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Effects on muscle strength, maximal jump height, flexibility and postural sway after soccer and Zumba exercise among female hospital employees: a 9-month randomised controlled trial

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ABSTRACT
This 9-month randomised controlled workplace physical activity trial investigated the effects of soccer and Zumba exercise, respectively, on muscle strength, maximal jump height, sit-and-reach flexibility and postural sway among female workers. A total of 107 female hospital employees aged 25–63 were cluster-randomised to a soccer group, a Zumba group or a control group. Training was conducted outside working hours as two to three 1-h weekly sessions the first 3 months and once a week the last 6 months. Tests were conducted at baseline, after 3 and 9 months. The soccer group improved maximal neck extension strength both after 3 (1.2 kg; $P < 0.05$) and 9 months (1.7 kg; $P < 0.01$) compared to the control group. The Zumba group improved maximal trunk extension strength (3.1 kg; $P = 0.04$) after 3 months, with improvements in postural sway velocity moment (–9.2 mm^2/s; $P < 0.05$) and lower limb lean mass (0.4 kg; $P < 0.05$) after 9 months. No significant intervention effects were revealed in vertical jump height or sit-and-reach flexibility. The present study indicates that workplace-initiated soccer and Zumba exercise may be beneficial for improvement of the neck and trunk strength, which may have preventive effects with regard to future perceived muscle pain in the respective body regions. Furthermore, the Zumba group revealed positive effects on lower limb lean mass and postural sway compared to the control group.

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KEYWORDS
Body composition; muscle strength; postural sway; soccer; football; Zumba

Introduction

Health care workers are on daily basis imposed to relatively heavy physical workload performed in unfavourable postures, e.g., during patient handling (Burdorf & Sorock, 1997; Skotte & Fallentin, 2008; Skotte, Essendrop, Hansen, & Schibye, 2002; Smedley, Egger, Cooper, & Coggon, 1995). Furthermore, it is documented that female health care workers have a higher prevalence of overweight and low physical capacity compared to most other female work groups (Christensen et al., 2011). Moreover, many studies have shown that muscle strength and endurance are low among workers who are exposed to long-term strenuous physical workload, particularly female workers (Pohjonen, 2001). The imbalance between low physical capacity and high physical work demands among health care workers may therefore increase the risk for musculoskeletal disorders, sickness absence and early retirement (Rasmussen et al., 2013).

Moreover, the average age in the workforce of health care workers is increasing (Buerhaus, Staiger, & Auerbach, 2000; Hart, 2007). Ageing is a multifactorial process that causes progressive physical weakness from a decline in muscle mass and muscle strength (Lauretani et al., 2003; Seene & Kaasik, 2012; Xue, Beamer, Chaves, Guralnik, & Fried, 2010). In addition to muscle atrophy, ageing is associated with deterioration in postural sway (Sarabon, Panjan, & Latash, 2013), exposing postmenopausal females for elevated risk of osteoporosis which increases the risk of falls and fractures (Korpelainen, Keinänen-Kiukaanniemi, Heikkinen, Väänänen, & Korpelainen, 2006a; Topinková, 2008; Xue et al., 2010), and may impair the ability to perform activities of daily life (Hartman, Fields, Byrne, & Hunter, 2007), and increase the risk of death (Xue et al., 2010). According to Korpelainen et al. (2006a), reduced balance, increased postural sway, reduced lower limb strength or reduced walking speed are other risk factors for fractures in older women (Korpelainen et al., 2006a), and it is suggested that regular physical activity may reduce the risk of fractures due to both skeletal and muscular improvements (Helge et al., 2010).

To prevent the imbalance between low physical capacity and high work demands, health care workers would benefit from improving their physical capacities. Furthermore, it is shown that specific strength training (Holviala, Sallinen, Kraemer, Alen, & Häkkinen, 2006), as well as soccer training (Krustrup et al., 2010) may improve muscle strength and balance among premenopausal women. With regard to trunk

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strength, a previous 16-week intervention study by Pedersen, Randers, Skotte, and Krustrup (2009) observed improvements in reflex response to sudden trunk loading among untrained females after twice-weekly 1-h soccer training sessions, which may reduce the risk of low back injuries (Pedersen et al., 2009).

According to Proper et al. (2003), sufficient intensity level and adherence are important assumptions for succeeding with implementation of workplace physical activity health promotion (Proper et al., 2003). In this context, one crucial goal for workplace physical activity health promotion initiatives aiming for improving muscular strength, postural sway and flexibility should be to introduce the workers for exercises that are both documented to be effective for those parameters and perceived pleasurable to the participants. Previous studies have suggested that the Latin-inspired dance-aerobic concept Zumba fitness may represent an exercise that is both pleasurable and health promoting with regard to aerobic capacity and fat metabolism (Donath, Roth, Hohn, Zahner, & Faude, 2013; Luettgen, Foster, Doberstein, Mikat, & Porcari, 2012).

