Journal of Aging and Physical Activity, 2012, 20, 198-214

Effects of Exercise on Health-Related Quality of Life and Fear of Falling in Home-Dwelling Older Women

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This randomized, controlled trial evaluated the effects of exercise on health-related quality of life (HRQoL) and fear of falling (FoF) among 149 home-dwelling older women. The 12-mo exercise program was intended to reduce the risk of falls and fractures. HRQoL was assessed by the RAND-36 Survey, and FoF, with a visual analog scale, at baseline, 12 mo, and 24 mo. On all RAND-36 scales, the scores indicated better health and well-being. The exercise had hardly any effect on HRQoL; only the general health score improved slightly compared with controls at 12 mo ($p = .019$), but this gain was lost at 24 mo. FoF decreased in both groups during the intervention with no between-groups difference at 12 or 24 mo. In conclusion, despite beneficial physiological changes, the exercise intervention showed rather limited effects on HRQoL and FoF among relatively high-functioning older women. This modest result may be partly because of insufficient responsiveness of the assessment instruments used.

Keywords: HRQoL, aged, exercise intervention, well-being

A number of observational studies have reported beneficial associations between exercise and well-being in both younger and older adults; more active older people feel better than their sedentary age-mates (e.g., Netz, Wu, Becker, & Tenenbaum, 2005; Wolin, Glynn, Colditz, Lee, & Kawachi, 2007). Regular exercise seems to be associated with enhanced global satisfaction, improved mood, and bodily or emotional well-being in late-middle-aged and older adults; objectively measured improvement in fitness is not necessitated (Netz et al., 2005; Rejeski & Mihalko, 2001). Several studies also suggest that a perceived improvement in functioning or well-being may reinforce the adoption of regular exercise and serve as a personal incentive to continued activity (McAuley, Elavsky, Jerome, Konopack, & Marquez, 2005; Rejeski & Mihalko, 2001).

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Fall-related injuries are a growing global problem among older people, often resulting in pain, functional limitations, impaired quality of life, extra health care costs, and excess mortality (Kannus, Sievanen, Palvanen, Jarvinen, & Parkkari, 2005). In the broad field of fall-prevention interventions, regular exercise seems promising because, in addition to preventing falls, it maintains physical functioning, mobility, and health (Chodzko-Zajko et al., 2009; Gillespie et al., 2009; Karinkanta, Piirtola, Sievänen, Uusi-Rasi, & Kannus, 2010; Liu & Latham, 2009). It is also thought that exercise is conducive to older adults' independence, social activity, and mood (Chodzko-Zajko et al., 2009).

In exercise-intervention studies, assessment of the spectrum of subjective experience rather than the level of global life satisfaction is warranted. One commonly used approach has been to assess health-related quality of life (HRQoL). Self-rated HRQoL encompasses subjective experience of one's body and emotions, as well as perception of functioning. The core of the concept is not the objective level of functioning or health status but the individual's perception and appraisal of them (Fayers & Machin, 2007; Halvorsrud & Kalfoss, 2007; Hays & Morales, 2001).

A favorable HRQoL response to exercise interventions has been observed in many clinical and healthy adult samples (Gillison, Skevington, Sato, Standage, & Evangelidou, 2009). However, evidence among older adults is inconsistent. In single randomized controlled trials (RCTs) both positive response and no response have been found among healthy or medically stable older adults (Cress et al., 1999; de Vreede et al., 2007; Martin, Church, Thompson, Earnest, & Blair, 2009; Okamoto, Nakatani, Morita, Saeki, & Kurumatani, 2007) and clinical older samples (Grahn Kronhed, Hallberg, Ödkvist, & Möller, 2009; Liu-Ambrose et al., 2005; Teixeira et al., 2010). Two meta-analyses of RCTs with physical activity interventions also indicate heterogeneity in the HRQoL outcomes. Li, Chen, Yang, and Tsauo (2009) found improvements in scores for pain, energy, physical function, and role limitations caused by physical problems in four RCTs of older women with osteoporosis and osteopenia. However, Kelley, Kelley, Hootman, and Jones (2009) observed only a modest increment in physical-functioning score in a meta-analysis of 11 RCTs in community-dwelling older subjects.

