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Specific care programme for the elders

Effects of exercise training and nutrition counseling on body composition and cardiometabolic factors in old individuals

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ABSTRACT

Background: Regular physical activity (PA) and nutritional counseling can reduce weight and trunk fat accumulation and influence cardiometabolic factors.
Methods: This study was an exercise training and nutritional counseling intervention, conducted in two 6-month phases. Participants were assessed at baseline and at 6 and 12 months. Participants (54 males and 63 females aged 71–90) were randomized into immediate exercise training group (Group 1) and delayed exercise training group (Group 2). At time-point 2, the groups crossed over.
Results: After the exercise training-phase by Group 1, a statistically significant increase ($P < 0.05$) was seen in physical activity (PA), energy intake, and total lean mass. A significant decrease was seen in weight, total fat mass, trunk fat mass, waist circumference, and blood pressure. At the 6-month follow-up, Group 1 saw a significant decrease in PA, energy intake, total lean mass and blood pressure. A significant increase was seen in waist circumference and total fat mass. After the 6-month control phase by Group 2, a significant decrease was measured in PA, systolic blood pressure, total fat mass, fat mass of the trunk and waist circumference. After a delayed 6-month exercise training-phase by Group 2, a significant increase was measured in PA, and a decrease in weight, total fat mass, trunk fat mass, waist circumference, blood pressure and triglyceride.
Conclusion: Our findings suggest that positive improvements in body composition and cardiometabolic factors in old people may be achieved by systematic exercise training in combination with nutrition counseling. This should be considered as an integral part of the health care system.
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1. Introduction

Intervention studies that include physical activity (PA) have decreased weight, visceral fat accumulation and are very effective in the prevention and treatment of cardiometabolic risk factors [1,2]. Exercise training has been shown to be effective in increasing high-density lipoprotein cholesterol (HDL), decreasing triglyceride (TG) levels and blood pressure (BP) [3]. These changes often take place independently of weight loss, but how much of the beneficial outcome is independent of weight loss and changes in body composition is not entirely clear [4].

The metabolic syndrome is characterized by numerous factors connected with cardiometabolic risk factors [5]. The syndrome is strongly linked to coronary heart disease, type 2 diabetes and, more generally, increased mortality [6]. Epidemiological studies have documented that the metabolic syndrome occurs commonly in middle-aged people and that there is a higher frequency in men and among older individuals [7]. The diagnosis and treatment of underlying risk factors for the metabolic syndrome should be an important strategy for the reduction of all-cause mortality associated with cardiometabolic risk factors in the general population [8].

Regular PA reduces the risk of cardiometabolic risk factors including high blood pressure, and diabetes [9]. Approximately 3.2 million people die each year due to physical inactivity but people who are insufficiently physically active have a 20–30% increased risk of all-cause mortality [9]. Moderate and vigorous physical activities are associated with positive changes in body composition and reduced risk of being classified with cardiometabolic risk factors, independently of age [10,11].

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The ultimate goal of public health research is to create and communicate scientific knowledge so the general population can make better choices about its food intake and lifestyle, so as to achieve and maintain good health throughout the life span [12]. The purpose of this study was to evaluate the effects of 6 months of exercise training and nutritional counseling on body composition and cardiometabolic risk factors in older people and a control group.

2. Methods

2.1. Study design

This study was a randomized trial, conducted in Reykjavik, Iceland. The trial was conducted in two 6-month intervention phases after enrollment with baseline assessments prior to the start of the study (time-point 1). Outcome assessments were performed at the end of the first intervention phase (time-point 2) and at the end of the second (delayed) intervention phase (time-point 3). Details about the study design have been described previously [13].

2.2. Study participants

The participants in this study were 117 individuals aged 71–90 years, 54 males and 63 females, drawn from the population-based Age, Gene/Environment Susceptibility – AGES Reykjavik Study [14]. Details about the characteristics of the participants have been described previously [13]. This study was approved by the National Bioethics Committee in Iceland (VSNb20080300114/03-1) and all participants gave written informed consent.