Female health care workers are well documented to have several physically demanding work tasks, mainly involving manual transfer of patients. Improvement of their general muscular strength and body balance (postural sway) would theoretically reduce their excessive risk for musculoskeletal disorders, impaired function and work disability. Both soccer and Zumba compose physical activities and body movements which may provide muscular and sensomotoric stimulation improving muscular strength in the trunk and lower limb region, as well as the postural sway. However, no previous randomised controlled intervention studies have investigated to what extent soccer and/or Zumba exercise may be effective on muscular strength, postural sway or flexibility among female hospital employees.

Therefore, the aim of the present study was to examine the short- and long-term effects of soccer and Zumba on the secondary outcomes muscular strength, maximal jump height, flexibility and postural sway among female hospital employees.

Methods

This cluster-randomised workplace physical activity intervention study was conducted between January 2011 and October 2011 with physical capacity measurements performed at baseline and after 3 and 9 months. The primary outcome from the study has previously been reported (Barene, Krustrup, Brekke, & Holtermann, 2014; Barene, Krustrup, Jackman, Brekke, & Holtermann, 2013). This article focuses on the secondary outcome muscle strength, maximal jump height, flexibility and postural sway. The project was ethically approved by the Regional Committees for Medical and Health Research Ethics, Norway (2010/2385-8), and registered in the International Standard Randomized Controlled Trial Number Register (ISRCTN61986892).

Recruitment of participants

The recruitment process is previously presented (Barene, Krustrup, Brekke, et al., 2014). In short, we aimed for recruiting health care personnel (primarily nurses and health care assistants) from a total of 675 employees at a Norwegian Hospital. Initially, 36 unit leaders were requested to distribute information about the project to their employees. In addition, a short information note about the content of the project and an invitation to information meetings was published electronically on the Hospitals intranet. At the end of the meetings, the attending health care personnel were asked to complete a screening questionnaire, and give consent or not to enrol in the study. A total of 185 completed the questionnaire. Of these, 147 were nurses or health care assistants and 38 employees of other professions, mainly bioengineers. Due to unforeseen administrative and logistic challenges at the workplace, there was a 10-week delay from completing screening questionnaire to the baseline test. During this period, 62 dropped out from the study. The criteria for inclusion in the study were hospital employees of either sex, aged from 25 to 65 years. Exclusion criteria were pregnancy, diagnosed angina pectoris and life-threatening diseases. A total of 118 employees (11 males and 107 females) fulfilled the inclusion criteria and consented to participate in the study, and were randomly allocated either to the soccer group, the Zumba group or the control group.

Randomisation procedure

The randomisation procedure is previously reported (Barene et al., 2013). Briefly, hospital employees in a single department working in close proximity to each other formed cluster 1 (n = 28), then two almost equal sized clusters, cluster 2 (n = 27) and cluster 3 (n = 29) were matched on sex, body mass index, age and work seniority. Information about age and work seniority was obtained from questionnaire. The remaining consenters were then assigned into three smaller clusters, cluster A (n = 11), B (n = 11) and C (n = 12), matched on the same variables as above. The randomisation was made by lot by blinded staff. The selection was conducted by drawing from three boxes: (1) the three different groups (soccer, Zumba or control), (2) the three large clusters (1, 2 or 3) and (3) the three small clusters (A, B or C). The selection was initiated by drawing one group from box 1, followed by drawing one cluster from box 2. This procedure was conducted until each cluster from box 2 was selected into either the soccer group, the Zumba group or the control group. The selection of the small clusters was conducted in the same manner as the above, i.e., randomly combined with one of the groups. The group composition was as follows: the soccer group: cluster 3 + C, the Zumba group: cluster 2 + B and the control group: cluster 1 + A (Barene et al., 2013). Due to the lesser number of male participants (n = 11), only females were included in the statistical analyses.

Intervention content

The exercise interventions were conducted between January and October 2011 and have previously been described (Barene, Krustrup, & Holtermann, 2014). In short, the training was conducted outside working hours as two to three 1-h sessions per week for the first 3 months and a frequency of

1–2 times per week during the last 6 months. External exercise facilities in close proximity to the Hospital were booked for each of the two exercise intervention groups. During the first 12 weeks, both intervention groups were supervised by experienced instructors, with a gradual reduction in supervision in the soccer group. Due to the characteristics of Zumba, all sessions were led by a certified instructor throughout the 40 weeks. The soccer sessions consisted of 3-/4-a-side matches in a traditional sports hall (10 x 20 m). Each session included an initial 5-min low-intensity warm-up and a 5-min rest after half-time. The Zumba sessions took place in a commercial fitness centre, and consisted of continuous dance movements to Latin music with a varying intensity level throughout the sessions. Average heart rate during exercise was 78% and 75% of maximum heart rate in the soccer group and the Zumba group, respectively (Barene et al., 2013; Barene, Krustrup, Brekke, et al., 2014).