Several exercise programs and HRQoL instruments have been applied in exercise-intervention studies. The importance of physical functioning is self-evident for purposes of falls prevention, but aspects of well-being such as positive mood or freedom from pain should also be considered. Increased fear of falling has been associated with decreased HRQoL (Chang, Chi, Yang, & Chou, 2010; Scheffer, Schuurmans, van Dijk, van der Hooft, & de Rooij, 2008). Furthermore, fear of falling may propel an older person into a vicious cycle of loss of confidence, restricted activity, impaired mood, impaired physical functioning, falls, and loss of independence. Exercise seems to be a promising intervention to reduce fear of falling and break the cycle because it may directly prevent the decline in physical functioning and mobility. However, few studies have assessed the effects of exercise on fear of falling; some beneficial results of Tai Chi training have been obtained (Zijlstra et al., 2007).

We recently completed a 1-year exercise RCT among relatively healthy, home-dwelling older women. The intervention reduced risk factors of falling and related fractures by preventing functional decline and bone fragility (Karinkanta et al., 2009; Karinkanta et al., 2007). In the current study we evaluated effects of the intervention on HRQoL and fear of falling.

Methods

Design and Participants

The study was a 12-month exercise RCT followed by a subsequent 1-year follow-up. The exercise intervention was intended to affect risk factors for falls and related fractures. The primary outcomes have been reported earlier (Karinkanta et al., 2009; Karinkanta et al., 2007). In this study, the secondary outcomes, HRQoL and fear of falling, are reported.

All assessments were done at baseline, after the intervention (12 months), and at follow-up (24 months) at the UKK Institute (Tampere, Finland) between 2002 and 2004.

The trial profile is presented in Figure 1. An invitation letter and a prescreening questionnaire were mailed to a random population sample (N = 4,032) of 70- to 79-year-old women living in the city of Tampere, Finland. Of the 858 women who expressed initial interest, 241 were eligible and invited to attend a screening examination; 149 of them met the inclusion criteria.

Besides age, the inclusion criteria were willingness to participate, full understanding of the study procedures, no history of any illness contraindicating exercise or limiting participation in the exercise program or of illness affecting balance or bone, no uncorrected vision problems, and taking no medications known to affect balance or bone metabolism (within 12 months before the enrollment). A subject was excluded if she did high-intensity exercises more than twice a week or if her femoral-neck T score was lower than –2.5 (i.e., indicating osteoporosis and requiring medical attention).

The baseline characteristics of the participants have been reported earlier (Karinkanta et al., 2007) and are also given in Table 1. Briefly, participants were relatively healthy, medically stable older women living independently at home. Their mean (*SD*) age was 72.7 (2.3) years. About half the women reported no or some exercise weekly; the other half reported brisk exercise once or twice a week.

Participants were randomly assigned to three exercise-training groups (a resistance-training group, a balance-jumping group, or a combination group doing resistance and balance-jumping training) and a nontraining control group (CON, n = 37; computer-generated randomization list, simple randomization with random allocation sequence to ensure equal group sizes; Karinkanta et al., 2007). For the current analysis the exercise groups were pooled (EX, n = 112) to increase statistical power. It is known from the literature that the exercise dose rather than its type influences HRQoL and well-being (Gillison et al., 2009; Martin et al., 2009; Netz et al., 2005).

The study was approved by the ethics committee of the Pirkanmaa Hospital District. All participants gave their written informed consent before the study.

