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Effects of Floorball and Strength Training in a Real-Life Setting on Health and Physical Function in Older Men

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Abstract: There is lacking information about the physiological response when conducting training of older men in a real-life setting. Seventy-six sedentary men aged 72.3 ± 0.6 (means ± SE; range: 63–92) years with a height, body mass and body mass index of 178.9 ± 0.8 cm; 92.1 ± 2.2 kg: 28.7 ± 0.6 kg/m^2, respectively, were recruited to floorball (FG, n = 29), strength (SG, n = 38) or bowls (BG, n = 9) training 1 h twice a week in municipal activity centers and senior sport clubs. Subjects were tested at baseline, after 12 and 24 weeks. Twelve weeks of floorball and strength training lead to reduced blood Hb1Ac, body mass, fat mass, visceral and android fat. Further, SG had a decrease in gynoid fat and blood total and LDL cholesterol. Both groups decreased heart rate at rest. In SG, systolic and diastolic blood pressure were also reduced. FG increased markers for bone growth. FG and SG improved functional capacity. The improvements in FG and SG were maintained after 24 weeks. BG did not have any changes. In conclusion, older men conducting floorball or strength training twice a week in a real-life setting can improve functional capacity and a high number of health factors, whereas playing bowls does not lead to physiological changes.

Keywords: exercise; aging; health; physical capacity; physical function; team sport; bowls; strength training; bone

1. Introduction

Aging is associated with loss of muscle mass and decline in physical function. Thus, the ability to perform activities of daily living, such as climbing stairs and get up from a chair is reduced in elderly [1–3]. In addition, balance deteriorate with age, and the risk of falls and fractures increases [4]. Aging entails also a number of health-related challenges, such as increase in body fat and blood lipids as well as decline in cardiovascular function with elevated blood pressure and reduced insulin resistance with a risk of development of type II diabetes [5,6].

Regular physical activity has been shown to improve functional capacity and the health profile of elderly [7–18]. Thus, aerobic training of older adults has have favorable health effects such as an increase in high-density lipoprotein (HDL) cholesterol and a decrease in plasma triglyceride, while a decrease in low-density lipoprotein (LDL) cholesterol) seems to be related to an accompanying weight loss [19]. Reduction in fat mass and increase in insulin sensitivity has also been seen in elderly with aerobic training [20]. Strength training in elderly has lowered total and LDL cholesterol as well as increased HDL cholesterol [9,21]. In addition, strength training increase strength and improves physical function and cardiorespiratory variables as well as increases insulin sensitivity combined with decreases in glycosylated hemoglobin in older adults [8,9,15,16]. However, changes in insulin sensitivity with strength training seem to be mostly related to eccentric training [9].

One of the challenges is to get older adults motivated to do aerobic or strength training and for them to maintain the training [22]. In contrast, team sports have been shown to motivate and sustain the participants' interest in continuing the training for years [22,23]. Team sports, such as soccer and floorball conducted as small-sided games, have been shown to have similar effects on the health of

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older adults as both aerobic and strength training. Body mass is reduced after a period with floorball [24] and soccer [25] training, fat percentage, android and visceral fat are lowered with floorball [26], glucose tolerance is elevated with soccer training [27], and lean body mass is increased with various team sport activities [25,28]. Furthermore cardiovascular health becomes better with regular floorball [24] and football [15] training, and also bone health and functional capacity are improved [24,26]. However, most studies of the effect of training of older adults are performed in a scientific environment, and there is lacking information about the physiological response when conducting training in a real-life setting.

Many older adults are not sufficiently active. In particular, older men take to a lesser extent part in physical activities compared to women [29], which may be caused by the fact that the existing offers are not attractive for older men. Thus, in the present study agreements were made with local sports clubs and municipalities to establish settings to conduct floorball, strength and bowls training with the participants being recruited through announcements in local newspapers. In addition, some participants were recruited through e-mails to wives, who were active in sports clubs.

Thus, the aim of this study was to examine the physiological adaptations in older men recruited to regular participation in floorball, strength or bowls training. It was hypothesized, that floorball training was superior to strength and bowls training when it comes to cardiovascular health, reduced body fat and glycosylated hemoglobin and increase in bone health [19]. While the effect on physical function was expected to be equal in the floorball and strength training group, but superior to the bowls training group.

2. Materials and Methods

2.1. Subjects

Seventy-six sedentary men aged 72.3 ± 0.6 (means ± SE; range: 63–92) years with a height, body mass and body mass index of 178.9 ± 0.8 cm; 92.1 ± 2.2 kg: 28.7 ± 0.6 kg/m^2, respectively, took part in the study. The participants were recruited from municipal activity centers, senior sport clubs as well as through announcements in local newspapers. Most subjects were recreationally active (walking or cycling for transportation on a daily basis), but no one had been involved in any type of regular physical training for the past 10 years.

The study was approved by the Committee on Health Research Ethics, Region of Copenhagen (H-18047204), and conducted in accordance with the guidelines of the declaration of Helsinki. The subjects were informed of any risks and discomforts associated with the experiments before giving their written informed consent to participate in the study.

2.2. Study Design

In the spring 2019, the participants were recruited to participate in physical activity in a center for elderly or in two sports clubs. The participants could freely choose whether they wanted to participate in floorball, strength or bowls (comparable to indoor pétanque) training. Twenty-nine subjects chose floorball (FG), 38 subjects chose strength training (SG), and no one chose to play bowls. The participants were training one h twice a week during a 12-week intervention period (INT). After the 12 weeks, participants in FG and SG had the opportunity to continue their activity for another 12 weeks, and 9 and 13, respectively, continued for another 12 weeks. In the fall 2019, nine subjects were recruited to play bowls (BG) for 12 weeks in a sport club. The subjects conducted a number of tests (see below) before, and after 12 and 24 weeks of training. In addition, on a separate day 19 participants from FG, 22 from SG and 9 from BG, completed a number of physiological measurements (see below). During the study period the participants maintained their habitual life routines and level of physical activity.

