This item was submitted to [Loughborough's Research Repository](#) by the author.
Items in Figshare are protected by copyright, with all rights reserved, unless otherwise indicated.

Effects of different chair-based exercises on salivary biomarkers and functional autonomy in institutionalized older women

PLEASE CITE THE PUBLISHED VERSION

<https://doi.org/10.1080/02701367.2018.1563272>

PUBLISHER

© 2019 SHAPE America. Published by Taylor and Francis

VERSION

AM (Accepted Manuscript)

PUBLISHER STATEMENT

This is an Accepted Manuscript of an article published by Taylor & Francis in Research Quarterly for Exercise and Sport on 5 February 2019, available online: <http://www.tandfonline.com/10.1080/02701367.2018.1563272>.

LICENCE

CC BY-NC-ND 4.0

REPOSITORY RECORD

Rieping, Tais, Guilherme Eustaquio Furtado, Rubens Vinicius Letieri, Matheus Uba Chupel, Juan C. Colado, Eef Hogervorst, Edith Filaire, Ana Maria Teixeira, and Jose Pedro Ferreira. 2019. "Effects of Different Chair-based Exercises on Salivary Biomarkers and Functional Autonomy in Institutionalized Older Women". figshare. <https://hdl.handle.net/2134/36933>.

WOMEN

Abstract

Purpose: The aim of this study was to test the effects of chair-based exercise programs on salivary stress hormones, physical fitness and functional autonomy of institutionalized older women. Methods: A total of 47 participants (80 ± 8.04 years old) were recruited and allocated into three groups: chair based aerobic exercises (CAE, $n = 19$), chair-based elastic-band strength exercises (CSE, $n = 15$) and a control group (CG, $n = 13$). A 14-week exercise intervention was done for the CAE and CSE, two times per week, in no consecutive days. The CG did not participate in any type of exercise but kept their regular lifestyle. Fear of falling, autonomy, physical fitness, salivary cortisol and alpha-amylase levels were assessed before and after the intervention. Results: CAE improved upper and lower body strength, agility-dynamic balance and autonomy with fear of falling decreasing significantly ($p < .05$, moderate effect size). Both exercise groups showed a trend towards an increase in salivary alpha-amylase levels (CAE = 43%, $d = .31$ and CSE = 44%, $d = .41$). Conclusion: Both exercise programs were able to improve functional autonomy, even in elders over 80 years of age. However, it might be interesting to investigate the effectiveness of combining both aerobic and strength exercises in a unique protocol. The modulation effect of exercise in the hormonal responses needs to be further explored.

Keywords: Activities of daily life, alpha-amylase, cortisol, physical fitness, autonomy.

WOMEN

24

25 Aging is a dynamic and complex process that involves factors such as the
26 environment, genetics, and lifestyle (Spirduso, Francis, & MacRae, 2005). It causes losses in
27 the central nervous, neuromuscular and skeletal systems, as well as deterioration of many
28 physical-functional fitness functions, such as walking speed, posture, balance, agility and
29 ultimately leading to lack of autonomy and institutionalization (Granacher, Lacroix,
30 Muehlbauer, Roettger, & Gollhofer, 2013). These justify the need to focus on ways to
31 maintain and improve global health and well-being related to physical health in aging
32 populations.

33 Benefits promoted by regular exercise in the older adults include the reduction of
34 functional limitations, the improvement of functional skills to perform daily life activities,
35 even in people with reduced mobility (Sherrington et al., 2016). Also, fall events in this age
36 group are very common and are clearly related to the loss of muscle function, postural
37 instability, change in gait pattern, poor balance, visual problems and the use of some
38 medications (Burton et al., 2015).

39 The literature has shown the effectiveness of both aerobic and strength exercises with
40 elastic bands in improving physical fitness in older adults (Granacher et al., 2013). These also
41 have the advantage of being affordable and adaptable for people with reduced mobility
42 (Chen, Li, Chang, Huang, & Cheng, 2015). However, the types of exercise and the methods
43 used can determine the degree of exercise participation and the results obtained, especially in
44 populations with special needs conditions (Nelson et al., 2007), given that they may be more
45 challenging to motivate in order to join exercise programs (Sequeira, 2007). The Chair-Based
46 Exercise (CBE) protocol was shown to be a suitable and appropriate method of exercise for
47 inactive older adults (Robinson et al., 2014). It consists of structured and progressive

WOMEN

exercises performed with a chair for support that guarantees the individual's stability during the session, respecting individual limitations without discouraging individuals to reach beyond their limits (Furtado et al., 2016).

CBE aerobic programs have been shown to improve cardiorespiratory fitness, decrease fear of falling and to have cognitive benefits in mentally healthy older adults (DeSure, Peterson, Gianan, & Pang, 2013). Recent studies have also demonstrated the effectiveness of exercise programs using elastics resistance exercises. Elastic is an alternative to traditional muscle strength exercise devices which reduces the risk of injury allowing individuals to perform a range of ergonomic movements and adjust the training intensity, eliciting higher intrinsic motivation in healthcare practitioners to advocate strength exercises (Colado & Triplett, 2008).