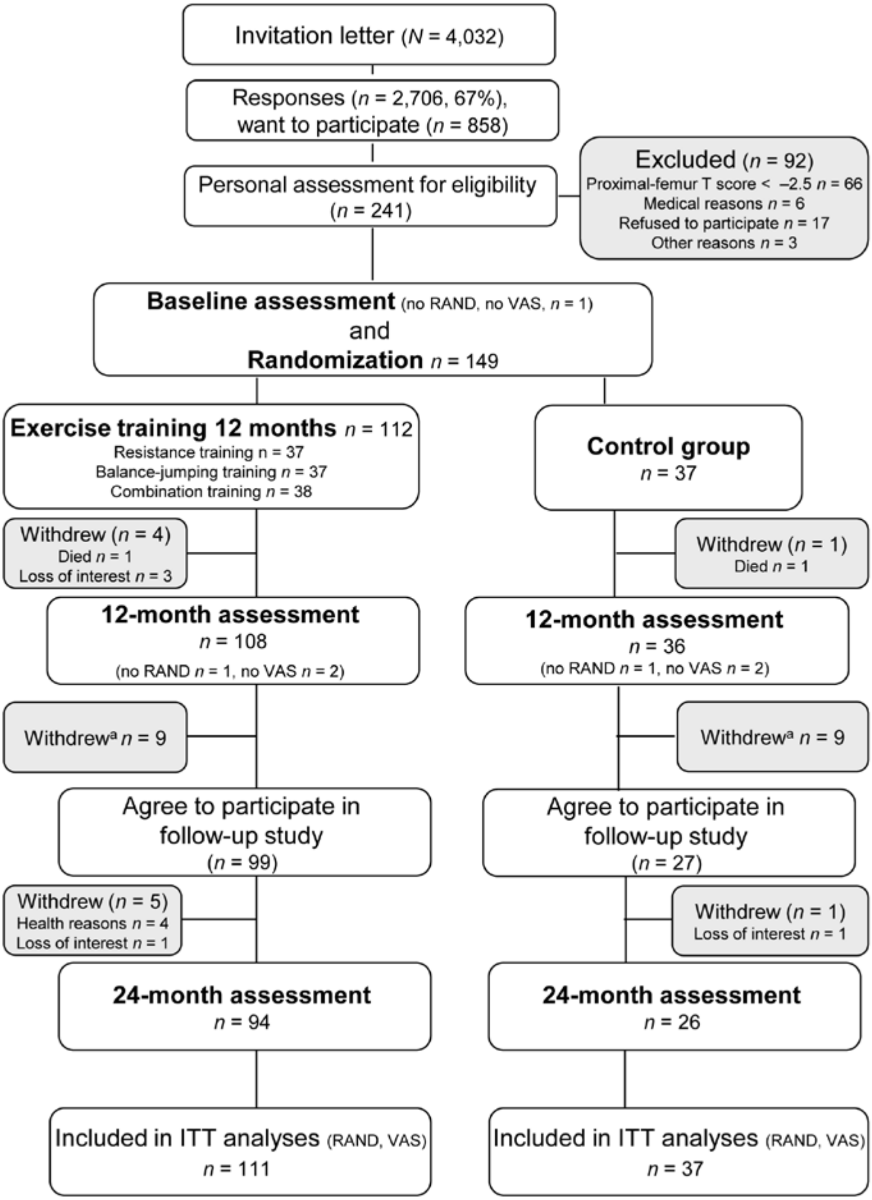


Figure 1 — Trial profile. RAND = RAND-36 Survey; VAS = visual analogue scale; ITT = intention to treat. [a]Participants were asked if they would be interested in continuing the study, including a monthly questionnaire on physical activity, health, and falls and participation in the 24-month assessment.

Table 1 Baseline Characteristics of the Participants

Characteristic	Exercise group, *n* = 112	Control group, *n* = 37
Age, years, *M* (*SD*)	72.8 (2.3)	72.0 (2.2)
Body-mass index, kg/m^2, *M* (*SD*)	28.1 (3.8)	29.6 (3.7)
Physical activity/week, *n* (%)		
none or some	50 (45)	17 (46)
brisk exercise 1×	25 (22)	9 (24)
brisk exercise 2×	37 (33)	11 (30)
Walking/day,[a] *n* (%)		
less than 1 km	6 (5)	4 (11)
1–3 km	72 (65)	24 (65)
4–6 km	26 (23)	8 (22)
over 6 km	7 (6)	1 (3)
Self-rated general health,[b] *n* (%)		
very good	4 (4)	2 (5)
good	49 (45)	13 (35)
fair	56 (51)	21 (57)
poor	1 (1)	1 (3)
very poor	0	0
Continuing medication by doctor, *n* (%)	60 (54)	23 (62)

[a]*n* = 148; [b]*n* = 147.

Training Programs

The supervised training programs have been described elsewhere (Karinkanta et al., 2007). Briefly, training intensity was moderate to high, and the assigned training frequency was three weekly sessions of 45 min for 12 months. All programs were progressive. The resistance training consisted of exercises for large muscle groups with increasing intensity from 50–60% of one-repetition maximum (1RM) to 75–80% of 1RM. The balance-jumping training comprised modified aerobics and step aerobics including a variety of balance, agility, and impact exercises. The degree of difficulty of movements, steps, impacts, and jumps was gradually increased. The combination training program consisted of resistance and balance-jumping training in alternating weeks. All classes took place in a downtown fitness center easily accessible by public transportation. Participants in CON were asked to maintain their prestudy level of physical activity during the 12-month trial.

