

Unexpected effects of cognitive-behavioural therapy on self-reported exercise behaviour and functional outcomes in older adults

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Abstract

Background: nearly 61% of older adults do not maintain recommended exercise levels emphasising the need for interventions that promote exercise.

Objectives: to compare self-reported exercise behaviour and functional outcomes over 1 year across three groups of older adults: a cognitive-behavioural therapy group, an attention-control education group and a control group.

Design: randomised intervention.

Setting: community exercise facilities.

Participants: three hundred and thirty-two older adults (mean age = 71.8 ± 5.1 years).

Methods: all three groups received exercise training three times per week for 2 weeks and then one time per week for 8 weeks, during which time the therapy and education groups received their interventions. Blinded data collectors measured follow-up exercise behaviour and functional outcomes at 3-month intervals.

Results: after controlling for previous year exercise behaviour, results showed that relative to the control group, the therapy and education groups increased their strengthening exercises over time (0.05 and 0.06 h/week higher, respectively); only the therapy group's change was significant. Also, relative to the control group, the therapy and education groups significantly reduced their 6-min walking distances over time (−1.6 m, $P = 0.030$ and −1.5 m, $P = 0.026$, respectively).

Conclusions: although the therapy group increased their strength training, they reduced their 6-min walking distance.

Keywords: cognitive-behavioural therapy, exercise behaviour, functional outcomes, elderly

Introduction

Compared with their sedentary peers, older adult exercisers experience a number of important health benefits [1]. Yet, in 2007, nearly 61% of older adults did not maintain recommended exercise levels [2]. This report describes the effects of cognitive-behavioural therapy (CBT) on exercise behaviour and functional outcomes over time. Being theoretically superior to interventions using health education, health risk appraisal and exercise prescription [3], we attempted to correct some of the limitations of prior CBT studies done with older adults.

Only a few studies focused on the effect of CBT on older adults' exercise behaviour and related functional outcomes. Atkins *et al.* [4] held exercise training stable across five small groups ($n = 13$ – 16 each). They found that CBT resulted in more walking than for cognitive or behavioural

modification alone, and only the CBT group outperformed the attention-control group. Jette *et al.* [5] compared CBT with exercise to control participants ($n = 108$), and found that CBT + exercise participants ($n = 107$) improved in strength at 6 months and showed trends towards improvement in tandem gait and the 10-ft. timed up-and-go test [5]. Compared with an exercise-only ($n = 19$) condition, Brawley *et al.* [6] found that older adults in a CBT + exercise group ($n = 16$) reported a higher frequency of moderate physical activity at 3 months, although their greater total volume was not different than the exercise-only group. Finally, Rejeski *et al.* [7] compared the 6-min walk test (6-MWT) and treadmill test of a group of older adults receiving CBT plus exercise ($n = 75$) to one receiving exercise-only ($n = 72$) at 3 months. Men with lower initial levels in the CBT + exercise group experienced the greatest improvement. These studies were limited in that they were short term (6 months

or less), had small sample sizes [4, 6] or were unable to separate the effects of CBT from exercise [5]. Thus, the purpose of this study was to compare self-reported exercise behaviour and functional outcomes at 3-month intervals over 1 year across three groups of older adults: a CBT group, an attention-control education group and a control group. Guided by the self-regulation of exercise maintenance model [8–10], thoughts or cognitions (interpretations) mediate behaviour [11]. Interpretation is defined as the awareness and subjective appraisal of sensations, thoughts and feelings associated with exercise. Our primary focus of CBT was to teach older adults to recognise and modify their thoughts, or interpretations, about exercise. We hypothesised that, after controlling for previous year exercise behaviour, the CBT group would report higher levels of exercise behaviour 3, 6, 9 and 12 months and greater improvements in functional outcomes 6, 9 and 12 months after initiation of exercise than the education or control groups.

Methods

Design

We recruited community-dwelling older adults mainly through newspaper articles and mailings to those who attended outreach education. Eight hundred and forty-two older adults telephoned; of which, 311 refused for personal reasons, such as not interested, too far to travel and involved too much time; 189 did not meet the inclusion criteria. Because men can make greater functional improvements than women, we stratified by gender. When individuals volunteered with their friends or spouses, they were randomised as a couple to reflect real-life situations and reduce contamination across groups. Using computer-generated randomisation allocation tables, we randomised the subjects to three groups: men, women and couples.

