HEART RESEARCH

Openventio PUBLISHERS

ISSN 2377-164X Open Journal http://dx.doi.org/10.17140/HROJ-1-103

Research

*Corresponding author
Juliano Boufleur Farinha
Department of Methods and Techniques Sports, Center of Physical Education and Sports, Federal University of Santa Maria, 97105-900, Santa Maria, RS, Brazil
Tel. 55-55-3220-8431
Fax. 55-55-3220-8431
E-mail: jbfarinha@yahoo.com.br

Volume 1 : Issue 1
Article Ref. #: 1000HROJ1103

Article History
Received: September 26th, 2014
Accepted: November 6th, 2014
Published: December 8th, 2014

Citation
Farinha JB, Martins MDS, Benetti CB, et al. Impact of resistance training on quality of life and ischemia modified albumin levels in men with cardiovascular risk factors. *Heart Res Open J.* 2014; 1(1): 15-21. doi: 10.17140/HROJ-1-103

Impact of Resistance Training on Quality of Life and Ischemia Modified Albumin Levels in Men with Cardiovascular Risk Factors

Juliano Boufleur Farinha[1,2*], Mariane da Silveira Martins[1], Chane Basso Benetti[1], Aline Alves Courtes[3], Sílvio Terra Stefanello[3], Manuela Sangoi Cardoso[4], Rafael Noal Moresco[4], Félix Alexandre Antunes Soares[3] and Daniela Lopes dos Santos[1]

[1]Department of Methods and Sports, Center of Physical Education and Sports, Federal University of Santa Maria, RS, Brazil

[2]School of Physical Education, Federal University of Rio Grande do Sul, RS, Brazil

[3]Department of Biochemistry and Molecular Biology, Center of Natural and Exact Sciences, Federal University of Santa Maria, RS, Brazil

[4]Department of Clinical and Toxicological Analysis, Health Sciences Center, Federal University of Santa Maria, RS, Brazil

ABSTRACT

Purpose: There are limited data concerning the effects of Resistance Training (RT) on the components of Quality of Life (QOL) and Ischemia Modified Albumin (IMA) serum levels, even though QOL is an important characteristic related to the treatment success involving non communicable diseases. Studies regarding IMA and physical activity have focused only in the acute effects of exercise. Thereby, the purpose of this study is to investigate the effects of a moderate intensity RT on Health-related Quality of Life (HRQoL) and IMA levels in men with cardiovascular risk factors.

Methods: Nineteen sedentary men (59 ± 8.63 years old) with metabolic syndrome (MS) components underwent a RT with sessions three times a week, comprising 12 exercises, during 12 weeks. The Short-Form 36 was administered to evaluate the domains of physical and mental components of HRQOL pre and post-intervention. Body composition and serum biochemical parameters were analyzed.

Results: Volunteers had total body fat content and total muscle mass unchanged along the intervention. With regard to serum analysis, triglycerides and IMA levels remained unchanged with RT, while increased HDL levels ($p < 0.001$) and reduced ratio between total and HDL cholesterol ($p = 0.006$) were observed. Moreover, improvements in the HRQOL subscales of role-physical ($p = 0.048$), general health ($p < 0.001$), vitality ($p < 0.001$), social functioning ($p = 0.044$) and mental health ($p = 0.006$) were verified after the RT.

Conclusions: It was concluded that a moderate RT is useful in providing benefits on quality of life in men with cardiovascular risk factors, despite the maintenance of IMA levels.

KEYWORDS: Quality of Life; Middle aged; Strength training; Health, Metabolic Syndrome X; Ischemia-modified serum albumin.

MAIN KEY FINDINGS

- Resistance training provides improvements on physical and mental components of quality of life in men with cardiovascular risk factors;
- Benefits on quality of life outcomes afforded by moderate resistance training are independent of changes in ischemia modified albumin levels and body composition adaptations.

