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Effects of two periodized training programs: aerobic interval and functional resistance on isokinetic muscle strength, physical fitness and clinical parameters in Metabolic Syndrome. Non-randomized controlled clinical trial

Presidente Prudente

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Effects of two periodized training programs: aerobic interval and functional resistance on isokinetic muscle strength, physical fitness and clinical parameters in Metabolic Syndrome. Non-randomized controlled clinical trial

Dissertation presented to the Faculdade de Ciências e Tecnologia - FCT / UNESP, Presidente Prudente campus, the Pos-Graduate Program in Physical Therapy

Supervisor: Prof. Dr. Jayme Netto Junior

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ATA DA DEFESA PÚBLICA DA DISSERTAÇÃO DE MESTRADO DE CARLOS IVÁN MESA CASTRILLÓN, DISCENTE DO PROGRAMA DE PÓS-GRADUAÇÃO EM FISIOTERAPIA, DA FACULDADE DE CIÊNCIAS E TECNOLOGIA - CÂMPUS DE PRESIDENTE PRUDENTE.

Aos 23 dias do mês de fevereiro do ano de 2017, às 14:00 horas, no(a) Anfiteatro I, reuniu-se a Comissão Examinadora da Defesa Pública, composta pelos seguintes membros: Prof. Dr. JAYME NETTO JUNIOR - Orientador(a) do(a) Departamento de Fisioterapia / Faculdade de Ciencias e Tecnologia de Presidente Prudente, Prof. Dr. FABIO DO NASCIMENTO BASTOS do(a) Departamento de Ciências Patológicas / Universidade Estadual de Londrina, Prof. Dr. FABIO SANTOS DE LIRA do(a) Departamento de Educação Física / Faculdade de Ciências e Tecnologia de Presidente Prudente - SP, sob a presidência do primeiro, a fim de proceder a arguição pública da DISSERTAÇÃO DE MESTRADO de CARLOS IVÁN MESA CASTRILLÓN, intitulada EFFECTS OF TWO PERIODIZED TRAINING PROGRAMS: AEROBIC INTERVAL AND FUNCTIONAL RESISTANCE ON ISOKINETIC MUSCLE STRENGTH, PHYSICAL FITNESS AND CLINICAL PARAMETERS IN PARTICIPANTS WITH METABOLIC SYNDROME. NON-RANDOMIZED CLINICAL TRIAL. Após a exposição, o discente foi arguido oralmente pelos membros da Comissão Examinadora, tendo recebido o conceito final:_ _ _Aprovado_ _ _ _ . Nada mais havendo, foi lavrada a presente ata, que após lida e aprovada, foi assinada pelos membros da Comissão Examinadora.

Prof. Dr. JAYME NETTO JUNIOR

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Epigraph

"There is a driving force more powerful than steam, electricity and nuclear power: the will"

Albert Einstein

Summary

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List of Abbreviations and Symbols