2.3. Intervention strategy

The intervention consisted of a 6-month exercise training program, with the emphasis on daily endurance training and strength training twice a week. This was supported by three short lectures on nutrition and four lectures on healthy aging, endurance and strength training. Physical activity has been defined as any bodily movement produced by skeletal muscles that results in energy expenditure, while exercise, a subset of physical activity, is physical activity that is planned, structured, repetitive and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective [15]. Lectures were held in the 1st, 4th, 12th and the 22nd week of the intervention phase. Each session was around 45 minutes.

The endurance training consisted of daily walking, which gradually increased from 20 minutes to 45 minutes during the intervention phase. The strength training took place twice a week and consisted of 12 exercises for all major muscle groups. For the first 3 months the focus was on strength endurance training and in the latter 3 months on strength power. A health instructor was on site once or twice a week for the endurance training but always on site for the strength training. The intervention has been described in detail previously [13].

Both groups were asked to fill out a 3-day food record at all time-points. All participants received detailed instructions on how to describe their food intake accurately according to household measurements and/or standard portion sizes. They were asked to record all foods and drinks consumed for three consecutive days, either from Thursday to Saturday or from Sunday to Tuesday. The three nutrition lectures during the exercise training-phase were based on information on dietary habits for this age group from the National Nutrition Survey in 2002 and food-based dietary recommendations from the Icelandic Public Health Institute [16]. Furthermore, Group 2 also received two short individual counseling interviews and two sessions of hands-on training in a kitchen during their 6-month exercise training session.

2.4. Nutrition counseling

Both groups were informed and provided with a referral letter from the practitioners of the study to attend counseling sessions about diet and nutrition. All participants received three motivational lectures on nutrition during the training-phase. The first lecture was about the importance of vegetable and fruit consumption, whole grain bread and other cereal rich in fiber, low-fat dairy products, cod-liver oil or other vitamin D supplements and water. The second lecture started with a revision of the first session, but mainly aimed at putting proper proportions and amounts of foods on the plate; fish, meat and another kind of meals were discussed, salt consumption, and use of oil and soft fat instead of hard fat were emphasized. The third and last nutrition lecture during the intervention phase started with a recap of the first two lectures, but also covered the importance of healthy bodyweight, the importance of eating healthily while on vacation and how the presentation of food influences eating behaviour. Lectures were held in the 4th, 12th and the 22nd week of the intervention phase. Group 2 also received two 10-minute individual nutrition counseling visits and two group sessions of hands-on training in a kitchen during their 6-month exercise training session. These sessions had the same focus as the aforementioned lectures.

2.5. Outcome measurements

Baseline measurements, demographic and clinical data were collected by trained research staff as previously described [13]. Whole-body composition was measured using Dual energy X-ray absorptiometry, GE Lunar, iDXA Software 11.40.004 from GE Healthcare, Madison, WI [17].

The definition of metabolic syndrome used was that provided by the National Cholesterol Education Program [18] and was comprised of elevated levels of waist circumference, BP, TG, plasma glucose (GLU), and low HDL. All these parameters were estimated using a standard protocol as previously described [14].

Total PA was assessed with Actigraph accelerometers (AG; Model 7164, version 2.2; ActiGraph Health Services, Fort Walton Beach, Florida, USA), which were programmed to record PA over one-minute intervals (60 s epoch). The accelerometers were worn on the hip for six consecutive days, four week days and two weekend days, from the time the participant woke up until he or she went to sleep. Only data from monitors worn a minimum of 8 hours per day, for at least two weekdays and one weekend day were included in the analysis. Average counts per minute (cpm) for these days measured by the accelerometer were calculated for each participant and were used to estimate PA level. Details about PA measured with ActiGraph accelerometers have been described previously [13].

Data from the dietary records were entered into ICEFOOD (program of the Icelandic Nutrition Council) for nutrient calculations, using the Icelandic nutrient database ISGEM which consists of 452 food codes. Nutrient losses due to food preparation were included in the calculations.

2.6. Statistical analysis

Comparisons of variables between groups at baseline were done using the *t*-test for continuous variables and the Chi^2 test for binary variables. Age- and sex-adjusted comparisons at baseline

Table 1
Unadjusted baseline characteristics of subjects randomized to Group 1 (immediate intervention) and Group 2 (delayed intervention).

