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Effects of a physical training and nutritional intervention program in frail elderly people regarding habitual physical activity level and activities of daily living—A randomized controlled pilot study

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ABSTRACT

The aim of this randomized controlled pilot study is to describe the effects of a physical training and nutritional intervention program on the physical activity level and activities of daily living (ADL) in frail elderly people. Ninety-six community-dwelling frail elderly people (58 women) above the age of 75 were included in the study. The 12-week physical and/or nutritional intervention program was followed by six months of home-based exercises for the training groups, followed up with training diaries. At baseline the subjects were screened for physical activity level, walking habits, and ADL. These measurements were repeated immediately after the intervention at 3 months, and at 2nd follow-up at 9 months. ADL data were also collected 24 months after baseline at 3rd follow-up. The intention-to-treat analyses showed an increase of the habitual physical activity level and walking duration at 1st follow-up for the two training groups compared to the other groups. These increases remained at 2nd follow-up. The nutrition intervention did not show any significant results. No significant effects on ADL were shown however, there were moderate correlations between increases in physical activity level and ADL as well as between the amounts of home-based exercises and ADL for the two training groups.

1. Introduction

Epidemiological data demonstrate that a low physical activity level is strongly related to functional decline (Fiatarone Singh, 2002; Brach et al., 2003). However, several reviews show that there is still a lack of evidence as to whether a physical training intervention can affect limitations in activities of daily living (ADL) (Keysor and Jette, 2001; Latham et al., 2004).

Frailty has been defined as a clinical syndrome comprised of unintentional weight loss, self-reported exhaustion, muscle weakness, slow walking speed and low level of physical activity in men and women over the age of 65 (Chin et al., 1999; Fried et al., 2001). A combination of low physical activity and weight loss has been shown to be a significant predictor of mortality (Chin et al., 1999). Management of frail elderly persons is challenging and requires comprehensive evaluation and management programs (Kane, 2002). Since the definition of frailty emphasizes several nutrition-related aspects, such as body composition and physical function, it seems warranted to investigate if nutrition intervention may enhance the effect of physical training.

Three published randomized controlled trials have focused on both physical training and nutrition in frail community-dwelling elderly people (De Jong et al., 2000; Chin et al., 2001, 2002). The results of the studies showed a positive effect of physical training on physical performance and fitness and of nutritional supplementation on bone mass (De Jong et al., 2000; Chin et al., 2001). The studies showed a non-significant effect on ADL and psychological well-being (Chin et al., 2001, 2002). We recently published data on the frail elderly subjects as described in this article, showing a significant positive effect of three months of physical training on lower extremity muscle strength at 1st follow-up (Rydwik et al., 2008). In line with other studies (De Jong et al., 2000; Chin et al., 2001, 2002), we did not observe any further positive effect on physical performance when adding a nutritional intervention to the physical training intervention. To our knowledge, no studies have evaluated the effect of a physical training program on habitual physical activity level in frail elderly people. However, a study on geriatric patients after discharge from a geriatric clinic showed an increase in habitual physical activity level directly after a physical training intervention but this increase did not remain at 2-years follow-up (Hauer et al., 2003).

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We hypothesized that a physical training intervention alone or in combination with a nutritional intervention program would increase the habitual physical activity level and that this would have an impact on ADL. Therefore, the aim of this pilot study was to describe the effects of a supervised physical training program followed by six months of unsupervised home-based exercises, alone or in combination with a nutritional intervention program, on physical activity level and ADL at 3, 9 and 24 months and to analyze how the results of these measures affect each other. In this article we therefore present data on habitual physical activity level and ADL with a 3rd follow-up 24 months after baseline. We also present data on six months of unsupervised home-based exercises that followed the supervised 12-week program described in the recent published paper (Rydwik et al., 2008).