Instruments and Assessments

HRQoL was assessed by means of the standard Finnish version (Aalto, Aro, & Teperi, 1999) of the RAND-36 Health Survey, which is the parallel survey of the SF-36 (Hays & Morales, 2001; Hays, Sherbourne, & Mazel, 1993). These surveys are widely used in different settings including exercise interventions (de Vreede et al., 2007; Kelley et al., 2009; Martin et al., 2009; Teixeira et al., 2010). Their psychometric properties in late-middle-aged and older adults have been found to be quite good compared with other generic HRQoL instruments (Halvorsrud & Kalfoss, 2007)

The RAND-36 consists of eight scales, each comprising 2–10 questions. The scales represent separate but conceptually related aspects of HRQoL; the overall level of subjective HRQoL is portrayed by the scale's score profile. The scales of physical functioning and physical role functioning reflect the respondent's self-rated capability in activities of daily living and mobility. The other scales cover emotional well-being, energy and vitality, bodily pain, general health, and limitations in role functions and interaction (social functioning, emotional role functioning). The item responses were scored, and the scale values, 0–100 for each scale, were calculated according to standard procedure (Aalto et al., 1999).

To ensure adequacy of RAND-36 scores, we scrutinized the psychometric properties of the scales at each measurement and compared them with those of the Finnish standardization study (Aalto et al., 1999; Fayers & Machin, 2007). The scale scores were compared with the population reference values and the values of the female age-equivalent samples of that study. Conceptual stability of the three measurements (McHorney, 1996) was assessed by principal-component analyses with orthogonal and oblique rotations (Nupponen & Karinkanta, 2009).

Fear of falling was assessed by a visual analog scale (VAS), that is, a horizontal 100-mm-long line connecting the statements *No fear at all* (0) on the left and *Very great fear* (100) on the right. The participant was asked to indicate her overall fear of falling during daily life by drawing a mark on this line. The fear-of-falling score was the number of millimeters between *no fear at all* and the subject's mark.

The participants filled in the RAND-36 and VAS questionnaires at home and returned them when taking the physical-performance tests. During this visit they were asked to verify the completeness of the answers.

Statistical Analyses

The results were based on intention-to-treat analyses of all available participants. In addition, efficacy analyses for the exercise were done by including only participants whose average training frequency was twice a week or more during the intervention.

Based on the preliminary analyses concerning psychometric properties of the RAND-36, four variables (physical functioning, emotional well-being, energy and vitality, and general health) were used as continuous variables. The other four variables with limited dispersion and accumulation at the high end of the scale (physical role functioning, emotional role functioning, social functioning, and bodily pain) were considered dichotomous: ceiling effect (score = 100) and no ceiling effect (score < 100). For the continuous variables, linear mixed models with restricted maximum likelihood estimation were used to assess the effects of the exercise intervention at 12 months and 24 months. For the dichotomous variables, generalized estimating equations were used. These statistical models for repeated measures allow incorporation of incomplete longitudinal data in the analyses. Post hoc between-groups comparisons were performed using Sidak's adjustment for multiple comparisons. Because of the skewed distribution of the fear-of-falling variable, original values were transformed for logit scores—$\log\{(\text{VAS})/(100 - \text{VAS})\}$, 0 = 0.1, 100 = 99.9—which were used in the linear mixed-model analysis (Fayers & Machin, 2007; Senn, 1993). All analyses were age-adjusted.

All comparisons of change were made between the pooled EX group (n = 112) and the CON group (n = 37). Pooling was deemed to be justified because no between-groups differences were indicated in the separate analyses of the three exercise groups (data not shown). Prestudy power analysis for estimating the required sample size was based on the primary outcomes of the study (Karinkanta et al., 2007). SPSS 17.0 version was used and a significance level of .05 was maintained for all analyses.

Results

Adherence

The feasibility and safety of the exercise program have been reported elsewhere (Karinkanta et al., 2007). Briefly, mean training compliance, measured as attendance at all training sessions, was 67% (range 0–100%), and 76 women (68%) trained on average twice a week a more. The rates of dropout and missing data were low during the intervention (12 months) and acceptable during the follow-up (24 months; Figure 1). There were no differences in the numbers of monthly reported health problems between EX and CON (p = .955; Karinkanta et al., 2007).

There were proportionally more dropouts in CON than in EX at 24 months (28% vs. 13%; Figure 1). Controls who failed to complete the 24-month assessment were slightly older and heavier, and, compared with the attendees, many of them showed a decline in self-rated physical functioning during the first year. No corresponding selection was seen in EX. However, training compliance was somewhat better among the trainees who attended the follow-up than among those who did not (Karinkanta et al., 2009).

