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Original Article

Additional effects of stretching training program and supplementation with ômega-3 in older people

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Abstract
Introduction: A number of body modifications accompanies aging, for instance, reduction in muscle performance, balance and flexibility. Physical exercise, as well as anti-inflammatory nutrients, can proportionate benefits in the preservation of physical abilities. In this study, we hypothesize that supplementation with ômega-3 fatty acid could have an additional effect on a flexibility exercise program in elderly. **Aim**: To evaluate the effects of ômega-3 on flexibility and articular mobility in elderly submitted to a flexibility-training program. **Methods**: this is a double blind randomized study with a non-probabilistic sample. Twenty-one participants, submitted to a 12 weeks flexibility exercises program, were distributed in two groups, receiving an ômega-3 supplement (PAS), or placebo (PAP). At the beginning and at the end of the experiment, the participants were evaluated for anthropometric measures (body mass and height - to calculate body mass index - and waist circumference), and flexibility measures (movements of lateral flexion of the cervical spine, shoulder flexion, hip flexion, dorsiflexion and plantar flexion). **Results**: when compared the beginning and the end of the study, both groups showed significant differences in some movements. To PAP, the differences were: right cervical (8%), shoulder (10%) and dorsi flexion by left ankle (22%); to PAS, the differences were shoulder movement to right (8%) and left (11%) sides **a**nd planti flexion by right ankle (19%). However, the ômega-3 supplementation was not enough to promote additional effects on any of the investigated variables. **Conclusion:** The present lead us to conclude that stretching physical activities seem to be beneficial for the elderly. However, our results did not show any additional benefits with the use of ômega-3 supplementation.
Keywords: muscle-stretching, exercise, aging, ômega-3 fatty-acid, supplementation.

Introduction

The aging process leads to adverse modifications in the body structure, declines physical function, and ultimately increases the risk of disability and dependence. A number of these modifications occur in muscle-skeletal system such as changes in the size and in the proportion of different muscle fiber types, a reduction in bone mineral density and the presence of degenerative processes in the articulations. As consequence, some abilities are compromised, such as strength, power, balance and flexibility (Brady et al. 2014, Brinkley et al. 2009).

The negative outcomes of aging are supposed to be associated to a low-grade chronic inflammation (Franceschi et al. 2000) Included in the concept of immunosenescence, the inflammatory status of aging is called inflammaging (Jenny 2012) Although the precise etiology of this process remains unknown, it has been observed an increased level of inflammatory cytokines, probably due to macrophages modifications. These cytokines enhance oxidative stress, oxide cell membrane, and favor degenerative processes (Brady et al. 2014, Brinkley et al. 2009, Miljkovic et al. 2015).

In this context, it is important to search strategies aiming to reduce the age-related losses (Toscano et al. 2009). Physical activity and physical exercise have been extensively studied. The World Health Organization recommends that programs directed to elderly have to include different components of physical fitness, in order to ensure the maintenance of mobility and independence: cardiorespiratory, muscle resistance and power, balance and flexibility (WHO 2010, Tripton 2010).

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Considering the inflammatory feature of aging process, other possible intervention aiming to preserve muscle function could be the intake of anti-inflammatory nutritional supplements. The ômega-3 fatty acids have a variety of anti-inflammatory and immune-modulating effects. Studies have pointed that ômega-3 fatty-acids, mainly EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid), have effects on chronic or excessive inflammation such as rheumatoid arthritis (Carrilo-Trip et al. 2005). Some epidemiological studies have shown a reduction in inflammatory status of articulations with the supplementation of EPA and DHA (Carrilo-Trip et al. 2005, Akabas & Deckelbaum 2006, Mesa García et al. 2006). Gray et al. (2014) observed reduced markers of oxidative stress after a single bout of eccentric exercise in a group supplemented with ômega-3, when compared to a placebo group.

In this study, we hypothesize that supplementation could have an additional effect on a flexibility exercise program in elderly. As such, the aim of this study was to evaluate the effects of ômega-3 on flexibility and articular mobility in elderly submitted to a flexibility-training program.

Material and methods

Sample

This study was performed with a non-probabilistic sample of twenty-one elderly, recruited from regional community adult of Ferraz de Vasconcelos City, São Paulo, Brazil. To be included, they have to be 60 years or older, and be able to train two times per week in the course of 12 weeks. Exclusion criteria evaluated participation in any regular and structured physical activity for the last 3 months, motor deficiency, cognitive impairment or debilitating conditions, and medical contraindications to exercise. All the participants signed an informed consent and the research protocol was approved by the Ethic Committee of São Judas Tadeu University (process number 091/2010).

