

Clinical effectiveness of START (STrAtegies for RelaTives) psychological intervention for family carers and the effects on cost of care for people with dementia: six year follow-up of a randomised controlled trial

Short title START: Six year clinical and dementia cost outcome

Gill Livingston¹², Monica Manela ¹, Aidan O’Keeffe ³, Penny Rapaport¹, Claudia Cooper¹² Martin Knapp⁴, Derek King⁴, Renee Romeo ⁵, Zuzana Walker^{1,6}, Juanita Hoe¹ Cath Mummery⁷, Julie Barber³

GL-Professor of Older People’s psychiatry; MM –research doctor, A O’K-lecturer in statistics, PR- Principal Clinical Psychologist, CC- Reader, MK- Professor of Social Policy, DK-Assistant Professorial Research Fellow, RR – Senior Lecturer in Health Economics ZW- Reader in Psychiatry of the Elderly, JH- Senior Clinical Research Associate, CM - Consultant Neurologist, Honorary Senior Lecturer, JB- Associate Professor in Medical Statistics,

1. UCL, Division of Psychiatry, Floor 6, Maple house, 149 Tottenham Court Rd, W1T 7NF
2. Camden and Islington NHS Foundation Trust, St Pancras Hospital, London4 St. Pancras Way, London NW1 OPE
3. UCL Statistical Science and PRIMENT Clinical Trials Unit UCL, Gower Street, London WC1E 6BT
4. Personal Social Services Research Unit, London School of Economics & Political Science, Houghton Street, London, WC2A 2AE
5. King’s College London, Institute of Psychiatry Psychology and Neuroscience, De Crespigny Park, London SE5 8AF
6. Essex Partnership University NHS Foundation Trust, Essex, UK
7. UCL, Institute of Neurology Gower Street, London WC1E 6BT

Corresponding author g.livingston@ucl.ac.uk

Abstract

Background

START (STrAtegies for RelaTives) intervention reduced depressive and anxiety symptoms of family carers of people with dementia at home over two years and was cost-effective.

Aims

To assess clinical-effectiveness over six years and impact on costs and care home admission.

Methods

We conducted a randomised, parallel group, superiority trial recruiting from 04/11/2009 to 08/06/2011 with six year follow-up. 260 self-identified family carers of people with dementia were randomised 2:1 to START, an eight-session manual-based coping intervention delivered by supervised psychology graduates or Treatment as Usual (TAU). The primary outcome was affective symptoms (hospital anxiety and depression total score; HADS-T), and secondary outcomes included patient and carer service costs, and care home admission.

Results

222 (85.8%) of 173 carers randomised to START and 87 to TAU, were included in the 6-year analyses. Over 72-months, the intervention group HADS-T scores were lower compared to TAU (adjusted mean difference -2.00; 95% Confidence Interval [CI]: -3.38 to -0.63). In the final year, median patient-related costs were £5759 and £16964 ($p=0.07$), and median carer-related costs were £377 and £274 in intervention and TAU groups respectively. There were no significant group differences in time until care home admission [Intensity ratio START:TAU = 0.88 (CI: 0.58 to 1.35)].

Conclusions

START is clinically effective and this effect lasts for six years without increasing costs. This is the first intervention for which such a long-term clinical and possible economic benefit has been demonstrated. It has potential to make a difference to individual carers whilst not increasing costs.

Declarations of interest

None

Word count 249

Trial Registration: ISCTRN 70017938

Introduction

Families provide most of the care to people with dementia living at home and family carers have worse physical health, more absences from work, lower quality of life and are more likely to be anxious or depressed than non-carers(1-4). Currently around 50 million people globally have dementia, projected to nearly triple by 2050, while the present annual global cost is US\$818 billion(5). Nearly 85% of costs are family and social rather than medical costs(6).

