism. Heart rate variability (HRV) has been studied for several years to investigate cardiovascular autonomic modulation. HRV describes the differences between consecutives heart beats (RR intervals) that are related to the influences of the autonomic nervous system on the sinus node, it is a non-invasive measurement that can be used in healthy individuals, athletes and sick people (Pumprla, J., Howorka, K., Groves, D., Chester, M., & Nolan, 2002).

Aging, especially in people that have cardiovascular diseases, impairs HRV which suggests an unbalance on autonomic cardiovascular modulation. However, physical exercises have positive effects on HRV, even for people that have hypertension, cardiac insufficiency and diabetes without autonomic neuropathy (Kuo, T. B., Lin, T., Yang, C. C., Li, C. L., Chen, C. F., & Chou, 1999; Miyaki et al., 2012).

Regarding public health, populational aging creates new demands and costs for the social services and programs, furthermore, there are some indirect costs also when productivity decreases not to mention the adverse effects on people's quality of life (World Health Organization, 2013).

Sedentary lifestyle is strongly related to cardiovascular diseases that supposedly increase the individual and governmental costs with pharmacological treatment. Therefore, the use of non-pharmacological strategies such as regular physical exercise, not only improves functional capacity but also autonomic cardiovascular modulation reducing the cardiovascular risk and consequently the costs with medicines.

The question that remains is if the cardiovascular benefits of physical exercise are related to a possible reduction of the medicine use with consequent savings of financial resources, especially for the elderly. So, the objectives of this study were to compare the metabolic profile, blood pressure, cardiovascular autonomic modulation and expenses with medicine between physically active elderly and sedentary elderly.

Methods

35 elderlies (12 men and 23 women, age 68,6±6,25 years) residents on the metropolitan region of São Paulo were selected. This study was approved by the Ethical Committee of the São Judas Tadeu University, under number 029/2011. Subjects were divided into 2 groups: Active group, 22 elderlies (10 men and 12 women) with average age of 67,09±5,92 years; Sedentary group, 13 elderlies (2 men and 11 women) with average age of 70,15±6,10 years;

A seminar informing the objectives, procedures and importance of this research was performed, after this, the participants signed the consent form. Inclusion criteria were: minimum age of 60 years; absence of joint, bone or muscle disease that interfere on the physical exercises practice. Exclusion criteria: participants that had no time available to participate in the experimental protocol or that presented cognitive deficits that compromised the filling of the questionnaires.

The subjects of the active group had 2 years of training, 2 times per week, with moderate intensity. The sessions lasted 1 hour and 20 minutes, of which 10 minutes of warm up, 15 minutes of aerobic activity on a treadmill (60% to 75% of maximum HR), 15 minutes of aerobic activity on a stationary bicycle (60% to 75% of maximum HR), 30 minutes of resistance exercise for each muscle group with sets of 15 repetitions and low to moderate intensity, and 10 minutes of relaxation. The subjects of the sedentary group did not participate in any physical activity program, and lived in a building with no adequate infrastructure for the physical exercise practice.

Level of physical activity: The international physical activity questionnaire (IPAQ), short version was applied, to assess the level of physical active per week, with reference to the minutes of activities performed;

Expenses with medicines: A questionnaire was applied to verify the monthly expenses with medicines;

Metabolic profile: glycemia, cholesterol and triglycerides were analyzed after 4 hours of fasting: glycemia was analyzed in glucose concentration meter (Roche) with reagent strips (Accu-Chek Advantage, Roche); cholesterol and triglycerides were analyzed in a GCT apparatus (Accu-trend, Roche) with reagent strips (Accu-trend, Roche);

Blood pressure: The blood pressure was evaluated by the auscultatory method with the use of an aneroid cuff sphygmomanometer (Missouri) and a calibrated stethoscope. All hemodynamic evaluations were performed by the same evaluator in accordance with the guidelines of the American Heart Association (Whelton, P. K., Carey, R. M., Aronow, W. S., Casey, D. E., Collins, K. J., Himmelfarb, C. D., ... & MacLaughlin, 2017).