ISSN 2377-164X Open Journal http://dx.doi.org/10.17140/HROJ-1-103

ABBREVIATIONS: BMI: Body Mass Index; CVD: Cardiovascular diseases; HDL: High-density cholesterol; HRQoL: Health-related Quality of Life; IMA: Ischemia Modified Albumin; LDL: Low-Density Cholesterol; MS: Metabolic Syndrome; QoL: Quality of Life; RT: Resistance Training; SF-36: 36-Item Short-Form Health Survey; TC: Total Cholesterol; 1RM: One maximal repetition.

INTRODUCTION

It is widely known that sedentary lifestyle and high caloric diets are related to the development of Cardiovascular diseases' (CVD) risk factors, such as hypertension, insulin resistance, dyslipidemia and central obesity.[1] In this regard, evidences demonstrate that middle-aged and elderly male have more frequently unknown diabetes, hypertension, apolipoprotein and cytokines levels than women,[2] besides android fat distribution that accelerate CVD onset. Moreover, Brazil is among the first five countries in the world with the biggest number of obese people,[3] with men presenting almost 10% more unconditional probability of dying between 30 and 70 years old due to non-communicable diseases than women in the same conditions (rates of 479/10,000 and 333/10,000 in 2010, respectively).[4] In addition to the main traditional risk factors of CVD,[1] increased Ischemia Modified Albumin (IMA) levels reflect a reduced capacity of albumin to bind to cobalt, which is considered a marker of myocardial ischemia and myocardial necrosis linked to inflammation and hyperglycemia,[5] despite criticisms of low specificity in clinical practice. In this respect, very few studies have investigated the effects of relatively few weeks of intervention with exercise training on IMA levels.

There are few data concerning Quality of Life (QoL) outcomes and Resistance Training (RT) in sedentary men with Metabolic Syndrome (MS), when compared with aerobic training.[6] In this sense, a better Health-related Quality of Life (HRQoL) is influenced by increased adherence to therapies and reduced use of medications and number of hospitalizations in patients with diabetes and/or MS.[7,8] An impaired QoL is recognized as a predictor of increased CVD risk[9] and obese individuals were found to have worse HRQoL, more mentally unhealthy days and more activity-limiting days than healthy adults.[10] The regular physical exercise has been strongly recommended for the prevention and treatment of CVD and their risk factors.[11] Moderate intensity RT, for instance, promotes whole-body insulin sensitivity,[12] mitochondrial[13] and cardiovascular system adaptations.[11] Considering that there are limited data about the impact of RT as a unique intervention on self-reported QoL in middle-aged and elderly male and that studies regarding IMA and physical activity have focused in the acute effects of exercise, this study has the purpose of investigating the effects of a moderate intensity RT on HRQoL and IMA levels in men with cardiovascular risk factors. We hypothesize that 12 weeks of moderate intensity RT in middle-aged and elderly male would improve physical components of HRQoL and decrease the IMA levels.

MATERIALS AND METHODS

Subjects

After media advertisements about the study and a meeting where they were fully informed about the protocol, nineteen men were recruited to participate. The inclusion criteria consisted of being sedentary men (no participation in regular and structured exercises in the previous six months), non smokers, aged between 45 and 74 years old, body mass index (BMI) > 25 kg/m² and the presence of the following risk factors: triglycerides levels ≥ 150 mg/dL or specific drug treatment, High-Density Cholesterol (HDL) levels ≤ 40 mg/dL or specific drug treatment, fasting glucose levels ≥ 100 mg/dL or specific drug treatment, systolic blood pressure ≥ 130 and/or diastolic ≥ 85 mmHg or specific drug treatment and waist circumference ≥ 90 cm.[1] It is clear that each of the above characteristics is treated as independent cardiovascular risk factor, and these may or may not act in an additive manner.[1] Men with liver, renal and heart diseases, muscular or joint disability were excluded from the study. It is clear that each of the above characteristics is treated as independent cardiovascular risk factor, and these may or may not act in an additive manner.[1] Besides, the subjects were instructed to maintain their habitual food intake during the intervention. This study was approved by the institutional Ethics Committee (permit number: 0032.0.243.000-07), was in accordance to the Declaration of Helsinki and all the participants signed a written informed consent.