	Group 1 (n = 56)	Group 2 (n = 61)	Between-group difference[†]	Between-group difference[‡]
	Males; n = 25, females; n = 31	Males; n = 29, females; n = 32		
Characteristic	Mean ± SD (range)	Mean ± SD (range)	P-value	P-value
Age	80.8 ± 4.7 (73–90)	78.3 ± 4.1 (71–88)	.003	
Height (cm)	165.5 ± 8.18 (149.0–185.0)	168.5 ± 8.0 (149.0–185.0)	.082	.204
Weight (kg)	75.9 ± 17.2 (49.4–157.0)	78.0 ± 12.3 (50.7–105.8)	.442	.796
BMI (kg/m^2)	27.6 ± 5.3 (20.6–45.9)	27.4 ± 3.4 (20.1–36.3)	.793	.406
Fat mass total (kg)	27.9 ± 11.6 (12.4–74.7)	28.3 ± 7.9 (6.5–49.1)	.865	.607
Fat mass of the trunk (kg)	15.4 ± 7.6 (4.5–49.8)	15.3 ± 4.8 (3.0–27.0)	.933	.365
Lean mass total (kg)	45.2 ± 8.0 (31.5–74.0)	47.1 ± 8.5 (32.8–62.9)	.269	.802
Waist circumference (cm)	91.3 ± 14.5 (68–153)	91.7 ± 12.1 (70–120)	.892	.420
SBP (mmHg)	158.9 ± 21.1 (110–218)	154.5 ± 25.5 (105–216)	.231	.254
DBP (mmHg)	78.6 ± 10.2 (57–112)	79.0 ± 10.3 (57–108)	.820	.783
HDL cholesterol (mmol/L)	1.60 ± 0.42 (0.82–2.62)	1.58 ± 0.47 (0.60–2.79)	.856	.675
TG (mmol/L)	1.09 ± 0.51 (0.49–2.86)	1.11 ± 0.59 (0.47–4.26)	.856	.803
Fasting glucose (mmol/L)	5.33 ± 0.67 (4.26–7.75)	5.39 ± 0.70 (4.26–7.75)	.620	.429
Energy intake (kJ/day)	7293 ± 1736 (3742–11,578)	7248 ± 1706 (3739–13,224)	.676	.426
Physical activity (cpm)	259 ± 123 (100–589)	254 ± 102 (106–537)	.694	.275
Hypertension medication (%)	62.5% (n = 35)	54.1% (n = 33)	.358	.554
Current smoker (%)	1.8% (n = 1)	3.3% (n = 2)	.615	.666

Values are shown as numbers in groups (n), means with standard deviation (SD), range and difference between groups with P-value. Values for hypertension medication and current smokers are shown as percentage (%) and number (n). SD: standard deviation; SBP: systolic blood pressure; DBP: diastolic blood pressure; HDL cholesterol: high-density lipoprotein; TG: triglycerides; BMI: body mass index.
[†] Without adjustment.
[‡] With adjustment for age and sex.

were made with ordinary least squares regression for continuous variables and logistic regression for binary variables. The difference in each variable at baseline and progression over time was analyzed using a repeated measures model with a first-order autoregressive covariance structure. A parameter was included in the model to represent each time-point for the immediate exercise training group (I), Group 1: μ_{I1}, μ_{I2}, μ_{I3}; and the delayed exercise training group (D), Group 2: μ_{D1}, μ_{D2}, μ_{D3}. An adjustment was made for age and sex. Adjusted means and contrasts between time-points were estimated from linear combinations of the model parameters and are shown in Tables 2 and 3.

Power calculation was conducted on the research. It was given that the mean effect-size was 0.25 SD from each point of every outcome variable with 80% power, where t-test (paired-means test) was used to measure the first against the second measurement. The sample size was estimated 100 (n = 100) at the end of the research. The participation was assumed to be 75% and the dropout about 20% because of the duration of the exercise-training intervention. The results were generated using the SAS MIXED model procedure in SAS/STAT software, version 9.2.

3. Results

3.1. Baseline and time-points

The results from the baseline measurements are shown in Table 1. Group 1 was two and a half years older on average. No statistically significant differences were observed between the groups for any of the cardiometabolic risk factors (Table 1). Table 2 shows cardiometabolic risk factors, body composition, energy intake, and PA at the three time-points after adjustments for age

Table 2
Values in means at three time-points in body composition, cardiometabolic risk factors, energy intake and physical activity for subjects in Group 1 and Group 2.