The START (STrAtegies for RelaTives) multicomponent intervention for family carers, individually delivered by supervised non-clinically trained psychology degree graduates, was tested by our research team in a randomised controlled trial and was the first to show both clinical-effectiveness (reduced anxiety and depressive symptoms, decreased depression caseness, improved quality of life) and cost-effectiveness for family carers of people with dementia(7, 8). We found that START carers' decrease in symptom score was greater than the minimum clinically important difference and at 8 months they were one fifth as likely to have case-level depression as controls. These benefits persisted for two years(9), when the intervention was also cost-neutral (9). To the best of our knowledge, there are no clinically and cost-effective interventions for family carers with effects known beyond five years(10) (11, 12), and none are manualised; so the intervention can be delivered consistently to participants; by graduates without clinical training, with potential to implement at scale.

Objectives

Our aim is to determine the long-term (up to 6 years from baseline) clinical effectiveness of START for family carers' affective symptoms and costs compared to Treatment as Usual (TAU) in terms of:

- 1) Primary outcome
 - Total HADS score (hospital anxiety and depression total score; HADS-T) in carers of people with dementia
- 2) Secondary outcomes
 - Anxiety and depression caseness and scores
 - Time until care home admission and death of the person with dementia
 - Time spent at home
 - Cost of care for both people with dementia and carers

Methods

We registered a trial protocol before recruitment began <https://doi.org/10.1186/ISRCTN70017938>. Methods and results up to two years follow-up are reported in detail elsewhere (7-9, 13, 14). We requested from funders and ethics committee, and were granted a no-cost extension to the trial, registered this with ISCTRN prior to analysis, to consider longer term outcome. The primary outcome was defined as repeated measures of the HADS-T. A standard reporting protocol was used.

Intervention and delivery

We developed the eight-session START manual-based individual coping intervention for dementia family carers from the American "Coping with Caregiving"(15). We trained and supervised psychology graduates to deliver the intervention (see supplementary figure 1), and PR supervised them clinically as a group with additional time

available for individual support. There was a strong practical focus in the training programme on how to deliver the therapy, potential clinical dilemmas, empathic listening, effective use of supervision, safe working practice and when to ask for help. They were trained to adhere to the manual and we used role-play, with senior members of the team completing a competency checklist, to ensure they could deliver each session competently. We monitored intervention fidelity using a checklist out of a possible five points, and it was satisfactory. Therapists worked with carers to identify individual difficulties, find workable solutions rather than give answers or recommendations. They then implemented strategies including: behavioural management, communication strategies, identifying and changing unhelpful thoughts, positive reframing, accessing support, future planning and increasing pleasant events. Each session included a relaxation exercise and we asked carers to practice the individualised strategies and relaxation between sessions. The final session was used to agree a plan of what to do in future based upon what that carer had felt worked. The carer kept their own manual and relaxation CDs.

In summary, START is a parallel-group, superiority, single-blind, randomised controlled trial (RCT) conducted in the UK (four sites). Participants were selected from varied clinical services, so we could see if the intervention was generalisable- a mental health trust in a large city; a trust in a semi-rural area, a tertiary neurological clinic for rare and young-onset dementia; and a mental health trust where patients were allocated to a specialist nurse (Admiral Nurse). We recruited 260 participants to the study, to fulfil the power requirements of the 8-month study. We recruited self-identified family carers providing at least weekly support to people with a clinical diagnosis of dementia, living in their own homes and referred to the service we recruited from during the previous year. We excluded those who were unable to give informed consent or who lived more than 1.5 hours travelling time from the researchers' base. We recruited from 04/11/2009 to 08/06/2011 through three mental health trusts and a tertiary neurology clinic. Last follow up was 28/04/2017. Standard treatment includes medical, psychological and social interventions, consisting of assessment, diagnosis and information-giving, risk assessment and management (e.g. fire, driving, adequate nutrition and self-care, vulnerability, managing money), drug treatment, cognitive stimulation therapy, practical support, treatment of neuropsychiatric and cognitive symptoms, assessment of capacity, help in making long-term decisions, and carer support. Patients in both groups received TAU and we have described service use in both groups in detail(16).