2. Subjects and methods

2.1. Subjects

Subjects were recruited through questionnaires, advertisements in the local newspaper, through primary care and the home service administration organized by the local authorities (Rydwik et al., 2008). Inclusion criteria were: unintentional weight loss >5% during the last 12 months and/or body mass index (BMI) <20 kg/m^2 and; low physical activity level (≤grade 3 in a six-graded scale of physical activity (Mattiasson-Nilo et al., 1990; Frandin and Grimby, 1994). Exclusion criteria were: age under 75, BMI >30 kg/m^2; non-walkers; people with recent cardiac problems requiring hospital care; recent hip fracture or surgery during the last six months; present cancer treatment; stroke within the last two years and less than 7 points of a total 9 point score on the short form of the Mini Mental State Examination (MMSE) (Callahan et al., 2002), and institutionalization.

Fig. 1 shows detailed information concerning successive recruitment and drop-out of participants. All subjects (n = 437) who fulfilled the inclusion criteria regarding unintentional weight loss and/or BMI < 20 kg/m^2 were contacted by telephone for screening. A final sample of 96 subjects was included in the study.

2.2. Procedure

After baseline measures were conducted the subjects were randomized consecutively in batches to four different groups. With instructions from a statistician, study personnel conducted the randomization procedure in an open manner. For each new batch, randomization started with the oldest individual to avoid age differences between groups.

Randomization was done to the following four treatment groups: Training (n = 23): Specific physical training + general diet advice. Training/nutrition (n = 25): Specific physical training + -specific individualized diet counseling and group-session training. Nutrition (n = 25): Specific individualized diet counseling and group-session training + general physical training advice. Control (n = 23): General physical training advice and general diet advice.

The subjects were assessed at baseline (0 months), 1st follow-up (3 months), 2nd follow-up (9 months, i.e., 6 months after the end of the intervention). At 3rd follow-up (24 months), the subjects were contacted by telephone and were interviewed about personal and instrumental ADL (see Section 2.5). Neither the test leaders nor the subjects were blinded. The same test leader conducted all physical performance measurements on all occasions, but did not take part in the physical training program.

The study was approved by the Ethical committee at the Karolinska Institutet. All participants were informed about the study procedures and they gave written informed consent for participation.

2.3. Baseline characteristics

The subjects were examined by a geriatrician for medical history, medication and physical status. Types of walking aids were recorded. BMI was calculated by dividing the body weight (kg) by height^2 (m).

2.4. Primary outcome measures

Habitual physical activity level was estimated using Classification of Physical Activity, a six-graded ordinal scale including both physical training/exercises and domestic activities, see Appendix A (Mattiasson-Nilo et al., 1990; Frandin and Grimby, 1994). The subjects were asked about walking habits concerning both the frequency (days per week or month) and duration (minutes, hours) of their outdoor walks (Frandin et al., 1991). In this study the categories were ordered as follows: regarding frequency, the scale was ordered from 1 to 7, where 1: never, 2: almost never, 3: once a month, 4: 1–2 times/week, 5: 3–4 times/week, 6: almost daily, and 7: daily. Regarding duration, the scale was ordered from 0 to 5, where 0: 0 min, 1: 0–15 min, 2: 15–30 min, 3: 30–60 min, 4: 1–2 h and 5: >2 h.

2.5. Secondary outcome measures

Personal ADL was estimated by the test leader using Functional Independence Measure (FIM) (Kidd et al., 1995; Daving et al., 2000, 2001). This ordinal scale consists of a 13-item (motor items), 7-graded scale where 6 and 7 indicate independence with or without devices. The total score is 91 points.

Instrumental ADL was estimated by the test leader using Instrumental Activity Measures (IAM), a supplementary scale to FIM (Grimby et al., 1998; Daving et al., 2000). This ordinal scale consists of an 8-item (e.g., cleaning, washing, cooking, shopping, public transportation, etc.), 7-graded scale where 6 and 7 indicate independence with or without devices. The total score is 56 points.