Sample

Older adults were included if they had transportation; were able to read, write and speak English; and were not discouraged to exercise by their healthcare provider. We excluded people who engaged in three or more days per week of aerobic and strength exercise over the previous year. Also excluded were those who scored <24 with at least a high school education or 17 with less than a high school education, in the Mini-Mental State Examination [12], and failed to remember 3 of 20 words, in the Delayed Word Recall [13, 14].

Procedures

After screening and baseline measures, all three groups received supervised exercise training three times per week for 2 weeks at a local community facility. All exercise training (except for a 2-week life event) was provided by a research team member with a bachelor's degree in physical education and 15 years of experience working with older

adults. Then, in a second phase, supervised exercise training occurred once a week for the subsequent 8 weeks. During this second phase, we encouraged participants to exercise independently for an additional 2–5 days/week. The exercise sessions involved 5–10 min of warm-up, 40–45 min of upper and lower body flexibility and strength training using resistance bands (Therabands) and a cool down. Resistance training included activities such as chair stands, side and forward leg raises, knee flexion and extension, hip flexion and extension, bicep curls, shoulder flexion, arm raises and triceps extension. Stretch exercises included neck and shoulder rotation; triceps and shoulder stretches and wrist, hamstring quadriceps and calf stretches. For endurance exercise, all participants were encouraged to walk. We followed and gave participants copies of the NIA [15] exercise guide along with three tensions of resistance bands to use at home. During the second phase, the CBT and education groups (typically ~8–10 members each) also participated in their respective interventions for 8 weeks before or after their weekly exercise sessions. Then, we encouraged all participants to exercise on their own. A research assistant blinded to group assessed exercise behaviour at 3, 6, 9 and 12 months and functional outcomes at 6, 9 and 12 months after initiation of exercise. Participants were paid \$20 at 6-month, \$30 at 9-month and \$50 at 12-month follow-ups. These procedures have been described in more detail elsewhere [16].

Cognitive-behavioural intervention

A doctorally prepared licensed professional counsellor who specialised in group work created curricular manuals for the CBT and education groups. After CBT expert feedback, we revised the manuals to ensure consistency of the CBT concepts. The counsellor used a psychoeducational group approach for the CBT groups (lasting 60–75 min each), because it is effective and useful for older adults [17] and combined an educational and psychological focus to develop new life skills [18, 19]. Participants regularly completed and shared thought logs and exercise plans, which include relapse prevention strategies. We described this approach and each session in detail elsewhere [16, 20].

Integrity of the CBT sessions

To monitor the integrity, we audiotaped all sessions. The counsellor completed session checklists of the key content delivered. Using a separate checklist, a psychologist with experience in CBT reviewed the content delivery of >15% of the session audiotapes. Total per cent agreement ranged from 95.8 to 100%, and kappa statistics were 0.65 and above [21].

Health promotion education (attention-control)

In the education groups, the counsellor focused on health-related information that was relevant to older adults,

including depression, quackery in healthcare, how to talk to medical professionals and other health-related information. Exercise was not discussed in these groups.

The education group was delivered in a typical ‘classroom’ style where the counsellor disseminated information to participants without making it personally relevant to their lives. In contrast, in the CBT group, the counsellor used a psychoeducation model where participants were regularly encouraged to reflect on how information could be useful to their specific situations.

Measures

After aided recall questions to review milestone events of the prior month, we asked participants, ‘In the past month, have you done any walking for exercise’. We used standard probes to inquire about different types of walking such as hiking or treadmill. Then we asked about running, bicycling, calisthenics, sports, dancing as well as winter and water activities, following up with standardised probes for each. After each exercise activity they reported, we asked ‘How many times over that past month? About how many minutes each time? How much effort did you put into it (light, moderate, vigorous, very vigorous)?’ At baseline, we asked about the previous year and scored only activities performed at least 10 times [22]. We repeated interviews at months 3, 6, 9 and 12. For each activity, we computed hours per week by dividing the product of number of times per month and minutes each time by 60 min/h and then by 4 weeks/month $\{[(\text{times/month} \times \text{minutes/time}) / 60] / 4\}$ [22]. Finally, we aggregated across similar activities, using the Ainsworth *et al.* compendium [23], providing a score for each, flexibility (i.e. yoga), strength (i.e. resistance-type exercises, pushups, sit-ups) and aerobic (i.e. walking, running, bicycling, basketball).

The Functional Fitness Test (FFT) [24] includes the 6-MWT to measure endurance, the arm curl and 30-s chair stand tests to measure strength, the back-scratch and chair sit-and-reach tests to measure flexibility and the 8-ft. up-and-go test (8-UGT) to measure power, speed, agility and dynamic balance. The FFT has been shown to have good validity without regard to specificity of training [24]. We followed Rikli and Jones’ [24] procedures.