Resistance Training

The supervised RT took place in the Physical Education and Sports Center gym of the Universidad Federal de Santa Maria and was performed three days per week during 12 weeks, with 48-72 h of recovery between sessions. In the beginning of the RT sessions, there was a low intensity indoor walking for 10 min. The 12-week RT consisted of the following exercises, alternating upper and lower resistance machines: chest press, rower machine, lat pull-down, triceps pulley extension, biceps curl, leg press, leg curl, ankle plantar flexion, hip abduction and adduction, trunk extension and abdominals. After one week of adaptation in which the volunteers performed two sets of 12 repetitions in each exercise, they performed three sets of 12 repetitions until the end of the training. The exercises of RT were established at 50% of one Maximal Repetition (1MR), and a good technique practice was emphasized, reducing the potential for excessive muscle soreness and injury.[11] In the end of sessions, the stretching was performed individually, with emphasis in the upper and lower back, shoulders, arms, chest, abdomen, thighs and calves.

Functional Assessments

To estimate the largest load that an individual can

move in a single maximal effort and thus prescribe the training load, a submaximal test was used to estimate the 1MR in the bench press, rower machine, leg press and knee flexion exercises.[14] The cardiorespiratory fitness was assessed with Bruce's modified treadmill protocol.[15] Moreover, the resting levels of systolic and diastolic blood pressure were measured with a digital sphygmomanometer (Omron, Kyoto, Japan) and the flexibility of lumbar and hamstring muscles were assessed by the sit-and-reach test.[16]

Anthropometric Measurements

The subjects were weighted in a scale (Plenna, São Paulo, Brazil), heighted in a stadiometer (Cardiomed, Curitiba, Brazil) and the abdominal circumference was measured with a spring-loaded metal tape (Cardiomed, Curitiba, Brazil). Total body fat and muscle contents were estimated by the tetrapolar impedance technique (Maltron, Rayleigh, UK), according to manufacturer's instructions.

Biochemical Assays

After 12 h fasting and 48 h without exercise practice, the blood samples were taken from an antecubital vein. The samples were drawn into serum separator tubes (BD Diagnostics, Plymouth, UK) and routinely centrifuged at 1500 g for 15 min. Afterwards, the serum was frozen at -80 ºC until analysis. The triglycerides, Total Cholesterol (TC) and HDL levels were determined spectrophotometrically, with commercially available assay kits (Labtest, Lagoa Santa, Brazil). The concentration of low-density cholesterol (LDL) was estimated[17] and the TC/HDL ratio was also calculated. The levels of IMA were measured calorimetrically on a automated analyzer (Cobas MIRA®, Roche Diagnostics, Basel, Switzerland), based on albumin's properties of bind to cobalt as previously described.[5]

Quality of Life

The HRQoL was assessed using the 36-Item Short-Form Health Survey (SF-36), which was previously translated and validated to the Brazilian population.[18] It should be emphasized that a bibliographic study about the growth of QoL measures identified SF-36 as the most widely generic used questionnaire in the evaluation of patients' health.[19] The scoring of each of the eight subscales (physical functioning, role-physical, bodily pain, vitality, general health, social functioning, role-emotional, and mental health) range from 0 (poor state) to 100 (good state of HRQoL) and were calculated by standard scoring protocol.[20]

Statistical Analysis

After the Shapiro-Wilk normality test was performed, Student's t test or Wilcoxon Rank Test were used to determine significant differences between the pre and post-training means. The Statistical Package for Social Sciences (SPSS 14.0, Chicago, USA) was used and statistical significance was set at $p < .05$. The data were expressed as mean ± standard deviation.