Some of the participants took medicine with the most frequent type being diabetes medication (12%), blood pressure medication (47%), cholesterol lowering medication (22%), anticoagulants (18%), and heart medication (15%). In BG, more subjects were taking medication for heart function, diabetes and cholesterol-lowering, compared to FG and SG (33, 29, 67% in BG compared to 9, 14, 8%

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in FG and 14, 12, 14% in SG respectively). There were no significant changes in medication during the 24-week intervention period.

There were no differences between groups at baseline for age, height, body mass index (BMI), blood pressure (BP), android fat, gynoid fat, visceral fat, blood glycosylated hemoglobin (HBA1c) and high-density lipoprotein (HDL cholesterol), but differences between groups at baseline for four physical tests as well as plasma low density lipoprotein (LDL cholesterol) and glucose were observed (Table 1).

Table 1. Baseline data for the floorball training group (n = 22), the strength training group (n = 24) and the bowls training group (n = 9). For the functional tests the number of subjects were 29 and 38 in the floorball and strength training group, respectively.

	Floorball	Strength	Bowls
Age (years)	71.1±0.8	73.0±0.8	72.8±1.6
Height (cm)	179.8±1.3	179.0±1.3	176.2±1.9
BMI (kg/m²)	28.7±0.9	27.8±0.8	31.2±2.3
Android fat (%)	44.2±2.0	43.9±1.6	47.9±3.1
Gynoid fat (%)	31.3±1.2	31.0±1.3	37.4±3.2
Visceral fat (kg)	2.47±0.25	2.35±0.22	2.63±0.39
Diastolic BP (mmHg)	83.4±2.3	88.2±2.2	88.7±2.7
Systolic BP (mmHg)	133.9±3.9	146.6±4.9	138.4±3.8
LDL cholesterol (mmol/l)	3.4±0.2	3.9±0.2 $^{\beta}$	2.6±1.8 $^{\gamma}$
HDL cholesterol (mmol/l)	1.4±0.1	1.4±0.1	1.4±0.1
HBA1c (mmol/mol)	37.0±1.1	38.0±0.9	39.7±2.7
Glucose (mmol/l)	6.1 ±0.2 $^{\beta}$	6.0±0.2 $^{\beta}$	7.5±0.6 $^{\alpha, \gamma}$
6-min walk (m)	567±12 $^{\beta,\gamma}$	521±13 $^{\alpha, \beta}$	447±24 $^{\alpha,\gamma}$
Rise & Sit 30s (reps)	12.0±0.3$^{\beta}$	11.5±0.3	9.2±1.9 $^{\alpha}$
2.45 Up&Go (s)	6.0±0.2 $^{\beta}$	6.6±0.3	7.6±0.8 $^{\alpha}$
Arm flexion (reps)	19.2±0.6 $^{\beta}$	18.3±0.6 $^{\beta}$	13.1±0.9 $^{\alpha,\gamma}$
Handgrip (KP)	43.2±1.2	40.7±1.4	36.1±2.1

Values are mean ± SE. Hb1Ac: glycosylated hemoglobin, HDL: High Density Lipoprotein, LDL: Low Density Lipoprotein. ANGIV OGSÅ ANDRE FORKORTELSER: F.EKS. BP: Blood pressure RET TIL OVERALT; $^{\alpha}$ Significant ($p < 0.05$) different from the floorball training group; $^{\gamma}$ Significant ($p < 0.05$) different from the strength training group. $^{\beta}$ Significant ($p < 0.05$) different from the bowls training group.

2.3. Training

2.3.1. Floorball Training

Floorball is a team sport like hockey but played indoor with plastic sticks (http://www.floorball.org). All sessions started with a 10-min warm-up period, including mobility, stretching, and technical exercises. The participants completed small-sided game with 3–5 players in each team. The court size was adapted to the physical function of the participants (the better the function, the larger the court). In the first part of the intervention period, the participants completed 4-min playing intervals separated by 4 min of rest. During the first 4 weeks (weeks 1–4), four 4-min intervals were conducted, i.e., total training time was 16 min per session. In the following 4 weeks (weeks 5-8), the participants completed six 4-min intervals, i.e., total training time was 24 minutes per session, and in the last 4 weeks (weeks 9–12), eight 4-min intervals were performed with a total training time of 32 minutes.

2.3.2. Strength Training

At each session, participants in the strength-training group conducted a 10-min warm-up session, including mobility, stretching and low load strength exercises with a technical focus. The strength-training program consisted of eight exercises focusing on leg, arm and core muscles. In the

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first four weeks, the participants performed 2 times 10 repetitions of each exercise with a low load separated by 2 min of rest. In the last 8 weeks, the participants completed 3 times 10 repetitions with an increasing load according to the individual's progress.

2.3.3. Bowls Training

Bowls is a ball game that is similar to pétanque. However, unlike pétanque, bowls is primarily played indoors. Bowls is a technical and strategic precision game that involves placing the team's own balls as close to the target ball as possible, and at the same time shooting away the opponent's balls. In bowls, the balls are asymmetrical in weight. Bowls were typically played 3 vs 3 or 4 vs 4. A bowls-training session lasted approximately 90 min.

2.3.4. Training Compliance

In FG, SG and BG training compliance was 76.6 ± 3.5%; 76.5 ± 3.8% and 87.0 ± 8.2%, respectively, corresponding to ~1.6 training sessions a week, with no difference between groups. Training compliance was not registered in the second 12-wk intervention period.

2.4. Measuring and Test Procedures

Subjects were instructed to refrain from strenuous exercise for at least 36 h before testing and physiological measurements. Subjects on medicine were instructed to take their habitual medicine on experimental days.