Analysis of data

We used a mixed-effects longitudinal modelling approach to build models examining the effects of CBT over time on each type of exercise separately (flexibility, strength, aerobic and walking) and for each FFT outcome using HLM 6.04 (Scientific Software International, 2007). Mixed-effect modelling is superior to repeated measures ANOVA, because individuals with missing data at some time periods are included in the mixed-effect analyses, but dropped in repeated measures ANOVA [25]. We built the longitudinal models using a ground-up approach [16, 26].

Table 1. Demographic variables for each group

	Therapy (<i>n</i> = 113) Mean (SD)	Education (<i>n</i> = 110) Mean (SD)	Control (<i>n</i> = 109) Mean (SD)
Age	71.62 (5.34)	72.14 (4.79)	71.63 (5.13)
Delayed Word Recall	5.96 (1.37)	5.49 (1.56)	5.58 (1.67)
Mini-Mental State Exam	28.17 (1.49)	28.14 (1.62)	28.17 (1.69)
MET-h/week/previous year	5.66 (7.26)	5.83 (8.77)	5.96 (8.23)
Perceived physical function	73.82 (21.94)	75.56 (18.56)	73.24 (22.04)
Per cent intervention attendance	0.83 (0.22)	0.81 (0.25)	
Follow-up exercise attendance	0.84 (0.20)	0.83 (0.23)	0.81 (0.23)
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
Gender			
Female	86 (76.1)	83 (75.5)	83 (76.1)
Ethnicity			
Amer Indian/Alaskan Native	1 (0.9)	0	0
Black, not Hispanic origin	19 (16.8)	11 (10.0)	11 (10.1)
Hispanic	0 (0)	0	1 (0.9)
White, not Hispanic origin	93 (82.3)	99 (90.0)	97 (89.0)
Highest education			
8th grade and/or some HS	5 (4.4)	5 (4.5)	11 (10.1)
12th grade	31 (27.4)	40 (36.4)	33 (30.3)
Some college	31 (27.4)	34 (30.9)	31 (28.4)
4 years of college	24 (21.2)	19 (17.3)	15 (13.8)
Graduate school	22 (19.5)	12 (10.9)	19 (17.4)

Findings

Of the 332 participants who started the intervention and follow-up exercise phase of the study, only 20 participants dropped out during or after this phase, 7 in the CBT group, 5 in the education group and 8 in the control group, resulting in an attrition rate of 6.0%. We found no differences in demographic variables across groups (see Table 1). Table 2 depicts raw means and standard deviations of exercise behaviour and functional outcomes by group and month.

Participants reported exercise behaviour differences across groups only with regards to strengthening exercises. Controlling for previous year’s exercise behaviour, the control group’s 3-month status for strengthening exercises was 1.25 h/week ($P < 0.0005$). The CBT and education group’s 3-month status was slightly lower by -0.25 ($P = 0.093$) and -0.15 ($P = 0.327$) h/week, respectively. Then, the control group reported a significant monthly rate of reduction in strengthening exercises (-0.06 h/week each month, $P = 0.001$). The CBT group’s monthly differential rate of change over that of the control group was 0.05 h/week each month ($P = 0.049$), whereas the education group’s differential was 0.06 h/week each month ($P = 0.132$). Thus, relative to the control group, the CBT and education groups did better over time, but only the CBT group’s change was significant.

For the functional measures, the groups showed differences only in the 6-MWT over time. At baseline, the control group walked 510.2 m in 6 min; the CBT group walked 3.8 m less ($P = 0.791$) and the education group walked 3.5 m further ($P = 0.786$) in 6 min. The control group participants significantly increased their 6-MWT

Table 2. Mean (SD) of exercise behaviour and functional outcomes by group and month