Measurement procedures pre- and post-intervention

The test leaders were blinded to group allocation when conducting all pre-intervention, during intervention and post-intervention measurements. The baseline tests were conducted immediately after the ethics approval, whereas the re-tests were conducted within 3 weeks after 3 and 9 months, respectively. The participants were requested to not perform any kind of exhaustive exercise the day before testing.

(1) Lean mass

Lower limb lean mass was determined by dual-energy x-ray absorptiometry scans (QDR Discovery Wi, Hologic Inc., Bedford MA, USA) (Ellis, 2000; Rothney, Brychta, Schaefer, Chen, & Skarulis, 2009).

(2) Maximal isometric force measurements

Isometric muscle strength was measured with Newtest Isometric Force System dynamometer (Newtest, Oy, Oulu, Finland) (Korpelainen, Keinänen-Kiukaanniemi, Heikkinen, Väänänen, & Korpelainen, 2006b), and included measurements of neck extension, trunk flexion and extension and leg extension. To ensure test–retest reliability from the baseline test to the 3- and 9-month follow-up, respectively, the equipment was individually adjusted and the settings registered at baseline. Familiarisation with maximal isometric force measurements included one submaximal contraction (approximately 70–80% of maximal contraction). Isometric strength was recorded for three maximal efforts, each lasting for 3–5 s. The highest value in Newton (N) was accepted as the result. If the measured maximal values deviated from each other by more than 10%, an extra measurement was performed.

Trunk force flexion was measured with the participants standing in upright position facing away from the dynamometer, with the hip support placed at the level of iliac crest and the chest support placed at the level of xiphoid process (see Figure 1A). Trunk force extension was measured with the participants facing to the post of the dynamometer with the chest support at level of inferior angle of the scapula. Neck force extension was measured using the same principles as in the trunk extension, with the lower edge of the head support at the level of external occipital protuberance (see Figure 1B). Leg force extension was measured with the participants in a sitting position on a dynamometer chair with their knees at 120° and ankles at 90° flexion while pressing maximal against strain gauges to assess the peak strength of their legs (see Figure 1C). A seatbelt was mounted around the participant's hips to prevent the hips to be lifted from the seat during the test. The dynamometer was placed above the head of the participants out of their sight.

(3) Maximal jump height measurements

Measurements of maximal jump height were performed on a force platform (OR6-5-2000, AMTI, Watertown, MA, USA) (Jensen, Leissring, Garceau, Petushek, & Ebben, 2009), and data were collected at 1000 Hz, real time displayed and saved with the use of computer software (NetForce 2.0, AMTI, Watertown, MA, USA) for later analyses. AMTI-NetForce-platform (AMTI, Watertown, MA, USA), software version 2.2.1 (2006), was used together with AccuPower Software. Maximal jump height was performed with hands fixed on hips,

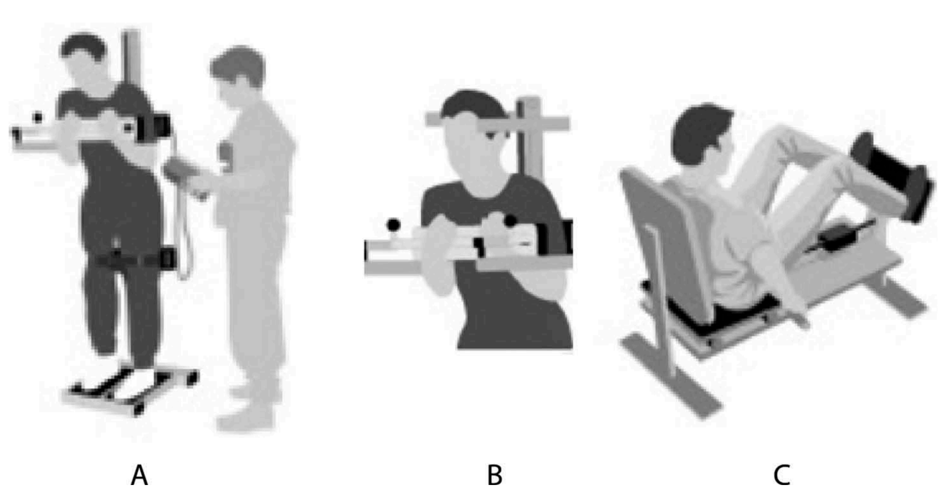

Figure 1. Illustration of Newtest Force Isometric Testing System measuring: (A) trunk force, (B) neck force and (C) leg force.

and knees bent to 90° before jump was completed. Jump heights were calculated from flight time using the equation; $h = (f^2 \times g)/8$ where h = jump, f = height time and g = acceleration due to gravity (Oliver, Armstrong, & Williams, 2008; Vuorimaa, Virlander, Kurkilahti, Vasankari, & Häkkinen, 2006). Two repeats were performed, with a 30-s rest period between the jumps. The best result was used for the analyses.