2.4.1. Functional Capacity Tests

At the training facilities, six standardized functional exercises were performed, including (a) maximal number of sit-to-stand repetitions in 30 s, (b) time to stand, walk 2 × 2.45 m (out and back around a cone) and sit (2.45 Up&Go (Timed Up and Go)), (c) maximal distance in a 6-min walking test, (d) maximal number of repetitions of biceps-curls with an 8 kg dumbbell [30], (e) maximal hand-grip strength with an adjustable hydraulic hand dynamometer (JAMAR; North Coast Medical, Oakleigh, Victoria, Australia). The tests were performed indoors on a wooden surface. FJERN BLANK SIDE

2.4.2. Additional Experimental Day

Subjects reported to the laboratory between 07:00 and 10:00 AM after an overnight fast. A blood sample was taken from a cubital vein for determination of plasma high density lipoprotein (HDL), low density lipoprotein (LDL) and total cholesterol, glucose, and glycated hemoglobin (HbA1c). Body composition was determined by whole-body dual-energy X-ray absorptiometry (DXA) scanning (Lunar Prodigy Advance; GE-medical Systems, Madison, Wisconsin, USA) and analyses by software (enCORE v15, GE-medical Systems, Madison, Wisconsin, USA). Then subjects rested at least 15 min in a supine position before blood pressure was measured six consecutive times by an automatic upper arm blood pressure monitor (M7; OMRON, Vernon Hills, Illinois, USA), while at the same time heart rate was measured (Polar Team System; Polar Electro Oy, Finland).

2.4.3. Blood Analysis

Blood samples were analyzed for total, HDL and LDL cholesterol, glucose, and HbA1c using turbidimetric immunoassay (Tosoh G8, Tosoh Bioscience Inc., South San Francisco, CA, USA) at the clinical biochemical unit at the Copenhagen main hospital (Rigshospitalet) using an automatic analyzer with enzymatic kits (COBAS 8000, Roche Diagnotics International Ltd, Rotkreuz, Switzerland)

2.4.4. Heart Rate During Training

At selected training sessions, subjects were wearing a heart rate monitor (Polar Team System; Polar Electro Oy, Finland) to measure heart rate. Heart rate data were subsequently analyzed using appropriate software (Polar ProTrainer 5, Polar Electro Oy, Finland).

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2.5. Statistics

Comparisons of baseline outcome measures between FG, CG and BG were performed using ANOVA with post hoc Bonferoni Multiple Comparisons. The effect of floorball , strength and bowls training was evaluated by General Linier Model analyses including the final outcome measure as dependent variable and training type as fixed factor while adjusting for baseline values of the outcome. Crosstabs with Chi-square tests we used to look for differences in the distribution of medicine intake between groups. Analyses of changes were based on comparisons of date before and after 12- and 24-week training intervention period [1], as well as comparisons between data after 12 and 24 weeks. Distribution of the data was checked for normality before applying Annova and Linear regression. IBM SPSS statistics 25.0 was used for all tests. P < 0.05 was chosen as the level of significance and all data are presented as means ±SE.

3. Results

3.1. Effects of 12 Weeks of Training

3.1.1. Heart Rate During Training

Figure 1 shows the distribution of heart rate during one session of floorball, strength and bowls training. Mean and peak heart rate was 118 ± 4.6 and 149 ±5.2 bpm, respectively, for floorball, 102 ± 3.2 and 133 ± 3.7 bpm for strength training and 84 ± 7.3 and 104 ± 8.8 bpm for bowls training.

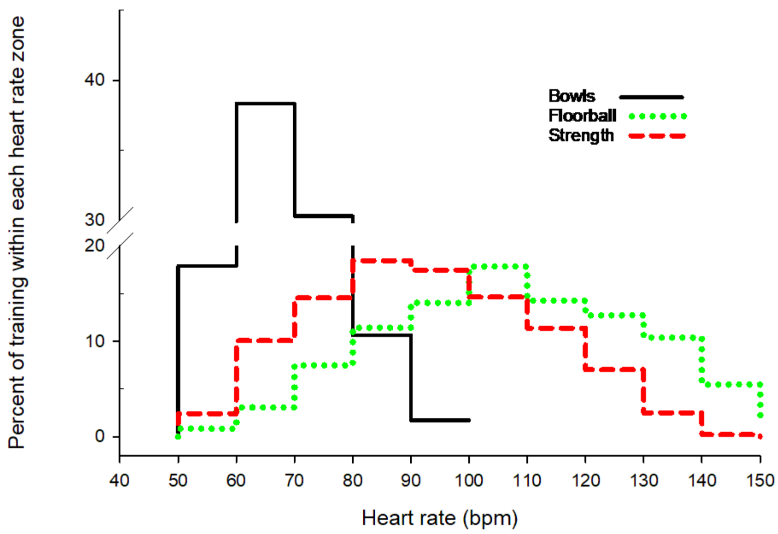

Figure 1. Heart rate distribution for one session of floorball training (68 min, n = 22), strength training (55 min, n = 24) and bowls training (88 min, n = 5). Data are presented as means within each heart rate zone (40–49 bpm, 50–59 bpm, 60–69 bpm etc.).

3.1.2. Body Composition

Body mass decreased in FG (-1.4 ± 0.7%, P = 0.031) and SG (-1.3 ± 0.6%, P = 0.03) during INT, and the changes were different (P = 0.013 and P = 0.015, respectively) from BG, where no change was observed (Figure 2). BMI decreased in FG (-1.4 ± 0.7%, P = 0.03) and SG (-1.1± 0.7%, P = 0.05) with no change in BG. The change in BMI in FG and SG was different (P = 0.023 and P = 0.038) from that in BG. Fat mass and visceral fat decreased in FG (-3.9 ± 1.9%, P = 0.0.023; -6.3 ± 3.5%, P = 0.044) and SG (-3.4± 1.1%, P = 0.004; -5.2 ± 2.1%, P = 0.024) during INT, which were different (P = 0.04) from BG, where no changes were observed. Android fat decreased in FG (-6.9 ± 1.0%, P = 0.007) and SG (-3.4 ± 1.3%, P = 0.013) during INT, which were not different from BG, where no change was observed. Gynoid fat did not change in FG, but decreased in SG (-2.1 ± 0.8%, P = 0.007), which was not different from BG, where no change was observed (Figure 2). No change in total, leg and arm lean mass during INT was observed in any of the groups (Table 2). There were no differences between changes in FG and SG during INT for any of the measurements of body composition (Figure 2; Table 2).