Group	Month	Walk, h/week	Aerobics, h/week	Strength, h/week	Flexibility, h/week	Chair stands in 30 s	Sit-and-reach, cm ^a	Arm curls in 30 s	Back-scratch, cm ^b	Up-and-go, s	6-min walk, m
CBT	0					11.2 (2.9)	-7.4 (11.2)	12.8 (3.5)	-8.6 (11.4)	7.6 (2.5)	501.9 (112.5)
	3	1.4 (1.3)	2.2 (2.1)	1.0 (0.8)	0.9 (0.9)						
	6	1.8 (1.6)	2.6 (2.2)	1.0 (0.7)	0.9 (0.9)	12.5 (3.6)	-5.3 (11.2)	14.9 (4.0)	-8.1 (11.4)	7.5 (2.9)	511.1 (123.9)
	9	1.5 (1.4)	2.2 (2.2)	1.0 (1.2)	0.8 (0.6)	12.6 (3.6)	-5.1 (10.9)	15.1 (4.0)	-7.9 (11.4)	7.2 (2.8)	505.2 (120.4)
Education	12	1.5 (1.3)	2.6 (2.7)	0.9 (1.0)	0.7 (0.8)	12.7 (3.8)	-3.8 (10.9)	15.9 (4.8)	-7.1 (10.4)	7.0 (2.5)	520.8 (116.0)
	0					10.7 (2.8)	-6.9 (10.7)	11.9 (3.4)	-8.6 (11.2)	7.3 (1.3)	514.6 (81.5)
	3	1.5 (1.1)	2.4 (2.4)	1.1 (0.8)	0.9 (0.8)						
	6	1.6 (1.4)	2.6 (2.3)	1.0 (0.9)	0.8 (1.0)	12.1 (3.8)	-3.6 (11.4)	14.3 (4.4)	-7.1 (10.9)	6.9 (1.5)	515.1 (96.7)
Control	9	1.5 (1.2)	2.4 (2.6)	1.2 (2.3)	0.8 (0.9)	12.1 (3.4)	-3.3 (10.4)	14.5 (4.1)	-7.9 (11.4)	6.9 (1.5)	519.7 (86.0)
	12	1.5 (1.4)	2.6 (3.1)	1.2 (2.4)	1.2 (1.8)	12.5 (4.0)	-3.3 (11.4)	14.9 (4.4)	-7.6 (11.7)	7.1 (1.8)	516.5 (104.8)
	0					11.0 (2.8)	-7.9 (12.2)	12.0 (3.4)	-8.4 (10.7)	7.5 (2.3)	499.4 (100.9)
	3	1.5 (1.3)	2.5 (2.2)	1.3 (1.3)	1.1 (1.2)						
	6	1.3 (1.5)	2.1 (2.0)	1.2 (1.3)	0.7 (0.9)	12.3 (3.8)	-4.6 (10.7)	14.7 (4.2)	-6.9 (9.9)	6.9 (2.0)	513.4 (113.3)
	9	1.5 (1.8)	2.2 (2.5)	1.0 (1.0)	0.7 (0.7)	12.5 (3.9)	-4.3 (10.4)	14.9 (3.9)	-7.4 (10.4)	6.9 (2.2)	518.6 (116.2)
	12	1.5 (1.4)	2.5 (2.9)	1.1 (1.1)	0.8 (0.7)	12.7 (4.3)	-2.8 (10.4)	15.4 (3.9)	-7.4 (10.2)	7.0 (2.1)	527.7 (112.2)

^aNegative score reflects distance between fingertips and toes; positive score reflects overlapping fingertips with toes.

^bNegative score reflects distance between fingertips; positive score reflects overlapping fingertips.

distance over time, showing a monthly rate of change of 1.3 m ($P = 0.006$). The CBT group showed a negative differential monthly rate of change of -1.6 m ($P = 0.030$), indicating significantly less improvement than the control group. The education group's differential monthly rate of change was also significantly less than the control group (-1.5 m each month, $P = 0.026$). Thus, relative to the control group, the CBT and education groups significantly reduced their 6-min walking distances over time.

Diagnostic tests indicated that the model was operating reasonably well. Specifically, Q-Q plots showed modest issues with the normality with the residuals. The scatterplots showed that the residuals were distributed fairly evenly around zero with no strong evidence of heteroscedasticity. The final models accounted for only 1% of the variance at each level.

Discussion

Unexpectedly, the CBT and education groups did better than the control group over time on only self-reported strengthening exercises; however, these differences were not clinically significant. Also unexpected was the finding that the control group outperformed the CBT and education groups on the 6-MWT. One explanation for these findings might be that because the CBT group did brief homework activities each week and the education group brought in health topics each week, also a type of homework, exercise may have appeared to be of second importance. To control participants, the primary, and the only, focus was on exercise. Another explanation may be that there simply was bias in the delivery of the exercise training, because the trainer was not blinded to groups. Another explanation may be that the cognitive-behavioural intervention was not effective.