Exercises, aimed at both aerobic and muscle-strength development, trigger a series of changes in the autonomic nervous system (ANS) regulated mechanisms. Several studies have revealed that alpha-amylase (AA) levels increase under conditions of physical and psychobiological stress (Urs Markus Nater et al., 2006). Its main function is the organic degradation of starch molecules in the digestion process, and it has also been implicated in the modulation of alpha-adrenergic and beta-adrenergic mechanisms (Lehninger, Nelson, & Cox, 2007; U. M. Nater & Rohleder, 2009). While vigorous exercise is related with immune suppression and a higher prevalence of upper respiratory tract infections, moderate exercise seems to promote activation of this enzyme at non-pathological levels increasing health benefits (Walsh et al., 2011).

Cortisol (CORT) is another essential hormone and considered to be the main modulator of the adaptive response to biological and psychological stress (Lehninger et al., 2007). CORT is produced by the adrenal glands, involved in energy metabolism, regulation

WOMEN

of the immune system and bone metabolism. Its release is the result of nerve stimuli sent by the ANS when facing a stressful situation (Lehninger et al., 2007). CORT has catabolic functions, increases blood pressure, increases blood glucose and energy availability to the muscle, concomitant with a suspension of anabolic activities (Fries, Dettenborn, & Kirschbaum, 2009).

Unlike AA, CORT has been well studied over many years and there are several studies that **report** its increased levels with exercise (Mckune, Bach, Semple, & Dyer, 2014). However, no exercise intervention studies relating AA and CORT concentrations with simultaneously objective and subjective measurements of physical and functional autonomy in older women have been **done**, with most exercise studies **on** AA focusing in adults or athletes (Allgrove, Gomes, Hough, & Gleeson, 2008).

This study aims to inspect the effectiveness of two CBE programs, one aerobic and the other a muscle-strength elastic band program on the behavior of biological stress/autonomous function biochemical markers (AA and CORT), physical fitness and functional autonomy in institutionalized older women.

Methods

Recruitment

This study is a chair-based exercise intervention with institutionalized-dwelling older women, part of the XXXXXXXXXX study protocol (XXXXXX et al., XXXXX). Participants were older women living in two different home care services (HCS). A presentation was done to all eligible participants and HCS staff, communicating the stages of the study, possible risks involved and the option of leaving the intervention spontaneously. Participants signed an informed consent term. This study was approved by the Ethics and Human Subjects Review

WOMEN

Board of the XXXXXXXXXXXXXXX XXXXXXX XXXXXXXXXX , University of XXXXXXXXX,
XXXXXXXXXX (University of XXXXXXX code number CE/XXXXXXXXXX/000202013),
respecting the guidelines for human research of the Helsinki declaration.

Sample Selection Criteria

Participants had to be over 75 years old and to have their medication treatment stabilized. If
there was any uncontrolled comorbidity, the participation in the classes was not permitted.
The exclusion criteria included: completing the '8-foot-up and go test' (8-FGT) in more than
30 seconds (revealing of a high mobility dependency); uncontrolled respiratory diseases and
musculoskeletal impairments that prevented the performance of the physical fitness tests;
cognitive, hearing and visual impairment; severe morbid obesity or the use of drugs that
significantly impaired attention; being engaged in an alternative exercise training program.

Sample Size

Calculation of sample size was done using G*Power (version 3.1.9.2). Alpha was adjusted at
.05 and power at .85 for repeated measures ANOVA. This required a sample size of 75
participants. The initial sample was composed of 70 institutionalized sedentary women from
two nursing homes. Additionally, 18 participants were recruited in the same centers to
prevent an estimated **sample** loss of 30% of participants. At the end of the intervention, the
final sample was composed of 47 women (**age = 80 ± 8.04** years old), allocated into three
groups: chair aerobic exercises (CAE, n = 19), chair elastic-band muscle strength exercises
(CSE, n = 15) and a non-exercise control group (CG, n = 13). **A 14-week CBE intervention**
was applied in the CAE and CSE groups. The CG group did not participate in any type of

WOMEN

exercise intervention but was encouraged to engage in complementary activities provided by the HCS like outside tours, art education and cultural activities (see figure 1).

[Insert figure 1 about here, please]

Figure 1 - Flowchart of the study design according to CONSORT guidelines for experimental studies.

Outcome Measures and Data Collection

The data collection was done in the morning period (09:00 to 11:30 am), before and after the 14-weeks intervention. The same variable, for all the participants, was always measured by the same staff of the research team, without making reference to the exercise programs. The functional autonomy was evaluated by psychometric rate scales and the physical- functional fitness tests as described above. The quality of data was analyzed and reported for each physical-functional fitness measure through scores of internal consistency reliability (ICR).

Stress hormones data collections

Saliva was collected between 09:00 - 11:30h a.m., with a minimum of 30 minutes after first diurnal food intake. Participants were seated, with their head tilted down, eyes open and instructed to perform a minimum of orofacial movements. The saliva was collected into polypropylene tubes, which were sealed and refrigerated immediately after collection of the sample. The levels of salivary cortisol (sCORT) were evaluated by ELISA (Salimetrics, UK), and alpha salivary AA (sAA) by kinetic assay (Salimetrics, UK), following the manufacturer instructions. The detection limits and correlation with serum samples were reported by the manufacturer as $<.007$ ug/dL, $r = .91$ respectively for sCORT and 1 pg/mL, $r = .96$ for sAA.