HRQoL Level and Measurement Properties of the Scales

The rates of complete responses were high for all RAND-36 scales (Table 2). The RAND-36 item distributions accumulated at the favorable end of the response scale, indicating healthier or more satisfactory values. Consequently, the score distributions were strongly skewed; general health scores were the only exception. Compared with the age-matched women's reference data (Aalto et al., 1999), mean values were higher and variances smaller in the current study. The means, medians, and standard deviations of the scale scores are given in Table 2.

Homogeneity, convergence, and discriminatory power of the scales were somewhat impaired by the heavy accumulation of responses at one end of the scale. In this study, the alphas were around .80 (Table 2), slightly lower than in the Finnish reference study (.80–.94). The proportions of the highest scores (ceiling effect) for bodily pain, physical role functioning, emotional role functioning, and social functioning (Table 2) were larger than those in the population sample of 65- to 79 year-olds (Aalto et al., 1999). Principal-component analyses revealed two uncorrelated components (energy and vitality, physical capability) with almost equal proportions of explained variance and nearly identical item loadings and communalities at the three measurements; total percentages explained were 36–40% (Nupponen & Karinkanta, 2009).

Table 2 Descriptive Data on Participants' Health-Related Quality of Life and Fear of Falling

Scale	*n*	*M*	*SD*	Range	Median	Ceiling effect,[a] %	Complete responses, %	Cronbach's α
RAND-36 Subscale								
Physical functioning								
baseline	148	82.7	13.0	40–100	85	9.5	97.3	.76
12 months	142	84.0	13.6	25–100	85	14.1	99.3	.80
24 months	120	81.1	16.7	10–100	85	11.7	96.6	.86
Physical role functioning								
baseline	148	83.6	27.6	0–100	100	65.5	100.0	.75
12 months	142	80.8	31.2	0–100	100	64.1	100.0	.81
24 months	120	74.4	34.5	0–100	100	55.0	99.2	.81
Emotional role functioning								
baseline	148	76.8	33.4	0–100	100	60.1	100.0	.71
12 months	142	83.1	28.8	0–100	100	67.6	100.0	.66
24 months	120	75.6	34.5	0–100	100	52.5	99.2	.54
Energy and vitality								
baseline	148	73.5	17.0	30–100	75	6.8	100.0	.79
12 months	142	73.6	17.3	25–100	75	6.3	100.0	.83
24 months	120	70.4	18.5	15–100	75	4.2	99.2	.79
Emotional well-being								
baseline	148	83.1	14.5	40–100	88	10.1	100.0	.82
12 months	142	83.3	13.7	36–100	88	11.3	100.0	.79
24 months	120	80.8	16.4	32–100	84	10.8	98.3	.81

(continued)

