Research paper

Influence of chair-based yoga on salivary anti-microbial proteins, functional fitness, perceived stress and well-being in older women: A randomized pilot controlled trial

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ABSTRACT

Introduction: Chair-based Yoga (CBY) practice could be used as a therapy easily adaptable to older people's needs, as a tool to attenuate immunosenescence and to improve emotional status. The main goal of the study was to assess the changes mediated by CBY practice on salivary IgA and lysozyme levels, health-related emotional status (HrES) and functional fitness parameters in older women living in social caregiver centers.

Methods: Thirty-four older women (age: 83.16 ± 7.4 years) participated in the study and were divided in two groups, an Exercise Group (EG, n = 15) using CBY and a Control Group (CG, n = 10). All the subjects were assessed before and after the exercise program. EG practiced exercise 2–3 times per week for a period of 28 weeks, and the CG was not involved in any type of exercise program. Saliva samples, physical fitness tests and HrES psychometric rate scales were collected during rest, at baseline, and at the end of the exercise program.

Results: Flexibility was improved in the exercise group. IgA and lysozyme levels and IgA and lysozyme secretion rates tended to increase or were maintained in the EG, and a trend towards an improvement in the participants HrES was also found but only in the EG.

Conclusions: The present study shows a positive effect of CBY program in older women, which may lead to an improved well-being and used as a good therapeutic co-adjunct to usual medication treatment.

1. Introduction

Diminishing immune system functions and increasing incidence of neuropsychological diseases are two of the main consequences of the aging process [1]. Immunosenescence is the term used to represent changes in the immune system associated with aging [2], characterized as a state of deregulation, rather than a deficit of immune function [4], as it involves cellular and molecular changes in both innate and adaptive immunity. This may lead to increased incidence of infectious diseases as well as heightened rates of autoimmunity, cancer, and inflammatory conditions [2,4]. The mucosal immune system is the first line of protection of the body, reducing the need for the systemic immunity, which is principally pro-inflammatory and potentially tissue damaging [5,6].

Another aging-process consequence concerns the relationship between low levels of mental health and social involvement [7]. Positive HrES and well-being is seen as a basic feature of mental health [8]. Higher levels of negative feelings, for example, are often associated with poor physical health behaviors and mental disorders [8,9] such as depression [10], anxiety [11], and psychological stress [12]. It is now recognized that gradients of physical and mental health together, are a function of socioeconomic status [13].

Exercise has been reported as a way of attenuating the effects of immunosenescence in older people [14,15]. Long-term, moderate and structured exercise interventions in geriatric populations appear to be associated with a reduction in the risk of infectious diseases [2]. It may also represent a viable integrative exercise-therapy in patients for whom pharmacological treatment is unavailable, ineffective or inappropriate [16,17]. It is considered as one of the more appealing interventions both in terms of efficacy, cost, effectiveness and logistics [4], with advantages over dietary supplementation, involving endocrine modulation, immunomodulation, or additional vaccination [2].

There is some consensus that regular moderate regular exercise may reduce the risk of upper respiratory tract infections (URTI) or sympto-
matology of URTI, as it increases both concentration and secretion rate of salivary immunoglobulin A (SIgA) in older adults [2,18]. SIgA is thought to be crucial against infections, as it is a defense mechanism against pathogens trying to enter through the oral mucosa by preventing their adherence and penetration of the mucosal epithelium [6,19]. Saliva also contains other proteins with antimicrobial actions, including lysozyme which aids in the destruction of bacterial cell walls [6].

Until today, the majority of the studies using exercise have assessed saliva SIgA as a marker of mucosal immunity [20]. There is little data available regarding the changes in salivary lysozyme concentration with acute or chronic exercise in this population. However, other bodily practices similar to yoga, introduced in clinical trials as an addition to drug treatment, produced satisfactory results in improving the immune system in older patients with infectious disease [21,22].

Each person has a unique genotype and a set of lifetime experiences that will effect health, disease risk and how they will respond to an intervention [13]. Some HrES indicators, such as perceived stress (PSS) are implicated in the onset and progression of many common and costly chronic diseases, including cardiovascular disease, chronic pain conditions and major depressive disorders [23]. It is possible to predict how an individual embedded in a particular social and physical environment using certain biomarkers that can have a predictive or diagnostic value when combined with carefully design longitudinal assessment of behavior and disease related to psychological stress.