(4) Sit-and-reach flexibility test

The sit-and-reach test measures the flexibility of the lower back and hamstrings. In the past, there has not been consensus with regard to the validity and reliability of the test. Nevertheless, recent studies suggest that the criterion-related validity of the sit-and-reach test is moderate (Ayala, Sainz De Baranda, De Ste Croix, & Santonja, 2011, 2012; Mayorga-Vega, Merino-Marban, & Viciana, 2014), whereas the reliability is suggested to be acceptable (Ayala et al., 2011, 2012). In the present study, the sit-and-reach test was performed using the procedures outlined in the ACSM manual (1998) (Ayala et al., 2012).

(5) Balance measurements

The Good Balance system® (Good Balance system, Metitur Oy, Jyvaskyla, Finland), which previously has been recognised for both valid and reliable postural sway measurements (Ha, Cho, & Lee, 2014; Hofmann, 1998; Sihvonen & Era, 1999), was used for measurement of postural sway velocity and velocity moment of the participants. On the basis of the vertical force signals from each corner of the platform, the system calculated the x (mediolateral) and y (anterioposterior) coordinates of the centre of pressure affecting the platform when the person was standing on it. On the basis of these coordinates values for x and y, the following parameters were calculated: (1) mean speed of the movement of the centre of pressure in the anterioposterior direction (mm/s); (2) mean speed of the movement of the centre of pressure in the mediolateral direction (mm/s) and (3) mean velocity moment (mm^2/s). Postural sway velocity moment is defined as the average horizontal area covered by movement of the centre (anterioposterior and mediolateral direction) of force per second (Era et al., 2005).

To measure postural sway, two types of balance tests were carried out. Test 1 was performed on the force platform with the participants in a standing position for 30 s. During the test, the participants were instructed to keep the gaze fixed on a mark cross on an opposite wall at a distance of 2 m at eye level with the arms crossed over the chest with hands resting on the opposite shoulder (Punakallio, 2003). Test 2 was performed as one-leg standing on preferred leg for 30 s. The participants were instructed to start in a position with a comfortable base of support with the free leg flexed at the knee joint and the big toe supported to lateral malleolus of the standing leg (Jakobsen, Sundstrup, Krustrup, & Aagaard, 2011). All tests were performed with shoes removed. Three measurements were performed for each test, and the average value was used in the statistical analyses. A rest period (2 min) was provided between measurements in order to prevent fatigue.

Statistical analyses

Before initiation of the study, a power calculation was carried out for the primary outcome, maximal oxygen uptake. Power was set at 0.8 with a significant level of 0.05. Based on previous workplace studies aiming to increase maximal oxygen uptake using comparable physical exercise interventions (Dishman, Oldenburg, O'Neal, & Shephard, 1998; Pohjonen & Ranta, 2001), an average improvement of 5% with a SD of 10 from baseline values was expected. Based on these assumptions, 32 participants were needed for comparison between each respective intervention group and the control group. In order to evaluate the effectiveness of the intervention, ANCOVA analyses with adjustment for baseline body mass index values were performed on both the primary and secondary outcomes in accordance with the intention-to-treat principle, i.e., all randomised participants were included in the analyses with missing values substituted with carried-forward or carried-backwards measured variables (Antes, 2010; Schulz, Altman, & Moher, 2011). To avoid false negative results, further exploratory analyses were performed using the ANCOVA model with body mass index as covariate, including data from only those participants who completed both the pre- and post-tests (defined as per protocol analyses). All results are given as contrast estimates between the intervention groups and the control group together with an associated confidence interval (CI) and level of significance. To evaluate the strength of the intervention findings, effect sizes were calculated using Cohen's d. In order to evaluate the group-wise changes in the sit-and-reach flexibility test, one-sample t-tests were performed and are reported with P-values. $P < 0.05$ was defined as the level of statistical significance. IBM SPSS Statistics version 22 was used for all statistical analyses.

Results

The participant's average age, weight and height were 45.8 ± 9.3 years, 70.6 ± 9.7 kg and 166.9 ± 5.9 cm, respectively. Table 1 shows the participant's baseline isometric strength in different body parts, maximal jump height and lower limb lean mass, as well as baseline values for postural sway in normal standing with the eyes closed and one leg standing with the eyes open.

Changes in isometric strength

Based on the intention-to-treat analyses, the Zumba group significantly improved ($P = 0.04$) the isometric trunk extension strength compared to the control group after 3 months, i.e., 30.5 N, 95% CI, 1.4–59.6, which was supported by the independent t-test, i.e., $t(68) = 2.018$, $P = 0.048$. This corresponds to a moderate effect size ($d = 0.48$). No such improvement was revealed for the soccer group (6.1 N, 95% CI, −22.9 to 35.0, $P = 0.68$) (Table 2). In fact, the Zumba group showed a tendency for increase ($P < 0.10$) in trunk extension strength compared to the soccer group after 3 months, i.e., 24.4 N, 95% CI, −4.3 to 53.1. However, after 3 months, the soccer group significantly increased ($P < 0.05$) the isometric neck extension strength compared to the control group, i.e., 11.4 N, 95% CI,

Table 1. Descriptive information of study population at baseline. The table presents age, anthropometry, trunk and lower limb lean mass, maximal trunk flexion and extension, maximal neck and leg extension, maximal jump height, sit-and-reach flexibility and postural sway for the soccer group, the Zumba group and the control group, respectively.