RESULTS

The analyzed sample (M = 59, SD = 8.63 years old) comprised six former smokers and thirteen nonsmokers. Moreover, 42.10% of them took antihypertensive agents, 31.50% took lipid-lowering agents and 26.30% took oral hypoglycemic agents. Table 1 demonstrates that RT resulted in increased levels of diastolic blood pressure [$t(18) = -2.45$, $p = .025$], greater distance reached in flexibility test [$t(18) = -4.96$, $p < .001$] and increased VO_2 max [$t(18) = -2.16$, $p = .044$] levels. Furthermore, volunteers presented decreased total exercise test duration [$t(18) = -2.167$, $p = .044$] and TC/HDL ratio [$t(18) = 3.12$, $p = .006$] and increased TC [$t(18) = -2.34$, $p = .031$] and HDL levels [$t(18) = -5.76$, $p < .001$] in comparison with baseline levels. Contrary to our hypothesis, 12 weeks of moderate intensity RT did not decrease IMA levels in middle-aged and elderly male. Other anthropometric, functional and biochemical variables did not change after the exercise intervention.

Variables	Pre-training	Post-training
Body Mass (kg)	93.66 ± 16.30	94.2 ± 16.68
BMI (kg/m²)	31.46 ± 5.56	31.63 ± 5.62
Abdominal Circumference (cm)	109.64 ± 12.31	109.57 ± 13.13
Total Muscle Mass (kg)	63.19 ± 6.38	63.02 ± 6.15
Total Body Fat Content (kg)	31.62 ± 10.25	31.85 ± 10.64
Systolic Blood Pressure (mmHg)	124.21 ± 17.31	128.42 ± 16.87
Diastolic Blood Pressure (mmHg)	70.94 ± 10.79	75.94 ± 10.35*
Total Exercise Test Duration (min)	9.26 ± 2.72	9.6 ± 2.55*
VO_2 max (mL/kg/min)	34.88 ± 8.00	35.89 ± 7.52*
Sit-and-reach test (cm)	17.74 ± 10.87	19.97 ± 10.45**
Triglycerides (mg/dL)	147.45 ± 71.59	139.14 ± 83.62
Total Cholesterol (mg/dL)	217.31 ± 43.05	241.42 ± 56.36*
HDL (mg/dL)	45.57 ± 12.86	60.15 ± 20.29**
TC/HDL	4.97 ± 1.25	4.21 ± 1.05**
LDL (mg/ dL)	142.24 ± 38.26	153.43 ± 51.42
IMA (UABS)	0.468 ± 0.069	0.482 ± 0.121

Values expressed as mean ± SD. BMI: Body Mass Index. VO_2max: maximal oxygen uptake. HDL: High-Density Cholesterol. LDL: Low-Density Cholesterol. IMA: Ischemia Modified Albumin. UABS: Units of Absorbance. * $p < 0.05$ post *vs.* pre resistance training.

Table 1: Anthropometric, functional and biochemical characteristics of men with metabolic syndrome risk factors pre and post-training.

Table 2 shows the results of the submaximal strength test pre and post-training. Increases in the load moved in the bench press [t(18) = -9.07, p < .001], leg press [t(18) = -5.26, p < .001], rower machine [t(18) = -14.14, p < .001] and knee flexion [t(18) = -8.63, p < .001] exercises were observed.

Exercises	Pre-training	Post-training
Bench Press (kg)	58.83 ± 17.31	68.45 ± 17.88**
Leg Press (kg)	124.55 ± 22.67	138.56 ± 25.28**
Rower machine(kg)	44.12 ± 6.62	54.96 ± 8.38**
Knee Flexion (kg)	17.50 ± 2.59	21.78 ± 2.39**

**p < 0.01 and *p < 0.01 post *vs.* pre-training.

Table 2: Load moved in the strength test pre and post-training.