The voluntaries included were submitted to a flexibility exercises program, and they were randomly distributed, in a double blind feature, in two groups according to supplementation: PAS- physical activity group with supplementation of ômega-3 (n=9) and PAP- physical activity group with the use of placebo (n= 12). At the end of the study, the number of dropouts was seven and the reasons to abandoning the study are described at Figure 1.

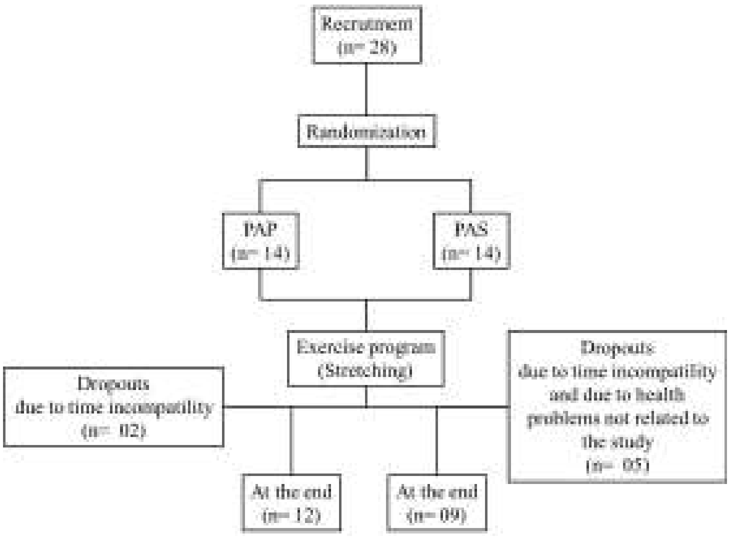

Figure 1. Experimental design

Exercises program

The flexibility exercise program consisted of static muscle stretching carried out over twenty-four session (three months). The exercise session was adapted of a previous study (Conceição et al. 2008), with a periodicity of twice a week (Tuesdays and Thursdays from 14h to 15h), and duration of 60 minutes. All exercises were applied on maximal voluntary articular joint (three sets of 30 seconds and rest 10 seconds between exercises) with intensity controlled by pain scale according to Branco et al (2006). At the end of the exercise program, the participants who had a frequency of participation in the program lower than 75% were excluded from the database.

Nutritional supplementation

The supplement formulation was based on recent WHO lipid recommendations, 0.25 to 2g/day (FAO 2010), and the participants were advised to not eat fish during the intervention. The participants were supplemented with two capsules of one gram each of fish oil or placebo and were instructed to take one capsule in the morning and one capsule in the evening with water, together with the main meals. The capsules were provided in a white plastic bottle labeled with the name of subjects. The manufacturer provided these capsules after signing a contract of donation to form a scientific partnership. The fish oil offered contained adequate amounts of EPA and DHA (330mg and 220mg, respectively; 0.1g of saturated fatty acids, 0.2g of monounsaturated fatty acids and 0.65g of polyunsaturated fatty acids). Subjects were advised to maintain the bottles stored in a cool, dry place, protected from light.

Participants were questioned weekly, after activities, with regard to pain and the correct intake of the supplement. They had to return the empty bottle before receiving another one and, in cases where there were any capsules left; they were questioned about the reasons (usually due to forgetting at some time or day). Adherence to supplementation was considered as adequate as the total consumption observed was greater than 95% of the supplied.

Evaluated parameters

Anthropometric

The voluntaries were weighed on a digital scale (Soehnle®, 200kg capacity and 100 grams sensitivity). At the time of data collection, individuals remained barefoot, wearing two pieces of lightweight clothing and were helped to position their feet on the center of the scale platform, evenly distributing their weight on the lower limbs. In the time of weight measurement, they were requested to stay upright and look forward during the time necessary to stabilize the display device, according to the evaluator's discretion. Reading was made and the value was recorded. Height was obtained using a stadiometer (Soehnle®) attached to the wall. The measurement was performed with the subject placed in a standing position, barefoot, with feet together. The upper surfaces of the heel, pelvis, shoulder girdle and occipital region were in contact with the instrument. The measurement was done with individuals in inspiratory apnea and with their heads in the Frankfurt plane, parallel to the ground with the cursor at an angle of 90 degrees. The classification of body mass index (BMI) was established using the pattern equation ($BMI = weight/height^2$) according previously publication (Lebrão & Laurenti 2005).