	The soccer group (*N* = 37)		The Zumba group (*N* = 35)		The control group (*N* = 35)		Total (*N* = 107)	
Characteristics	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age (years)	44.1	8.7	45.9	9.6	47.4	9.5	45.8	9.3
Weight (kg)	69.2	9.2	71.2	8.2	71.4	11.5	70.6	9.7
Height (cm)	167.3	5.4	167.7	6.3	165.8	5.9	166.9	5.9
Trunk lean mass (g)	22312	2372	22443	2546	22216	2506	22322	2451
Lower limb lean mass (g)	14459	2025	14606	1829	14669	1859	14576	1894
Trunk flexion (N)	376.1	89.6	364.8	95.7	378.5	79.5	373.2	87.9
Trunk extension (N)	488.8	128.7	486.8	101.7	497.3	98.7	488.3	92.3
Neck extension (N)	147.0	37.1	162.1	28.9	160.1	32.4	156.0	33.6
Leg extension (N)	1470.4	311.4	1555.4	285.1	1459.6	270.6	1494.7	290.4
Maximal jump height (cm)	21.4	4.2	19.5	4.2	19.1	5.1	20.0	4.6
Sit-and-reach flexibility (cm)	47.0	6.2	49.0	8.5	48.4	6.9	48.1	7.3
Postural sway								
Normal standing (eyes closed)								
Mean X (mm)	−4.8	5.6	−5.0	4.4	−5.3	4.9	−5.0	5.0
Mean Y (mm)	−119.4	17.0	−121.9	15.0	−121.9	17.0	121.0	16.2
X Extension (mm)	404.3	96.2	459.5	172.7	438.9	105.5	433.6	130.1
Y Extension (mm)	320.2	80.4	336.5	99.4	362.7	95.1	339.0	92.5
X Speed (mm/s)	13.2	3.1	15.3	5.8	14.6	3.5	14.3	4.4
Y Speed (mm/s)	10.7	2.7	11.2	3.3	12.1	3.2	11.3	3.1
Velocity moment (mm^2/s)	51.4	21.9	57.7	32.5	60.5	25.8	56.4	27.1
One leg (eyes open)								
Mean X (mm)	−9.5	11.0	−8.7	4.0	−5.9	8.8	−8.1	8.6
Mean Y (mm)	−105.5	15.2	−104.7	16.3	−106.4	15.9	−105.5	15.6
X Extension (mm)	620.1	132.6	641.7	159.2	672.0	190.1	643.6	161.1
Y Extension (mm)	514.4	87.3	522.4	132.4	565.5	201.1	533.1	146.0
X Speed (mm/s)	20.7	4.4	21.4	5.3	22.8	6.9	21.6	5.6
Y Speed (mm/s)	17.2	2.9	17.4	4.4	19.2	7.3	18.0	5.1
Velocity moment (mm^2/s)	84.6	27.4	85.7	30.2	97.3	47.6	88.9	35.7

Note: The following abbreviations are used with regard to postural sway: Mean X and Y refers to the mean value for the movement (mm) of the centre of pressure in the mediolateral and the anteroposterior direction, respectively. The X and Y Extension refers to the exact distance (mm) along the respective directions. The X and Y Speed refers to the mean speed (mm/s) along the respective directions.

0.2–22.6, with no such increase in the Zumba group (2.3 N, 95% CI, −9.3 to 14.0, $P = 0.69$). In comparison between the two intervention groups, the soccer group showed a tendency for increase ($P = 0.12$) in neck strength compared to the Zumba group, i.e., 9.0 N, 95% CI, −2.3 to 20.4.

After 9 months, the soccer group further increased ($P < 0.01$) the isometric neck extension strength compared to control group, i.e., 16.4 N, 95% CI, 4.1–28.7, whereas no such improvement was observed in the Zumba group (7.3 N, 95% CI, −5.4 to 20.0, $P = 0.26$). In comparison between the two intervention groups, the soccer group showed a tendency for increase in neck strength compared to the Zumba group after 9 months (9.1 N, 95% CI, −3.4 to 21.6, $P = 0.15$). No additional intervention effects were observed with regard to isometric strength.

Changes in maximal jump height

No intervention effects were observed in maximal jump height during the 9-month intervention period.