WOMEN

Physical-functional fitness screen

The Physical Fitness test battery was used since it is appropriate for research and clinical purposes in older populations (Rikli & Jones, 2013). Lower-body dynamic muscle strength is determined with the thirty seconds chair-seated and stand (30s-CS) test that assess the total number of chair-stands finished per time (ICR = .86). The upper body strength is determined with the thirty seconds arm-curl (30s-AC) test that evaluates the total number of arm curls executed in that time (ICR = .92). The upper-body flexibility was determined with the back scratch test (BST), that considers the distance (centimeters) of overlap or between the tips of the middle fingers of the back (ICR = .84). The 8-FGT was used for assessment of dynamic balance, which evaluates the time needed for the participant to get up from the chair around either side of a cone placed at 8 feet distance and to sit back down (ICR = .80). The physical tests stations were set in circuit-style to minimize fatigue. Participants performed each test two times in order to get familiarized with them.

Self-perceived risk of falls

Falls Efficacy Scale (FES) was used to measure fear of falling. The minimum score is 100 and the maximum score is 10 points. The lower score corresponding to a high self-efficacy and low fear of falling (Tinetti, Richman, & Powell, 1990);

Instrumental and independent activities of daily living

The Lawton Scale of Instrumental Activities of Daily Life (IADL) and the Katz Index of Independence in Activities of Daily life (ADL) were used. These index rank adequacy of

WOMEN

performance in the daily activities. In the IADL, a summary score indicates low function, dependent (zero) to high function and independent, 8 points (Sequeira, 2007). In the ADL, A total of 6 points designates full function, 4 points denotes moderate disability, and 2 or less indicates severe functional disability (Wallace & Shelkey, 2007).

Charlson Comorbidity Index (CCI)

The severity of comorbidity was assessed according to the CCI, based on the register of diseases or clinical conditions of each individual, based on 19 conditions forming a single and continuous index (Charlson, Szatrowski, Peterson, & Gold, 1994). In our study sample, there was a prevalence of diagnosed mental disorders, such as depression, anxiety and chronic stress.

Anthropometric assessment

The standard and described procedures were followed (Chumlea & Baumgartner, 1989).

Body mass was assessed using a compact scale (Seca®, model 770, Germany) with a precision of 0.1 kilos. **Stature** was analyzed using a stadiometer (SecaBodymeter®, model 208, Germany) with a precision of 0.1 centimeters. For body mass index (BMI) the standard formula was applied.

Exercise programs

The two exercise programs were designed and developed by **health professionals, based on the American College of Sports Medicine** guidelines (Nelson et al., 2007), and CBE protocol and are described in detail below. The sessions of both CBE were executed three times per week, on non-consecutive days (separated by 48 hours), for 14 weeks, and lasted 45 minutes. A total of 35 sessions was offered. An attendance of the exercise classes of 60% to 70% was

WOMEN

determined as a minimum for each participant to be part of the CBE groups. During the intervention, no participant was excluded from both CBE for consecutive absences or low participation, but they were not considered for statistical analysis.

Chair-aerobic exercises to improve walking (CAE)

CAE was structured with 5 minutes of warming-up, with six general mobility exercises and dynamic stretching; 35 minutes with 7 to 10 exercises with chair support, using repetitions of callisthenics and body weight exercises aimed to improve walking. The circuit training protocol was used increasing complexity of movements and sequences between series, preserving the aerobic characteristic of the session; 5 minutes of cooling-down with stretching and breathing exercises. Furthermore, heart rate monitors (POLAR, M810) were randomly used in five participants during the exercise sessions, as aid adjustment and control of training loads. For safety reasons, exercise intensity was indirectly predicted using the Karvonen's formula but with maximal heart rate (HR_{max}) being calculated using Franklin formula ($HR_{max} = 207 \text{ beat per minute} - 0.7 \times \text{chronological age}$). Additionally, the modified BORG PES was used, comprising a subjective rate scale ranging from 0 to 10 points, with identical intervals and with reference to the quality of effort: (0) nothing at all; (1) very weak; (2) weak; (3) moderate; (4) somewhat strong; (5-6) strong; (7-9) very strong; (10) very, very strong (almost maximal).

Chair elastic-band muscle strength exercises (CSE)

A periodization CSE program was followed by the participants using the three less resistant elastic bands: yellow, red and green (Thera Band®, Akron, Ohio, US), with the support of a chair. Participants performed two sessions of pre-intervention familiarization to adjust to the

WOMEN

Rated Perceived Exertion (RPE) scale, learn the correct technique of the exercises, select the color, length, and width of the grip of the bands. Each exercise session consisted of (a) general 5-minutes warming-up including six exercises for general body activation; (b) followed by 35 minutes of an elastic-band resistance including 8-10 exercises, 15-20 repetitions, 2-3 series and cadence of execution (2 seconds of concentric phase and 2-3 seconds of eccentric contraction); (d) completed by 5 minutes of cooling-down with brief static stretching and breathing exercises for the muscles trained. The elastic band resistance exercises were chosen **in order to use** mainly multi-joint exercises. The intensity was held at 10 submaximal repetitions with a perceived exertion level of 6 (somewhat-hard) to 8 (hard) on the OMNI scale (Colado & Triplett, 2008), that comprises a subjective effort scale ranging from 0 to 10 points, with same intervals to the quality of effort: (0) extremely easy; (1-2) easy; (3-5) somewhat easy, (6-7) somewhat-hard; (8) hard; (9-10) extremely-hard (Robertson et al., 2003). The loads were adjusted every week to maintain appropriate training intensities by adapting the levels of resistance.