Psychological stressors can induce increases in inflammatory processes that may contribute to the development of chronic diseases and mental health disorders [23]. Overall, it appears that some cytokines increase fairly and consistently in saliva, in response to acute stress. The deregulation of inflammatory processes is associated with autoimmune diseases, eliciting dynamic changes in health behaviors [24]. In older people, in general, there is a prevalence of cortisol, a hormone secreted by the adrenal gland, involved in the genesis of stress related conditions. It is known that chronic stress and high levels of cortisol interfere with memory, and affect cognition and quality of life, increasing the risk of depression, and lower life expectancy [25].

The adaptation to physical or psychological stress usually involves the activation of the hypothalamic-pituitary-adrenal axis [26]. Normally it is hyper-activated and changes in diurnal or stress-induced secretion of the cortisol hormone could predispose older adults to negative health outcomes associated with the development of cognitive impairment [25,27]. Cortisol levels are also affected by exercise, depending on its intensity and duration [28].

The behavioral and psychological symptoms of dementia, for example, have a strong negative impact on both patients and caregivers health [29]. Using pharmacological approaches as treatment involves the use of potentially harmful drugs [30]. As an alternative, physical exercise has been regarded as a potentially effective non-pharmacological intervention for treating those symptoms, especially depression [31].

The implementation of regular exercise in long-term care facilities, institutions which typically care for a large number of patients with behavioral impairments, should be emphasized, and the participation of those patients in exercise classes should be encouraged [32].

Hatha yoga is a 4000-year-old holistic path of health and self-development [33] that aims to incorporate exercises interlinking body exercises and meditation [34]. Asanas, which are yoga exercise-positions or positions, are often combined with breathing and meditation practices that also cultivate awareness, relaxation and concentration [34]. Practicing asanas can also have a range of emotional benefits by reducing stress, improving quality of life [35], postural control and mobility in older adults [36].

Yoga is easily adaptable to the needs of older people practitioners, and choosing it as a therapy to maintain mucosal immune health in this population could be an useful strategy [37]. A systematic review suggested that the benefits of yoga may exceed those of conventional exercise interventions for self-rated health status, aerobic fitness, and strength [38]. However, even in older people with physical impairment, to perform the full practice of yoga may require specific adaptations, supported by a chair [39]. Chair-based Yoga (CBY) is a safe modified yoga program and adherence to recruitment is feasible [40]. The exercises are performed with the support of a chair, which has the purpose of providing a wider recovery range for those who feel more tired [41].

Galantino and colleagues have found that a structured program of CBY in older adults at higher risk of falling promoted beneficial effects on improving mobility and reducing fear of falling [40]. Others researchers have also found that CBY modulated effects on functional fitness, cardiometabolic outcomes and other salivary biomarkers [39,42]. However, there is still little evidence in the literature for the use of CBY as a tool to promote psychological well-being and additional systematic research is needed to assess the influence of this activity on older persons immunity levels [34,40,43]. The main purpose of this study was to assess the changes mediated by a Chair-based yoga on HrES indicators, salivary IgA and lysozyme levels, of institutionalized older women living in health and social caregiver centers (HSC).

2. Methods

2.1. Design and ethical statement

This study is an exercise-based intervention controlled trial with institutionalized-dwelling older women living in Coimbra (Portugal), included in the PRO-MECSHI study protocol [44]. The study was approved by the Ethical Committee of the Sport Sciences and Physical Education Faculty, – University of Coimbra (Ref.: CE/FCDEF-UC/000202013) and respected the Portuguese Resolution [Art. 4st; Law n. 12/2005, 1st series] on ethics in research with humans [45], following the guidelines for ethics in scientific experiments in exercise science research [46] and complied with the guidelines for research with human beings of the Helsinki Declaration [47].

2.2. Sample size estimation

Initially, 64 participants were recruited for this study. Sample size was estimated using the method described and previously published in Teixeira and colleagues [44]. Briefly, alpha (Type I error rate) was adjusted at 0.05 and power (Type II error rate) at 0.85 using G* Power Version 3.1.9.2 [48]. For this study, a required sample of 25 participants for both (intervention and control group) was estimated to provide enough information about the outcomes. Details of sample dropping-out are presented in Fig. 1.