Outcome and values	Group 1			Group 2		
	(n = 56)	(n = 48)	(n = 45)	(n = 61)	(n = 58)	(n = 50)
	Time-point 1	Time-point 2	Time-point 3	Time-point 1	Time-point 2	Time-point 3
	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
Weight (kg)	77.2 (1.9)	75.9 (1.9)	75.7 (1.9)	76.5 (1.8)	76.0 (1.8)	74.5 (1.8)
BMI (kg/m^2)	27.7 (0.6)	27.3 (0.6)	27.3 (0.6)	27.0 (0.6)	26.9 (0.6)	26.4 (0.6)
Fat mass total (kg)	28.2 (1.3)	26.7 (1.3)	27.2 (1.3)	27.2 (1.3)	26.4 (1.3)	25.6 (1.3)
Fat mass of the trunk (kg)	15.7 (0.8)	14.7 (0.8)	14.9 (0.8)	14.6 (0.8)	14.0 (0.8)	13.6 (0.8)
Lean mass total (kg)	46.3 (0.7)	46.7 (0.7)	46.2 (0.7)	46.5 (0.7)	46.8 (0.7)	46.6 (0.7)
Waist circumference (cm)	92.6 (1.5)	86.1 (1.5)	87.2 (1.5)	90.8 (1.5)	86.6 (1.5)	83.7 (1.5)
SBP (mmHg)	158.7 (2.7)	153.3 (2.8)	147.1 (2.9)	154.3 (2.6)	147.9 (2.7)	139.3 (2.8)
DBP (mmHg)	78.8 (1.2)	76.3 (1.3)	73.9 (1.3)	78.4 (1.2)	77.9 (1.2)	73.2 (1.3)
HDL cholesterol (mmol/L)	1.57 (0.1)	1.62 (0.1)	1.68 (0.1)	1.60 (0.1)	1.69 (0.1)	1.70 (0.1)
TG (mmol/L)	1.08 (0.1)	1.02 (0.1)	1.06 (0.1)	1.11 (0.1)	1.17 (0.1)	1.03 (0.1)
Fasting glucose (mmol/L)	5.32 (0.1)	5.42 (0.1)	5.42 (0.1)	5.42 (0.1)	5.60 (0.1)	5.62 (0.1)
Energy intake (kJ/day)	7390 (212)	8105 (226)	7565 (240)	7144 (219)	6988 (220)	7379 (236)
Physical activity (cpm)	272.9 (16.9)	307.1 (15.7)	277.1 (16.4)	247.0 (16.1)	211.7 (15.0)	337.6 (16.0)

Values are shown as means with standard error (SE) at three time-points: baseline (time-point 1), after training-phase by Group 1 and control-phase by Group 2 (time-point 2), and after follow-up by Group 2 and delayed training-phase by Group 2 (time-point 3). The results are presented with an adjustment for age and sex. SE: standard error; SBP: systolic blood pressure; DBP: diastolic blood pressure; HDL cholesterol: high-density lipoprotein; TG: triglycerides; BMI: body mass index.

Table 3
Mean changes between time-points 1 and 2 and between time-points 2 to 3 in body composition, cardiometabolic risk factors, energy intake and physical activity for subjects in Group 1 and Group 2.