Statistical Analyses

Descriptive statistics are presented using mean and standard deviations (SD). The normal distribution was tested using the Shapiro-Wilk test. Data were log transformed to reduce bias arising from non-uniformity. Since some assumptions for repeated measures ANOVA performance were violated, we used univariate analysis to avoid significant error. Baseline comparisons between groups were performed using Kruskal-Wallis tests. Within-group comparisons between Pre- and Post- moments were performed using Wilcoxon's signed-rank test for Likert scales instruments and biological outcomes (sCORT and sAA). T-test for paired samples was used to verify within changes in physical fitness parameters after

WOMEN

interventions. Percentage of change ($[\text{Post value}/\text{Pre value}]-1$) was calculated and presented for each variable. To report the magnitude of changes the effect size of the point biserial correlation (r_{pb}) was calculated and converted for standardized Cohen's d , categorized as trivial ($d < .2$), small ($d = .2$ to $.6$), moderate ($d = .6$ to 1.2), large ($d = 1.2$ to 2.0), very large ($d = 2.0$ to 4.0) and nearly perfect ($d > 4.0$). Level of statistical significance for $p < .05$ was assumed. The Statistical Program for Social Sciences - SPSS, version 23.0 for Windows was used.

Results

In total, 78 potential participants were screened for eligibility (see figure 1 flowchart). Firstly, 11 participants were excluded (not meet the inclusion criteria) and 6 participants lost interest after the study intervention was explained. Initially, 61 older adults who met the inclusion criteria were allocated to the different intervention groups. In total 14 participants withdrew and of 2 participants were excluded from analyses due to the low exercise adherence ($n = 1$ for each group). Finally, a total of 47 participants (CAE with $n = 19$, CSE with $n = 15$ and CG with $n = 13$) completed the 14-weeks study (see figure 01). Table 1 shows the result of the descriptive statistics of the data relating to the characterization of the two experimental and control groups at baseline. There were no statistically significant differences between CAE, CSE and CG for the baseline characteristics or dependent variables at the beginning of the study ($p > .05$).

[Insert table 1 about here, please]

WOMEN

Table 2 shows the differences between the mean and standard deviation values and the degree of significance for each group after 14 weeks of intervention. Significant differences were found for 30'sAC, 8-FUGT and FES in the CAE group ($p < .05$, moderate effect size), while no significant alterations were observed in these makers for the other groups ($p > .05$). The backstretch test showed a trend **towards** improvement, with a moderate effect size, in the CAE group ($p = .06$, +23%, $d = .85$). The values for the 30s-CS and instrumental ADL in the CSE group increased significantly (**$p < .05$, with a moderate effect**), but other variables remained unchanged after 14 weeks of intervention in this group. Independent ADL scores remained unaffected in all groups ($p > .05$).

[Insert figure 2 about here, please]

Results for the **changes in** salivary sCORT and sAA after the 14 weeks are shown in the figure 2. Both exercising groups showed a slight increase in sAA (CAE = 43%, $d = .31$ and CSE = 44%, $d = .41$). A small effect size and a non-significant decrease was observed for sAA levels in the CG (-39%, $d = .37$). Salivary CORT levels showed a small increase **for all the groups: CAE** (23%, $d = .22$), **CSE** (14%, $d = .53$) and **CG** (12%, $d = .43$).

Discussion

The most important findings of the present study indicate that the CAE **program** was proficient in improving upper body strength, agility-dynamic balance and in decreasing the fear of falling. **The CSE program** also improved lower body strength and instrumental ADL. Independent ADL was not affected. Both exercise groups showed a clinically relevant response by increasing sAA levels. **According to a recent study, the concentration levels of**

WOMEN

cortisol in persons over 80 years old, with the sample collection done at similar times of the day as the ones in our study, varied between 0.30 and 1.1 ug/mL (Nasr-Esfahani, Moghadam, Tangestaninejad, Mirkhani, & Momeni, 2006). In this sense, the variation of sCOR after exercise mediation occurred in a range of values that did not affect the participants' state of health. Regarding salivary alpha-amylase, the references values for this age range from 3.1 and 423.1 ug/mL for adults (Salimetrics UK, 2017).

The sample of this study consisted of 47 institutionalized older women, which presented homogeneity for all the variables and no baseline differences. Adherence was good, with only 2 participants engaging insufficiently. Observed differences between the two active groups (CAE and CSE) and controls were therefore not affected by inherent methodological or selection bias. However, it is important to note that the sample was in a pre-classification state of obesity according to WHO classification ($BMI > 25,0 \text{ kg/m}^2$). This is an important factor in our analysis since obesity is not only a risk factor but also interferes with ADL and consequently the independence and autonomy of the older adults (WHO, 2015). This may be why independent ADL was not affected, while instrumental ADL improved with CSE, but not with CAE. Regarding the high scores of CCI present in all groups, the most commonly reported conditions were: peripheral cardiovascular disease, lung and cardiometabolic diseases, followed by mental-health disorders (anxiety and chronic stress). Some of these conditions were treated with beta-blockers that may have interfered with the functioning of the autonomous nervous system and therefore affected our results. It must be kept in mind that this is an older pre-obese population, living in a homecare institution with high dependency needs and physically frail in some cases (Milte & Crotty, 2014).