Cardiovascular autonomic modulation: The heart rate variability was obtained through the S810 polar heart rate device. For this analysis, we used selected samples of 5 minutes with sampling frequency of 2000Hz. We performed a spectral analysis of the time domain that showed parameters of sympathetic modulation, such as

the pulse interval (PI), variance of the pulse interval (Var-PI) and low frequency band (LF, 0,20-0,75 Hz). It also showed parameters of parasympathetic modulation such as the high frequency band (HF, 0,75-3,0 Hz). Finally, it showed the relation between LF/HF that represented the sympathetic-vagal balance (Ishise et al., 1998).

Statistical analysis

The data are expressed as mean ± SD. We used GraphPad InStat software (version 3.1) and the Student´s t-test for comparisons between the groups. Kolmogorov-Smirnov´s test was used to assess the variance homogeneity. The Pearson correlation was used to verify the relationship between determined variables. Significance level was established at $p<0.05$ for all tests.

Results

The aim of the present study was to evaluate the influence of an active lifestyle in metabolic parameters, blood pressure, autonomic cardiovascular modulation and the expenses with medicines in the elderlies compared to a sedentary lifestyle.

As expected, there was an increase in the level of physical activity of the training group 164 ± 18 minutes of active physical per week, when compared to the sedentary group 44 ± 17 minutes ($p<0,05$).

Glucose concentration was 100 ± 9 mg/dl in the active group and 90 ± 38 mg/dl in the sedentary group, total cholesterol was 145±42 mg/dl in the active group and 162 ± 16 mg/dl in the sedentary group and triglycerides was 130 ± 62 mg/dl in the active group and 137 ± 39 mg/dl in the sedentary group, analyzed after 4 hours of fasting, and all these data had no statistical significance comparing the groups (data shown in figure 1).

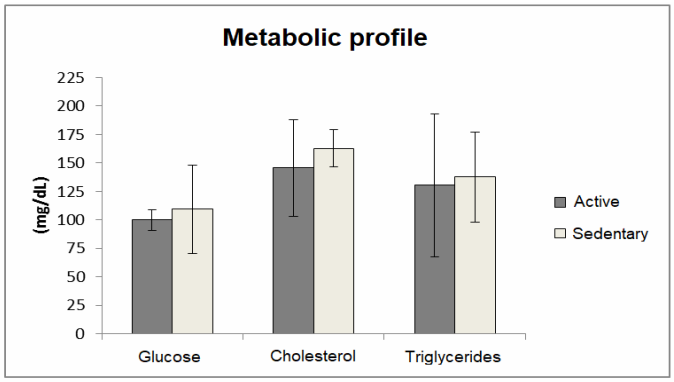

Fig. 1. Glucose, cholesterol and triglycerides concentration in the active group and sedentary group.

Figure 2 demonstrates blood pressure values. There was a significant reduction in the active group when compared to the sedentary (systolic blood pressure 126±8 mmHg active, 139±13 mmHg sedentary; diastolic blood pressure 79±3 active, 86±7 sedentary).

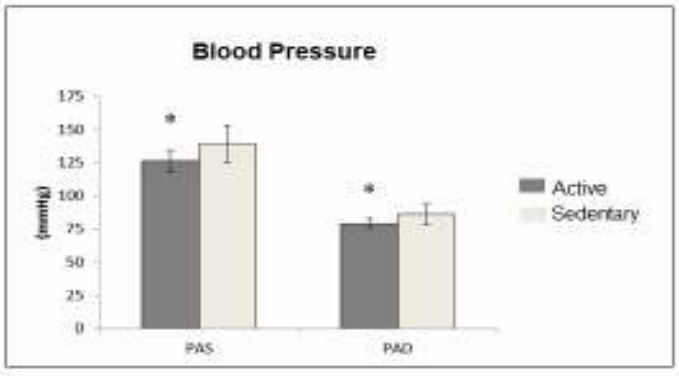

Fig. 2. Systolic and diastolic blood pressure in both groups.
* $p<0.05$ when compared to sedentary group.