Strengths of this study include the larger sample size than prior works [4, 6] and the longer follow-up compared

with others studying CBT and exercise in older adults [4-7]. However, there were several limitations that may have affected the results. One logistical limitation was that sessions varied according to facility, with some participants exercising before and others exercising after CBT. Fatigue after exercise may have reduced participant attention and varied the dose of the intervention.

Another limitation was the randomisation of couples to groups. A number of older adults wanted to participate with their spouse, relative or partner. Thus, we kept them together. However, this sets up dependent data with unknown effects. Because this is important for programmes with older adults, future researchers might consider using the data of only one person of the couple.

Using self-reported exercise was a limitation for a couple of reasons. The exercise behaviour interview was developed and standardised from a paper-pencil instrument [22] and therefore had no reliability and validity. In addition, self-report measures are inherently questionable. However, measuring exercise behaviour via observation in a large community study would be formidable. Future researchers might include a subsample of participants who wear an accelerometer for a predetermined amount of time to determine the validity of the self-reported behaviour. This also has its limitations in that it is generally assumed that exercisers self-report their exercise as accurately without wearing an accelerometer as they do wearing one.

Using physical functional outcomes was a strength of this study. As might somewhat be expected, we found the CBT group to report more strength training than the control group, but our functional measures reflecting strength (arm curl, 30-s chair-stand and 8-UGT) did not reflect this finding. These discrepant results further support our lack of confidence in the self-reported exercise behaviour.

Participants were well educated, which limits generalisability. In addition, we may have been too lenient in our

baseline exercise exclusion criteria. Researchers might consider recruiting sedentary older adults who have a diversity of educational experiences.

It may be that the self-regulation of exercise maintenance model [8, 9] needs more explication and specificity promoting a firm theoretical understanding and greater strength in the interventions [27]. For example, the model might need further development to identify mediating variables between interpretation and behaviour. Although our CBT sessions were guided by a specific CBT protocol, reviewed by a CBT expert and monitored for integrity, it may have been that several aspects of the intervention were not specific enough to produce strong effects. The specificity might also be enhanced through individual interventions as opposed to group interventions.

Finally, non-specific factors that were not specified or directed by the theory might have affected the results [28]. Future research might include measures of participant evaluation and satisfaction with the programme [28].

Key points

- Randomised intervention
 - community-dwelling older adults
 - cognitive-behavioural therapy intervention
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Conflicts of interest

None declared.

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Seasonal variation of serum vitamin D and the effect of vitamin D supplementation in Irish community-dwelling older people

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Abstract

Background: Ireland is at 53°N, and its population risk of vitamin D deficiency is high. Previous Irish studies suggested a significant seasonality of serum 25-hydroxyvitamin D [25(OH)D] and a beneficial effect of supplementation in raising 25(OH)D levels. However, in Irish older people, little is known about the magnitude of the supplementation effect and whether supplementation affects 25(OH)D seasonality.

Design: cross-sectional observational.

Setting: outpatient clinic.

Subjects: five hundred and forty-six community-dwelling subjects (mean age 73.0, SD 7.4; 68.5% females) were assessed between September 2007 and May 2009.

Methods: for supplemented and non-supplemented: 'cosinor' analysis (Pulse_XP[®]) of monthly 25(OH)D. Period global solar radiation (GSR) and solar elevation angle (SEA) data were collected as proxy markers of ultraviolet-B radiation exposure. Multivariate linear regression was conducted to investigate the independent effect of GSR and SEA on 25(OH)D, controlling for confounders.

Results: supplemented group ($N = 183$): 89.1% were on cholecalciferol 800 IU/day. Mean 25(OH)D = 64.1 (95% confidence interval: 52.2–75.8) nmol/l, with no significant seasonality; regression: neither GSR nor SEA predicted 25(OH)D. Non-supplemented group ($N = 363$): mean 25(OH)D = 40.3 (35.5–45.0) nmol/l, with significant seasonality (55.5% variance remaining), peak in August, amplitude = 6.0 (3.1–8.8) nmol/l; regression: both GSR ($P = 0.002$) and the interaction GSR * SEA ($P = 0.018$) predicted 25(OH)D.

Conclusions: vitamin D supplementation was associated with a mean serum 25(OH)D increase of 23.8 nmol/l. Interestingly, supplementation seemed to blunt seasonality. In the supplemented group, 72.1% had individual 25(OH)D levels below the recommended 75 nmol/l. There is a case for universal supplementation in Irish older people, probably at a higher dose. Further research is needed to establish the optimum dose.

Keywords: vitamin D, seasonal variation, dietary supplements, aged, Ireland, elderly