Significant improvements were observed only in the IADL questionnaire for the CSE group and in FES for CAE group. Both the improvement in independence levels and the

WOMEN

reduced risk of falls in the older adults when engaging in PE is well documented in the literature and supports our findings (Burton et al., 2015). However, this was only the case for CAE, and not for CSE, in our study. Particularly in our study, this can be explained by the significant improvement in the dynamic balance test in the CAE group ($p \leq .05$). Looking at the data from the functional fitness tests, some improvements were observed for most tests in both active groups and more so for the CAE group, where the only test not showing improvements was the 30s-CS. Intriguing, this was the only variable which showed a significant increase for the CSE group, where elders could do almost two more repetitions in the 30-CS test in the same 30 seconds. This may be explained by the physiological characteristics of this variable, which recruits more type II fibers and relies more on the anaerobic metabolism. This data is supported by other studies which showed better results in this test when the group engaged in a strength exercise protocol (Daly et al., 2015).

On the other hand, CAE was more effective for all the other variables, including the agility-dynamic balance test. This last variable was the one which improved most after the CAE program, which can also be explained by the aerobic characteristic of this test. Improvements in cardiorespiratory fitness are well documented for older adults that participate in aerobic exercise programs (Theou et al., 2011). For the most optimal improvements, strength and aerobic exercises should be performed, not necessarily together since each type of exercise leads to specific responses and results on physical fitness (ACSM, 2009), but according to the individual needs and limitations of each elderly. The control group, as expected, did not show any improvements in the study variables, instead, a decrease in almost all of the physical fitness tests was observed, emphasizing the importance of being and staying active across the lifespan. Lack of exercise is a risk factor for the loss of independence in older adults (Ensrud et al., 2007). Unlike the present study, most research

WOMEN

with sAA is done on the acute effects of exercise (Patacchioli et al., 2015). This study found that sAA levels increased in both active groups, although not reaching statistical significance, but in a range of 43% for both groups. Moreover, in the control group, sAA levels decreased almost in the same range as the other groups increase (-39%). That means not only that exercise is an effective way to elevate sAA, but that these results seem to have clinical relevance. A caveat is that in this older population, effects of medication and illness could have affected outcomes and this needs to be further investigated.

Recent research has shown that exercise has an acute effect on sAA and sCORT, increasing their concentrations after exercise (Hatta, Nishihira, & Higashiura, 2013; Koibuchi & Suzuki, 2014). Other studies have linked these biomarkers with other stressful situations, apart from exercise, and have shown much higher responses of sAA and sCORT to stress (Koibuchi & Suzuki, 2014). Our results showed no statistically significant differences in the concentrations of sAA or sCORT before and after 14 weeks of exercise. However, there is a tendency for an increase in sCORT concentrations for all groups. In the intervention groups, this would be an expected response to exercise, since exercise does not only promote an increase in CORT secretion by the adrenal gland but can also promote an increase in adrenal gland volume itself (Hatta et al., 2013).

The sAA response seems to have a relationship with the exercise, since it shows an increasing trend in both active groups and a decrease in the control group. Although not significant, we can see a tendency of the sAA response to the exercise that could have become significant if the program was extended for a longer period. A study by Hatta et al. (2013) reported an increase in sAA concentrations after a bout of walking exercise. However, it must be considered that this study observed the effect of an acute exercise on sAA, as did most studies investigating this enzyme (Mckune et al., 2014). The same increased tendency

WOMEN

of sAA concentrations after 14 weeks of exercise was noticed in our CSE group in accordance to the reported in literature for younger samples (Allgrove et al., 2008). Based on this, and in the tendency shown in a review of 15 articles which studied the effect of different types of exercise on sAA (Koibuchi & Suzuki, 2014), we can assume that CSE can cause an increase in sAA concentrations, not only immediately after exercise, but also in long-term, which may be associated with the increased in plasma catecholamines **seen** in response to exercise. Because those hormones are also regulated by the NAS and seem to interfere with salivary secretion they could be involved in the control of salivary electrolytes and protein levels (Chicharro, Lucía, Pérez, Vaquero, & Ureña, 1998) essential for maintaining mucosal immunity. In addition, saliva composition is mostly regulated by the action of adrenergic mediators, just as catecholamines are. **Thus, our results show that sAA seems to be a potential predictor of adrenergic activity, with better accuracy than sCOR.**

Conclusion

In this study, the exercise programs implemented were effective in improving the functional autonomy of older adults. Hormonal responses to exercise showed a tendency to increase. Combining both types of exercise **could be used** by specialists and other healthcare providers as a feasible exercise program method for the older adult population. Adherence and outcomes of this combination need to be further investigated. It is also possible that a longer intervention protocol could have yielded more significant effects in all the tests used, including the hormonal responses to exercise. Therefore, we recognize the need for new studies that seek to investigate the response of these and other markers, with long-term combined exercise-effects. Also, it is recommended that future studies seek to individually monitor the use of beta-blocker drugs in order to reduce its influence on study results.

WOMEN

384

385

What Does This Article Add?