Outcome and values	Group 1 (n = 48)	Group 1 (n = 45)	Group 2 (n = 58)	Group 2 (n = 50)
	Change from time-point 1 to 2	Change from time-point 2 to 3	Change from time-point 1 to 2	Change from time-point 2 to 3
	Difference in means (95% CI)	Difference in means (95% CI)	Difference in means (95% CI)	Difference in means (95% CI)
Weight (kg)	−1.32 (−1.88 to −0.77)***	−0.20 (−0.77 to 0.38)	−0.55 (−1.05 to 0.04)*	−1.51 (−2.06 to −0.97)***
BMI (kg/m^2)	−0.46 (−0.68 to −0.25)***	0.00 (−0.22 to 0.22)	−0.17 (−0.36 to 0.02)	−0.46 (−0.67 to −0.25)***
Fat mass total (kg)	−1.48 (−1.94 to −1.03)***	0.49 (0.00 to 0.95)*	−0.88 (−1.29 to −0.48)***	−0.73 (−1.16 to −0.30)***
Fat mass of the trunk (kg)	−1.02 (−1.35 to −0.69)***	0.22 (−0.12 to 0.55)	−0.62 (−0.92 to −0.32)***	−0.41 (−0.73 to −0.09)*
Lean mass total (kg)	0.40 (0.04 to 0.77)*	−0.43 (−0.80 to −0.06)*	0.27 (−0.06 to 0.60)	−0.13 (−0.48 to 0.22)
Waist circumference (cm)	−6.45 (−7.45 to −5.45)***	1.08 (0.05 to 2.11)*	−4.25 (−5.16 to −3.35)***	−2.92 (−3.89 to −1.95)***
SBP (mmHg)	−5.33 (−9.71 to −0.94)*	−6.24 (−10.77 to −1.70)**	−6.41 (−10.46 to −2.36)**	−8.61 (−12.90 to −4.33)***
DBP (mmHg)	−2.58 (−4.82 to −0.33)*	−2.38 (−4.70 to −0.06)*	−0.46 (−2.52 to 1.60)	−4.74 (−6.93 to −2.55)***
HDL cholesterol (mmol/L)	0.05 (−0.01 to 0.11)	0.07 (0.00 to 0.13)*	0.08 (0.03 to 0.14)**	0.01 (−0.05 to 0.07)
TG (mmol/L)	−0.07 (−0.16 to 0.03)	0.04 (−0. 50 to 0.14)	0.06 (0.02 to 0.14)	−0.14 (−0.22 to 0.05)**
Fasting glucose (mmol/L)	0.10 (0.01 to 0.22)	0.00 (−0.11 to 0.12)	0.18 (0.08 to 0.29)***	0.01 (−0.10 to 0.12)
Energy intake (kJ/day)	714 (260 to 1168)**	−539 (−1020 to −58)*	−156 (−594 to 282)	391 (−68 to 850)
Physical activity (cpm)	34.2 (0.8 to 67.6)*	−30.1 (−60.7 to 0.6)	−35.2 (−66.2 to −4.3)*	125.9 (96.0 to 155.8)***

Values are shown as mean changes (95% CI) between time-point 1 and time-point 2, and between time-point 2 and time-point 3 in Group 1 and Group 2. The results are presented with an adjustment for age and sex.
Significant differences in change between time-points; * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.
MTI: multimodal training intervention; SBP: systolic blood pressure; DBP: diastolic blood pressure; HDL cholesterol: high-density lipoprotein; TG: triglycerides; BMI: body mass index.

and sex, and Table 3 shows changes between time-points 1 and 2 and between time-points 2 to 3.

3.2. Cardiometabolic risk factors

Mean changes between time-points 1 and time-point 2 can be seen in Table 3. After the immediate exercise training-phase, Group 1 decreased their waist circumference (−6.45 cm; $P < 0.001$), systolic blood pressure (SBP) (−5.33 mmHg; $P = 0.017$) and diastolic blood pressure (DBP) (−2.58 mmHg; $P = 0.025$). Group 2, after their control-phase decreased their waist circumference (−4.25 cm; $P < 0.001$), SBP (−6.41 mmHg; $P = 0.002$), but increased HDL (0.08 mmol/L; $P = 0.003$) and GLU (0.18 mmHg; $P < 0.001$) (Table 3).

At time-point 3, Group 1 had increased waist circumference (1.08 cm; $P = 0.040$); SBP and DBP had decreased further (−6.24 mmHg; $P = 0.007$; −2.38 mmHg; $P = 0.045$ respectively), and HDL had risen (0.07 mmol/L; $P = 0.037$). Group 2, in the delayed exercise training-phase, saw decreased waist circumference (−2.92 cm; $P < 0.001$), SBP (−8.61 mmHg; $P < 0.001$), and both lower DBP (−4.74 mmHg; $P < 0.001$) and TG (−0.14 mmol/L; $P = 0.003$) (Table 3).

3.3. Body composition

Group 1 experienced decreased weight (−1.32 kg; $P < 0.001$), BMI (−0.46 kg/m^2; $P < 0.001$), total fat mass (−1.48 kg; $P < 0.001$), fat mass of the trunk (−1.02 kg; $P < 0.001$) and increased total lean mass (0.40 kg; $P = 0.031$). In Group 2's control-phase, weight decreased (−0.55 kg; $P = 0.034$), as well as total fat mass (−0.88 kg; $P < 0.001$), and fat mass of the trunk (−0.62 kg; $P < 0.001$) (Table 3).