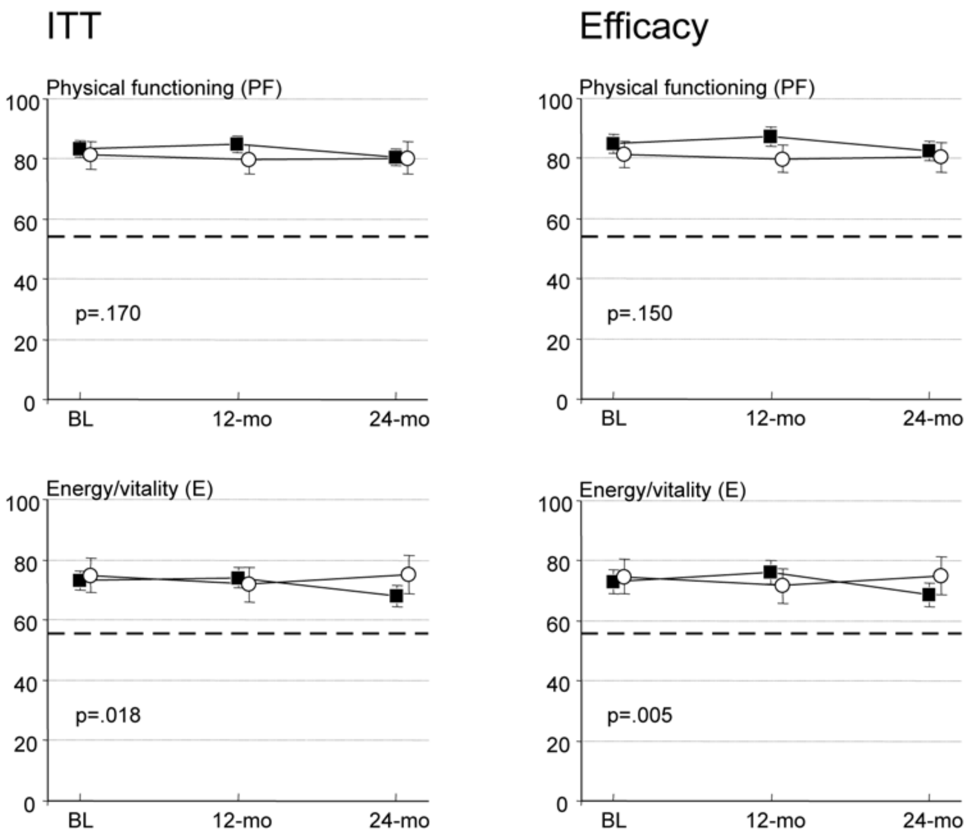
Table 2 ***(continued)***

Scale	*n*	*M*	*SD*	Range	Median	Ceiling effect,[a] %	Complete responses, %	Cronbach's α
Social functioning								
baseline	148	92.7	13.5	50–100	100	72.3	100.0	.74
12 months	141[b]	93.2	14.0	12.5–100	100	73.8	99.3	.70
24 months	120	88.8	18.7	12.5–100	100	65.0	100.0	.91
Pain								
baseline	148	80.9	17.6	10–100	80	27.0	100.0	.77
12 months	142	80.3	19.9	22.5–100	90	31.7	100.0	.84
24 months	120	78.9	20.5	10–100	80	30.0	100.0	.85
General health								
baseline	148	65.3	14.4	25–95	65	0.0	100.0	.60
12 months	142	67.4	14.9	25–100	70	1.4	100.0	.64
24 months	120	65.5	15.4	25–100	65	1.7	99.2	.67
Fear of Falling								
Baseline	148	24.0	19.3	0–87	23	9.5	—	—
12 months	140	13.0	17.7	0–88	5	36.4	—	—
24 months	120	16.5	20.4	0–92	9	41.7	—	—

[a]In the fear-of-falling score, floor effect (0, *no fear at all*) also means best possible. [b]One participant had a missing item on this 2-item scale, so the score could not be calculated.

Effects of the Intervention on HRQoL

Statistically significant between-groups differences in change were found in only two of the eight HRQoL variables (Figure 2, Table 3). During the intervention, general health score slightly improved in EX but decreased in CON. Mean difference in change was 6 score units, 95% CI 1–11, $t(259.9) = 2.369$, $p = .019$. However, this minor benefit in change in general health at 12 months was lost at 24 months (Figure 2). In contrast, no statistically significant between-groups difference was found in energy and vitality score at 12 months, but it was decreased in EX and increased in CON at 24 months—mean difference in change 9 score units, 95% CI 3–16, $t(261.0) = –2.846$, $p = .005$ (Figure 2).



(continued)

Figure 2 — Age-adjusted mean score and 95% CI in four main RAND-36 Survey variables at baseline (BL), 12 months, and 24 months by group (EX = exercise, CON = control). ITT = intention-to-treat analysis; Efficacy = efficacy analysis (≥2 × week trained participants). The *p* values are for Time × Group interaction (three time points, two groups), linear mixed-model analysis with age at baseline as covariate. The age–sex norm group was 70- to 74-year old women in the study by Aalto et al. (1999).

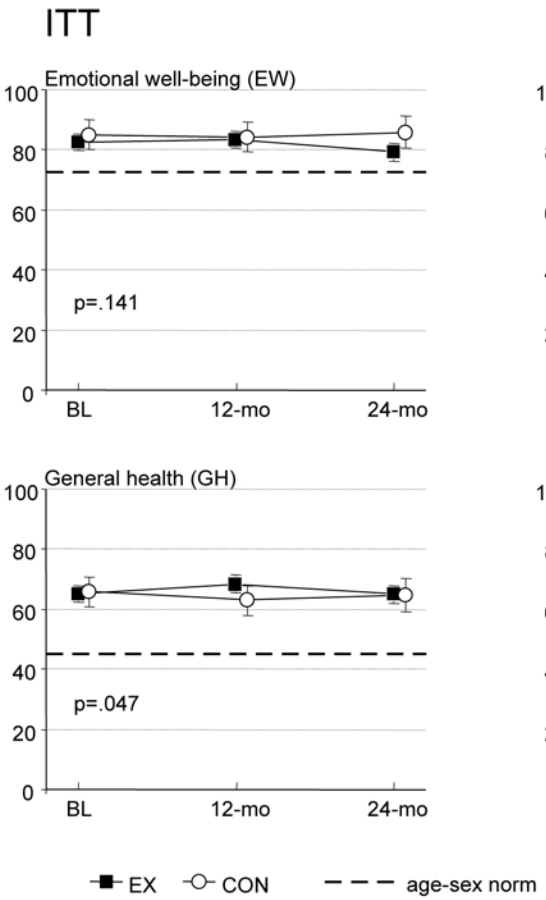


Figure 2 *(continued)*

In the efficacy analyses of subjects who trained at least twice a week, the between-groups difference in change in general health score was statistically significant and larger than in the intention-to-treat analyses (Figure 2). In addition, there was a significant between-groups difference in energy and vitality score at 12 months, favoring the EX group (Figure 2).