Randomisation and masking

Participants were randomised 2:1 to intervention: TAU, in order to maintain study power given the potential for clustering of outcomes by therapist in the intervention arm. Randomisation was stratified by centre using random permuted blocks via an online computer-generated randomisation system from an independent Clinical Trials Unit. Assessors were blinded to randomisation status, but study participants knew their allocation.

Outcome measures

We collected carer and patient socio-demographic details at baseline and we measured dementia severity using the clinical dementia rating (CDR)(17). We also administered the Neuropsychiatric Inventory (NPI)(18), as neuropsychiatric symptoms are associated with carer psychological morbidity, and the Zarit burden interview(19). Each item is scored as the product of severity and frequency giving a potential score of 0-12 and scores are summed giving a possible total from 0-144. Higher scores indicate more neuropsychiatric symptoms and more burden, respectively. We also measured carers' anxiety and depressive symptoms, using the Hospital Anxiety and Depression Scale HADS(20, 21) at

baseline, 4, 8, 12 and 24 months. In an agreed extension with our funders and ethics committees, we continued to collect carer HADS scores and place of residence for patients six-monthly from 24 until 72 months. We recorded the date that a patient was admitted to a care home or had died, and stopped measuring the HADS at that point. HADS is a scale, validated for all age groups and settings, in people who are physically well or ill, and in Asian and African ethnic groups(19); summarised as HADS-D (depression) HADS-A (anxiety) with scores from 0 to 21 and a total HADS score (HADS-T) from 0 to 42 (higher scores indicating more symptoms). The total score (HADS-T) is our chosen primary outcome as it has better sensitivity and positive predictive value than either of the individual scales in identifying depression, when compared to International Classification of Diseases (ICD) depression diagnosis criteria(21). HADS-D and HADS-A are also validated as scores for “caseness” and were dichotomised as “case” and “non-case”, with a cut-point of ≥ 9 (19).

The Client Service Receipt Inventory (CSRI)(22) measured health and social care service use retrospectively until 24 months, but not beyond that point. Each carer reported their own and the patient’s service use over the previous 4 months, covering the full range of services (8). Service contacts were multiplied by their unit costs (2009-10 prices) obtained from publicly available sources: NHS reference costs(23) for inpatient and outpatient attendances, and the PSSRU volume(24) for other services. Costs were discounted to present values at an annual rate of 3.5% (25).

Statistical analysis

Analyses were conducted based on intention to treat using a predefined statistical analysis plan. Most analyses were carried out using STATA (version 14), but some models (as detailed) were fitted using R.

HADS scores

HADS data included in the primary 72-month analysis are those collected while the carer was still actively looking after the patient (i.e. patient was still living at home). Data collected after the patient had died or was admitted to a care home was excluded.

To be included in the primary long term analysis, the individual must have had at least one follow-up HADS-T score. Those excluded therefore have no follow-up measurements at any time point (so had died or withdrawn by 4 month; see consort diagram). For those with available HADS-T data, we compare the group as randomised, regardless of the number of therapy sessions attended in the intervention group (an intention to treatment comparison).

We used mixed effects linear regression models to assess the effect of the START intervention on repeated measurements of HADS-T over 72 months. Initially we adjusted for treatment centre, HADS-T at baseline and time but then extended this model to include adjustments for carer age, carer sex, baseline NPI score and Zarit score. We also investigated whether the treatment effect changed over time by including a treatment by time interaction. We chose not to allow for therapist clustering in these models since previous analyses of data up to 24 months had indicated that clustering effects were negligible. As a sensitivity analysis however models were refitted allowing for therapist clustering. For all cases estimates obtained were not substantially different.

We used scatter plots of residuals and fitted values to check model assumptions. The correlation structure assumed in the main analyses was compound symmetry; however, models were refitted in sensitivity analyses with alternative

structures (autoregressive (order 1) and linear spatial correlation assumptions). For all models these investigations supported the models used for the main analyses.