For the measurement of waist circumference (WC), an inelastic fiberglass tape was used. The subjects were maintained in an upright position with arms loose and relaxed abdomen. The tape was placed horizontally at the midpoint between the last rib and the iliac crest. The cutoff points used were those established by the World Health Organization for adults. As there are no specific values for the elderly, values of WC $\geq$ 88 cm for women and values of WC $\geq$ 102 cm for men were considered as very high risk for cardiovascular diseases (WHO 1997).

Flexibility

Flexibility was evaluated before the start of the study, on the 13th week of the intervention and after the completion of activities. The evaluation always took place in the morning at the same time. Flexibility was measured using a pendulum goniometer (fleximeter Sanny®) conform previously publications (Monteiro 2005). Movements of lateral flexion of the cervical spine, shoulder flexion, hip flexion, dorsiflexion and plantar flexion were evaluated. Flexibility was evaluated without any prior warm-up and subjects remained in an upright posture with anatomical foot placement at a right angle, legs and hands facing forward, and joints at zero degrees of motion. Individuals were asked not to perform any physical activity during the previous 24 hours. According to the motion of each joint, each subject was asked to perform the movement in an active manner until maximum amplitude was achieved (i.e. until feeling a slight discomfort) and to remain in this position until the results were obtained. Movement were performed using the muscular contraction of the individuals themselves and the evaluator did not influence the participants' movements. The fleximeter was adjusted to zero degrees, and three measurements were taken for each movement, where and the highest value was adopted.

Statistical analyses

Data are presented as median and statistical analyses were performed using SPSS software (v 18.0; IBM, Armonk, NY, USA). Analysis of comparisons between time and groups over the period was performed by non-parametric test Wilcoxon. Statistical significance was established at $p<0.05$.

Results

The socio-demographic (baseline) variables are described at Table 1 and no significant differences were found between groups.

Table 1. Sample characteristics.

Socio-demographic characteristics		PAS n	PAS %	PAP n	PAP %	*p*
Gender	female	8	88.9	10	83.3	0.612
	male	1	11.1	2	16.7	
Age (years)	60 – 69	7	77.8	8	66.7	0.477
	≥ 70	2	22.2	4	33.3	
Marital status	with partner	3	33.3	6	50.0	0.377
	without partner	6	66.7	6	50.0	
Race	mixed race	6	66.7	8	66.7	0,155
	white	1	11.1	4	33.3	
	black	2	22.2	0	0	
Tobacco use	non-smoker	5	55.6	7	58.3	0.623
	ex-smoker	4	44.4	5	41.7	
Living alone	yes	3	33.3	3	25.0	0.523
	no	6	66.7	9	75.0	

Values expressed in frequency and perceptual of socio-demographic parameters of supplemented by omega-3 fatty acids and trained (PAS) and placebo and trained (PAP) groups and p-values between the PAS and PAP groups.

Table 2 depicts the anthropometric variable at the beginning and at the end of the study. The intervention was not efficient to promote effects on those variables.

Table 2. Anthropometric variables at the beginning and at the end of the study

Parameters	PAS Before	PAS After	PAP Before	PAP After
Body mass (kg)	74 (47.4 - 82.3)	73.3 (47.9 - 82)	74.4 (51.7 - 92.4)	72.1 (51.9 - 90.9)
BMI (kg/m^2)	31.20 (22.63 - 38.61)	30.91 (22.63 - 38.47)	30.58 (22.67 – 41.07)	29.53 (22.76 - 40.4
WC (cm)	97 (79 - 107)	95 (78 - 106)	99 (82 - 120)	98 (80 - 109)

Values expressed in median of anthropometric parameters of supplemented by omega-3 fatty acids and trained (PAS) and placebo and trained (PAP) groups. *Indicate significant difference ($p< 0.05$) to before.

With regard to flexibility (Table 3), there were significant increments ($p<0.05$) in right cervical movement (8%), left shoulder movement (10%) and dorsi flexion by left ankle (22 %) in PAS group and shoulder movement to right (8 %) and left (11 %) sides and planti flexion by right ankle (19%) in PAB group.

Table 3. Joint flexibility at the beginning and at the end of the study.