Fear of Falling

The fear-of-falling responses accumulated near zero at baseline; the median was 23. Only 6% of the participants expressed unambiguous (>50) fear of falling during daily activities at baseline, and 10% reported no fear at all (0, floor effect; Table 2). Decreased values were found at 12 months and 24 months: In the total sample the fear-of-falling medians were 5 and 9, respectively (Table 2). However, the linear mixed model revealed no between-groups difference in change at either

Table 3 Ceiling Effects of Four RAND-36 Scales by Group

Scale	Group	Ceiling Effect, % Baseline (n = 148)	12-month (n = 142)	24-month (n = 120)	Wald $\chi^2(2)$	p^a
Physical role functioning					3.965	.14
	control	76	57	56		
	exercise	62	66	55		
Emotional role functioning					0.611	.74
	control	57	63	56		
	exercise	61	69	52		
Social functioning[b]					1.321	.52
	control	76	71	72		
	exercise	71	75	63		
Pain					3.122	.21
	control	38	34	28		
	exercise	23	31	31		

Note. The between-groups differences were analyzed by general estimation equations (GEE) of binary responses (ceiling effect [score = 100] and no ceiling effect [score < 100]).

[a]p value for Time × Group interaction (3 time points, 2 groups), GEE model with age at baseline as covariate. [b]n = 141 at 12 months.

Table 4 Descriptive Data on Fear of Falling Using a Visual Analogue Scale

Time	Group	n	M (SD)	Range, 0–100	Median	0 mm,[a] %	>50 mm,[b] %
Baseline	control	37	24.9 (19.0)	0–87	23	5	11
	exercise	111	22.4 (18.3)	0–70	22	11	6
12 months	control	34	16.9 (21.2)	0–65	7	41	6
	exercise	106	10.7 (15.7)	0–80	3	35	2
24 months	control	26	22.2 (24.7)	0–92	16	39	12
	exercise	94	15.1 (19.1)	0–85	6	43	6

[a]No fear of falling; [b]Unambiguous fear of falling.

measurement, $F(2, 268.7) = 0.194$, $p = .824$. The descriptive data of fear of falling by group at baseline, 12 months, and 24 months are given in Table 4.

Discussion

Our study evaluated the effects of a moderate- to high-intensity exercise intervention on HRQoL and fear of falling in relatively healthy home-dwelling older women. This study was explorative; no hypotheses were made concerning the effects of the exercise program on RAND-36 variables or fear of falling. Although positive effects were observed in muscle strength, dynamic balance, and bone structure (Karinkanta et al., 2009; Karinkanta et al., 2007), we found hardly any impact of training on HRQoL and fear of falling.

In RAND-36 variables, we found only one statistically significant exercise effect after the intervention: General health score slightly increased in EX and decreased in CON. The absolute between-groups difference (6 score units) was small and trivial considering the rather poor psychometric properties of the general health scale in this study. However, this difference is in line with other studies reporting exercise effect on this subscale (Grahn Kronhed et al., 2009; Martin et al., 2009; Okamoto et al., 2007). On the other hand, Teixeira et al. (2010) and Eyigor, Karapolat, Durmaz, Ibisoglu, and Cakir (2009) recently reported much larger and clinically significant HRQoL improvements on this subscale, as well as other scales, among osteoporotic postmenopausal Brazilian women and healthy older Turkish women, respectively. Our results, however, are congruent with the recent meta-analysis by Kelley et al. (2009), which indicated a rather weak role of exercise interventions in HRQoL.