2.6. Interventions

2.6.1. Physical training

The subjects randomized to the physical training program participated in an organized regular physical group training of approximately on1 h, twice a week for twelve weeks, in total 24 training sessions. The program has been thoroughly described elsewhere (Rydwik et al., 2008). Briefly, the program consisted of three corresponding sections of each 20 min: (a) warm-up including aerobic training; (b) individually prescribed muscle strength training (60–80% intensity) including training on stationary equipment as well as functional muscle strength training such as chair stand, step-up and toe raise; (c) balance training, i.e., Qigong, including cool-down performed in groups of 5–8 subjects. Before as well as twice during the intervention program the subjects were screened for muscle strength with one repetition maximum on stationary equipment (lower extremities – Leg press, upper extremities – Pull-down and Dips, (Scandinavian Mobility, Norway)) to ensure intensity and progression of the muscle strength section. After each section the subjects were asked to score the effort on the Category Ratio-10 (CR-10) scale according to Borg (1982), and heart rate was registered. The training program was planned by a physiotherapist and led by a trained instructor with the help of a trained physiotherapy assistant. The trained instructor was not involved in assessments of outcome measures. The trained physiotherapy assistant helped the instructor with registration of heart rate and scored effort, as well as ensured correct load and safety during balance training, etc.

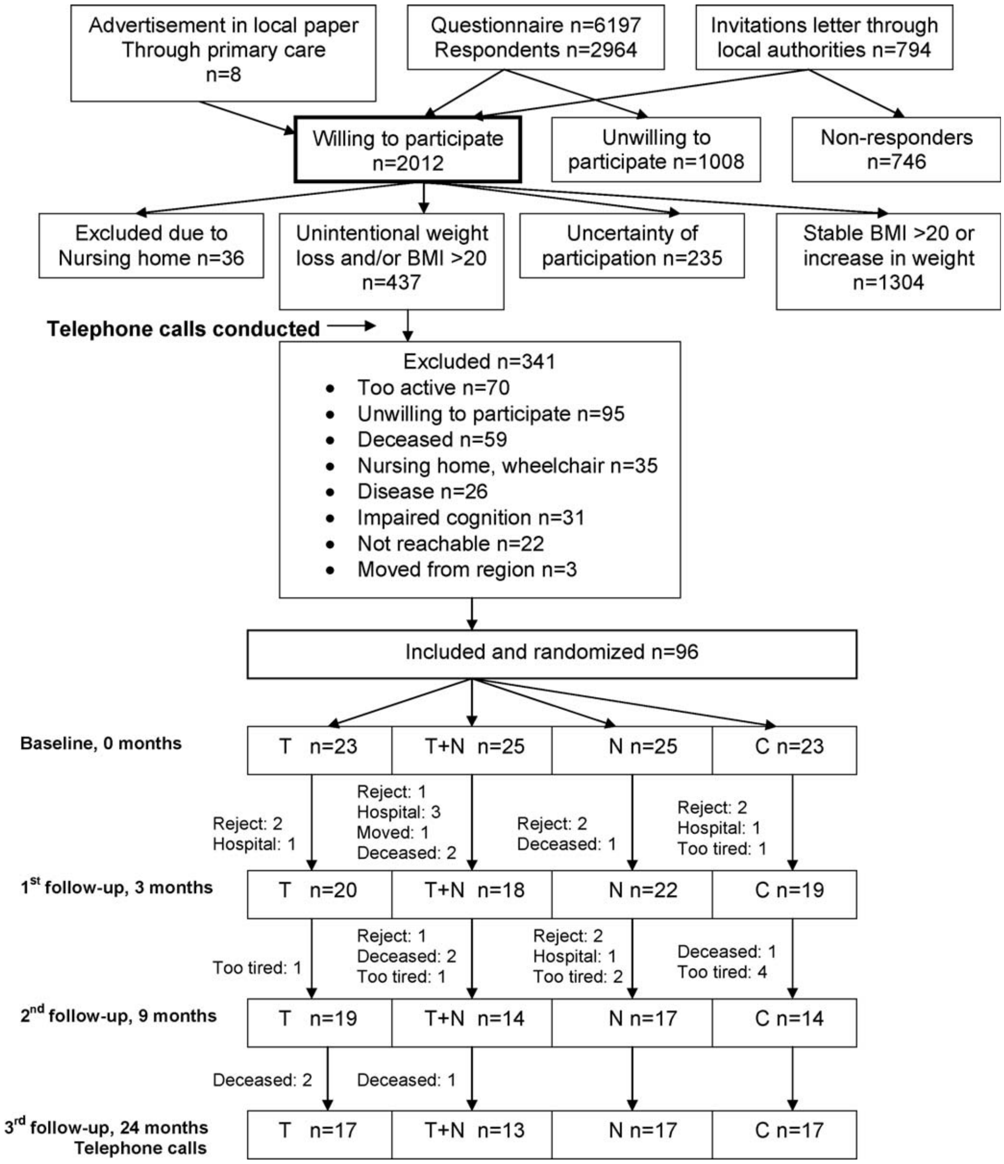

Fig. 1. The flow of recruitment, inclusion/exclusion and drop-out of subjects from baseline to 3rd follow-up.