2.3. Recruitment

Participants were older women living in two different HSC. All participants or their legal representatives were asked to give a full informed consent before the beginning the study. In the first visit, for the initial recruitment, a presentation was delivered to all eligible participants and HSC staff, communicating the stages of the study protocol, objectives, possible risks involved and the possibility of leaving the intervention spontaneously at any time. In case of acceptance, the participants having given their agreement to the study protocol signed a consent form.

2.4. Inclusion and exclusion criteria

In the second visit, base line assessment was performed by trained research team personnel with expertise in different data collection techniques. The combination information of baseline screening, measures of biosocial and global health status as well as information from the HSC medical staff, were used to select the participants to be included in the study (Fig. 1). Physical tests were performed by a specialist physiotherapist in geriatric populations. The inclusion criteria
to participate in the study were: a) female aged over 60 years, b) showing functional ability to fully participate in the CBY program; c) for those with cognitive impairment, disease must be controlled by drug therapy. The exclusion criteria were: a) taking more than 50 s to complete the task of the Eight-foot-up and go test [49,50]; b) simultaneous participation in other structured physical exercise programs; c) severe cardiovascular disease, musculoskeletal dysfunctions, mental disorder or uncontrolled similar clinical condition; e) hearing and/or vision impairment; f) need of special nutritional support; g) starting a new drug medication during the data collection period.

2.5. Randomization

After applying the selection criteria, a total sample of 47 women was recruited for the allocation phase. A simple randomization was performed using computer generated algorithms (Microsoft Excel, 2016). The software assigned a code to each individual generating a random sequence containing even and odd numbers. To guarantee equal distribution (1:1) and not to influence the research, the assignment into groups was computerised. The computer divided the numbers into two arms: the even numbers were allocated to the exercise group (EG) and followed the CBY program, and the odd numbers were assigned to the control group (CG). A 28-week CBY was done for the EG group and the CG group did not participate in any physical exercise intervention, but was encouraged to maintain complementary activity by the HSC.

2.6. Anthropometric measures

Body mass was determined using a portable scale (Seca®, model 770, Germany) with a precision of 0.1 kg. Stature was determined using a portable stadiometer (Seca Bodymeter®, model 208, Germany) with a precision of 0.1 cm. Body mass index (BMI) was calculated according the formula [BMI = weight/height²] [51].

2.7. Clinical health status

Comorbidity was evaluated using The Charlson Comorbidity Index (CCI) that measures burden of disease and has a weighted index based on 19 comorbid conditions. This score can be combined with age to form a single index [52]. Medication use was assessed through medical record, identifying and reporting polypharmacy (takes more than 3 prescription drugs per day) and also, categorizing medications by the Portuguese Classification System of Human Medicine. Medications of all the study participants did not change during the intervention program.

2.8. Biochemical markers

Saliva was collected by passive drool using a method previously described [39]. Briefly, the subjects salivate into high quality polypropylene vials for 3 min. Collection was always done at the same time in the morning aiming to minimize the circadian effect of some markers.

Fig. 1. Flowchart of the study design.
used in the study. After collection, the tubes containing the saliva were stored at −20 °C until further analysis, then defrosted and centrifuged in order to collect the saliva sample [54]. The volumes were measured and the flow secretion rate calculated. The concentration of Lysozyme and IgA was determined by competitive ELISA (AbGcam, UK and Salimetrics®, UK, respectively), according to the manufacturer instructions.

2.9. Health related emotional status screening

Developed in 1998 by World Health Organization (WHO), the Portuguese version of WHO-S was used for assessing emotional well-being [55]. This questionnaire has five items that evaluate the level of positive subjective well-being during the last two weeks. A six items response option (from 0 to 5) is offered on a Likert scale, where 0 means ‘never’, 1 – ‘sometimes’, 2 – ‘less than half the time’, 3 – ‘more than half the time’, 4 – ‘most of the time’ and 5 – ‘all the time’. The net score is calculated through the sum of the response values to the five questions, and can vary from 0 to 25 points. The higher the score, the better the perception of well-being [56]. Psychological stress was assessed through the Portuguese version of Perceived Stress Scale (PSS) to determine the perceived level of stress and coping. The scale has 14 items, with 5 response options on a Likert scale, where 1 means – ‘never’, 2 – ‘hardly never’, 3 – ‘sometimes’, 4 – ‘often’ and 5 – ‘very often’. The results may vary from 14 to 56 values, which higher scores indicating greater perceived stress. The items 4, 5, 6, 7, 9, 10 and 13 are reversed in order to maintain the same (positive) answer direction for all scale items [57].