Between time-points 2 and 3, Group 1 saw increased total fat mass (0.49 kg; $P = 0.035$) and decreased total lean mass (−0.43 kg; $P = 0.024$). Group 2, between the same time-points, while in the delayed exercise training-phase saw decreased weight (−1.5 kg; $P < 0.001$), BMI (−0.46 kg/m^2; $P < 0.001$), and both less total fat mass (−0.73 kg; $P = 0.001$) and fat mass of the trunk (−0.41 kg; $P = 0.011$) (Table 3).

3.4. Physical activity and energy intake

For Group 1 in the exercise training-phase, both PA and energy intake increased (34.2 cpm; $P = 0.045$; 714.5 kJ/day; $P = 0.002$). In contrast, Group 2, in control phase saw decreased PA (−35.2 cpm; $P = 0.026$) while energy intake remained unchanged (−155.6 kJ/day; $P = 0.484$) (Table 3).

In Group 1 PA decreased (−30.1 cpm; $P = 0.054$) and energy intake fell (−539.2 kJ/day; $P = 0.028$) in the six-month follow-up phase, but Group 2, in the delayed exercise training-phase, increased PA (125.9 cpm; $P < 0.001$) and had a trend towards increased energy intake (390.9 kJ/day; $P = 0.094$) (Table 3).

3.5. Profiles of change for body composition

The profiles of change for the groups for body composition factors from time-point 1 to time-point 2 were not parallel for weight ($P = 0.043$), but parallel for total fat mass ($P = 0.053$) and total lean mass ($P = 0.529$). From time-point 2 to time-point 3 the profiles of change were not parallel for weight ($P = 0.001$) and total fat mass ($P < 0.001$), but parallel for total lean mass ($P = 0.247$) (Fig. 1A–C).

4. Discussion

This study demonstrates that beneficial health effects can be obtained with regular exercise training and nutritional counseling intervention among elderly people. The main finding was a reduction in waist circumference, BMI and fat mass in both groups. The reduction was more apparent among those involved in active exercise training and nutritional counseling, which increased