Changes in lower limb lean mass

After 9 months, the Zumba group significantly increased ($P = 0.04$) the lower limb lean mass compared to the control group, i.e., 398 g, 95% CI, 13–784, with no such change in the soccer group (217 g, 95% CI, −164 to 598, $P = 0.26$) (Table 2). This corresponds to a moderate effect size ($d = 0.59$). During the 9-month intervention period, no intervention effects were revealed in trunk lean mass for any of the intervention groups in comparison to the control group, i.e., 173 g, 95% CI, −311 to 658 ($P = 0.48$) in the Zumba group and −30 g, 95% CI, −509 to 449 ($P = 0.90$) in the soccer group (Table 2).

Changes in sit-and-reach flexibility

Based on the one-sample *t*-test, both the soccer group (1.5 ± 2.6 cm, $P < 0.01$) and the control group (2.9 ± 5.9 cm, $P = 0.02$) showed a group-wise significant increase in the sit-and-reach flexibility after 3 months, with only a small numerical increase in the Zumba group (0.4 ± 3.3 cm, $P = 0.55$). The only significant between-group difference ($P < 0.05$) was revealed between the control group and the Zumba group (−2.6 cm, 95% CI, −4.8 to −0.5) (Table 2). After 9 months, all three groups showed a numerical but insignificant group-wise improvement in sit-and-reach flexibility, i.e., the soccer group, $P = 0.09$; the Zumba group, $P = 0.72$; and the control group, $P = 0.08$, with no significant between-group differences (Table 2).

Changes in postural sway

After 9 months, the Zumba group significantly improved ($P = 0.03$) the mean speed of the centre of pressure in the mediolateral direction (X movement) in normal standing position with the eyes closed compared to the control group, i.e., −1.7 mm/s, 95% CI, −3.3 to −0.2, with no such improvement in the soccer group (−0.5 mm/s, 95% CI, −2.1 to 1.1, $P = 0.50$)

Table 2. A comparison of changes in isometric strength, trunk and lower limb lean mass, maximal jump height and sit-and-reach flexibility based on the intention-to-treat principle from baseline to 3- and 9-month follow-up, respectively, in the intervention groups (the soccer group, *n* = 37, and the Zumba group, *n* = 35) compared to the control group (*n* = 35).

	The soccer group (*n* = 37)			The Zumba group (*n* = 35)		
Characteristics	Diff.	95% CI	Sig.	Diff.	95% CI	Sig
Trunk flexion (N)						
0–3 months	5.1	−31.9 to 42.1	0.601	12.3	−24.9 to 49.5	0.535
0–9 months	−2.3	−40.6 to 36.1	0.907	−0.4	−38.9 to 38.2	0.985
Trunk extension (N)						
0–3 months	6.1	−22.9 to 35.0	0.677	30.5	1.4 to 59.6	0.040
0–9 months	15.4	−18.2 to 49.1	0.365	23.5	−10.3 to 57.3	0.171
Neck extension (N)						
0–3 months	11.4	0.2 to 22.6	0.047	2.4	−9.3 to 14.0	0.688
0–9 months	16.4	4.1 to 28.7	0.009	7.3	−5.4 to 20.0	0.257
Leg extension (N)						
0–3 months	6.9	−65.7 to 79.4	0.852	−9.5	−82.4 to 63.4	0.796
0–9 months	−96.2	−212.2 to 19.8	0.103	−67.2	−183.8 to 49.3	0.255
Trunk lean mass (g)						
0–3 months	−30	−509 to 449	0.902	173	−311 to 658	0.480
0–9 months	−321	−885 to 242	0.261	−363	−933 to 208	0.210
Lower limb lean mass (g)						
0–3 months	190	−186 to 565	0.320	39	−341 to 420	0.838
0–9 months	217	−164 to 598	0.260	398	13 to 784	0.043
Maximal jump height (cm)						
0–3 months	−0.4	−1.8 to 0.9	0.503	0.0	−1.3 to 1.3	0.960
0–9 months	−0.6	−2.3 to 1.2	0.531	−0.5	−2.3 to 1.3	0.582
Sit-and-reach flexibility (cm)						
0–3 months	−1.5	−3.7 to 0.6	0.167	−2.6	−4.8 to −0.5	0.017
0–9 months	−1.0	−3.3 to 1.3	0.377	−1.8	−4.1 to 0.4	0.112

Note: The *P*-values illustrate differences between each respective intervention group and the control group.

Table 3. A comparison of changes in postural sway (normal standing with eyes closed) based on the intention-to-treat principle from baseline to 3- and 9-month follow-up, respectively, in the intervention groups (the soccer group, *n* = 37, and the Zumba group, *n* = 35) compared to the control group (*n* = 35).