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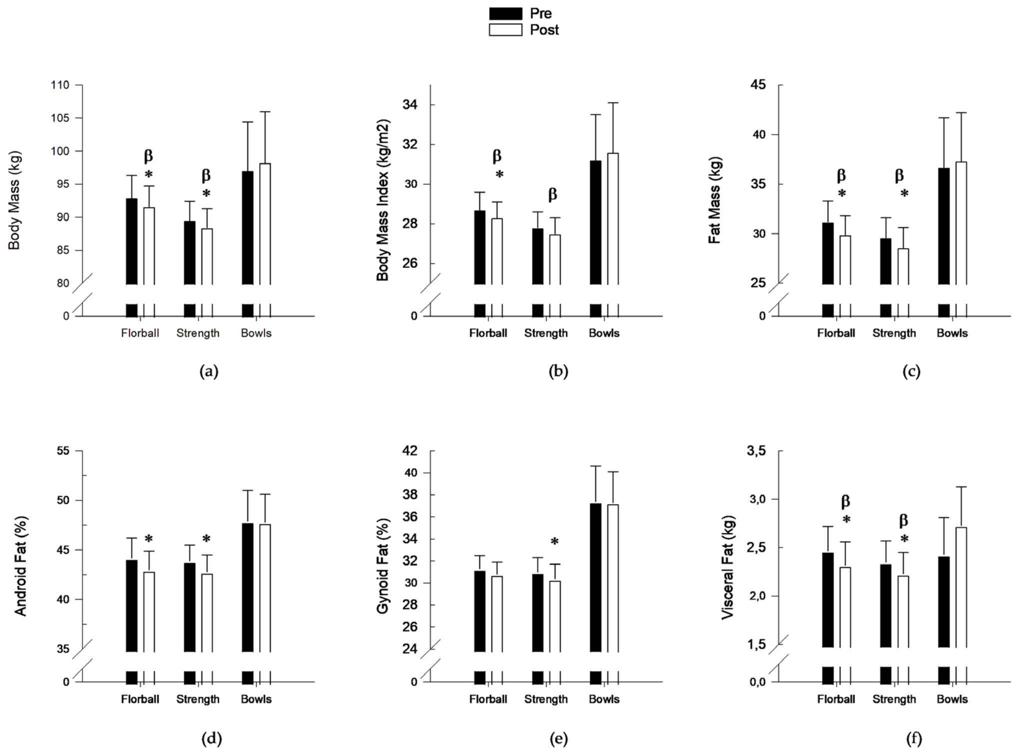

Figure 2. (**a**) Body mass; (**b**) Body mass index; (**c**) Fat mass; (**d**) Android fat mass; (**e**) Gynoid fat mass and (**f**) Visceral fat mass before (pre, filled bars) and after (post, open bars) 12 weeks of training floorball (n = 22), strength (n = 24) and bowls (n = 9). Data are presented as mean ± SE. * Significant ($p < 0.05$) within group change from baseline. $^{\beta}$ Change significant ($p < 0.05$) different from change in Bowls.

Table 2. Blood glycosylated haemoglobin, glucose, High Density Lipoprotein, Low Density Lipoprotein and total cholesterol (A); total lean body mass, leg lean mass and arm lean mass (B) before (Pre) and after (Post) 12 weeks of floorball, strength and bowls training.

	Floorball (n = 22)		**Strength (n = 24)**		**Bowls (n = 9)**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
A						
Hb1Ac (mmol/mol)	36.4±1.2	35.5±1.0*	38.0±0.9	35.3±1.6*	38.3±1.7	38.4±1.3
Glucose (mmol/l)	6.0±0.2	6.0±0.2$^{\beta}$	6.0±0.2	6.0±0.2$^{\beta}$	7.2±0.2	7.7±0.4*
HDL cholesterol (mmol/l)	1.4±0.1	1.5±0.1	1.4±0.1	1.6±0.1*	1.3±0.1	1.4±0.1
LDL cholesterol (mmol/l)	3.5±0.2	3.4±0.1	3.9±0.2	3.5±0.2*	2.3±0.4	2.2±0.3
Total cholesterol(mmol/l)	5.2±0.2	5.1±0.2	5.6±0.2	5.3±0.2*	4.2±0.4	4.3±0.3
B						
Lean body mass (kg)	58.2±1.5	58.2±1.5	56.2±1.2	56.3±1.3	57.3±3.0	58.2±3.4
Leg lean mass (kg)	20.1±0.6	20.1±0.6	19.1±0.5	19.2±0.6	19.9±1.1	20.2±1.3
Arm lean mass (kg)	7.0±0.2	7.0±0.2	6.7±0.2	8.0±0.2	6.9±0.5	6.9±0.6

Values are mean ± SE. Hb1Ac: Glycosylated hemoglobin, HDL: High Density Lipoprotein, LDL: Low Density Lipoprotein. *Significant ($p < 0.05$) within group change from baseline. $^{\beta}$ Change significant ($p < 0.05$) different from change in bowls training group.

3.1.3. Plasma Bone Markers, Bone Mass and Bone Mass Density

There was an increase in plasma P1NP (11.8 ± 5.2%, P = 0.017) in FG during INT, which was not different from SG and BG, where no changes were observed (Table 3). Plasma osteocalcin increased in FG (10.6 ± 4.8%, P = 0.017) during INT, which was different (P<0.05) from a decrease in SG (-5.5 ± 5.2%, P = 0.049). The decrease in SG was different (P=0.018) from BG, where no change was observed. For plasma CTX, there were no changes in FG, SG or BG during INT, Total, leg and arm bone mass, as well as total, leg and arm BMD did not change during INT in either group (Table 3).

Table 3. Blood bone markers (CTX, P1NP and osteocalcin), bone mass and Bone Mass Density before (Pre) and after (Post) 12 weeks of floorball, strength and bowls training.