The analysis of the cardiovascular autonomic modulation presented a reduction in the pulse interval 911±122 ms for the active group in relation to the sedentary group 2488±1732 ms and it also showed an increase in the variance of the pulse interval 2038±904 ms to the active group in relation to the sedentary 936±126 ms (data shown in figure 3). These data means increased parasympathetic activity. The low frequency band, the high frequency band and the sympathetic-vagal balance data showed no statistical significance comparing the groups.

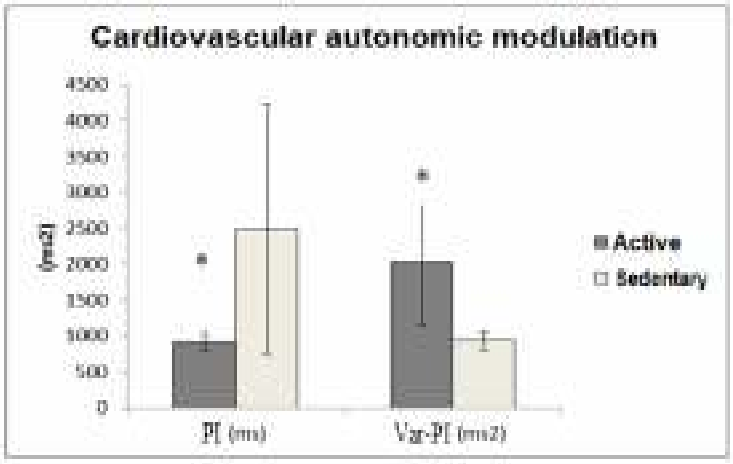

Fig. 3. Pulse interval (PI) and variance of the pulse interval (Var-PI), in the active group for both experimental groups.
* = p<0.05, when compared to the sedentary group.

The results obtained with the questionnaire of expenses with medicines showed significant reduction in the active group when compared to the sedentary (Figure 4).

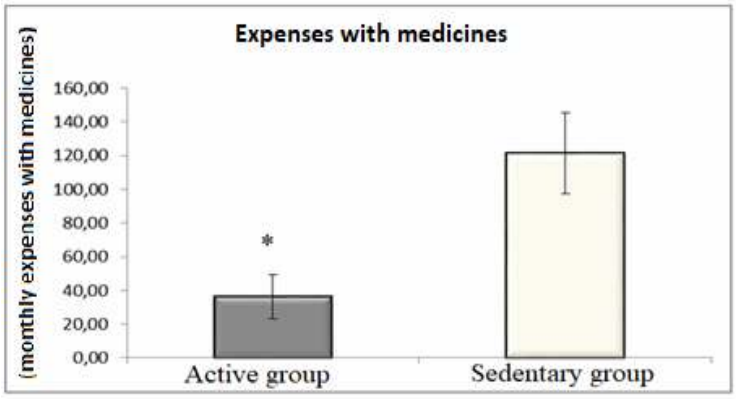

Fig. 4. Expenses with medicines in both groups.
* = p<0.05 when compared to the sedentary group.

Figure 5 shows a moderate negative correlation of reduced expenses with medicines with increased level of physical activity r= -0,6769 and p<0,0001 (figure 5). This result suggests that there is significative linear relation between these two variables.