Flexibility		PAS (median and range) Before	PAS (median and range) After	PAP (median and range) Before	PAP (median and range) After
Cervical spine (cm)	R	36 (20 - 47)	37 (20 - 50)*	35 (23 - 40)	35 (26 - 49)
	L	34 (20 - 54)	41 (25 - 54)	33 (21 - 48)	36 (25 - 45)
Shoulder (cm)	R	106 (96 - 129)	119 (97 - 139)	106 (71 - 114)	110 (80 - 125)*
	L	98 (83 - 106)	105 (83 - 129)*	89,5 (70 - 116)	99 (79 - 126)*
Hip (cm)	R	59 (40 - 89)	62 (57 - 86)	62.5 (41 - 88)	59 (44 - 88)
	L	64 (39 - 71)	64 (36 - 74)	57.5 (42 - 87)	55.5 (46 - 89)
Dorsiflexion (cm)	R	23 (5 - 32)	19 (15 - 31)	14.5 (6 - 28)	17 (11 - 29)
	L	19 (11 - 29)	19 (12 - 32)*	15 (6 - 30)	20.5 (12 - 25)
Plantiflexion (cm)	R	35 (25 - 45)	39 (27 - 52)	31 (8 - 35)	39.5 (28 - 64)*
	L	37 (16 - 42)	38 (35 - 48)	36 (5 - 49)	39.5 (22 - 54)

Values of joint flexibility by right (R) and left (L) side of supplemented by omega-3 fatty acids and trained (PAS) and placebo and trained (PAP) groups. *Indicate significant difference ($p< 0.05$) compared with before. Different letters indicates statistical differences between groups.

Discussion

It is a consensus that physical activity is beneficial for the elderly and that flexibility exercises facilitate the development and maintenance of a range of motion, assisting in the level of independence and daily living activities of these individuals (Rêgo et al. 2011, Dantas et al. 2011). Loss of flexibility not only limits the amplitude and type of movement performed by a joint, but also increases the probability of the occurrence of lesions in the muscles involved. In this aged group, flexibility is important to allow individuals to carry out daily movements, such as combing their hair, brushing their teeth, tying shoelaces and reaching cupboards, amongst other activities (Fidelis et al. 2013).

The benefits of omega-3 fatty acids, especially EPA (eicosapentaenoic) and DHA (docosahexaenoic acid), derived from fish oil, are also well documented (FAO, 2010). A recent review by Swanson et al. (Swanson et al. 2012) highlighted a beneficial association of their use not only with cardiovascular function, but also for preventing clinical events such as the Alzheimer's disease, both related to the aging process and observed in other studies (Irving et al. 2009, Wang et al. 2012). Endogenous anti-inflammatory mediators associated with resolvin and protectin (potent inhibitors of neutrophils) have been identified and related to the metabolism of the omega-3 fatty acids, and these findings are supported by the existence of various diseases with exacerbated inflammatory responses (Isobe et al. 2012). However, there are no robust studies that relate the anti-inflammatory action of omega-3 to reductions in pain and improvements in flexibility, despite the fact that studies published by Bistrian (Bistrian 2004) and Calder (2004) related benefits in individuals with joint diseases.

Although no associations have been reported in the literature, the present study evaluated the effect of flexibility exercises on older adults that were supplemented, or not, with omega-3 supplements, in order to verify whether the known anti-inflammatory effects of these molecules could reduce pain and improve intervention outcomes. However, no statistically significant differences were observed between the exercise groups that received omega-3 supplementation (PAS) and that received the placebo (PAP), despite the improvement in the range of motion for both groups.

In th same way of any experimental study, the present investigation has some methodological limitations, particularly regarding the absence of a control group that underwent supplement use but without physical intervention. This group would have enabled us to measure the effect of the fatty acids alone. Another limitation was the use of two grams of supplement and an intervention that lasted 12 weeks; this quantity and period may have been insufficient to allow the observation of differences between groups.

As in the present study, several papers have studied the impact of stretching exercises in the elderly (Cyrino et al. 2004, Stanziano et al. 2009, Gallon et al. 2011), with improvements related in a range of motions at different joints and in body equilibrium (Albino et al. 2012). Varejão et al. (2007) also evaluated the influence of flexibility gain in the elderly, aiming to verify the influence of flexibility on the autonomy and quality of life of elderly women. As in the present study, the groups showed improvements and increases in flexibility.