	The soccer group (*n* = 37)			The Zumba group (*n* = 35)		
Characteristics	Diff.	95% CI	Sig.	Diff.	95% CI	Sig
X Extension (mm)						
0–3 months	−18.3	−63.5 to 27.0	0.425	−19.3	−64.7 to 26.0	0.400
0–9 months	−25.1	−75.8 to 25.7	0.329	−52.7	−103.6 to −1.9	0.042
Y Extension (mm)						
0–3 months	5.5	−23.6 to 34.7	0.708	5.2	−24.0 to 34.5	0.724
0–9 months	9.5	−18.5 to 37.6	0.501	−17.5	−45.6 to 10.6	0.220
X Speed (mm/s)						
0–3 months	−0.3	−1.7 to 1.2	0.722	−0.6	−2.0 to 0.8	0.378
0–9 months	−0.5	−2.1 to 1.1	0.548	−1.7	−3.3 to −0.2	0.031
Y Speed (mm/s)						
0–3 months	0.2	−0.8 to 1.2	0.708	0.2	−0.8 to 1.1	0.724
0–9 months	0.3	−0.6 to 1.3	0.501	−0.6	−1.5 to 0.4	0.221
Velocity moment (mm^2/s)						
0–3 months	−4.0	−14.0 to 6.0	0.432	−4.1	−14.2 to 6.0	0.420
0–9 months	−3.9	−13.0 to 5.2	0.396	−9.2	−18.3 to −0.1	0.049

Note: The *P*-values illustrate differences between each respective intervention group and the control group.

(Table 3). Furthermore, the Zumba group showed a corresponding significant improvement ($P < 0.05$) in the postural sway velocity moment in normal standing position with the eyes closed compared to the control group after 9 months, i.e., −9.2 mm^2/s, 95% CI, −18.3 to −0.1, with no such improvement in the soccer group (−3.9 mm^2/s, 95% CI, −13.0 to 5.2, $P = 0.40$). No intervention effects were observed in postural sway when the participants were standing on one leg with the eyes open after 3 or 9 months.

Discussion

To the best of our knowledge, this is the first randomised controlled workplace physical activity trial to evaluate the short- and long-term effects of soccer and Zumba on muscle strength, maximal jump height, flexibility and postural sway. The soccer group showed significant improvements in neck extension strength both after 3 and 9 months, whereas the Zumba group revealed an improvement in trunk flexion strength after 3 months, as well as improvements in the lower limb lean mass and velocity moment in postural sway test.

Isometric strength

In the soccer group, the improvement in neck extension strength after 3 and 9 months is in accordance to previous physical activity intervention studies involving specific strength exercises among male and female office workers with chronic non-specific neck pain (Andersen et al., 2008; Blangsted, Sogaard, Hansen, Hannerz, & Sjogaard, 2008; Ylinen et al., 2003), but in contrast to others. For example, an intervention study by Rolving et al. (2014), comprising home-based general physical activity or specific strength training, revealed no effects in neck extension strength among females with non-specific neck pain (Rolving et al., 2014), whereas Hakkinen, Salo, Tarvainen, Wiren, and Ylinen (2007) observed no improvement with manual therapy and stretching among females with chronic neck pain after 3 months (Hakkinen et al., 2007). It is suggested that increased muscle strength may be a powerful tool in prevention and rehabilitation of muscle pain in the neck–shoulder region (Mortensen et al., 2014; Ylinen, Salo, Nykänen, Kautiainen, & Häkkinen, 2004), which is in accordance with a corresponding relationship between the improvement of neck strength in the present study and a similar decrease in neck pain intensity and duration of pain in the same population reported in a previous paper (Barene, Krustrup, & Holtermann, 2014).

In the Zumba group, the significant increase in trunk extension strength observed after 3 months corresponds to a recent study reporting improvements in trunk strength endurance after 2 months among young females with no previous experience with Zumba (Donath et al., 2013). Moreover, the improvement in trunk extension in the Zumba group in the present study corresponds to a numerical, but insignificant increase in trunk lean mass at the same time point (Table 2). Previous physical activity intervention studies have shown that soccer training lead to significant improvements in total lean mass among untrained males after 12 weeks (Krustrup et al., 2009), in lower limb lean mass among untrained premenopausal females after 14 weeks (Helge et al., 2010), 4 and 16 months (Krustrup et al., 2010), as well as in elite female soccer players after 16 weeks (Jackman et al., 2013). In the present study, the soccer group revealed no significant improvement in lean mass compared to the control group. To the best of our knowledge, no previous intervention studies have examined changes in body lean mass after Zumba exercise.

Maximal jump height

In the present study, no intervention effects were observed in maximal jump height, neither in the soccer group or the Zumba group. The lack of improvement in vertical jump height in the present study is in accordance with a previous intervention study by Glowacki et al. (2004), who revealed no effect on vertical jump height after 12 weeks of resistance training or endurance training, respectively, among untrained males (Glowacki et al., 2004). Moreover, previous intervention studies have suggested that endurance training alone decreases vertical jump height (Dudley & Fleck, 1987; Tanaka & Swensen, 1998). In contrast, resistance training alone is suggested to have positive effects on vertical jump height (Hennessy & Watson, 1994; Hunter, Demment, & Miller, 1987; McCarthy, Agre, Graf, Pozniak, & Vailas, 1995). A possible explanation of the divergent findings involving vertical jump height may be due to varying types of exercise and protocols used in the studies (Glowacki et al., 2004).