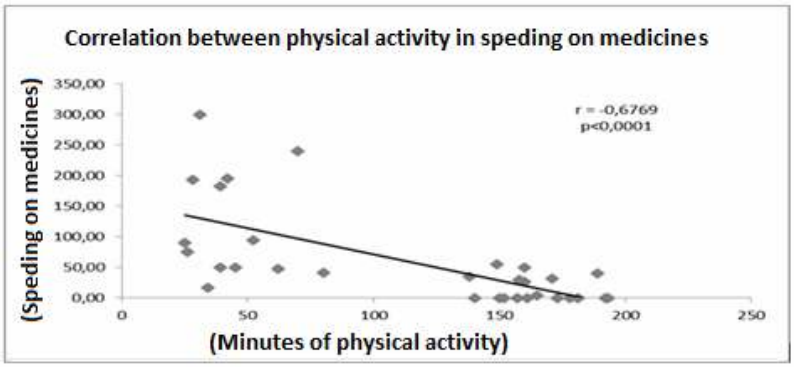

Figure 5: medicines expenditure in Reais (R$) and minutes of physical activity in both groups.
p<0.05 means significative correlation between the variables.

Discussion

The aim of the present study was to evaluate the influence of an active lifestyle in metabolic parameters, blood pressure, autonomic cardiovascular modulation and the expenses with medicines in the elderlies compared to a sedentary lifestyle. The main result of this study was an increased parasympathetic activity associated a

significant reduction in blood pressure values. Moreover, there was a moderate correlation of reduced expenses with medicines with increased level of physical activity.

The effects of physical active on the lipid and lipoprotein profile are known, physically active individuals have higher concentrations of HDL cholesterol and lower concentrations of triglycerides, LDL, VLDL and total cholesterol compared to sedentary individuals (Kim & Kim, 2012) . High intensity and volume exercises induce favorable changes in the lipid profile and may reduce the risk of cardiovascular diseases. However, when we analyzed the metabolic indexes of our sample, although we did not find statistical differences, the group of active elderly showed discrete lower concentrations for glycemia, cholesterol and triglycerides (Lira, F. S., Rosa, J. C., Lima-Silva, A. E., Souza, H. A., Caperuto, E. C., Seelaender, M. C., & Santos, 2010).

Blood pressure is the result of the instantaneous combination of cardiac debit and of peripheral vascular resistance, and any change in one or other of these components, or even both, interferes with blood pressure levels (Irigoyen, M. C., Lacchini, S., De Angelis, K., & Michelini, 2003). The blood pressure levels generated by the cardiac and vascular component are strictly controlled by complex mechanisms that modulate not only maintenance but also the momentary variation of blood pressure, regulating vessel size, vascular reactivity, fluid distribution inside and outside of vessels and cardiac debit (Irigoyen, M. C., Lacchini, S., De Angelis, K., & Michelini, 2003). The acute or chronic physical exercise promotes cardiovascular changes such as reduction of blood pressure at rest and in submaximal loads. Physical activity programs have been shown to decrease systolic and diastolic blood pressure in both hypertensive and normotensive individuals. In Meta-analysis with randomized controlled trials, effect of aerobic physical exercise on blood pressure, showed that this modality of exercise reduced, on average, 3.8 mmHg and 2.6 mmHg systolic and diastolic pressure (Whelton, S. P., Chin, A., Xin, X., & He, 2002).

In the present study the participants performed 15 minutes of aerobic activity on a treadmill and 15 minutes of aerobic activity on a stationary bicycle, associated with 30 minutes of resistance exercise of moderate intensity. The active group, besides reducing the values of blood pressure, reached parameters considered normal for the American Heart Association (Whelton, P. K., Carey, R. M., Aronow, W. S., Casey, D. E., Collins, K. J., Himmelfarb, C. D., MacLaughlin, 2017).

The Heart rate variability (HRV) is a sensitive indicator of cardiovascular health. Currently, it is known that HR variability decreases with aging and the cardioprotective effect of physical exercise associated with the heart rate variability parameter has been studied (Vanderlei, Pastre, Hoshi, Dias, & Fernandes, 2009). This effect was confirmed in the current study, the variance of the pulse interval of the active group was higher than in the sedentary elderly, that is considered an indicator of cardioprotection. Moreover, this cardioprotection was accompanied by lower blood pressure values, evidencing a positive adaptation of the cardiovascular autonomic modulation. In fact, a meta-analysis reported that aerobic training is associated with increased parasympathetic modulation (Sandercock, G. R., Bromley, P. D., & Brodie, 2004).