	Floorball (n = 19)		**Strength (n = 22)**		**Bowls (n = 7)**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
CTX (ng/l)	237.9 ± 35.4	249±43	359±44	332±38	303±76	330±88
P1NP (µg/l)	41.8±2.6	46.7±4.0*	50.2±3.3	50.1±3.6	47.4±8.8	49.5±9.4
Osteocalcin (µg/l)	13.5±0.8	15.0±1.0*$^{\alpha}$	18.8±1.8	17.8±1.6*$^{\beta\gamma}$	17.8±3.4	19.8±4.3$^{\alpha}$
Total bone mass (kg)	3.26±0.10	3.26±0.10	3.15±0.06	3.13±0.07	3.11±0.14	3.09±0.13
Leg bone mass (kg)	1.25±0.04	1.24±0.03	1.23±0.03	1.22±0.03	1.17±0.04	1.18±0.04
Arm bone mass (g)	0.49±0.07	0.49±0.08	0.47±0.06	0.47±0.07	397±51	444±23
Total BMD (g cm^2)	1.33±0.03	1.33±0.02	1.32±0.03	1.32±0.02	1.29±0.04	1.29±0.04
Leg BMD (g cm^2)	1.42±0.03	1.41±0.03	1.42±0.02	1.41±0.03	1.33±0.14	1.33±0.05
Arm BMD (g cm^2)	1.10±0.11	1.08±0.10	1.06±0.03	1.08±0.02	1.05±0.03	1.05±0.03

Values are mean ± SE. CTX: Carboxy-terminal collagen crosslinks, P1NP: Serum/plasma procollagen-type 1 N propeptide, BMD: Bone Mass Density. * Significant ($p < 0.05$) within group change from baseline ($p < 0.05$). $^{\alpha}$ Change significant ($p < 0.05$) different from change in strength training group. $^{\beta}$ Change significant ($p < 0.05$) different from change in bowls training group. $^{\gamma}$ Change significant ($p < 0.05$) different from change in floorball training group.

3.1.4. Plasma Cholesterol

Plasma HDL cholesterol did not change in FG but increased in SG (13.2 ± 5.5%, P = 0.026) during INT, with the change not being different from BG, where no change was observed. For plasma LDL cholesterol, there was no change in FG during INT, but there was a decrease in SG (-9.9 ± 2.7%, P = 0.001), which was not different from no change in BG. Total plasma cholesterol did not change in FG during INT with SG having a decrease (-4.5 ± 2.0%, P = 0.04), which was not different from BG, where no change was observed (Table 2). There were no differences between changes in FG and SG during INT for any of the measurements of plasma cholesterol.

3.1.5. Blood Glycosylated Hemoglobin and Glucose

Hb1Ac decreased in FG (-2.6 ± 1.3%, P = 0.026) and SG (-3.5 ± 1.5%, P = 0.041) during INT (Table 2). The changes in FG and SG were not different from BG, where no change was observed. In FG and SG, no change in blood glucose was observed during INT, which were different (P = 0.012 and P = 0.006) from an increase in BG (7.7 ± 3.1%, P = 0.028) (Table 2).

3.1.6. Heart Rate and Blood Pressure at Rest

HR at rest decreased in FG (-9.2 ± 3.1%, P = 0.008) and SG (-6.9 ± 2.2%, P = 0.005) during INT, and the decrease in FG was different from BG, where no change was observed. Diastolic and systolic blood pressure did not change in FG but decreased in SG (-4.1 ± 1.9%, P = 0.004; -4.1 ± 1.9%, P = 0.03) during INT, which were different (P = 0.036 and P = 0.016) from BG, where no changes were observed (Figure 3).

There were no differences between changes in FG and SG for heart rate at rest and blood pressure (Figure 3).

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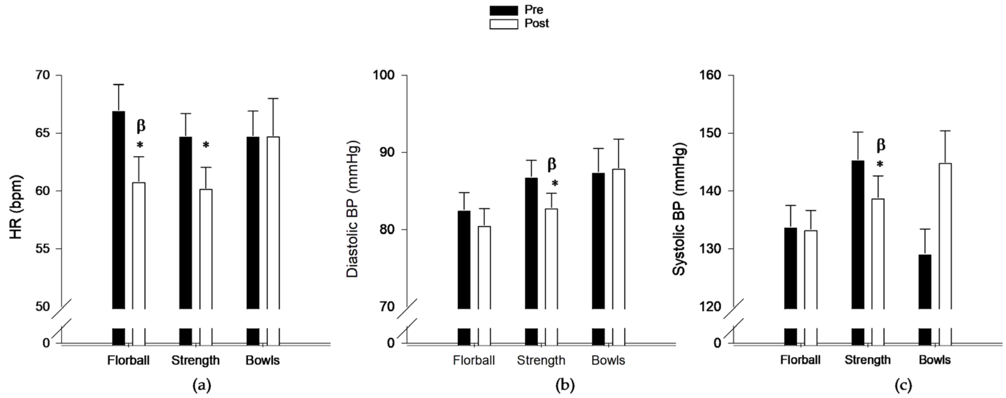

Figure 3. (**a**) Heart rate, (**b**) Diastolic blood pressure (BP) and (**c**) Systolic blood pressure (BP) at rest before (pre, filled bars) and after 3 months (post, open bars) of training floorball (n = 22), strength (n = 24) and bowls (n = 9). Data are presented as mean ± SE. * Significant (p < 0.05) within group change from baseline. β Change significant (p < 0.05) different from changes in Bowls.

3.1.7. Functional Measurements

The distance covered in 6 min and number of sit-to-stand repetitions in 30 s increased, and time for Timed Up and Go decreased in FG (6.1 ±1.8%, P = 0.02; 24.3 ± 3.8%, P < 0.001; -18.9 ± 2.0%, P < 0.001) and SG (6.0 ± 1.7%, P = 0.001; 18.7± 2.5%, P < 0.00; -18.1 ± 2.8%, P < 0.001) during INT, which were different (P < 0.05) from BG, where no change was observed (Figure 4). The number of arm curls did not change in FG and SG during INT, whereas there was a decrease in BG (-9.3 ± 3.8%, P = 0.038) which was different from FG and SG (P = 0.006 and P = 0.009). Handgrip did not change in FG, SG or BG during INT. For none of the functional measurements differences between changes in FG and SG during INT were observed (Figure 4).