With regard to the soccer group, the lack of improvement is in contrast to previous soccer intervention studies reporting significant increases in maximal jump height among untrained premenopausal females after 14 weeks (Helge et al., 2010) and untrained males after 12 weeks (Milanović, Pantelić, Sporiš, Mohr, & Krustrup, 2015), respectively, which may be explained by the multiple sprints, turns, tackles, shots, accelerations and decelerations associated with recreational soccer. The lack of improvement in vertical jump height in the soccer group in the present study may be due to a lower degree of high impact involvements among the participants compared to the above-mentioned studies, potentially related to a higher average age among the participants in the present study, i.e., 44 ± 9 vs. 34 ± 4 (Milanović et al., 2015) and 37 ± 8 (Helge et al., 2010) years. With regard to the Zumba group, the findings in the present study are in accordance to a previous intervention study by Donath et al. (2013), who did not observe any significant improvements in maximal jump performance measured by the jump-and-reach test (Donath et al., 2013).

Flexibility

Both after 3 and 9 months, the intervention groups as well as the control group showed improvements in the sit-and-reach flexibility. Furthermore, after 3 months, the control group showed an unexpected significant increase in the flexibility in comparison to the Zumba group. Because the sit-and-reach test involves whole body motion, it is suggested that the validity of the test may be influenced by many anthropometric and joint flexibility factors in the shoulders, spine and lower and upper extremities (Ayala et al., 2011; Rodríguez-García, López-Miñarro, Yuste, & De Baranda, 2008). In this context, several factors have been reported to affect the reproducibility of hamstring flexibility including different pelvic position and stability, ankle position, and the phase of menstrual cycle in females. However, with regard to the Zumba group, the lack of effect in flexibility is in accordance to the aforementioned study by Donath et al., who revealed no significant changes in spine and pelvic flexibility after Zumba exercise (Donath et al., 2013). To the best of our knowledge, no previous intervention study has evaluated the sit-and-reach flexibility after recreational soccer among females.

Postural sway

In the soccer group, no intervention effects were observed in postural sway with the participants standing on one leg or both legs. This is in contrast to previous soccer intervention studies among both untrained males (Jakobsen et al., 2011) and premenopausal females, reporting significant improvements in both one leg and both legs postural sway after both 14 weeks (Helge et al., 2010) and 16 months (Krustrup et al., 2010) of twice-weekly soccer sessions. However, it should be noted that the latter studies used the Flamingo balance tests which is different from the balance platform used in the present study. As for the soccer group, the Zumba group did not reveal any effects in postural sway performed on one leg, nor after 3 or 9 months. This is in contrast to Donath et al. (2013), who observed significant improvements in one leg balance after Zumba exercise measured by the star excursion balance test (Donath et al., 2013). However, when performed in normal standing position with eyes closed, the Zumba group significantly improved the sway velocity moment compared to the control group after 9 months.

The calculation of velocity moment takes into account both the distances from the geometric midpoint of the whole test and the speed of movement during the same period (Punakallio, 2003), and may thus be an important indicator of a person's postural balance. Based on previous study by Era et al. (2005), suggesting that deterioration in balance function starts at relatively young ages and further accelerates from about 60 years upwards (Era et al., 2005), the significant improvement in velocity moment in the Zumba group compared to the control group after 9 months indicates that long-term Zumba participation may decelerate or increase the balance ability among middle-aged females. The test–retest reliability has previously been reported to be acceptable (Ha et al., 2014).

Strengths and limitations of the study

Strengths of the study are the randomised controlled study design, as well as the use of the conservative intention-to-treat analyses in the statistical calculations. Additional strengths are the evaluation of both short-term and long-term effects from the two exercises, and also the relatively high rates of participation to the different tests during the intervention period, especially at baseline and at the 3 month follow-up. Weaknesses of the study are the relatively modest adherence rate in the two exercise groups between 3 and 9 months. Other limitations of the study are the lack of information about employees not willing to participate in the study, which may decrease the generalisability of the findings to other groups, as well as the lack of control for diet and/or physical activity habits during the intervention period in the two exercise intervention groups and the control group. With regard to the statistical analyses, the use of mixed model statistics to evaluate a potential group-by-time interaction prior to the post-hoc analysis would presumably be appropriate.

Conclusion

The present study showed that workplace-initiated soccer and Zumba exercise improved the neck and trunk strength for female hospital employees, which may have preventive effects with regard to future muscle pain in these body regions. Zumba exercise also revealed positive effects on lower limb lean mass and postural sway, which may reduce the risk of falls and fractures.

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