Using logistic regression we also investigated whether those randomised subjects excluded from the modelling of HADS (i.e. those with no HADS outcome data) had significantly different baseline characteristics when compared with those included and planned to adjust the main analyses of HADS-T for such significant factors in a sensitivity analysis. These models identified baseline NPI and Zarit burden scores as significantly related to higher odds of dropping out (Odds ratio (OR) 1.018;95% CI 1.001, 1.035; OR 1.023 with 95% CI 1.002, 1.044 respectively. Adjustment for baseline NPI and Zarit scores did not substantially impact on the results.

The analyses described for the HADS total score were repeated for anxiety and depression subscales of the HADS. We investigated the effect of the START intervention on the occurrence of cases of anxiety/depression, using mixed effects logistic regression models, with a participant-level random effect.

If care home admission or death of the care recipient occurred prior to 72 months, the carer was not followed-up beyond the last visit prior to death or care home admission. Given the possibility of a relationship between HADS scores and death/care home admission, we conducted sensitivity analyses to consider the impact of such informative censoring. Joint mixed effect models for the longitudinal HADS scores and time to institutionalisation or death were fitted to account for the correlation between the longitudinal and survival outcomes(26). The HADS component treatment effect estimates were compared with those obtained from the previously fitted mixed models. [Note: Joint models were fitted using the JM package in R(27)].

Time until care home admission

We employed a multi-state model (depicted pictorially in supplementary Figure 2)(28) to analyse time until care home admission while accounting for the possibility of patient death. The model was set up to allow transition from living at home to one of two states, care home admission or death. Effect estimates from the model are 'intensity ratios' which are analogous to hazard ratio estimates in a Cox proportional hazards model but pertain to the specific transitions within the multi-state model. As before, models were fitted adjusting for centre, carer age, carer sex, baseline NPI and Zarit score. [Note: Multi state models were fitted using the msm package in R(28)].

Time spent at home

In a further analysis of patient time spent at home (i.e. prior to care home admission or death), we fitted models for time to admission or death using a standard survival analysis. We used a log rank test to compare the randomised groups and then fitted a Cox regression model to provide a treatment effect estimate adjusted for centre, carer age, carer sex, baseline HADS total, baseline NPI total and Zarit total score.

Costs

Costs of services used by patients and carers were estimated up to the earliest of either their withdrawal from the study, death of either the patient or carer, or end of the follow-up period (72 months). For patients who remained at home, costs of NHS and social care services used by them or their carers were extrapolated from the last complete year of data (in most cases, 12-24 months post-randomisation). For patients admitted to care homes, unit costs of care home residence were applied for the duration of stay, and we assumed that carer service use costs would continue. Costs were carried forward as long as the patient/carers remained alive. In an initial analysis, the difference

in costs between treatment arms at 72 months was assessed statistically using the non-parametric Wilcoxon Rank-Sum test(29).

Patient involvement

This study was devised and conducted with patient and public involvement (PPI) and representatives on the management and steering group. They helped shape the original questions, added qualitative questions about the experience and took part in interpreting the findings. They have also presented them.

Results

Participant flow and recruitment

The Consort diagram (Figure 1) shows participant flow through the study. We randomised 260/472 (55%) of the carers referred; 173 (67%) participants to intervention and 87 (33%) to TAU. Others refused (n=181; 38%), did not meet inclusion criteria (n=22; 5%) or were uncontactable (n=9, 2%). The characteristics of the randomised groups generally achieved good balance in terms of socio-demographic and clinical characteristics (see supplementary table 1). Carers were mostly spouses/partners (109; 42%) or children (113; 44%). The proportions of patients who died (before they were admitted to a care home), were admitted to care homes and withdrew by randomised group is shown in supplementary table 2. There is no evidence of significant differences in the proportions of participants in each end-status category between the START and TAU groups.