However, it is not clear in the literature whether the cardiovascular benefits of physical exercise interfere, decreasing the use of medications, with consequent saving of financial resources for the elderly. Our results show that the active elderly spent an average of (R$) 36.36 against (R$) 121.38 for sedentary elderly, suggesting that elderly individuals who do not practice physical exercise spend almost the triple in medicine than physically active individuals. Corroborating with our data. One study was published with 28,943 Brazilian elderly individuals aged 60 years or older, who showed that 69% had at least one chronic disease and 43.9% of those had hypertension. Considering that 50% of this population had a personal income of ¾ of a minimum wage, the average monthly expense with medicines would commits approximately a quarter of the income (23%) of this population (Lima-Costa, M. F., Barreto, S. M., & Giatti, 2003).

These data suggest that elderly people with a sedentary lifestyle control metabolic parameters, blood pressure levels and/or other diseases with medicines, while the physically active elderly may have the benefits of physical exercise to maintain their health and still can save the resources spent with the medicines.

Conclusion

Thus, we concluded that physical exercise practiced in two sessions of 80 minutes each week in low to moderate intensity is sufficient to reduce blood pressure levels significantly and to increase cardiac parasympathetic modulation. Moreover, the participants with more minutes per week of physical activity presented reduced expenses with medicines. That suggests that the cardiovascular benefits obtained with the practice of physical activity might be responsible for a reduction in the destination of financial resources to medicines. The data obtained in the present study lead us to suggest that the active lifestyle can generate an economy of practically 15% per month, which represented, for our sample, (R$) 85.02 per month. However, new studies are needed to better establish the relationship between physical activity and medicines use.

This study, reinforces the important role of regular physical exercise practice as a form of non-pharmacological treatment in dysfunctions in the organism due to the aging process, and emphasizes that such effects may reduce expenses with medicines for the elderly.

References

Bertagnolli, M., Campos, C., Schenkel, P. C., de Oliveira, V. L. L., De Angelis, K., Belló-Klein, A., … Irigoyen, M. C. (2006). Baroreflex sensitivity improvement is associated with decreased oxidative stress in trained spontaneously hypertensive rat. *Journal of Hypertension*, *24*(12), 2437–43. https://doi.org/10.1097/01.hjh.0000251905.08547.17

Irigoyen, M. C., Lacchini, S., De Angelis, K., & Michelini, L. C. (2003). Fisiopatologia da hipertensão: o que avançamos?. *Rev. Soc. Cardiol. Estado de Säo Paulo*, *1*, 20–45.

Ishise, H., Asanoi, H., Ishizaka, S., Joho, S., Kameyama, T., Leary, D. S. O., … Entee, K. M. (1998). Time course of sympathovagal imbalance and left ventricular dysfunction in conscious dogs with heart failure. *Journal of Applied Physiology*, *84*(4), 1234–1241.

Kim, J.-W., & Kim, D.-Y. (2012). Effects of Aerobic Exercise Training on Serum Sex Hormone Binding Globulin, Body Fat Index, and Metabolic Syndrome Factors in Obese Postmenopausal Women. *Metabolic Syndrome and Related Disorders*, *10*(6), 452–457. https://doi.org/10.1089/met.2012.0036

Kuo, T. B., Lin, T., Yang, C. C., Li, C. L., Chen, C. F., & Chou, P. (1999). Effect of aging on gender differences in neural control of heart rate. *American Journal of Physiology-Heart and Circulatory Physiology*, *277*(6), 2233–2239.