As to HRQoL, men with cardiovascular risk factors showed increases on the role-physical [t(18) = -2.92, p = .048], general health [t(18) = -2.92, p < .001], vitality [t(18) = -4.79, p < .001], social functioning [t(18) = -2.22, p = .044] and mental health [t(18) = -3.01, p = .006] scoring scales after the training protocol (see Table 3).

Scales	Pre-training	Post-training
Physical Functioning	83.15 ± 12.38	84.31 ± 11.69
Role-physical	65.78 ± 29.11	78.94 ± 33.60*
Bodily Pain	67.89 ± 22.48	69.00 ± 21.96
General Health	67.84 ± 20.19	74.94 ± 16.91**
Vitality	55.26 ± 6.34	74.73 ± 16.02**
Social Functioning	79.6 ± 22.13	89.47 ± 15.73*
Role-emotional	75.43 ± 33.03	84.21 ± 34.00
Mental Health	75.15 ± 17.81	81.68 ± 16.12**

Values are expressed as mean ± SD. *p < 0.05 and **p < 0.01 post *vs.* resistance training.

Table 3: SF-36 questionnaire subscales scoring of men with cardiovascular risk factors pre and post-training

DISCUSSION

The main findings in this study include that a 12-week moderate intensity RT improved QoL parameters, both in physical (role-physical and general health) and mental components (vitality, social functioning and mental health) in men with cardiovascular risk factors. Middle-aged and elderly men also demonstrated increases on HDL and TC/HDL parameters, despite no changes in body composition and IMA levels after the exercise intervention. Moreover, the moderate intensity RT program was sufficient to induce functional adaptations, such as increases in lumbar and hamstring muscles' flexibility, in VO_2max values, in the total time elapsed in cardiorespiratory test and loads moved in the strength tests. RT is known for reducing body fat percentage and increasing lean body mass.[8-11] However, our results did not corroborate these findings, as well as previously studies encompassing moderate intensity RT.[21-22] Thus, it is speculated that more intensive RT programs and/or more weeks of training are necessary to significantly improve body composition parameters in men.

Increased levels of HDL induced by RT are clinically relevant, since previous studies suggest that HDL possess antiatherogenic and antioxidant properties by inhibiting LDL oxidation, anti-inflammatory functions as it inhibits pro inflammatory signalling cascades, besides antiplatelet and antithrombotic functions, stimulating reverse cholesterol transport and providing a decreased risk of CVD.[23] In this regard, another study showed that elevated systemic levels of HDL were accompanied by the modulation of lipoprotein lipase and hepatic lipase activities in sedentary individuals who underwent six months of aerobic training.[24] The mechanisms by which moderate intensity RT may increase the HDL levels are yet to be elucidated. With regard to TC/HDL ratio, a RT thrice a week lasting 9 weeks also induced a decreased ratio (~17.5%)[25], similar to our findings (~15.5%).

Most investigations involving IMA and physical activity have focused on the acute effects of exercise,[26-29] but only one study was found to investigate the chronic effects of exercise training (aerobic) in non-athletes[30] and no studies were found regarding RT and IMA levels. In this matter, three months of moderate-intensity walking unchanged IMA levels in type 2 diabetes mellitus patients, while its levels increased in the sedentary group.[30] The authors argue that the unchanged IMA levels in exercised group may be a result of increased antioxidant markers concentrations provided by physical training, which can prevent oxidation changes of albumin and, consequently, IMA synthesis.[30] Another hypothesis is that the decreased blood pressure obtained as a result of aerobic training may improve circulation and prevent ischemia, partially inhibiting the increase of IMA levels.[30] In our study, RT did not decrease blood pressure values. The effects of other RT programs on IMA levels and/or with other populations require further clarification.