2.10. Functional fitness assessment

Functional fitness (FF) was measured using the tests of the Senior Fitness Test battery [58]. The chair sit-and-reach test was used to evaluate the lower-body flexibility, measuring the maximum forward reach toward or past the toes, in centimetres (cm). The participant is usually sitting on the edge of a chair with one leg bent and the other extended. The agility and dynamic balance was assessed using the 8-foot up-and-go test (FGT) that measures the time needed for the participant to get up from the chair, walk as quickly as possible around either side of a cone placed 8 feet away (2.44 cm), and sit back down in the chair.

2.11. Exercise program description

The CBY consisted of an exercise class intervention, based on the essential philosophy of Hatha Yoga and its āsanas [38], lasted 28 weeks and participants of EG maintained a frequency of two-three times weekly. Each session had a maximum duration of 50 min divided into three parts: a) 10 min to warm-up, with standing or sitting exercises of joint mobilization and exercises to promote respiratory body awareness; 3) the standing or sitting practice of āsanas and postures sequences, with the duration of 30 min; c) 10 min to cool down and relaxation, through sitting or lying respiratory body awareness exercises, localized massages, exercises for muscle relief and meditation and vocalization (see Appendix A). The exercise intensity was acquired using heart rate (HR) monitor (Polar, RCX5) and predicted using the Karvonen’s formula to predict target HR. The maximal (max) HR was calculated using Franklin, Whaley and Howley formula [max HR = 207 (beats per minute) − 0.7 × age] for older people [59] and followed a low to moderate intensity effort, reaching intensities around 50–70% of maximum HR values recommended [60]. For this study, exercises sequence was prepared cautiously and reviewed according to the participant’s evolution aiming to easily achieve moderate intensities in classes [34].

2.12. Exercise adherence

The classes were offered 2–3 times/week for a period of 28 weeks. The percentage of exercise adherence to group classes was calculated individually and collectively through the total sum of the participation. Entries were recorded in a checklist. When participants had two consecutive absences, they were contacted to return to the group classes. An adherence of 60%-70% to the exercise program classes was established as minimum value for each participant not be excluded from the statistical analysis [61]. During the 28 weeks of the intervention program, no participant was excluded from the CBY classes for consecutive absences or low exercise adherence.

2.13. Masking

The instructor of the exercise sessions did not take part in the data collection procedures. Precaution was taken to avoid interaction between CBY participants and the individuals from the control group by staggering the timings of the daily activities from both groups.

2.14. Statistical analysis

The normality of data was checked by Shapiro-Wilk test. Since there was no normality distribution of data, comparisons between groups at baseline were made using the Mann-Whitney U test. Within-group comparisons between pre and post intervention were performed using the Wilcoxon’s signed-rank test. Descriptive statistics are presented as mean ± standard deviation. Percent of change after intervention was calculated ([Post/Pre]-1) and presented for each variable. Correlations between parameters in variables were assessed according to Spearman’s rank correlation coefficient. To report the strength of the CBY intervention the effect size was calculated and considered as trivial (d ≤ 0.2), small (0.2 < d < 0.6), moderate (0.6 < d < 1.2), large (1.2 < d < 2.0), very large (2.0 < d < 4.0) and nearly perfect (d > 4.0) [62]. Level of significance was set at p < 0.05. All statistical analysis was performed using SPSS (IBM, Statistics, version 22).

3. Results

Table 1 presents the sample characteristics at baseline and comparisons between groups, in order to test for the homogeneity between the groups. The 25 participants that took part in the study (EG, n = 15 and CG, n = 10) varied in age from 74 to 96 years and both groups showed a similarity of age (EG = 83.73 ± 6.86 and GC = 82.73 ± 8.46; p = 0.911, d = 0.18) and of anthropometric measures. No significant differences were found between both groups and almost all studied parameters demonstrate a small clinical relevance, being the perceived psychological stress level the only one that presented differences with a moderate effect size (p = 0.052, d = 0.85). Regarding the clinical status, both groups were homogeneous according to the characteristics related to their comorbidities and the number of medications used. They were both characterized as a multi-comorbid and polymedicated population.