Lakatta, E. G. (2003). Arterial and cardiac aging: major shareholders in cardiovascular disease enterprises. *Circulation*, *107*(3), 490–497.

Lima-Costa, M. F., Barreto, S. M., & Giatti, L. (2003). Condições de saúde, capacidade funcional, uso de serviços de saúde e gastos com medicamentos da população idosa brasileira: um estudo descritivo baseado na Pesquisa Nacional por Amostra de Domicílios. *Cad Saúde Pública*, *19*(3), 735–743.

Lira, F. S., Rosa, J. C., Lima-Silva, A. E., Souza, H. A., Caperuto, E. C., Seelaender, M. C., ... & Santos, R. V. (2010). Sedentary subjects have higher PAI-1 and lipoproteins levels than highly trained athletes. *Diabetology & Metabolic Syndrome*, *2*(1), 7.

Lutz, W., Sanderson, W., & Scherbov, S. (2001). The end of world population growth. *Nature*, *412*(6846), 543–545.

Miyaki, A., Maeda, S., Choi, Y., Akazawa, N., Tanabe, Y., & Ajisaka, R. (2012). Habitual aerobic exercise increases plasma pentraxin 3 levels in middle-aged and elderly women. *Applied Physiology, Nutrition, and Metabolism*, *37*(5), 907–911. https://doi.org/10.1139/h2012-069

Pumprla, J., Howorka, K., Groves, D., Chester, M., & Nolan, J. (2002). Functional assessment of heart rate variability: physiological basis and practical applications. *International Journal of Cardiology*, *84*(1), 1–14.

Sandercock, G. R., Bromley, P. D., & Brodie, D. A. (2004). Effects of Exercise on Heart Rate Variability: Inferences from Meta-Analysis. *American College of Sports Medicine*, *37*, 433–439.

Schmidt, M. I., Duncan, B. B., Hoffmann, J. F., Moura, L. D., Malta, D. C., & Carvalho, R. M. S. V. D. (2009). Prevalence of diabetes and hypertension based on self-reported morbidity survey. *Revista de Saude Publica*, *43*, 74–82.

Trombetta, I. C., Batalha, L. T., Halpern, A., Negrão, C. A., & Barreto, A. C. (2005). *Cardiologia do exercício-do atleta ao cardiopata*.

Vanderlei, M., Pastre, C. M., Hoshi, A., Dias, T., & Fernandes, M. (2009). Noções básicas de variabilidade da frequência cardíaca e sua aplicabilidade clínica. *Revista Brasileira Cir Cardiovascular*, *24*(2), 205–217. https://doi.org/10.1590/S0102-76382009000200018

Verardi, C. E. L., Nagamine, K. K., Neiva, C. M., Filho, D. M. P., Domingos, N. A. M., Ciolac, E. G., & de Miyazaki, C. O. S. (2014). Physical activity - the attitude of the institutionalised elderly. *Journal of Physical Education and Sport*, *14*(3), 324–330. https://doi.org/10.7752/jpes.2014.03049

Whelton, P. K., Carey, R. M., Aronow, W. S., Casey, D. E., Collins, K. J., Himmelfarb, C. D., ... & MacLaughlin, E. J. (2017). ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practic. *Journal of the American College of Cardiology*.

Whelton, S. P., Chin, A., Xin, X., & He, J. (2002). Effect of aerobic exercise on blood pressurea meta-analysis of randomized, controlled trials. *Annals of Internal Medicine*, *136*(7), 493–503.

World Health Organization. (2011). *Global status report on noncommunicable diseases 2010. Geneva: World Health Organization.*

World Health Organization. (2013). *Health topics: Chronic diseases. Geneva: World Health Organization;*

Ziogas, G. G.; Thomas, T. R; Harris, W. S. (1997). Exercise training, postprandial hypertriglyceridemia, and LDL subfraction distribution. *Med Sci Sports Exerc*, *29*, 896–991.