°/s: degrees per seconds

$: Dollars

≤: less or equal

Δ: delta or Mean difference

1 RM: one repetition maximum

%: Percent

30sCST: 30-second chair-stand test

AGIL: agility

AIT: Aerobic Interval Training

BMI: Body Mass Index

cm: centimeters

COO: coordination

EMM: Estimated Mean Change

ES-r: eta squared

et al: and others

FLEX: flexibility

FRT: Functional Resistance Training

GAR: general aerobic resistance

g/day: grams per day

H: Kruskal-Wallis test statistic

HDL-C: High Density Lipoprotein-Cholesterol

HR: heart rate

HRmax: maximum heart rate

HRR: heart rate reserve

HRrest: resting heart rate

J: Joules

Kg: Kilograms

Kg/m2: kilograms per meter squared

Km/h: kilometers per hour

MetS: Metabolic Syndrome

mg/dL: milligrams per deciliter

mmHg: millimeters of mercury

N·m: Newton · meters

p-value: Probability value

r: Effect size estimate

Rebec: Registro Brasilerio de Ensaios Clínicos

reps: repetitions

RESISFOR: arm muscle strength resistance

SEBT: Star Excursion Balance Test

SPSS: Statistical Product and Service Solutions

U: Mann-Whitney statistic test

Vo2max: Maximum Oxygen Consumption

Vo2peak: Peak Oxygen Consumption

X2: chi- squared statistic test

RESUMO

Introdução: A Síndrome Metabólica é uma condição sistêmica relacionada com transtornos musculoesqueléticos. O treinamento aeróbio intervalado é amplamente utilizado como tratamento mas seus efeitos sobre a força muscular e aptidão física, ainda são pouco descritos. **Objetivo:** Analisar e comparar os efeitos de dois programas periodizados: treinamento aeróbio intervalado e treinamento funcional resistido na força muscular isocinética, aptidão física, e parâmetros clínicos em sujeitos com Síndrome Metabólica. **Métodos:** 68 participantes com idade entre 35 e 60 anos e diagnóstico de Síndrome Metabólica, foram divididos em três grupos, controle sem intervenção, treinamento aeróbio intervalado e resistido funcional, os quais foram submetidos a programas de exercício periodizado, totalizando 39 sessões. **Análise estatística:** Utilizou-se análise de covariância (ANCOVA) e Kruskal-Wallis para dados paramétricos e não paramétricos, respectivamente. **Resultados:** Os grupos aeróbio e resistido melhoraram a força de flexão de joelho. Houve diferenças significativas na agilidade e resistência aeróbia geral incluindo um tamanho de efeito grande que favorece ao grupo aeróbio intervalado. **Conclusão:** Ambos treinamentos tiveram um tamanho de efeito médio na força de flexão de joelho e efeito baixo na força de extensão. Além disso tiveram grande efeito na agilidade, mas só exercício aeróbio intervalado foi efetivo na melhora da resistência aeróbia geral com tamanho de efeito grande.

Palavras-Chave: Síndrome X Metabólica; Exercício; Treinamento de Resistência; Dinamômetro de Força Muscular, Aptidão Física

ABSTRACT

Introduction: Metabolic Syndrome is a systemic condition related to musculoskeletal disorders. Aerobic interval training is widely used as treatment but its effects on muscular strength and musculoskeletal symptoms are still modestly described. **Objective:** to analyze and to compare the effects of two periodized programs, aerobic interval and functional resistance training on isokinetic muscular strength, physical fitness, and clinical parameters in participants with Metabolic Syndrome. **Methods**: 68 participants aged 35 and 60 years old, with Metabolic Syndrome diagnostic, were divided in three groups: control with no intervention, aerobic interval and functional resistance training, who were submitted in exercise programs, totalizing 39 sessions. **Statistical analysis:** We used covariance (ANCOVA) and Kruskal-Wallis analysis for parametric and non-parametric data, respectively. **Results**: Aerobic and resistance training improved knee flexion muscle strength. There were significant differences in agility and overall aerobic endurance, including a large effect size that favors the interval aerobic group. **Conclusion**: 16 weeks of either aerobic interval or functional resistance training had a medium effect on knee flexion strength and a low effect on knee extension strength. Both training program had a large effect on agility, but only aerobic interval training was effective to improve general aerobic resistance with a large effect size.

Key words: Metabolic Syndrome X; Exercise; Resistance Training; Muscle Strength Dynamometer; Physical Fitness.

INTRODUCTION

Non-communicable diseases or chronic diseases are classified into 4 main types, cardiovascular diseases, diabetes, cancer and chronic respiratory diseases, which are the principal cause of mortality in the world. They are related with tobacco use, physical inactivity, unhealthy diet, and use of alcohol, which are behavioural risk factors [(1)]. Cardiovascular diseases are the leading cause of death and disability and it is preventable by treating the cardiovascular risk factors that increases the chance of suffer stroke and acute myocardial infarction [(2)].

The presence of several cardiovascular risk factors is defined as Metabolic Syndrome (MetS). Some organizations have published their own criteria to diagnose MetS and the principal statements according to the organizations can be observed in chart 1. We have used a joint scientific statement to define MetS as the presence of three of five indicators of cardiovascular risk like, high blood pressure (systolic ≥130 and/or diastolic ≥ 85 mmHG), elevated triglycerides (≥ 150 mg/dL), reduced High Density Lipoprotein-Cholesterol (HDL-C) (<40 mg/dL in men and <50mg/dL in women), high levels of glucose in plasma (≥ 100mg/dL) and abdominal obesity (≥ 90 cm men and ≥80 cm women in South America) [(3)].