With regard to cervical evaluation, Carvalho et al. (2006) reported data to corroborate the findings of the present study. The authors observed a statistically significant difference between groups of active older adults, when compared with sedentary older adults, for movements of lateral bending and rotation (right and left). The function of the neck is related to mobility, which is modified by postural changes and stretching exercises. The present study found an increase in cervical flexibility, for lateral bending movements on both sides, for PAS and PAP, and for movement on the right in the PAS ($p<0.05$).

Increased flexibility in the cervical region can assist in reducing headaches and neck pain, as well as improve the quality of vision of the elderly, which may decrease with the aging process, in turn facilitating daily activities for these individuals (Strimpakos 2011). Luiz et al. (2009) found that functional factors associated with visual impairment were related to depression, poor balance, and a higher number of impaired instrumental activities of daily living.

The loss in the ability to execute activities of daily living (ADL) occurs, amongst other factors, due to decreased flexibility in large joints, such as the shoulder. In a short time, this reduced flexibility can hamper the picking up of objects placed above head level, hair brushing, as well as the tying of shoelaces. In this study, shoulder flexion was improved in both groups ($p <0.05$). However, if flexibility training is not maintained improved flexibility may decline again, as shown by Ruberti et al. (2008), who found that six months of detraining decreased the flexibility of shoulders and movements.

With respect to the hip joint, an increase in flexion movements to both sides was observed in the PAS, and to the left side in the PAP, in agreement with the findings of Gallon et al. (Gallon et al. 2011), who analyzed the effects of stretching on flexibility of the elderly and noted increased flexibility of the hip joints. Decreased flexibility in the lower limbs may impair the functional capacity of the elderly and increases in function can contribute improve gait and reduce the risk of falls (Cruz et al. 2012). Gawryszewski (2010) reported a fall frequency of 32.1% in the elderly; of those who had suffered falls, 53% had a single fall, and 19% had experienced a fracture as a result, with the majority of falls (59%) occurring at home. Other factors associated with falls are described by Perracini et al. (2012), who observed a lower fall rate in the more active elderly (47.4%), compared to the less active elderly (71.4%) ($p = 0.013$). A low frequency of falls was also observed in a study by Beck et al. (2011), carried out with elderly practitioners of physical activities in Santa Catarina, Brazil.

Similar improvements in hip flexibility, to those of the present study, were were described by Cristopoliskl et al.(2008), who observed changes in the gait pattern and increase of 2-4 degrees in the hip flexion movement in individuals after a session. Watt et al. (2011) found that an exercise-intervention group showed an increase ($p \leq 0.05$) in speed and length of stride, as well as in the movement of passive hip extension, indicating that a stretching program is effective in improving some measures related to age and decline of gait function in the elderly.

The foot has the function of equilibrating body weight, adjusting to any surface and promoting balance and motion. The ankle joint is used as the primary strategy of postural control and balance in the standing posture and prevents falls. This capacity may be decreased in the elderly and stretching exercises can help improve ankle joint stability, as observed by Johnson et al. (2007), who found an similar increases in the range of motion in the ankle dorsiflexion after flexibility exercises to those found in the present study. In the current study, we found significant increases in the ankle flexion movement (2.08 to 4.45 degrees) and ankle extension movement (4.12 to 8.25 degrees) ($p <0.05$) in the flexing movement to the left in the PAS and the extension movement to the right in the PAP, respectively. Zakas et al.(2005) found improvements in the joint ranges of seniors when investigating the effects of static stretching on the range of motion of the lower extremities and trunk of elderly women.

With regard to the use of omega-3 supplementation, together with flexibility exercises, we found no differences in flexibility ratings after the intervention, although trends toward better results in the flexion of the left cervical ($p = 0.058$) and the extension of the right ankle ($p = 0.057$) were observed. In general, supplementation appears to offer no significant impact on flexibility; probably studies using larger amount of omega-3, over longer periods of intervention, and in comparison to a control group, could show different results.

Some limitations in this study are present. This is a relatively small-sampled and short-term study without long-term follow-up data, additionally; there are pitfalls addresses to ÔMEGA-3 content analyses. In this way future research should examine if the improvement in exercise group was not an educational effect of the short-term exercise.

Conclusion

The present lead us to conclude that stretching physical activities seem to be beneficial for the elderly. However, our results did not show any additional benefits with the use of ômega-3 supplementation.

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