A recent meta-analysis reported that adults with higher BMI had reduced physical HRQoL, with a dose relationship across all BMI categories, while mental HRQoL was only reduced in grade III obese subjects.[31] In this context, associations have been demonstrated between obesity and anxiety and depression disorders, particularly among severe obese individuals and women.[32] Our findings corroborate the hypothesis that weight loss is not mandatory for improvements in HRQoL when cardiovascular fitness is increased in obese individuals.[33] Accordingly, a study with young men demonstrated associations between higher physical fitness levels and increased scores in vitality and general and mental health subscales of HRQoL.[34] In fact, it is clear that a better QoL is linked to reduced health public costs.[7,8] Most studies involving physical training and

HRQoL have studied the consequences of an aerobic training on QoL outcomes,[6] leaving aside the RT. In our study, a 12-week RT performed three times a week improved role-physical, general health, vitality, social functioning and mental health domains. Similarly, studies demonstrated that RT performed thrice a week for 7 weeks benefits QoL, mental health and well-being of sedentary adults[35] and that QoL subscales of vitality and social functioning were improved by 10-week RT in depressed elder.[36] In this regard, data published elsewhere showed associations between muscle strength and QoL and that its improvement facilitates the performance in daily living activities, such as climbing stairs, dressing, cleaning and carrying objects.[8] On the same line of research, previous data suggest that the preservation of muscle strength promoted by RT may positively impact functional outcomes and health indices related to QoL.[37] This study includes as limitations the small sample size, the lack of a control group and that seasonal factor that may have influenced blood pressure levels along the intervention.

CONCLUSION

In conclusion, it was demonstrated that resistance training presents positive effects on physical and mental components of health-related quality of life, despite the maintenance of ischemia modified albumin levels in men with cardiovascular risk factors. Future trials are necessary to investigate the impact of different resistance training protocols in quality of life parameters, since its understanding is important for the reduction of health public costs.

DISCLOSURE OF INTEREST

The authors declare no conflict of interest concerning this article.

REFERENCES

1. Alberti KG, Eckel RH, Grundy SM, et al. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention. National Heart, Lung, and Blood Institute, American Heart Association, World Heart Federation, International Atherosclerosis Society and International Association for the Study of Obesity. *Circulation.* 2009;120(16):1640-1645. doi: 10.1161/CIRCULATIONAHA.109.192644

2. Regitz-Zagrosek V, Lehmkuhl E, Weickert MO. Gender differences in the metabolic syndrome and their role for cardiovascular disease. *Clin Res Cardiol.* 2006; 95(3): 136-1347. doi: 10.1007/s00392-006-0351-5

3. Ng M, Fleming T, Robinson M, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. 2014; 384(9945):766-781. doi: 10.1016/S0140-6736(14)60460-8

4. Stevens A, Schmidt MI, Duncan BB. Gender inequalities in non communicable disease mortality in Brazil. *Cien Saude Colet.* 2012; 17(10): 2627-2634. doi: http://dx.doi.org/10.1590/S1413-81232012001000012

5. Kaefer M, Piva SJ, De Carvalho JA, et al. Association between ischemia modified albumin, inflammation and hyperglycemia in type 2 diabetes mellitus. *Clin Biochem.* 2010; 43(4-5): 450-454. doi: 10.1016/j.clinbiochem.2009.11.018

6. van der Heijden MM, van Dooren FE, Pop VJ, Pouwer F. Effects of exercise training on quality of life, symptoms of depression, symptoms of anxiety and emotional well-being in type 2 diabetes mellitus: a systematic review. *Diabetologia*. 2013; 56(6): 1210-1225. doi: 10.1007/s00125-013-2871-7

7. Zhang X, Norris SL, Chowdhury FM, Gregg EW, Zhang P. The effects of interventions on health-related quality of life among persons with diabetes: a systematic review. *Med Care*. 2007; 45(9): 820-834. doi: 10.1097/MLR.0b013e3180618b55

8. Levinger I, Goodman C, Hare DL, Jerums G, Selig S. The effect of resistance training on functional capacity and quality of life in individuals with high and low numbers of metabolic risk factors. *Diabetes Care.* 2007; 30(9): 2205-2210. doi: 10.2337/dc07-0841