The back stretch flexibility test values show beneficial clinical relevant results in the EG group (p = 0.003, d = 0.93, +42%), with a moderate magnitude of the effect sizes. In the CG, no changes were observed. A trend towards an improvement in the wellness index results (p = 0.055, d = 0.65, +26%) was found with a moderate magnitude of the effect size and clinical relevance in the EG group (Table 2). There were no significant changes in terms of the other parameters. In both EG and CG, the levels of salivary lysozyme and lysozyme secretion rate showed a non-significant increment and a small magnitude of the effect sizes. Also, levels of IgA and IgA secretion rate did not change in both groups before and after the intervention (Fig. 2). Differences between groups after the intervention were only seen for the two-minutes step test and back stretch test (p < 0.0.05).
The aims of this study were to assess the changes mediated by a CBY on HRsS, salivary IgA and lysozyme levels of institutionalized older women living in centers of social care. Institutionalized older women, were randomly divided in two groups with similar characteristics at baseline with respect to age, sex, morphological and biocellular parameters, and global health. The sample’s higher average age value (84 years) allowed us to draw conclusions on an older and less studied population [18,63].

The current literature is suggestive of yoga benefits in relieving stress and improving quality of life [66], corroborating the results found in the present study. The yoga background as a psycho-somatic-spiritual discipline for achieving union and harmony between mind and body, reveal considerable health benefits, including improved cognition, respiration and also, influenced immunity related to physiological stress events [67]. Some studies point out that the benefits modulated by their holistic approach such as meditation, are responsible for improving perception of psychological well-being and quality of life. Thus, research into this relationship need well-defined populations, adequate controls and improved long-term intervention designs [68], because the benefits are very specific for each age-population.

The results of this study revealed significant changes to the Back stretch test, demonstrating beneficial effects in older women’s flexibility after the CBY when compared with the EG values at baseline. Additionally, the results showed a trend for decreased time in execution of the Eight foot up and go agility test (p = 0.06, d = 0.36, −26%). According to a recent study [66], the differences between a Yoga exercise group and a control group in FF indicators after a 14 weeks period suggest that Yoga improves FF significantly and justifies its use in older subjects. The similarities between EG and CG on FF indicators after 28 weeks suggest that the CBY applied did not significantly improve the other FF indicators, and should be revised before a future intervention [39]. It is possible that more satisfactory results could be achieved by substantial changes in variables such as volume (time of exercise exposure) intensity (slight increase), decreasing the rest interval that related to the time sitting in the chair. Other researchers have found that a more intense and challenging yoga [38], without a chair-based method maybe more effective in older participants. It is important to clarify that the low heart rate average values of workload (50–60% of HRmax) achieved by the participants in this study are different from other interventions [69]. In fact, other studies have shown the effectiveness of structured exercise in biocellular parameters when the exercise was of moderate intensity, even in physically frail subjects [31].

Regarding the emotional wellness index, the present study showed a trend for the improvement of the participants subjective well-being levels. Such results confirm Vogler et al. [65] conclusions that physical and mental well-being (emotional and self-care) improved in a Yoga group, despite of the shorter intervention period (8-weeks) and the younger age group of the participants (73.21 ± 8.38 years old). Exercise also led to an increase in mood states, with statistically significant differences in depression, tension, and fatigue, more vigor and less anger [70]. Subjective perceived stress showed a small trend to decrease but with no statistical significance in this study (p = 0.10, d = 0.35, −11%) unlike other research [71]. However, the authors make clear that different types of intervention with different intensities can promote positive psychological effects, but the effects may be very different on physiological stress processes. In the specific case of this sample, which already had low scores of subjective perceived stress at baseline, these remained low after CBY. This is biologically confirmed in our study, since there were no alterations in the salivary cortisol levels of the EG. Our results are in agreement with Jacks et al. [28] findings, that related the effects of three intensities of exercise on salivary cortisol in active males and concluded that only high intensity and long duration exercise results in significant increase of salivary cortisol. No differences were found between resting, low and moderate intensity exercise.