Intervention adherence and fidelity

130 (75%) carers in the intervention group attended ≥ 5 therapy sessions, 8 (5%) withdrew before any therapy sessions. Ten therapists delivered the intervention, to between 11 and 32 carers each. The mean fidelity score was 4.7 (SD 0.66).

Primary outcome

Table 1 summarises HADS-T scores at each follow-up point. Analysis of HADS-T, adjusting for centre, baseline score, time and factors related to outcome (carer age and sex, NPI, Zarit) over the 6-year period, showed an average improvement in HADS-T of 2.00 points compared with TAU (95% CI: -3.38 to -0.63; $p=0.005$) (Table 2). In the model adjusting only for centre, baseline score and time, average score decrease was smaller but still significant and in favour of the intervention group (Table 2). A model including an interaction with time showed no evidence of differential effects of the intervention over time ($p=0.98$).

Secondary outcomes

Depression and anxiety caseness and scores

In the fully adjusted analyses there was a reduced odds of HADS-depression caseness in the intervention group compared to TAU, (OR =0.20 (95% CI: 0.08 to 0.52), $p = 0.001$). Reduction in HADS-anxiety caseness however was not significant (OR= 0.50, 95% CI: 0.24 to 1.07, $p = 0.07$) (Table 2).

Fully adjusted models for HADS-A and HADS-D continuous scores indicated significant beneficial intervention effects over 6 years, with average decreases of -0.97 (95% CI= -1.78 to -0.15,) and -1.06 (95% CI-1.78 to -0.35) respectively. Models showed no evidence of differential intervention effects with time for HADS-A or HADS-D ($p= 0.98$ and $p=0.94$, respectively).

Adjusted joint models were used as sensitivity analyses to allow for the possibility of a relationship between HADS scores and time to care home admission or death gave similar results to previous models for HADS-T, HADS-D and

HADS-A (HADS-T: 2.01 (95% CI -3.38 to -0.63), HADS-D: -1.07 (-1.78 to -0.37)), HADS-A: -0.97 (-1.78 to -0.16)). This suggests that censoring by death/care home admission is not problematic.

Analysis of time until patient care home admission and death

Figure 2 shows the cumulative incidence of care home admission and death over time by randomised group. The multi-state model adjusted for centre, carer age, carer sex, baseline HADS-T, baseline NPI and baseline Zarit gave intensity ratios for the START intervention versus TAU of 0.88 (95% CI 0.58 to 1.35) for the home-to-care-home transition and 0.81 (95% CI 0.50 to 1.30) for the home-to-death transition.

Analysis of time spent at home

Based on Kaplan Meier estimates, the estimated median time spent at home (i.e. time until death or institutionalisation) for the TAU group was 39.0 months (95% CI 31.1 to 49.4) and for START was 42.2 months (95% CI 33.3 to 54.7). Cox regression with adjustments for centre, carer age, baseline HADS total, NPI score and Zarit score, showed no evidence of a difference between the randomised groups (hazard ratio estimate: 0.81 (95% CI 0.59 to 1.11)).

Costs

Costs for carer and patient service use are shown in Table 3. Costs of services used by patients were much higher than costs for services used by carers across the full study period. In the final year of follow-up (61-72 months) median patient service use costs were £16,964 for TAU and £5,759 for START ($p=0.072$). Median carer service use costs were £377 for TAU and £274 for START.