9. Lidfeldt J, Nyberg P, Nerbrand C, Samsioe G, Schersten B, Agardh CD. Socio-demographic and psychosocial factors are associated with features of the metabolic syndrome. The Women's Health in the Lund Area (WHILA) study. *Diabetes Obes Metab.* 2003; 5(2): 106-112. doi: 10.1046/j.1463-1326.2003.00250.x

10. Ford ES, Li C. Metabolic syndrome and health-related quality of life among U.S. adults. *Ann Epidemiol.* 2008; 18(3): 165-171. doi: 10.1016/j.annepidem.2007.10.009

11. Williams MA, Haskell WL, Ades PA, et al. Resistance exercise in individuals with and without cardiovascular disease: 2007 update: a scientific statement from the American Heart Association Council on Clinical Cardiology and Council on Nutrition, Physical Activity, and Metabolism. *Circulation.* 2007; 116(5): 572-584. doi: 10.1161/CIRCULATIONAHA.107.185214

12. Klimcakova E, Polak J, Moro C, et al. Dynamic strength training improves insulin sensitivity without altering plasma levels and gene expression of adipokines in subcutaneous adipose tissue in obese men. *J Clin Endocrinol Metab*. 2006; 91(12): 5107-5112. doi: http://dx.doi.org/10.1210/jc.2006-0382

13. Hurley BF, Hanson ED, Sheaff AK. Strength training as a countermeasure to aging muscle and chronic disease. *Sports*

Med. 2011; 41(4): 289-306. doi: 10.2165/11585920-000000000-00000

14. Guedes D, Guedes J. Manual prático para avaliação em educação física. *Barueri: Manole*. 2006.

15. Bruce RA, Kusumi F, Hosmer D. Maximal oxygen intake and nomographic assessment of functional aerobic impairment in cardiovascular disease. *Am Heart J.* 1973; 85(4): 546-562. doi: 10.1016/0002-8703(73)90502-4

16. Taguchi N, Higaki Y, Inoue S, Kimura H, Tanaka K. Effects of a 12-month multicomponent exercise program on physical performance, daily physical activity, and quality of life in very elderly people with minor disabilities: an intervention study. *J Epidemiol.* 2010; 20(1): 21-29. doi: http://dx.doi.org/10.2188/jea.JE20081033

17. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clin Chem.* 1972; 18(6): 499-502.

18. Ciconelli R, Ferraz M, WWS, Meinão I, Quaresma R. Brazilian-portuguese version of SF-36: a reliable and valid quality of life outcome measure. *Rev Bras Reumatol.* 1999; 39: 143-150.

19. Garrat A, Schmidt L, Mackintosh A, Fitzpatrick R. Quality of life measurement: bibliographic study of patient assessed health outcome measures. *BMJ.* 2002;15: 324(7351): 1417. doi: http://dx.doi.org/10.1136/bmj.324.7351.1417

20. Ware JE, Kosinski M. Interpreting SF-36 summary health measures: a response. *Qual Life Res*. 2001; 10(5): 405-413. doi: 10.1023/A:1012588218728

21. Plotnikoff RC, Eves N, Jung M, Sigal RJ, Padwal R, Karunamuni N. Multicomponent, home-based resistance training for obese adults with type 2 diabetes: a randomized controlled trial. *Int J Obes (Lond)*. 2010; 34(12): 1733-1741. doi: 10.1038/ijo.2010.109

22. Misra A, Alappan NK, Vikram NK, et al. Effect of supervised progressive resistance-exercise training protocol on insulin sensitivity, glycemia, lipids, and body composition in Asian Indians with type 2 diabetes. *Diabetes Care*. 2008; 31(7): 1282-1287. doi: 10.2337/dc07-2316

23. Berrougui H, Momo CN, Khalil A. Health benefits of high-density lipoproteins in preventing cardiovascular diseases. *J Clin Lipidol.* 2012; 6(6): 524-533. doi: 10.1016/j.jacl.2012.04.004

24. Duncan GE, Perri MG, Theriaque DW, Hutson AD, Eckel RH, Stacpoole PW. Exercise training, without weight loss, increases insulin sensitivity and postheparin plasma lipase activity in previously sedentary adults. *Diabetes Care.* 2003; 26(3): 557-562. doi: 10.2337/diacare.26.3.557

25. Costa RR, Lima Alberton C, Tagliari M, Martins Kruel LF. Effects of resistance training on the lipid profile in obese women. *J Sports Med Phys Fitness.* 2011; 51(1): 169-177.