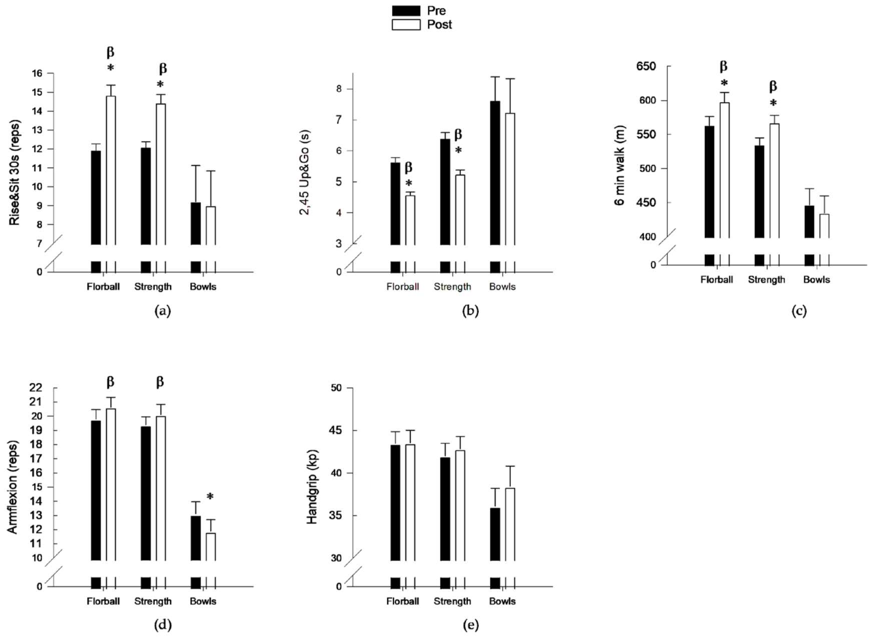

Figure 4. Functional tests. (a) Rise&Sit 30s; (b) 2.45 Up&Go; (c) 6-min walk; (d) Arm flexion; (e) Handgrip before (pre, filled bars) and after (post, open bars) 12 weeks of training. Floorball (n = 29), Strength (n = 38) and Bowls (n = 9). Data are presented as mean ± SE. * Significant (p < 0.05) within group change from baseline. β Change significant (p < 0.05) different from changes in Bowls.

3.2. Effects of 24 Weeks of Training

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Both FG and SG lowered fat mass (-3.9 ± 1.9%, P = 0.000; -3.4 ± 1.1%, P=0.002), android fat (-6.9 ± 1.0%, P = 0.001; -3.4 ± 1.3%, P = 0.000) and gynoid fat (-5.7 ± 2.7%, P=0.000; -4.3± 1.8%, P = 0.007) from baseline to 24 weeks of training. In addition, there was a decrease in body mass (-3.8 ± 1.9%, P=0.03) and visceral fat (-16.4 ± 7.2%, P = 0.000) in FG. In SG there was a decrease in LDL cholesterol (-15.9 ± 6.9%, P=0.001) and total cholesterol (-8.4 ± 4.4%, P=0.019). In the performance tests both FG and SG increased the performance in maximal walking distance in 6 min (6.8 ±3.0%, P=0.001; 8.5 ±2.7%, P=0.001), number of sit-to-stand repetitions in 30 s (27.4 ±3.7%, P=0.000; 20.6 ±7.9%, P=0.000) and Timed Up and Go (-23.3 ± 2.81%, P=0.000; -17.7±2.2%, P=0.000) (Table S1). No difference in the changes in body composition, bone markers, bone mass, bone mass density, cholesterol, heart rate at rest, blood pressure and functional capacity during the 24 weeks of training were observed between FG and SG. For both FG and SG the changes after 12 weeks were maintained during the following 12-week training period (Table S1).

Table 4. Blood bone markers (Carboxy-terminal collagen crosslinks, procollagen-type 1 N propeptide and Osteocalcin), bone mass and Bone Mass Density before (Pre) and after (Post) 12 weeks of training floorball, strength and bowls.

	Floorball (n = 19)		Strength (n = 22)		Bowls (n = 7)	
	Pre	Post	Pre	Post	Pre	Post
CTX (ng/l)	237.9 ± 35.4	249±43	359±44	332±38	303±76	330±88
P1NP (µg/l)	41.8±2.6	46.7±4.0*	50.2±3.3	50.1±3.6	47.4±8.8	49.5±9.4
Osteocalcin (µg/l)	13.5±0.8	15.0±1.0*$^{\alpha}$	18.8±1.8	17.8±1.6*$^{\beta\gamma}$	17.8±3.4	19.8±4.3$^{\alpha}$
Total bone mass (kg)	3.26±0.10	3.26±0.10	3.15±0.06	3.13±0.07	3.11±0.14	3.09±0.13
Leg bone mass (kg)	1.25±0.04	1.24±0.03	1.23±0.03	1.22±0.03	1.17±0.04	1.18±0.04
Arm bone mass (g)	0.49±0.07	0.49±0.08	0.47±0.06	0.47±0.07	397±51	444±23
Total BMD (g cm^2)	1.33±0.03	1.33±0.02	1.32±0.03	1.32±0.02	1.29±0.04	1.29±0.04
Leg BMD (g cm^2)	1.42±0.03	1.41±0.03	1.42±0.02	1.41±0.03	1.33±0.14	1.33±0.05
Arm BMD (g cm^2)	1.10±0.11	1.08±0.10	1.06±0.03	1.08±0.02	1.05±0.03	1.05±0.03

Values are mean ± SE. CTX = Carboxy-terminal collagen crosslinks, P1NP = Serum/plasma procollagen-type 1 N propeptide, BMD=Bone Mass Density. * Significant ($p < 0.05$) within group change from baseline. $^{\alpha}$ Change significant ($p < 0.05$) different from change in SG. $^{\beta}$ Change significant ($p < 0.05$) different from change in BG; $^{\gamma}$ Change significant ($p < 0.05$) different from change in FG.