Chart I. Different criteria used to diagnostic Metabolic Syndrome according to the organization

	World Health Organization (1998) [(4)]	National Cholesterol Education Program (2001) [(2)]	International Diabetes Federation (2005) [(5)]
Obesity	Waist/hip ratio >0,9 in men and >0,85 in women BMI >30kg/m²	Waist circumference >102 cm in men and >88 cm in women	Europeans waist circumference ≥ 94 cm in men and ≥ 80 cm in women [c]
Glucose in plasma	Insulin resistance (Impaired Fasting Glucose, Type 2 Diabetes Mellitus or reduced insulin sensitivity) [a]	≥ 110 mg/dL	≥ 100 mg/dL; or type II Diabetes Mellitus; or drug treatment
Triglycerides	≥ 150 mg/dL [b]	≥ 150 mg/dL	≥ 150 mg/dL or drug treatment
HDL-C	< 35 mg/dL in men and <39 mg/dL in women [b]	< 40 mg/dL in men and < 50 mg/dL in women	< 40 mg/dL in men or < 50 mg/dL in women or drug treatment
Blood pressure	Systolic ≥ 140 mmHg or dyastolic ≥ 90 mmHg	Systolic ≥ 130 mmHg or diastolic ≥ 85 mmHg	Systolic ≥ 130 mmHg or diastolic ≥ 85 mmHg or drug treatment
Others	Macroalbuminaria		

[a] Insulin resistance plus 2 additional risk factors; [b] Considered one unique criteria; [c] Abdominal obesity plus 2 additional risk factors

Epidemiological studies estimate that the prevalence of the Metabolic Syndrome is approximately 30% considering the adult population of Brazil [(6)], and in Latin America it ranges between 25 to 45% [(7)]. Further, the management cost of each individual MetS component was associated with higher future medical costs, calculated in more than $5000 of annual medical costs incurred over 5 years for people with three MetS components, meanwhile five components correspond to almost $6000 [(8)]. It makes necessary further strategies of intervention in the area.

Besides the socioeconomical impact, people with MetS may present other negative consequences on human physiology, like comorbidities diseases in musculoskeletal system. In this sense, previous researches have highlighted the association between MetS and osteoarthritis [(9)]. A study conducted in Russia analyzed a sample population of 1350 subjects with osteoarthritis of which 82.3% was detected MetS. Physical and functional disability was found in 20% of the total sample, where 90% were also diagnosed with MetS. The authors concluded that this condition could have an important role in the development and progression of osteoarthritis [(10)].

We note that in both conditions it may coexist common features such as increased waist circumference [(3,11)], decreased muscle strength [(12,13)] and joint overload [(14)]. Therefore, the treatment of MetS must be approached integrally taking its multisystem character into account in order to avoid excessive stress on the musculoskeletal system and to protect the joint component.

Still concerning the implications of chronic disease on musculoskeletal system it stands out sarcopenia. It is defined as progressive and generalized loss of muscle mass and strength, which may contribute to the development of physical and functional disability, poor quality of life and premature death [(15)]. Sarcopenia is related with the development of diabetes and hypertension that increase the risk of MetS [(16)].

On the other hand, strategies focused to prevent and treat cardiometabolic risk factors are important and address changes in lifestyle, such as regular physical exercise and nutritional control. It is of general agreement that exercise interventions have positive effects on MetS components. Thus, aerobic and resistance training are widely used [(2, 17, 18)].

According to the intensity, we can find different types of aerobic training in the literature. The traditional Light to moderate-intensity continuous training is usually performed at 50-75% VO2max and 30-60 minutes per session. High to severe-intensity exercise that is also known as High-Intensity Interval Training and can be divided according to the time and intensity [17, 19], as Sprint Interval Training characterized by 4-6 sets of 30 seconds at >100% VO2max, with intervals of 4-4,5 minutes of recovery; and Aerobic Interval Training (AIT) [20].

AIT has been highlighted because his related-benefits found in less time of training what draws attention of participants. The execution of the classical model, consist in 4 x 4 minutes intervals at 85-95% peak heart rate, with active recovery phases of 3 minutes at 70% peak heart rate [17]. AIT is the most used and effective in the MetS treatment, it consists of repeated bouts of high-intensity exercise separated by active recovery and appears as an efficient method to improve cardiorespiratory fitness [19, 20]. It also has shown to have benefits on waist circumference, HDL-C, systolic and diastolic blood pressure in people with MetS [21].