386

387

388

389

390

391

392

393

394

395

396

397

398

399

400

401

402

403

404

References

405

406

This article describes two different exercise protocols aimed at institutionalized populations with a very poor functional fitness level, some even classifying as physically frail. They use a chair for support enabling this population to start exercising from a secure position and gradually improve their fitness levels to a state where the chair is no longer needed. This study also showed that these alternative exercise programs, the Chair elastic-band muscle strength exercises (CSE) and the Chair-aerobic exercises to improve walking (CAE), were able to induce relevant changes in the functional fitness levels of the participants where improvements were observed in the Instrumental Activities of Daily Life and the Falls efficacy scale. The trend to increased the levels of salivary alpha-amylase reveal an improvement of mucosal immunity and an involvement in the control of the nervous autonomic system that plays an essential role in regulating blood pressure. The constant search for a better quality of life and autonomy in elderly individuals, is a concern of the social services of health care. The inclusion of these types of exercise can be considered co-adjuvant treatment of several diseases that can compromise functional autonomy, and more importantly, showed that chair-based exercises can improve physical fitness, even when started at advanced ages.

ACSM. (2009). American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Medicine and science in sports and exercise*,

WOMEN

- 407 41(3), 687–708. <https://doi.org/10.1249/MSS.0b013e3181915670>
- 408 Allgrove, J. E., Gomes, E., Hough, J., & Gleeson, M. (2008). Effects of exercise intensity on
409 salivary antimicrobial proteins and markers of stress in active men. *Journal of sports*
410 *sciences*, 26(6), 653–661. <https://doi.org/10.1080/02640410701716790>
- 411 Burton, E., Cavalheri, V., Adams, R., Browne, C. O., Boverly-spencer, P., Fenton, A. M., ...
412 Hill, K. D. (2015). Effectiveness of exercise programs to reduce falls in older people
413 with dementia living in the community : a systematic review and meta-analysis, 421–
414 434.
- 415 Charlson, M., Szatrowski, T. P., Peterson, J., & Gold, J. (1994). Validation of a combined
416 comorbidity index. *Journal of clinical epidemiology*, 47(11), 1245–51.
- 417 Chen, K., Li, C., Chang, Y., Huang, H., & Cheng, Y. (2015). An elastic band exercise
418 program for older adults using wheelchairs in Taiwan nursing homes : A cluster
419 randomized trial. *International Journal of Nursing Studies*, 52(1), 30–38.
420 <https://doi.org/10.1016/j.ijnurstu.2014.06.005>
- 421 Chicharro, J. L., Lucía, A., Pérez, M., Vaquero, A. F., & Ureña, R. (1998). Saliva
422 composition and exercise. *Sports Medicine*, 26(1), 17–27.
423 <https://doi.org/10.2165/00007256-199826010-00002>
- 424 Chumlea, W. C., & Baumgartner, R. N. (1989). Status of anthropometry and body
425 composition data in elderly subjects. *The American journal of clinical nutrition*, 50(5
426 Suppl), 1158-66–5.
- 427 Colado, J. C., & Triplett, N. T. (2008). Effects of a short-term resistance program using
428 elastic bands versus weight machines for sedentary middle-aged women. *Journal of*

WOMEN

- 429 *strength and conditioning research / National Strength & Conditioning Association,*
430 22(5), 1441–8. <https://doi.org/10.1519/JSC.0b013e31817ae67a>
- 431 Daly, R. M., Duckham, R. L., Tait, J. L., Rantalainen, T., Nowson, C. A., Taaffe, D. R., ...
432 Busija, L. (2015). Effectiveness of dual-task functional power training for preventing
433 falls in older people: study protocol for a cluster randomised controlled trial. *Trials,*
434 16(1), 120. <https://doi.org/10.1186/s13063-015-0652-y>
- 435 DeSure, A. R., Peterson, K., Gianan, F. V., & Pang, L. (2013). An exercise program to
436 prevent falls in institutionalized elderly with cognitive deficits: a crossover pilot study.
437 *Hawai'i journal of medicine & public health : a journal of Asia Pacific Medicine &*
438 *Public Health*, 72(11), 391–5.
- 439 Ensrud, K. E., Ewing, S. K., Taylor, B. C., Fink, H. A., Stone, K. L., Cauley, J. A., ...
440 Cawthon, P. M. (2007). Frailty and risk of falls, fracture, and mortality in older women:
441 The study of osteoporotic fractures. *Journals of Gerontology - Series A Biological*
442 *Sciences and Medical Sciences*, 62(7), 744–751. <https://doi.org/62/7/744> [pii]
- 443 Fries, E., Dettenborn, L., & Kirschbaum, C. (2009). The cortisol awakening response (CAR):
444 Facts and future directions. *International Journal of Psychophysiology*, 72(1), 67–73.
445 <https://doi.org/10.1016/j.ijpsycho.2008.03.014>
- 446 Furtado, G. E., Uba-Chupel, M., Carvalho, H. M., Souza, N. R., Ferreira, J. P., Teixeira, A.
447 M., ... Smith, B. K. (2016). Effects of a chair-yoga exercises on stress hormone levels,
448 daily life activities, falls and physical fitness in institutionalized older adults.
449 *Complementary Therapies in Clinical Practice*, 0(0), 144–156.
450 <https://doi.org/10.1016/j.ctcp.2016.05.012>
- 451 Granacher, U., Lacroix, A., Muehlbauer, T., Roettger, K., & Gollhofer, A. (2013). Effects of