This period of physical training was followed by six months of home-based exercises conducted by the subjects themselves. The subjects were encouraged to perform Qigong and functional muscle strength training (see above) and to take regular walks several times per week. The home-based exercises were not progressive. The subjects were instructed to fill in physical training diaries, noting minutes and intensity (Borg CR-10 scale) for each activity, to be sent in every month in pre-stamped envelopes. The procedure was followed up half way and at 2nd follow-up.

2.6.2. Nutritional treatment

The nutritional treatment consisted of individual dietary counseling based on baseline food record data. Using the results of the food record, a dietician/nutritionist tested different options that would cover the estimated needs of each individual. Results of the baseline tests were explained and changes in daily eating patterns and food choices were suggested and discussed at an individual session lasting about 1 h. If needed, the dietician/nutritionist also prescribed nutritional supplement. The nutritional treatment included five group sessions that covered topics like nutritional needs for elderly people, meal frequency and cooking methods. At each session a snack was served, intended to give an example of a nutritionally well balanced in-between meal.

The training/nutrition group and the nutrition group did not receive systematic specific advice regarding nutrition after completion of the 12-week program, but those who had been supplied with nutritional supplementation ($n = 3$) during the intervention period did receive nutritional supplement until 2nd follow-up.

2.6.3. General advice

The general physical training advice for the nutrition and control groups was to take walks three times per week for at least 20 min, to use staircases instead of an elevator from time to time and to follow the WHO recommendation of a total amount of 30 min of physical activity each day. The general diet advice for the training and control groups was to eat three main courses and 2–3 between-meal snacks including meat, fish or egg, fruit and vegetables, dairy products and fibre in combination with fluid every day.

2.7. Compliance

Numbers of attended sessions during the supervised physical training and the nutritional intervention program were recorded and expressed as percent of maximal number of sessions.

2.8. Statistical analyses

The analyses were conducted in JMP 6.0.0 (SAS, USA) and Stata 8.0 (Stata Corporation, Texas, USA). Data are described as mean ± S.D. or medians and interquartile range (IQR). Scatter plots for baseline variables against change in outcome variables were used to investigate whether baseline values had any impact on the magnitude of change. The between-group analyses were conducted with an intention-to-treat analysis, including all subjects regardless of compliance, by Wilcoxon–Kruskall–Wallis regarding habitual physical activity and walking habits.

To set clinically relevant limits the ADL scores were dichotomized into independency and dependency, where a 6 or 7 in the FIM and IAM scale were classified as independence and 1–5 as dependence. Changes in ADL, with baseline values included in the statistical model, were analyzed with a proportional odds logit model for ordinal data (McCullagh, 1980). To adjust for drop-out the analyses were performed separately for each follow up. Correlations analyses were performed using Spearman's rho for the training and training/nutrition groups. Total score of FIM and IAM were used for these analyses.

3. Results

3.1. Baseline characteristics

Table 1 shows a description of baseline characteristics. There groups were comparable at baseline except for walking aids, where there were more subjects without walking aids in the nutrition and control groups compared to training/nutrition group.

3.2. Compliance

The mean compliance rate during the 12-week organized physical training program was 65% (range 4–100%). For drop-out rate, see Fig. 1.

Twenty-seven of the 38 subjects (71%) in the training and training/nutrition groups who completed the 1st follow-up sent in the training diaries for, on average, 5 ± 2 months (Table 2). Outdoor walks, functional muscle strength training and Qigong were the most common activities. The activities were performed with a median intensity of 3 (IQR 3–3) and the intensity was similar between subjects as well as between activities. If all types of activities were summarized, only 5 subjects fulfilled on average the WHO's recommendation of 30 min of physical activity per day.