After the 28 weeks of CBY no statistically differences were found for either lysozyme or IgA. However, a trend towards an increase in both IgA (p = 0.53, d = 0.20, 26%) and Lysozyme (p = 0.42, d = 0.48, 87%) secretion rates were found for the EG, while in the control group a trend towards a decrease in the IgA secretion rate was found (p = 0.533, d = 0.35, −14%). A recent analogous study [72] reported that salivary lysozyme secretion increased after moderate intensity exercise and increased further after high intensity exercise, which implies that lysozyme levels may be related with exercise intensity. Also, several studies [18,70,73] have found an higher salivary SIgA concentration and secretion rates in older exercise participants than in their predominantly sedentary peers. However, these studies were applied to healthier, heterogeneous and younger exercise groups, experiencing more intense exercise programs.

On the other hand, Martins et al. [20], who studied the effects of aerobic conditioning in older subjects, with an higher mean age, also showed that salivary IgA concentration was unchanged in these subjects, suggesting that alterations in salivary IgA levels may also be related to age.

Overall, the performed study was useful to show that CBY practice may have a positive effect on flexibility, as well as in maintaining IgA and lysozyme salivary secretion rates, in a population of very old

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### Table 1

<table>
<thead>
<tr>
<th>Exercise group chair-based yoga (n = 15)</th>
<th>Control group non-exercise (n = 10)</th>
<th>p</th>
<th>Cohen’s d</th>
<th>Clinical relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>83.73(6.86)</td>
<td>82.30(8.46)</td>
<td>0.911</td>
<td>0.18</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.49(0.1)</td>
<td>1.51(0.09)</td>
<td>0.487</td>
<td>0.21</td>
</tr>
<tr>
<td>Weight (kilograms)</td>
<td>69.04(13.18)</td>
<td>68.9(13.94)</td>
<td>0.868</td>
<td>0.01</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>30.98(4.21)</td>
<td>30.04(5.20)</td>
<td>0.868</td>
<td>0.20</td>
</tr>
<tr>
<td>Comorbidity Index</td>
<td>6.72(1.31)</td>
<td>7.94(1.46)</td>
<td>0.122</td>
<td>0.15</td>
</tr>
<tr>
<td>Medication use (3 or more)</td>
<td>4.30(1.34)</td>
<td>3.58(1.68)</td>
<td>0.213</td>
<td>0.18</td>
</tr>
<tr>
<td>IgA (μg/mL)</td>
<td>199.43(105.99)</td>
<td>263.39(129.94)</td>
<td>0.165</td>
<td>0.54</td>
</tr>
<tr>
<td>Secretion rate IgA (mg/min)</td>
<td>118.43(58.16)</td>
<td>93.32(75.55)</td>
<td>0.182</td>
<td>0.37</td>
</tr>
<tr>
<td>Lysozyme (μg/mL)</td>
<td>10.78</td>
<td>1.42(0.74)</td>
<td>0.113</td>
<td>0.55</td>
</tr>
<tr>
<td>Secretion rate Lysozyme (mg/min)</td>
<td>2.24(3.94)</td>
<td>1.52(1.69)</td>
<td>0.405</td>
<td>0.24</td>
</tr>
<tr>
<td>Salivary Cortisol (μg/mL)</td>
<td>0.2(0.16)</td>
<td>0.27(0.13)</td>
<td>0.166</td>
<td>0.48</td>
</tr>
<tr>
<td>Wellness Index (#)</td>
<td>9.07(4.23)</td>
<td>10.9(3.51)</td>
<td>0.277</td>
<td>0.37</td>
</tr>
<tr>
<td>Perceived Stress scale (#)</td>
<td>22.93(6.27)</td>
<td>29.7(9.41)</td>
<td>0.052</td>
<td>0.85</td>
</tr>
<tr>
<td>Two-minutes step test (seconds)</td>
<td>39.73(16.88)</td>
<td>32.50(15.86)</td>
<td>0.279</td>
<td>0.44</td>
</tr>
<tr>
<td>Eight up-and-go test (seconds)</td>
<td>17.27(14.05)</td>
<td>20.04(13.17)</td>
<td>0.292</td>
<td>0.57</td>
</tr>
<tr>
<td>Back Stretch test (cm)</td>
<td>19.06(9.83)</td>
<td>16.99(9.97)</td>
<td>0.178</td>
<td>0.57</td>
</tr>
</tbody>
</table>

*p < 0.05; SD: Standard deviation; IgA: Immunoglobulin A.
Table 2

Mean changes in salivary anti-microbial proteins, health related emotional status and functional fitness indicators pre- and post-28-week intervention within the exercise and control groups and their clinical relevance.