WOMEN

- 452 core instability strength training on trunk muscle strength, spinal mobility, dynamic
453 balance and functional mobility in older adults. *Gerontology*, 59, 105–113.
454 <https://doi.org/10.1159/000343152>
- 455 Hatta, A., Nishihira, Y., & Higashiura, T. (2013). Effects of a single bout of walking on
456 psychophysiologic responses and executive function in elderly adults: a pilot study.
457 *Clinical interventions in aging*, 8, 945–52. <https://doi.org/10.2147/CIA.S46405>
- 458 Koibuchi, E., & Suzuki, Y. (2014). Exercise upregulates salivary amylase in humans.
459 *Experimental and Therapeutic Medicine*. <https://doi.org/10.3892/etm.2014.1497>
- 460 Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2007). *Lehninger Princípios de Bioquímica*.
461 (Sarvier, Org.) (4^o ed). São Paulo.
- 462 Mckune, A. J., Bach, C. W., Semple, S. J., & Dyer, B. J. (2014). Salivary cortisol and α -
463 amylase responses to repeated bouts of downhill running. *American Journal of Human*
464 *Biology*, 26(6), 850–855. <https://doi.org/10.1002/ajhb.22605>
- 465 Milte, R., & Crotty, M. (2014). Musculoskeletal health , frailty and functional decline. *Best*
466 *Practice & Research Clinical Rheumatology*, 1–16.
- 467 Nasr-Esfahani, M., Moghadam, M., Tangestaninejad, S., Mirkhani, V., & Momeni, A. R.
468 (2006). Rapid and efficient oxidation of Hantzsch 1,4-dihydropyridines with sodium
469 periodate catalyzed by manganese (III) Schiff base complexes. *Bioorganic and*
470 *Medicinal Chemistry*, 14(8), 2720–2724. <https://doi.org/10.1016/j.bmc.2005.11.051>
- 471 Nater, U. M., La Marca, R., Florin, L., Moses, A., Langhans, W., Koller, M. M., & Ehlert, U.
472 (2006). Stress-induced changes in human salivary alpha-amylase activity -- associations
473 with adrenergic activity. *Psychoneuroendocrinology*, 31(1), 49–58.

WOMEN

<https://doi.org/10.1016/j.psyneuen.2005.05.010>

Nater, U. M., & Rohleder, N. (2009). Salivary alpha-amylase as a non-invasive biomarker for the sympathetic nervous system: Current state of research. *Psychoneuroendocrinology*, 34(4), 486–496. <https://doi.org/10.1016/j.psyneuen.2009.01.014>

Nelson, M. E., Rejeski, W. J., Blair, S. N., Duncan, P. W., Judge, J. O., King, A. C., ... Castaneda-Sceppa, C. (2007). Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. *Medicine and science in sports and exercise*, 39(8), 1435–45. <https://doi.org/10.1249/mss.0b013e3180616aa2>

Patacchioli, F. R., Ghiciuc, C. M., Bernardi, M., Dima-Cozma, L. C., Fattorini, L., Squeo, M. R., ... Perrone, G. (2015). Salivary α -amylase and cortisol after exercise in menopause: influence of long-term HRT. *Climacteric*, 18(4), 528–535. <https://doi.org/10.3109/13697137.2015.1008444>

Rikli, R. E., & Jones, C. J. (2013). Development and validation of criterion-referenced clinically relevant fitness standards for maintaining physical independence in later years. *Gerontologist*, 53(2), 255–267. <https://doi.org/10.1093/geront/gns071>

Robertson, R. J., Goss, F. L., Rutkowski, J., Lenz, B., Dixon, C., Timmer, J., ... Andreacci, J. (2003). Concurrent validation of the OMNI perceived exertion scale for resistance exercise. *Medicine and science in sports and exercise*, 35(2), 333–41. <https://doi.org/10.1249/01.MSS.0000048831.15016.2A>

Robinson, K. R., Leighton, P., Logan, P., Gordon, A. L., Anthony, K., Harwood, R. H., ... Masud, T. (2014). Developing the principles of chair based exercise for older people: a modified Delphi study. *BMC geriatrics*, 14(1), 65. <https://doi.org/10.1186/1471-2318->

WOMEN

497 14-65

498 Salimetrics UK. (2017). Salimetrics: Saliva Collection, Saliva EIA kits, Saliva Testing, &
499 Salivary Bioscience Research.

500 Sequeira, C. A. da C. (2007). *Cuidar de Idosos Dependentes*. Coimbra: Quarteto Editora.

501 Sherrington, C., Fairhall, N., Kirkham, C., Clemson, L., Howard, K., Vogler, C., ... Lord, S.
502 R. (2016). Exercise and fall prevention self-management to reduce mobility-related
503 disability and falls after fall-related lower limb fracture in older people: protocol for the
504 RESTORE (Recovery Exercises and STEpping On afterR fractureE) randomised
505 controlled trial. *BMC geriatrics*, 16(1), 34. <https://doi.org/10.1186/s12877-016-0206-5>

506 Spirduso, W. W., Francis, K. L., & MacRae, P. G. (2005). *Physical dimensions of aging*.
507 Human Kinetics.

508 Teixeira, A. M., Ferreira, J. P., Hogervorst, E., Braga, M. F., Bandelow, S., Rama, L., ...
509 Pedrosa, F. M. (2016). Study Protocol on Hormonal Mediation of Exercise on
510 Cognition, Stress and Immunity (PRO-HMECSI): Effects of Different Exercise
511 Programmes in Institutionalized Elders. *Frontiers in Public Health*, 4, 133.
512 <https://doi.org/10.3389/fpubh.2016.00133>

513 Theou, O., Stathokostas, L., Roland, K. P., Jakobi, J. M., Patterson, C., Vandervoort, A. A.,
514 & Jones, G. R. (2011). The effectiveness of exercise interventions for the management
515 of frailty: a systematic review. *Journal of aging research*, 2011, 569194.
516 <https://doi.org/10.4061/2011/569194>

517 Tinetti, M. E., Richman, D., & Powell, L. (1990). Falls efficacy as a measure of fear of
518 falling. *Journal of gerontology*, 45(6), P239–P243.