Discussion

Main findings

This is the first RCT to demonstrate that family carers of people with dementia referred to specialist care experience benefits from an intervention delivered by supervised psychology graduates in terms of depression and anxiety symptoms and depression caseness, not only in the short-term but for up to 6 years. The difference is small but is statistically significant, greater than the minimally clinically important difference (that which is clinically significant to patients) and is sustained (30). The difference in costs appears to be economically large (cost per patient in the intervention group is around a third of the cost in the treatment as usual group) although there was no significant difference in time to care home admission or death. The reduced sample size, however, means that the test for differences in cost is underpowered (particularly given highly skewed cost data), but the estimated costs of health and care services used by patients appear to be lower for the intervention group compared to treatment as usual in the final year of follow-up. It is encouraging that this intervention does not therefore increase costs, and might actually be cost-saving. Carers in the control group were five times more likely to have clinically significant depression on a rating scale validated against caseness using ICD criteria. Predictably, health and social care costs increase over time for both groups, as a result of the worsening condition. There is a bigger increase in TAU group.

Strengths and limitations

The trial is randomised, with blinded follow-ups. The intervention was manual-based, standardised and supervised. High fidelity ratings and very low inter-cluster correlations show the results do not differ according to therapists, suggesting that the intervention can be delivered consistently.

We planned a pragmatic trial to include all family carers who presented to services so they had varied sociodemographic and clinical characteristics and came from a variety of services; consequently, our study has some external generalisability, that is, it suggests the intervention can be used in a variety of NHS settings. We did not have the power to analyse whether this intervention was more effective in subgroups; for example, those with more education or without a mental health history or with more family support. As this is a follow up of the original trial we do not have any data on unintended harms but the service use and mortality data do not suggest harm. At the time of the START intervention most patients had only recently presented to services and thus the intervention can be offered at the beginning of the patient pathway but may not be applicable to those who have had the diagnosis for many years. It was preventative and improved depression and so can be offered to those with and without depression (7). START's preventative effect highlights that carers can benefit from early intervention. A previously published qualitative analysis confirmed that carers used different components of the intervention and some continued to use these consciously over two years but we did not ask about this at six year follow up(14). Only patient care home admission and death and carer HADS were directly collected after 2 years and therefore the economic analysis involved modelling. Although the differences in costs were striking, the nature of dementia which inevitably meant attrition by death of some of those with it over six years, meant the numbers were smaller. Additionally, the data was skewed and they only approached the usual level taken as significant.

Comparison with other studies, meaning and implications

The practical nature of the intervention, in which carers were encouraged to develop and continue to use successful strategies, might also account for the longevity of the positive effects on carer mental health that we found – the most successful strategies were likely to be used repeatedly and therefore remembered and integrated into caring routines. The intervention included a final session on planning for the future. It is likely that the nature of caring difficulties will have evolved over six years. Intervention group participants were given a manual in which strategies they had found helpful for managing caring challenges, pleasant events were logged, and they were given relaxation exercises recordings, to refer to during future caring.

Our findings suggest that carers were able to continue using the skills and strategies they had practised, in the longer term. A focus on planning for the future, accessing support, and explicit consideration of how difficulties may change and emotion-focused and acceptance-based strategies, might have helped support this. It is also possible that carers revisited previously less personally relevant aspects of the manualised intervention as certain issues or challenges became more salient to their caring.

Many interventions for family carers of people with dementia have not worked in improving mood (31-33). Others have been effective but the effects have not been sustained(34). Most have not considered prevention. In general those that have been effective are multicomponent and delivered to individuals rather than groups for at least six sessions (35) (36) and our study was designed to follow this model. Some earlier interventions for family carers have