<table>
<thead>
<tr>
<th>Intervention group (chair-based yoga)</th>
<th>Control group (non-exercise)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-intervention</td>
<td>Post-intervention</td>
</tr>
<tr>
<td><strong>Clinical relevance</strong></td>
<td><strong>Clinical relevance</strong></td>
</tr>
<tr>
<td>Percentage of change</td>
<td>Cohen's d</td>
</tr>
<tr>
<td>IgA (μg/mL)</td>
<td>199.43(105.99)</td>
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<tr>
<td></td>
<td>263.39(129.94)</td>
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<td>118.43(58.16)</td>
</tr>
<tr>
<td></td>
<td>93.32(75.55)</td>
</tr>
<tr>
<td>Lysozyme (μg/mL)</td>
<td>1(0.78)</td>
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<tr>
<td></td>
<td>1.42(0.74)</td>
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<tr>
<td>Secretion rate Lysozyme (mg/min)</td>
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</tr>
<tr>
<td>Salivary Cortisol (μg/dL)</td>
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</tr>
<tr>
<td>Wellness Index (#)</td>
<td></td>
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<tr>
<td>Perceived Stress scale (#)</td>
<td></td>
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<tr>
<td>Two-minutes step test (seconds)</td>
<td></td>
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<tr>
<td>Eight up-and-go test (seconds)</td>
<td></td>
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<tr>
<td>Back Stretch test (cm)</td>
<td></td>
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</tbody>
</table>

Note: *p < 0.05; **p < 0.01; Cohen's d: Effect size within group. Different compared to the control group after 28 weeks; Cohen's d effect size compared to the control group after 28 weeks;

This study showed a positive effect of CBY practice flexibility in an older women population, which may help to achieve an improved subjective health-related emotional status, and it can be used as a complementary exercise-therapy to attenuate the effects of aging. It was also able to maintain the IgA and lysozyme salivary secretion rates, important factors involved in the antimicrobial mucosal defenses. Since this exercise protocol can easily be adaptable to the necessities of each individual, it should be a good co-adjuvant to medication.

5. Conclusion

This study was financially supported by the Portuguese National Funding Agency for Science, Research and Technology (FCT), it is integrated in the research project entitled "PRO-HMESCI: Hormonal mediation of exercise on cognition, stress and immunity" [FCT PTDC/DTP-DES/0154/2012]. The PhD students Mathew Uba-Chupel, Luciele Minuzzi, and Fátima Rosado conducted the biochemical analysis. José Pedro Ferreira and Ana Maria Teixeira coordinated the research and reviewed the paper.

Conflicts of interest

The authors declare that they have no competing interests.

Contributors

Mariana Marques wrote the paper and Matheus Uba-Chupel helped with the statistical analysis. Guilherme Furtado equally contributed to the first author. Filipa Pedrosa implemented the CBY protocol. Mathew Uba-Chupel, Luciele Minuzzi, and Fátima Rosado conducted the biochemical analysis. José Pedro Ferreira and Ana Maria Teixeira coordinated the research and reviewed the paper.

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Appendix A. Chair-based Yoga session description.

<table>
<thead>
<tr>
<th>Warm-up phase (10 minutes) (%)HR</th>
<th>Main part of the workout (35 minutes) (%)HR</th>
<th>Cool-down phase (10 minutes) (%)HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing or sitting practice of āsanas and postures sequences.</td>
<td>Standing or sitting exercises of joint mobilization and exercises to promote respiratory body awareness</td>
<td>Sitting or lying respiratory body awareness exercises, located massages, exercises for muscle relief and meditation and vocalization.</td>
</tr>
</tbody>
</table>

Standing or sitting exercises of āsanas and postures sequences:
1) “Seated Forward Bend” (Paschimottanasana)
2) “Butterfly” (Baddha Konasana)
3) “Seated Spinal Twist” (Ardha Matsyendrasana)
4) “Cow face pose” (Gomukhasana)
5) “Cat” (Cakravakasana)
6) “Child’s Pose” (Balasana)
7) “Snake” (Bhujangasana)
8) “Child’s Pose with arms” (Utthita Balasana);
9) “Side Bending Stretch” (Tiryaka Tadasana)
10) “Dorsal Torsion” (Kati Chakrasana);
11) “Triangle” (Trikonasana)
12) “Eagle” or “Half eagle” (Garudasana)

References