Forty-six out of 49 eligible subjects (one was excluded due to missing data on energy intake) completed the individual dietary counseling, and the mean compliance rate was 73% (range 20–100%) for the nutrition and training/nutrition groups.

3.3. Effects of intervention

The effects of the intervention program on habitual physical activity level, walking habits, and ADL are shown in Tables 3–5.

3.3.1. Habitual physical activity level

The nutrition and control groups were significantly more physically active at baseline compared to the training and training/nutrition groups. The training and training/nutrition groups significantly increased their habitual physical activity level between baseline and 1st follow-up compared to the control group (Table 3). This increase significantly remained at 2nd follow-up for the training group compared to the nutrition and control groups. The baseline values explained 27% of the variance in change between baseline and 1st follow-up. Thirty-seven percent and 39% of the subjects in the combined training group increased >1 category between baseline and 1st follow-up and between baseline and 2nd follow-up, respectively. Corresponding data for the combined nutrition and control group were 15% and 13%.

Table 1
Baseline characteristics and significant differences between groups, mean ± S.D.

Groups (*n*)	*T* (23)	T + N (25)	*N* (25)	*C* (23)
Age	83.5 ± 3.7	83.1 ± 4.0	83.1 ± 4.5	82.9 ± 4.0
Sex (male/female)	12/11	9/16	10/15	7/16
Continuous medications	6 ± 3	6 ± 3	7 ± 4	6 ± 3
BMI	21.9 ± 3.8	21.9 ± 3.4	21.8 ± 3.4	21.6 ± 3.6
Walking aids outdoors (*n*)				
No aid	8	4	14[a]	11[a]
Stick	5	7	5	2
Walker	10	13	6[a]	10
Walking aids indoors (*n*)				
No aid	17	15	21	18
Stick	4	4	3	2
Walker	2	5	1[a]	3

[a] Significant difference compared to T + N group, $p < 0.05$.

Table 2
Description of the home-based exercises according to training diaries conducted by the two training groups during on average 5 ± 2 months, mean ± S.D.

	Occasion/week	Hrs/week
Outdoor walks (*n* = 27)	3 ± 2.1	1.6 ± 1.5
Functional strength training (*n* = 22)	2.3 ± 2.4	0.4 ± 0.4
Qigong (*n* = 12)	1.9 ± 1.7	0.3 ± 0.2
Others (*n* = 6)	2.5 ± 2.0	1.2 ± 1.2

Others mean: swimming, bicycling, range of motion training, etc.

Table 3
Results of the intervention on physical activity level (PAL) and walking habits (WH), at baseline (B) and 3, and 9 months; data presented with median (IQR).

	PAL	WH-frequency	WH-duration
T-group (n)			
B (23)	2 (1–3)	5 (4–6)	2 (1–2)
3 months (20)	3 (2–3)[b*‡]	6 (4–6)	2 (2–3)
9 months (19)	3 (2–3)[b*‡]	5 (4–6)	3 (2–3)
T + N-group (n)			
B (25)	2 (2–2)	4 (2–5)	2 (1–2)
3 months (18)	3 (2–3)[b*]	5 (4–6)	2 (2–3)
9 months (14)	3 (2–3)	5 (4–6)	2 (2–2)
N-group			
B (25)	3 (2–3)[a¤§]	6 (4–6)	2 (2–3)
3 months (22)	3 (2–3)	5 (4–7)	2 (2–3)
9 months (17)	3 (2–3)	6 (4–6)	2 (2–2)
C-group			
B (23)	3 (2–3)[a¤§]	5 (4–6)	2 (2–3)
3 months (19)	3 (2–3)	5 (4–6)	2 (2–3)
9 months (14)	3 (2–3)	6 (5–6)	2 (2–3)

[a]Significant difference at baseline.
[b]Significant difference at follow-ups.
[§]Significant difference compared to T-group.
[*]Significant difference compared to C-group.
[‡]Significant difference compared to N-group.
[¤]Significant difference compared to T+N-group.
$p < 0.05$.

Table 4
Results of the intervention on total score of FIM (median and IQR) and number of subjects independent in personal ADL at B and 3, 9 and 24 months.