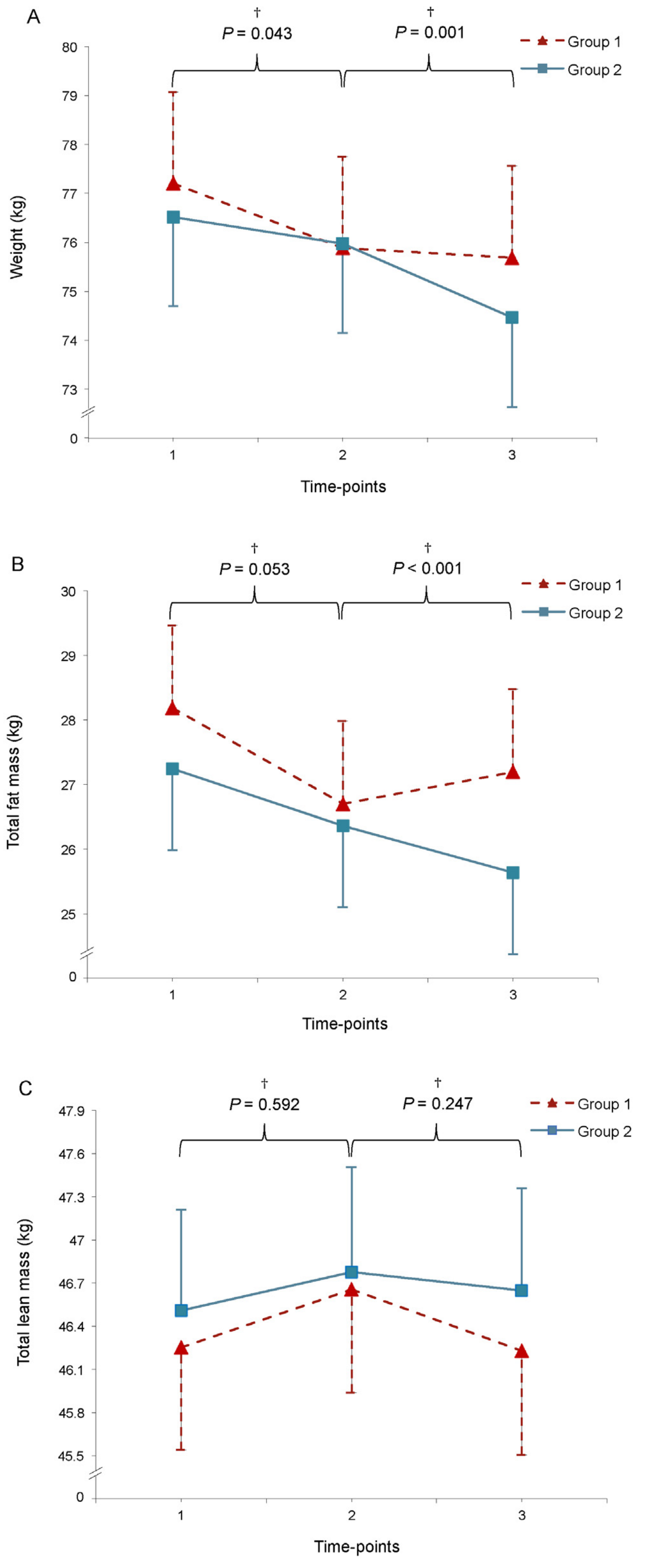

Fig. 1. A–C. Outcome measures from test of parallel profiles (†) between Group 1 and Group 2 in weight (A), total fat mass (B) and total lean mass (C) at three time-points: at baseline (1); after 6-month intervention by Group 1 and control phase by Group 2 (2), and after crossover phase by Group 1 and delayed intervention phase by Group 2 (3).

energy intake by 10%, whereas a 2% reduction was observed in the control group. An increase was seen in fat-free mass in Group 1 after the 6-month exercise training but went back to baseline after the 6-month follow-up. No change was seen in metabolic factors, except for TG. SBP was high in both groups but improved steadily constantly over the period of the study.

Weight reduction has been the main goal of most intervention studies of individuals with cardiometabolic risk factors [19], because it most likely activates one or more underlying mechanisms that lead to improvement and positive changes in these risk factors [19–21]. Increased weight and obesity are directly linked to high blood pressure, increased cholesterol and TG, lower HDL and their consequences such as heart disease and stroke. Waist circumference also provides a unique indicator of body fat distribution, which can identify individuals who are at increased risk for obesity related cardiometabolic risk factors, above and beyond the measurement of BMI [22]. In addition, waist circumference monitors the response to diet alone or diet and exercise together [22].

There is a possibility that the loss of weight after the age of 65 is truly attributable to the aging process [23], but the most noticeable and clinically relevant changes occurring with aging is the loss of muscle mass, with the accompanied increase in the proportion of body fat. These changes can have negative consequences for maintaining resting metabolic rate and metabolic resiliency as well as for maintaining reaction time, strength, flexibility, and balance for maintaining an active and independent lifestyle in older age. Therefore, our main focus in the design of the exercise training intervention was to challenge these aging changes without the attention to weight loss in general. An interesting result can be seen in a previously published paper [13] regarding physical performance, strength and endurance, but another important functional change accompanying older age is the loss of cardiovascular plasticity resulting in a decline in maximal heart rate, stroke volume, cardiac output, and arteriovenous oxygen difference [24]. But in our results, we can also see positive changes in the BP as in the fat-free mass by Group 1 or maintaining the fat-free mass by Group 2 after a 6-month exercise training intervention. In the follow-up time by Group 1, we can see the negative decline in the fat-free mass and increase in the fat mass. These changes serve as a reminder of how important it is for this age group to have easy access to fitness programs and professional assistance through the aging period.

As most intervention studies [20], we found reduced weight, BMI, and waist circumference in Group 1 after a 6-month exercise training intervention. In addition, total fat mass decreased by 5.3% and fat mass of the trunk by 6.4% in Group 1 after the intervention, confirming that regular exercise training and nutritional counseling education can reduce weight and visceral fat accumulation [1] and may therefore influence cardiometabolic risk factors [3,4]. Furthermore, Group 1 had a 0.86% increase in total lean mass at time-point 2. That finding demonstrates that older adults have the capacity to increase muscle strength [13] and muscle mass. Such an increase could further enable them to participate in exercise training, which can lead to improvements in the metabolic profile [25,26] as well as improvements in physical, functional, and endurance performance [13].