4. Discussion

The major findings of the present study were that 12 weeks of floorball and strength training twice a week in elderly men lead to reduced blood Hb1Ac, body mass, fat mass, visceral and android fat with, in contrast to the hypothesis, similar changes in the two groups. The strength training group also had a decrease in gynoid fat as well as in total blood and LDL cholesterol. Furthermore, both groups had a decrease in heart rate at rest, and in the strength training group systolic and diastolic blood pressure were also reduced. As hypothesized, the floorball group had an increase in markers for bone growth. Both groups had improvements in a number of the functional measurements with, as expected, similar responses. For all variables, the changes after 12 weeks were maintained during the following 12-week training period, with no further improvements related to health and physical function. The bowls group had no changes in any of the measured variables related to health and physical function

4.1. Body Composition

The older men in the present study had a BMI of ~28 kg/m^2, which classifies them as slightly obese. The men in both the floorball and strength training group lowered body mass by 1% during the 12-wk intervention period, and reduced fat mass by 4% and 3%, respectively, which included decrease in visceral fat of 6% and 5% and android fat of 7% and 3%, respectively, as well as a 2%-

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lowering of gynoid fat in the strength training group. Likewise, Vorup et al (2017) [24] found a reduction in total and visceral fat by 5% and 14%, respectively, but no reduction in body mass in older men (age: 70 years, BMI: 27 27 kg/m²) playing floorball 2 times 1 h a week for 12 weeks. Andersen et al. (2014) [25], though, found a reduction in body mass of 1% following 12 weeks of football training twice a week for 60 min in elderly men with type 2 diabetes of a similar age and BMI (age: 68 years, BMI: 29 kg/m²) as the men in the present study, and their reduction in total fat mass and android fat mass was 4% and 8%, respectively.

The changes in body mass and fat mass obtained during the first 12 weeks of the training intervention were maintained during the following 12 weeks suggesting that the effects are sustained. In accordance, Pedersen et al (2022) [26] observed that five years of floorball training, reduced fat percentage, android and visceral fat by 10, 13 and 18%, respectively, although body mass vas not changed. Furthermore, in the study by Andersen et al. (2016) [7] with 52 weeks of football training body mass was significantly reduced (3%), whereas android and gynoid fat were non-significantly reduced (6.5% and 2.2%, respectively). Thus, team sport activities conducted as small-sided games appear effective in reducing fat mass.

High fat-percentage is associated with an increased risk of developing type 2 diabetes and cardiovascular diseases [31-36]. In addition, visceral fat has been shown to be strongly associated with metabolic risk factors[33]. Thus, the present results suggest that conducting regular floorball or strength training have positive effects on the health profile in older men.

Neither the floorball nor the strength training group had changes in lean body mass. This is in contrast to a study showing that muscle mass increased with two weekly 1-h sessions of small-sided soccer games for 12 weeks in young untrained adults [37]. Vorup et al (2017) [28] also found an increase in leg muscle mass (~11%) after playing small sided team sport games (including 50% floorball) two times 20 min a week for 12 weeks in elderly men and women (age: 72 years; BMI: 26 kg/m²). However, in that study each training session was followed by ingestion of a drink with high protein content. Thus, it may be that proper caloric and protein intake is necessary to increase muscle mass after team sport among elderly, as there was no change in a control group ingesting an isocaloric drink. Lack of increase in muscle mass in older adults may also be due to 'anabolic resistance', which is characterized by an impaired ability to increase muscle mass because of a limited ability to utilize protein after an anabolic stimulus, e.g., exercise [38].

4.2. Blood Variables

The subjects in the floorball group had no change in plasma total, LDL and HDL cholesterol, which is similar to findings in Vorup et al (2017) [24] studying older men (age: 70 years, BMI: 27 kg/m²) playing floorball 2 times 1 h a week for 12 weeks. On the other hand, the subject in the strength training group had a reduction of plasma total cholesterol (5%) and LDL cholesterol (10%) as well as an increase in HDL cholesterol (13%), which were more pronounced compared to another study with strength training of elderly men (age: 66 years, BMI: 26 kg/m²) training once a week for 12 weeks [9,21], where the changes were -5%,-6% and 2%, respectively. Nevertheless, reduction in total and LDL cholesterol as well as increase in HDL cholesterol decrease the risk of coronary artery and peripheral vascular disease [19]. Thus, there were additional important adaptations for health promotion in the strength training group.

The subjects in the floorball group reduced blood Hb1Ac by 3%. Similarly, a study examining 12 weeks of 2 times 1 h of small-sided soccer training in men significant younger (50 years) than the men in the present study, but with diabetes mellitus [25], showed a reduction in blood HbA1c of 8%. On the other hand, Vorup et al (2017) [24] did not find any significant change Hb1Ac in men (age: 70 years; BMI: 27 kg/m²) playing floorball 2 times 1 h a week for 12 weeks, but observed a reduction (18%) in insulin resistance determined by homeostatic model assessment (HOMA-IR). Thus, it appears that team sport conducted as small-sided games can have a positive effect on blood glucose control. It may be due to the high intensity actions and high heart rate during the training (Figure 1), as it was observed that men (age: 58 years; BMI 28 kg/m²) with type 2 diabetes [25] conducting 10 weeks of high intensity interval 10–20–30 cycle training 3 times a week reduced HbA1c by 8%,

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whereas a similar group performing 150 min of moderate intensity exercise had no change in HbA1c [39].

Also, the subjects in the strength training group lowered (4%) blood Hb1Ac. In accordance, Chen et al. (2017) [9] showed that strength training 1 h a week for 12 weeks in elderly men (age: 66 years; BMI: 26 kg/m^2) reduced blood HbA1c by 6% and blood glucose by 5%, and James et al (2016) [21] found a reduction of 4% in blood glucose with 6 months of strength training 3 times 1 h a week among older men (age: 64 years; BMI: 26 kg/m^2).