	FIM	Showering (n)	Dressing (n)	Mobility (n)	Toileting (n)	Incontinence (n)	Feeding (n)
T-group (n)							
B (23)	88 (83–89)	19	23	23	23	23	23
3 months (20)	88 (84–89)	16	19	20	20	19	20
9 months (19)	87 (84–89)	17	18	19	19	18	19
24 months (17)	84 (77–88)	11	14	16	15	14	17
T+N-group (n)							
B (25)	84 (81–88)	19	23	25	24	21	25
3 months (18)	87 (83–88)	13	17	18	18	17	18
9 months (14)	87 (84–89)	12	13	14	13	13	14
24 months (13)	86 (79–86)	9	11	13	12	12	13
N-group							
B (25)	88 (86–89)[a¤]	23	24	25	25	25	25
3 months (22)	89 (87–90)	21	21	22	22	22	22
9 months (17)	88 (84–89)	16	16	17	17	17	17
24 months (17)	87 (83–89)	15	17	17	17	17	17
C-group							
B (23)	88 (83–90)[a¤]	21	23	23	23	21	23
3 months (19)	88 (85–90)	18	19	19	19	16	19
9 months (14)	90 (87–90)	13	14	14	14	13	14
24 months (17)	88 (84–89)	13	15	17	16	15	17

[a]Significant difference at baseline; ¤significant difference compared to T+N-group; $p < 0.05$.

3.3.2. Walking habits

The groups were comparable at baseline regarding walking habits, both frequency and duration (Table 3). The baseline values explained 21% of the variance in change regarding walking duration between baseline and 1st follow-up. There was a near-significant increase for the training group compared to the nutrition and control group respectively regarding walking duration between baseline and 1st follow-up ($p < 0.08$) and between baseline and 2nd follow-up ($p < 0.06$). However, when comparing the combined training and training/nutrition group with the combined nutrition and control group, there was a significant increase in walking duration for the combined training group between baseline and 1st follow-up ($p < 0.05$). This change was on a median level 0 (IQR = 0–1) for the combined trainings groups and 0 (IQR = 0–0) for the combined nutrition and control group. More subjects in the combined training group (37%) increased walking duration compared to the combined nutrition and control group (15%) between baseline and 1st follow-up. Corresponding numbers were 42% and 16% between baseline and 2nd follow-up.

3.3.3. ADL

There were no significant differences regarding personal ADL and instrumental ADL between groups at any of the three follow-ups (Tables 4 and 5).

3.4. Associations

There were several low to moderate significant correlations between increase in physical activity and improvement in ADL as well as between home-based exercises and improvements in personal ADL: (i) physical activity (baseline—2nd follow-up) versus personal ADL (baseline—2nd follow-up) $r = 0.36$ and versus personal ADL (1st follow-up—2nd follow-up) $r = 0.44$, respectively. (ii)

Table 5
Results of the intervention on total score of IAM* (median and IQR) and number of subjects independent in instrumental ADL at baseline and 3, 9 and 24 months.

	IAM	Light meal (n)	Full meal (n)	Light shopping (n)	Heavy shopping (n)	Cleaning (n)	Washing clothes (n)	Transportation (n)
T-group (n)								
B (23)	38 (31–43)	21	12	17	7	2	4	15
3 months (20)	37 (31–45)	19	7	15	5	3	4	11
9 months (19)	34 (30–45)	16	7	16	5	2	3	8
24 months (17)	34 (23–43)	13	6	10	4	1	2	7
T+N-group (n)								
B (25)	42 (28–48)	22	15	15	6	6	10	11
3 months (18)	44 (35–50)	14	13	14	6	4	9	12
9 months (14)	46 (40–48)	12	10	10	5	4	8	8
24 months (13)	40 (24–44)	11	7	9	2	3	5	5
N-group								
B (25)	45 (39–49)	25	18	21	7	6	9	16
3 months (22)	45 (39–49)	21	16	20	8	5	8	17
9 months (17)	41 (38–45)	17	12	13	7	5	5	9
24 months (17)	37 (31–41)	16	9	11	7	5	5	8
C-group								
B (23)	43 (37–48)	23	15	20	8	5	8	14
3 months (19)	44 (37–49)	19	13	16	9	6	7	13
9 months (14)	43 (37–53)	14	10	12	5	3	5	9
24 months (17)	40 (34–47)	15	9	12	4	4	4	9