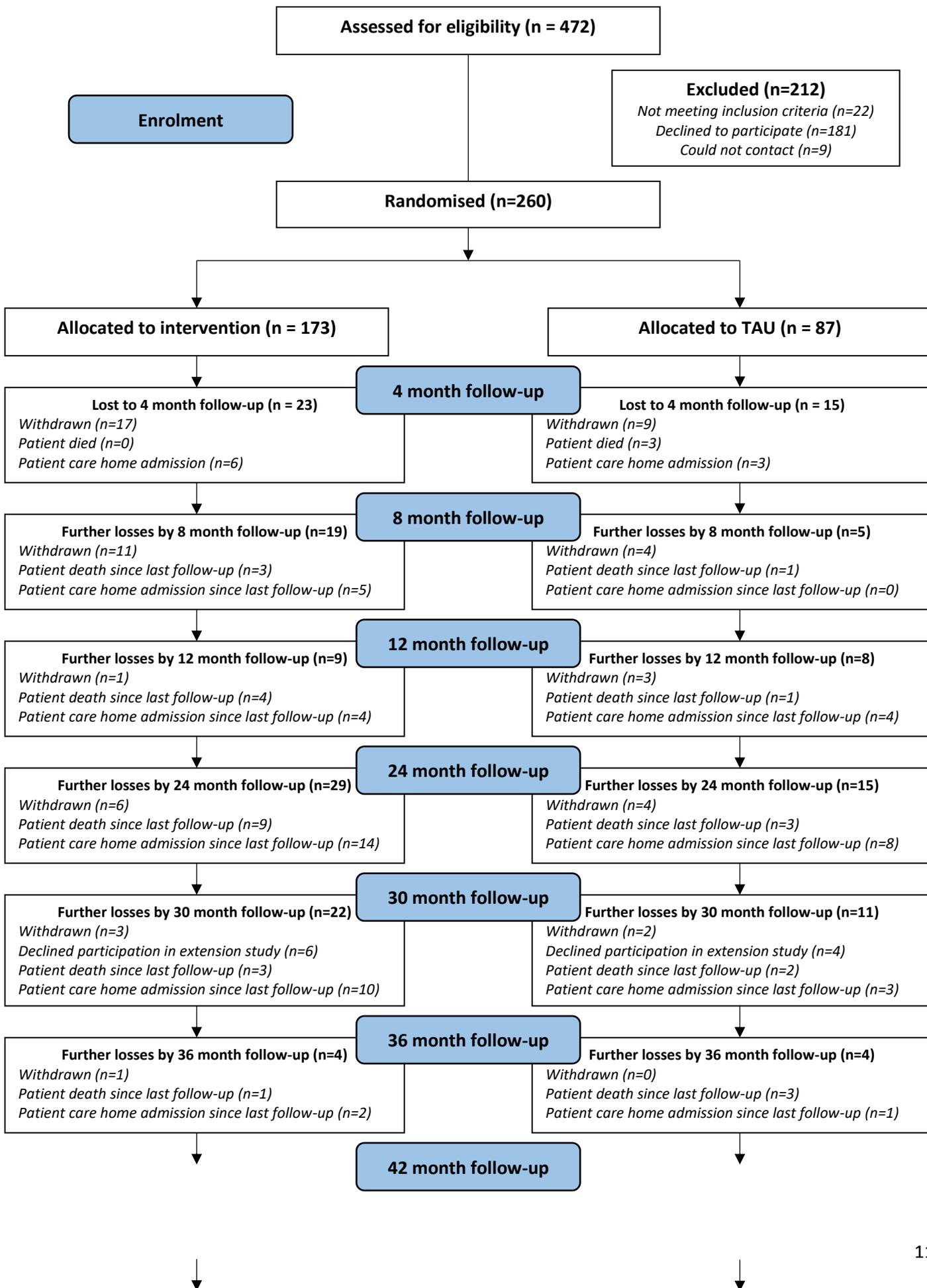
been effective and had sustained effects which have continued for between one and five years(10) (11, 12). Our study is in line with this but because it is manual-based and delivered by non-clinically trained psychology graduates it is designed to be scalable and practical and has economic findings to support this. We have more fully considered cost than most other studies although there is some evidence that interventions can generate saving(37) (38). There is little evidence that carer stress predicts care home admission in community-dwelling older people in general (39) but psychological interventions for family carers may reduce care home admission for people living with dementia, with a meta-analysis of the best-quality studies finding a significant reduction in the odds of care home admission, although the time to admission difference did not reach significance(40). Family carers become more anxious and depressed over time without intervention; thus we included carers who were not depressed at presentation (3, 4).