The lowering of blood HbA1c in both the floorball and strength training group is of clinical relevance, as a reduction by 1 percentage point lowers the risk of diabetes-related death by 21% (95% CI: 15–27%) [40]. After 24 weeks of training blood HbA1c was still lowered in both the floorball and the strength training group, suggesting that the positive health effect was sustained.

4.3. Bone Health

There was no change in BMD during the 12-week training intervention period in neither the floorball nor the strength training group. However, plasma markers for bone growth were higher (P1NP: 12%, osteocalcin: 5%) in the floorball group after 12 weeks of training indicating an increased rate of bone formation and turnover. This is in line with the finding by Helge et al (2014) [41], where 4 months of small-sided football training of elderly men (age: 68 years; BMI: 26 kg/m^2) lead to an increase in plasma P1NP of 41% and osteocalcin of 45%. In that study, leg BMD was not changed after 4 months but elevated by 5% after 12 months. Similarly, Pedersen et al. (2018) [42] observed no changes in BMD after 12 weeks of floorball training twice a week among elderly men (age: 70 years; BMI: 27 kg/m^2), but a significant increase in BMD after two years of floorball training which were maintained after 5 years with floorball training [26]. In accordance, studies examining recreational football training of older men found higher leg BMD after one year of training [41,43]. Apparently, team sport training does lead to increases in BMD when sustained.

No changes in plasma bone markers were observed in the strength or bowls training groups, except for a minimal reduction in osteocalcin in the strength training group, which could indicate a reduction in bone growth. As floorball and football are weight-bearing sports characterized by repeated intense bouts of sprints, accelerations, and decelerations bone growth is likely stimulated [42,43]. In strength and bowls training no such activities are conducted, which may explain the lack of changes in plasma markers of bone turnover. Bolam et al. (2013) [44] showed a gradual decline in BMD with age by an average of ~0.7% per year after the age of 50 years. Thus, emphasize the importance of conducting exercises that stimulate the bones. In that sense floorball and football training can be used, whereas strength training is less relevant.

4.4. Cardiovascular Effects

Both the floorball and strength training group had lower heart rate at rest (9% and 7%, respectively) after compared to before the training intervention period, which indicates significant adaptations in the cardiovascular system [45]. This has also been observed in Vorup et al (2017) [24] where a similar group of men (age: 70 years; BMI: 27 kg/m^2) showed a reduction of 8% in heart rate at rest after a period with floorball training twice a week for 12 weeks. Likewise, a group of elderly men (age: 68 years; BMI: 26 kg/m^2) conducting football training 2–3 times a week for 4 and 12 months lowered heart rate by 10% and 12%, respectively, which was associated with improvement in maximum oxygen uptake (VO2max) of 16% and 18%, respectively [15].

The floorball group had no change in blood pressure, which is in line with findings in the study by Vorup et al (2017) [24] where elderly men were playing floorball twice a week for 12 weeks. On the other hand, the strength training group lowered both systolic and diastolic blood pressure by 4%, which is another sign of improved cardiovascular profile, and reduced risk of cardiovascular disease. In contrast, Smith et al 2014 [15] showed only minor cardiovascular adaptions in older men (age 68 years; BMI: 26 kg/m^2) after both 4 and 12 months of strength training 2–3 times 1 h a week. Nevertheless, both floorball and strength training in older men appear to have positive cardiovascular effects.

4.5. Functional Capacity

The distance covered in the 6-min walk test and number of sit-to-stand repetitions in 30 s (Rise&Sit 30s) increased, and time for 2.45 Up&Go decreased in the floorball group (6%, 24% and 19%, respectively) during the 12-wk intervention period (Figure 4). This is in line with findings in Duncan et al (2022) [46] who showed that 12 weeks of recreational small-sided football training twice a week among elderly men (age: 66 years; BMI: 29 kg/m^2) resulted in improvement in the same functional tests (12%, 11% and 24%). Also, a study with elderly men (age: 69 years; BMI: 27 kg/m^2) playing floorball two times 60 min a week for 12 weeks[24] showed improvements in the 6-min walk test (4%), but with no changes in the other two tests. After 5 years of floorball training, though, there were significant improvements in all three tests (4%, 8%, 4%) [26].

Also, the strength training group had improvements in the 6-min walk, Rise&Sit 30s and 2.45 Up&Go (6%, 19%, 18%) test during the intervention period (Figure 4). Similarly, Chen et al (2017) [9] studied the effect of 12 weeks of either eccentric or concentric strength training for 12 weeks of one session a week in elderly men (age: 66 years; BMI: 26 kg/m^2) and found that both types of training lead to improvements in the 6-min walking (5% and 4%, respectively), Rise&Sit 30s (37% and 18%) and 2.45 Up&Go (28% and 22%) test. Thus, both floorball and strength training do lead to increased functional capacity, which was maintained when continuing the training for another 12 weeks.

5. Conclusions

Older men conducting floorball and strength training twice a week for 12 weeks in a real-time setting improve functional capacity and a high number of health factors such as reducing heart rate at rest, body fat (in various compartments) and blood Hb1Ac. In addition, floorball training leads to bone growth and strength training lowers blood total and LDL cholesterol as well blood pressure. The effects can be maintained when continuing the training for another 12 weeks. In contrast, playing bowls does not lead to physiological changes.

6. Perspectives

The many positive effects on the health profile and improved functional capacity of taking part in floorball and strength training conducted in a setting where the older men were recruited through information in local newspapers look promising to use these activities to activate sedentary elderly men. Around half of the participants continued with the training after the first 12 weeks, and in questionaries the participants in the floorball group expressed as motivation for continuing that they feel engrossed in the activity highlighting the playful element and joy of playing together. One of the participants expressed it as: *"you don't think about the fact that you're doing it...don't feel that you're training"*. In the strength, training group the main reason for continuing was that the strength training could be conducted individually and was flexible. Nevertheless, both training forms apparently are attractive for older men when they have a chance to get exposed to the activity.

Supplementary Materials: The following supporting information can be downloaded at: www.mdpi.com/xxx/s1, Table S1: Variables at baseline and after 12 and 24 weeks of floorball and strength training for the floorball group and strength group.

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