Physical activity (baseline—2nd follow-up) versus instrumental ADL (baseline—2nd follow-up) $r = 0.36$. (iii) Frequency of walking (baseline—2nd follow-up) versus personal ADL (1st follow-up—2nd follow-up) $r = 0.42$. (iv) Number of occasions and months of home-based exercises versus personal ADL (baseline—2nd follow-up) $r = 0.53$ and 0.50, respectively. (v) Hours, number of occasions and months of home-based exercises versus personal ADL (1st follow-up—2nd follow-up) $r = 0.47$, $r = 0.65$ and $r = 0.47$, respectively.

4. Discussion

This pilot study indicates that a physical training program alone or in combination with a nutritional intervention program followed by monitored home-based exercises increased the habitual physical activity level for frail elderly people. This interpretation is also supported by the significant increase in walking duration for the combined training group. Adding a nutritional intervention did not affect the results. The remaining increases in physical activity at 2nd follow-up (six months after the end of the supervised intervention) for the training group is in contrast to a previous study of geriatric patients after discharge (Hauer et al., 2003). In this latter study, the subjects were not encouraged to continue home-based exercises, but the type of measurements of physical activity was similar to our study, including both leisure and household activities.

The results of some studies of healthy elderly people indicate that the total physical activity level, measured with accelerometer, did not increase during an aerobic and/or muscle strength training intervention, especially not during training days (Meijer et al., 1999, 2000). This suggests a compensatory decline. However, Fujita et al. (2003) showed an increased physical activity level for healthy elderly people, measured with a physical activity diary, both directly after a six-month physical training intervention period and after another six months. Thus it is clearly a strong need for further research in this area especially for frail community-dwelling elderly people and the results of our study need to be confirmed in larger controlled trials.

The subjects in our study were included based on low physical activity level, but there was still a small, but significant difference between the groups at baseline due to larger range, i.e., there were more subjects scoring 1 (hardly any physical activity) in the training groups compared to the other groups. The reason for not conducting a co-variance analysis to control for the difference at baseline was that ordinal data require a non-parametric analysis. Instead, we present data from a scatter plot analysis showing that baseline values explained 27% of the changes between baseline and 3 months. This analysis showed that subjects with the lowest physical activity level at baseline improved more compared to subjects with a higher, but still low, physical activity level. It is possible that it is easier to "move" from grade 1 to 2 compared to from grade 3 to 4 (Appendix A). To reach grade 3 in the physical activity scale (Appendix A) the subjects can either fulfill the requirements regarding light domestic work or light physical exercise. The duration of light physical exercise fulfills the recommendations of the WHO of 30 min physical exercise per day; however, we still believe that this can be considered as a low physical activity level.

We observed no effect of the intention-to-treat analyses on ADL, which is in line with previous studies (Chin et al., 2001; Keysor and Jette, 2001; Latham et al., 2004). However, we found low to moderate correlations between increases in physical activity levels and walking frequency with improvements in ADL. There were also moderate correlations between performance of home-based exercises and personal ADL, showing an association between physical training and improvements in ADL for those who actually performed the exercises. These associations confirm partly our hypothesis, however intention-to-treat analyses are of importance since they reflect a larger population regarding, for example, compliance. But, one cannot expect to reach a positive result from a physical training program unless it is actually performed regularly. There are several possible explanations for the lack of observed ADL-effects of physical training programs in our study as well as in previously published studies in elderly people (Chin et al., 2001; Keysor and Jette, 2001; Latham et al., 2004). ADL is very much dependent on environmental barriers, and also on personal factors (Verbrugge and Jette, 1994). Even though a physical intervention program may succeed in improving muscle strength and/or balance, the elderly people might still keep their home service assistance either due to accommodation or a fear that they might not receive it again if the need were to arise in the future. Environmental barriers can also affect instrumental ADL; if, for example, the closest grocery store shuts down, which was the case for one of the subjects in our study. This led to a decrease in independence in heavy shopping regardless of change in the physical performance level.