In both groups, DBP baseline values were normal (as defined in guidelines [7]), while SBP values were elevated. Regular physical activity is said to be a cornerstone of prevention and management of hypertension [27] supported by this study by the decreased BP after the 6-month intervention (time-point 2) in Group 1. Furthermore, Appel et al. [28] showed that a diet rich in fruits, vegetables, low-fat dairy foods and food with reduced saturated and total fat can substantially lower blood pressure. The main goal in our diet recommendations through the intervention was a combination diet rich in fruits, vegetables, and low-fat dairy foods with reduced amounts of saturated fat and total fat.

Interestingly, SBP also decreased in Group 2 (control group) during the first 6 months. The most likely explanation for this decrease in Group 2 is the reduction in body mass and body fat observed in this group as well. The relation between SBP and increased weight and adiposity is well documented [29]. The decreased body mass and body fat in Group 2 could be a result of aging process in such elderly population as well as due to the reduced energy intake during these 6 months. Despite being non-significant, a decline in energy intake of 156 kJ/day (n.s.) may add up to 28,392 kJ over 26 weeks, which corresponds to the fat mass loss observed in this group [30]. In addition, it is possible that the 3-day dietary record taken during baseline measures was sufficient to motivate Group 2 and influence their dietary habits from time-point 1 to time-point 2 as it is known that habitual eating patterns may be influenced or changed by the recording process [31].

From time-point 2 to time-point 3, during which Group 2 received intervention, all the same beneficial effects of the intervention observed in Group 1 at time-point 2 were witnessed in Group 2. At the same time, Group 1 remained unchanged or regressed to baseline values on all variables except BP, which continued to decrease. However, during this period (time-point 2 to time-point 3), Group 1 maintained their strength and aerobic fitness [13], which are recognized to influence BP in a favorable manner [3]. It is also possible that the treatment effects of the hypertensive medications were enhanced by increased exercise training and/or better diet during the intervention and even beyond the intervention period.

The baseline values for the HDL, TG and GLU in our study were normal according to guidelines [7]. Therefore, they were not expected to change much over the course of the study. Although small statistical changes were observed, they are probably not clinically meaningful. More favorable changes in response to exercise training or diet usually occur in people with higher TG's or other blood lipids at baseline [32,33].

It seems that the Icelandic older males are more willing to participate in research like this than males from other countries. An explanation for this increased participation by the males can be attributed to the selection into the study. The spouse was also invited to participate in the study and 25 spouses wished to join the study. This method was used to increase the participation and minimize the dropout. This can also explain the small age difference between the groups after the randomization at baseline. Also, we experienced about 24% dropout during the study, not an unusual dropout rate given age and type of study; another Icelandic resistance exercise study [34] had a 9% dropout rate in a 12-week program compared to 26 weeks in our study.

In a recent paper [35] on the same topic of nutrition counseling and physical exercise, no effect was seen on energy intake or fat-free mass in community-dwelling frail elderly people. In our results we see changes in both lean mass and energy intake for Group 1 after their immediate 6-month exercise training. The reason for the difference may lie in the different health status of the participant, but also in a longer exercise training periods in our design, and higher and/or more accurate frequency, duration and intensity of our training. This is important for achieving one or more type of health outcome from an exercise training intervention for this age group [20].

This study had several limitations. First of all, it is not possible to estimate if the changes resulted from the endurance and resistance exercise training, dietary habits, or both of these elements over the intervention period. Secondly, age-related changes over time could have influenced the biological processes during the control period more rapidly than is normally observed among younger cohorts. Finally, because the study subjects were healthy old people, it may not be possible to generalize and to apply the present findings to older men and women with health problems.

5. Conclusion

Our findings suggest that improvements in body composition in old people may be improved by systematic exercise training in combination with nutrition counseling. Increased muscle strength and change in total lean mass affect metabolic profile in old adults. Regular exercise training in combination with nutrition counseling should be considered to be an integral part of the health care system.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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