WOMEN

519 <https://doi.org/10.1093/geronj/45.6.P239>

520 Wallace, M., & Shelkey, M. (2007). Katz Index of Independence in Activities of Daily

521 Living (ADL). *Urologic nursing : official journal of the American Urological*

522 *Association Allied*, 27(1), 93–94. <https://doi.org/10.1097/00004045-200105000-00020>

523 Walsh, N. P., Gleeson, M. M., Shephard, R. J., Jeffrey, M. G., Woods, A., Bishop, N. C., ...

524 Simon, P. (2011). Part one : Immune function and exercise. *Exercise immunology*

525 *review*, 17, 6–63.

526 WHO. (2015). World report on ageing and health. *Who*. <https://doi.org/10.1007/s13398-014->

527 0173-7.2

528

529

530

531

532

533

534

535

536

537

538

Table 1. Characteristics of experimental and control groups at baseline and comparison between groups by ANOVA one-way.

	Chair-aerobic improve walk exercises (n=19)	Chair elastic-band strength exercises (n=15)	Control group non exercise (n=13)	f value	p value
	mean (SD)	mean (SD)	mean (SD)		
Chronological age (years)	79.00 ± 7.63	83.47 ± 4.92	80.85 ± 10.86	1.314	.279
Height (centimeters)	1.50 ± .40	1.47 ± .41	1.51 ± .71	2.374	.105
Weight (kilos)	61.47 ± 1.039	63.97 ± 15.93	69.91 ± 16.00	1.431	.250
Body mass index (score)	27.09 ± 4.13	29.51 ± 7.24	30.73 ± 6.43	1.595	.214
Charlson Comorbidity Index (score)	7.21 ± 1.88	8.07 ± 1.91	8.77 ± 2.68	2.114	.133
Medication use (per unit)	3.12 (.88)	3.01 (.34)	4.02 (1.08)	1.567	.234

Table 2. Comparison between pre and post exercise intervention and control group (no exercise intervention)

	Aerobic improve walking (n=19)				Elastic-band strength exercises (n=15)				Control group non exercise (n=13)			
	Pre	Post	Percent	Effect	Pre	Post	Percent	Effect	Pre	Post	Percent	Effect
	Mean (SD)	Mean (SD)	change (%)	Size (d)	Mean (SD)	Mean (SD)	change	Size (d)	Mean (SD)	Mean (SD)	Change (%)	Size (d)
Alpha amylase (ug/mL) ^{&}	60.33 ± 126.55	86.50 ± 151.22	+43	.31	31.19 ± 52.15	44.66 ± 102.91	+44	.41	72.45 ± 154.10	44.21 ± 73.19	-39	.37
Cortisol (ug/mL) ^{&}	.27 ± .07	.31 ± .29	+13	.22	.24 ± .12	.27 ± .11	+14	.53	.26 ± .11	0.30 ± .14	+12	.43
Back stretch test (cm) [#]	27.05 ± 12.75	33.16 ± 12.92	+23	.06	27.77 ± 10.17	29.23 ± 13.09	+5	.09	25.88 ± 13.12	28.85 ± 13.26	+11	.46
30 seconds Arm-curl test (reps) [#]	8.79 ± 3.12	11.63 ± 3.67**	+32	.99	11.20 ± 5.80	11.93 ± 3.79	+7	.74	8.08 ± 4.57	7.54 ± 3.26	-7	.36
30 seconds chair-stand test (reps) [#]	9.26 ± 3.01	10.05 ± 3.01	+9	.49	6.67 ± 2.55	8.47 ± 3.44**	+27	1.12	7.15 ± 2.97	6.85 ± 3.46	-4	.16
Eight foot-up and-go test (time) [#]	12.77 ± 4.89	9.89 ± 2.53**	-23	1.31	20.62 ± 10.30	15.52 ± 6.82	-25	1.14	18.16 ± 12.50	16.72 ± 7.87	-8	.09
Falls efficacy scale (score) ^{&}	54.00 ± 26.76	25.53 ± 18.66**	-53	1.14	42.73 ± 23.73	31.4 ± 16.27	-27	.63	39.54 ± 20.55	27.92 ± 15.30	-29	.68
Instrumental ADL (score) ^{&}	20.53 ± 5.87	18.58 ± 7.14	-9	.33	23.73 ± 4.96	26.73 ± 4.17**	+13	.92	21.77 ± 5.31	22.62 ± 4.56	4	.21
Independent ADL (score) ^{&}	5.16 ± 1.42	5.11 ± 1.24	-1	.08	4.87 ± 1.12	4.53 ± 1.64	-7	.43	4.46 ± 1.33	4.62 ± .96	4	.32

** $p < .01$; * $p < .05$, # Comparison using T-test for paired samples; & Compared using Wilcoxon-signed rank test.