Our observations, together with those of other RCTs, of minimal or no effect (e.g., Cress et al., 1999; de Vreede et al., 2007; Okamoto et al., 2007) raise the question of whether the measured changes in physical-capacity variables are large enough to be recognized by the participant and, more important, whether this change makes any difference in her everyday life. It is not known which particular point during the training period would be optimal for the perception of change (McAuley et al., 2005; Rejeski & Mihalko, 2001). In addition, the relevance of the physical-functioning items is not guaranteed in high-functioning individuals. It is also possible that participants adapt to successive minor changes resulting from exercise training, which eventually modifies their internal standard for HRQoL. This latter interpretation is supported by the notion that in our study most RAND-36 scores decreased after the follow-up period (with no supervised exercise) in EX but not in CON. In the energy and vitality score this divergent trend between the groups was statistically significant. Corresponding observations have been reported by de Vreede et al. after a 6-month follow-up in community-dwelling older Dutch women.

In light of the recurrent observations, Rejeski and Mihalko (2001) have questioned the effect of exercise training on HRQoL in older people with normal or good physical functioning. In our high-functioning participants, RAND-36 data showed good technical quality and sufficient conceptual stability (Aalto et al., 1999; McHorney, 1996; Nupponen & Karinkanta, 2009). However, the level of scores was higher and ceiling effects larger than in the age-equivalent reference groups. The high level and substantial ceiling effect of SF-36 scores have been reported in several other exercise interventions with high-functioning older participants (e.g., Cress et al., 1999; de Vreede et al., 2007). Lesser but still notable accumulation of scores has been observed in large population samples (e.g., Wolin et al., 2007) and among community-dwelling older adults (e.g., McHorney, 1996) but less consistently in exercise interventions among nonclinical frail older adults (e.g., Helbostad, Sletvold, & Moe-Nilssen, 2004).

The strong ceiling effect and diminished variation impair the psychometric properties of the scales, rule out any substantial raise in scores, and conceal differential changes in several outcome variables. Insufficient responsiveness of the scales may thus mask the effects of an exercise intervention. So far no studies have been published on the sensitivity to change of the Finnish RAND-36 in healthy samples. Furthermore, HRQoL has typically been studied as a secondary outcome, and most exercise-intervention studies in older adults, including our study, have been underpowered (e.g., Cress et al., 1999; de Vreede et al., 2007); only the recent study by Martin et al. (2009) appears to have been adequately powered.

Fear of falling is conceptually linked with level of physical functioning (Zijlstra et al., 2007). In this study, the univariate correlations with the physical-functioning scores were –.20 (baseline) to –.40 (24 months). No significant difference in change was found between EX and CON. For both groups, fear-of-falling scores indicated less fear at 12 months and at 24 months than at baseline. However, the level of fear was low compared with observations by Lin, Wolf, Hwang, Gong, and Chen (2007), probably because the participants in that study had experienced a recent fall.

The observed floor effect suggests that fear of falling assessed by VAS was not a sufficiently sensitive indicator of fear in our high-functioning women. When we designed this study no validated instruments for measuring fear of falling had been adapted for use in Finland. Thus, a simple global measure of fear of falling, a VAS, was chosen even though good validation studies of this instrument were not available. Later, several fear-of-falling instruments were questioned because they lack sensitivity to detect different levels of fear and they do not assess fear during different activities (Yardley et al., 2005). The other criticism concerns the wording. The term *concern about falling* is closely related to fear but is less intense and emotional and may thus be a more socially acceptable expression than *fear* among older people (Yardley et al., 2005). Promising new instruments have recently been developed, but their responsiveness to change, especially in high-functioning older adults, needs to be tested (Delbaere et al., 2010; Yardley et al., 2005).

Conclusions

The 12-month exercise intervention showed rather limited effects on HRQoL and fear of falling in relatively healthy high-functioning older Finnish women. However, this may have been the result of deficient responsiveness of the assessment instruments used.

High ceiling effects and insufficient sensitivity have recurrently been reported in assessments of change by the SF-36 and the parallel RAND-36. Therefore, the utility of this commonly used generic multicomponent HRQoL instrument can be questioned, especially in high-functioning older adults. Another concern is the dynamic nature of HRQoL, which is susceptible to changes in internal standards. To assess fear of falling, more activity-specific surveys have recently been developed, but they need to be studied further in various older adult populations.

Acknowledgment

We thank the staff and all the study participants for participating in this trial and the Atletico Training Center for allowing free participation in training. This study was supported by the Academy of Finland, the Finnish Ministry of Education, the Medical Research Fund of Tampere University Hospital, the Juho Vainio Foundation, and the National Graduate School of Musculoskeletal Disorders and Biomaterials. Some of these data were presented at the 19th IAGG World Congress of Gerontology and Geriatrics, held in Paris, France, July 5–9, 2009.

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