Regarding personal ADL, most of the subjects scored high at baseline (near the ceiling) and therefore improvements were not detectable, however a possible decline in personal ADL during the 24 months follow-up period might have been possible to detect. Further, we also wanted to analyze the different subcategories of ADL, not just the total score. If we had found differences between groups, it would have been easier to interpret and implement the results in a clinical setting. A supplementary analysis of the original ordinal scale did not alter the results. The reason for using interview on the ADL assessments was to analyze what the subjects actually performed not what they could perform if closely monitored. The gap between what elderly people "can do" and what they "do do" has been described earlier (Sager et al., 1992).

To be able to affect ADL, it may be of importance to address other issues together with a physical training program, e.g., behavioral factors, including social support by significant others, task specific training and to target interventions at environmental barriers as well. Supervised physical training during an extended period, longer than 12 weeks, may also be of importance to be able to reach a significant positive effect.

There is no consensus regarding the definition of frailty in the literature. The definition used in the present study was chosen on the basis of the published literature at that time (Chin et al., 1999), but also for logistic and financial reasons. As mentioned earlier, we have not been able to show that a nutritional intervention did add any extra benefit, despite the fact that subjects were included due to nutrition-related aspects such as unintentional weight loss and/or low BMI (Rydwik et al., 2008). Reasons for this could be that we chose to apply individual dietary counseling and to work with food choices rather than nutrition supplements. Affecting people's food habits is very difficult and probably needs to be much more closely monitored than we were able to do in this study. However, since this approach resembles clinical routine, it was of importance to investigate this further.

The main limitations of this study refer to the sample size, the heterogeneity regarding factors such as instrumental ADL and the fairly high drop-out rate. The heterogeneity together with the unknown treatment effect(s) made it difficult to carry out a power analysis before the start of the study. A power calculation could have been conducted after the inclusion of the first batch, but due to economic and logistic factors it was not possible to increase the number of subjects. For the same reasons, the test leaders were not blinded to randomization. The subjects' execution of home-based exercises could also have been more closely monitored with weekly or monthly telephone calls. This might have enhanced the regularity of the exercises. Further, the home-based exercises were not progressive and of moderate intensity, since they were introduced to maintain the effects of the supervised physical training period. Objective measurements such as accelerometer or pedometer were not chosen due to lack of evidence of validity and reliability for frail elderly people at the time of the study (Marsh et al., 2007). If this had been the case, the use of such devices would have strengthened the results of the study.

5. Conclusions

In a previous study we have demonstrated a positive effect on lower extremity muscle strength in favor of the training groups. The present study adds data on physical activity level and ADL and indicates that physical training increased the habitual physical activity level in frail elderly people and that this increase remained over time for six months. Increase in physical activity and degree of home-based exercises were moderately related to improvements in ADL. The nutrition intervention did not add any extra benefit. Studies with larger sample sizes and targeted interventions towards behavioral and environmental factors are necessary before any further conclusions can be drawn.

Conflicts of interest statement

None.

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Appendix A

Classification system of physical activity including domestic activities (Mattiasson-Nilo et al., 1990; Frandin and Grimby, 1994).

1. Hardly any physical activity.
2. Mostly sitting, sometimes a walk, light gardening or similar tasks, sometimes light household activities such as heating up food, dusting or clearing up.
3. Light physical exercise around 2–4 h a week such as walks, fishing, dancing, and ordinary gardening, including walks to and from shops. Main responsibility for light domestic work such as cooking, clearing up and making beds. Performs or takes part in weekly cleaning.
4. Moderate exercise 1–2 h a week, e.g., jogging, swimming, gymnastics, heavy gardening, home-repairing, or light physical activity more than 4 h a week. Responsible for all domestic activities, light as well as heavy. Weekly cleaning with vacuum cleaning, washing floors and window-cleaning.
5. Moderate exercise at least 3 h a week, e.g., tennis, swimming, and jogging.
6. Hard or very hard exercise regularly and several times a week, where physical exertion is great, e.g., jogging and skiing.

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