However, this model widely used in previous studies, does not considerate the previously mentioned functional and musculoskeletal limitations of MetS population associated to sarcopenia [15, 16] and osteoarthritis [9]. Thus, has been recommended the prescription of a model of AIT periodized in order to facilitate the adaptation to exercise of a sedentary population and to prepare them to the excessive orthopaedic stress associated with AIT [22]. Therefore to include a previous period of initial conditioning could enhance musculoskeletal and functional capacity. Nevertheless, AIT does not appear to present improvements on muscular strength because his specificity [23].

Thereby, researches demonstrate that resistance training as well as to provide benefits in muscular conditioning is also recommended and well accepted as an effective treatment to reduce systolic blood pressure [24], and triglycerides [25]. It is noteworthy that both training methods promote different responses to human body; AIT is characterized predominantly for metabolic responses, while the major feature of resistance training is the structural adaptation [18].

Accordingly, the traditional resistance exercise is described as specific movement, working isolated muscle groups and improving strength on the isolated segment [18]. Other alternative is the functional resistance exercise (FRT), which uses multiple movements, thus, is advantageous by recruiting different muscular groups and high muscle activation during the movement [26, 27]. This type of training promotes musculoskeletal adaptations and improves metabolic responses equally effective as traditional resistance exercise in healthy people [27]. However, limited studies have analyzed the effects of these types of exercises in functional capacities and musculoskeletal symptoms in people with MetS.

In fact, low muscular strength and physical fitness have great importance in this condition because of its relationship with physical disability [28] and increased risk of mortality [29]. Additionally studies also suggest that increasing or maintaining muscular strength has many health-related implications, especially to prevent cardiovascular disease [24, 29].

In terms of physiology the role of muscular fitness on the MetS is related to the skeletal muscle that is the primary tissue for glucose and triglyceride metabolism [12]. Researches report that MetS may affect muscle strength through an insulin resistance state and intramuscular lipid content, which may lead to impaired muscle contractile function in myosin molecule [12]. Therefore increasing muscle mass and strength improves insulin sensitivity and intramuscular quality [18, 21].

Furthermore, studies suggest that MetS is linked with adverse results in cardio respiratory endurance, parameters of physical fitness as muscle strength and power, flexibility and performance in daily living activities [30-31]. Although the influence of physical activity on MetS risk factors is well described [23], the effects of exercise on the isokinetic muscle strength and physical fitness in this population still have been limitedly explored [31, 32].

In this context, we found four studies that compared both training modalities in different populations, but only one in MetS (Table I). Stensvold *et al* described the effects of aerobic (n=11) and resistance training (n=11) on muscle strength in MetS, measured by one repetition maximum test after 12 weeks [23]. However they did not focus their analysis on muscle strength outcomes or adverse events related to musculoskeletal symptoms, whose have been poorly reported in literature [17, 20].

Therefore, a clinical trial with larger sample size, a gold standard method of measurement muscle strength and a periodized training model of 16 weeks could help to understand the responses of physical fitness and muscular strength in MetS. Due to the importance of physical performance to protect against MetS and other comorbidities associated like osteoarthritis and sarcopenia, we justified the analysis of these variables to know the effect of two new approach of exercises program. We emphasize in the value of prescribing through a periodization model to facilitate the metabolic and musculoskeletal adaptation.

Finally, the analysis of muscular strength and physical fitness after AIT and FRT is necessary to better understand its role in preventing and treating the development of chronic disease and health-related outcomes. Thereby we hypothesized that AIT would not be more effective than FRT to increase muscle strength, however AIT would be better than FRT to improve physical fitness, and AIT would have more musculoskeletal complaints compared to FRT.

CONCLUSION

We conclude that our proposed model of 16 weeks of either aerobic interval or functional resistance training have a medium effect on knee flexion strength and a low effect on knee extension strength. Aerobic interval training is effective to improve agility and general aerobic resistance with a large effect size. Furthermore, Knee region was the principal complaint across all groups.

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