26. Roy D, Quiles J, Sharma R, et al. Ischemia-modified albumin concentrations in patients with peripheral vascular disease and exercise-induced skeletal muscle ischemia. *Clin Chem.* 2004; 50(9):1656-1660. doi: 10.1373/clinchem.2004.031690

27. Middleton N, Shave R, George K, et al. Novel application of flow propagation velocity and ischaemia-modified albumin in analysis of postexercise cardiac function in man. *Exp Physiol.* 2006; 91(3): 511-519. doi: 10.1113/expphysiol.2005.032631

28. Apple FS, Quist HE, Otto AP, Mathews WE, Murakami MM. Release characteristics of cardiac biomarkers and ischemia-modified albumin as measured by the albumin cobalt-binding test after a marathon race. *Clin Chem.* 2002; 48(7): 1097-1100.

29. Falkensammer J, Stojakovic T, Huber K, et al. Serum levels of ischemia-modified albumin in healthy volunteers after exercise-induced calf-muscle ischemia. *Clin Chem Lab Med*. 2007; 45(4): 535-540. doi: 10.1515/CCLM.2007.087

30. Kurban S, Mehmetoglu I, Yerlikaya HF, Gonen S, Erdem S. Effect of chronic regular exercise on serum ischemia-modified albumin levels and oxidative stress in type 2 diabetes mellitus. *Endocr Res.* 2011; 36(3): 116-123. doi: 10.3109/07435800.2011.566236

31. Ul-Haq Z, Mackay DF, Fenwick E, Pell JP. Meta-analysis of the association between body mass index and health-related quality of life among adults, assessed by the SF-36. *Obesity (Silver Spring)*. 2013; 21(3): E322-E327. doi: 10.1002/oby.20107

32. Scott KM, Bruffaerts R, Simon GE, et al. Obesity and mental disorders in the general population: results from the world mental health surveys. *Int J Obes (Lond)*. 2008; 32(1): 192-200. doi: 10.1038/sj.ijo.0803701

33. Rejeski WJ, Lang W, Neiberg RH, et al. Correlates of health-related quality of life in overweight and obese adults with type 2 diabetes. *Obesity (Silver Spring)*. 2006; 14(5): 870-883. doi: 10.1038/oby.2006.101

34. Hakkinen A, Rinne M, Vasankari T, Santtila M, Hakkinen K, Kyrolainen H. Association of physical fitness with health-related quality of life in Finnish young men. *Health Qual Life Outcomes.* 2010; 8: 15. doi: 10.1186/1477-7525-8-15

ISSN 2377-164X Open Journal http://dx.doi.org/10.17140/HROJ-1-103

35. Taspinar F, Aslanb UB, Agbugac B, Taspinara F. A comparison of the effects of hatha yoga and resistance exercise on mental health and well-being in sedentary adults: A pilot study. *Complement Ther Med.* 2014; 22(3): 433-440. doi: 10.1016/j.ctim.2014.03.007

36. Singh NA, Clements KM, Fiatarone MA. A randomized controlled trial of progressive resistance training in depressed elders. *J Gerontol A Biol Sci Med Sci.* 1997; 52(1): M27-M35. doi: 10.1093/gerona/52A.1.M27

37. Hurley BF, Roth SM. Strength training in the elderly: effects on risk factors for age-related diseases. *Sports Med.* 2000; 30(4): 249-268. doi: 10.2165/00007256-200030040-00002