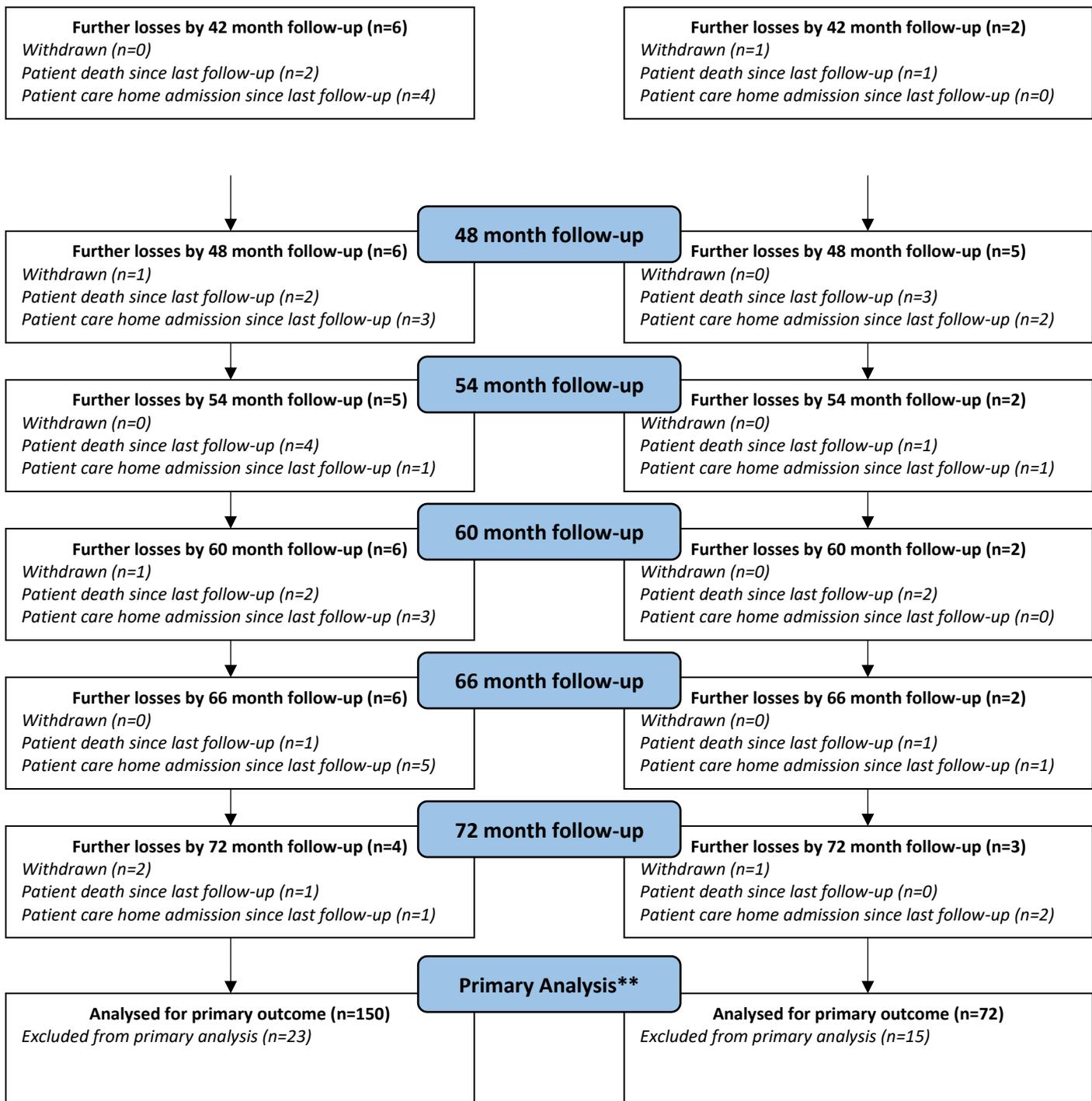
Future research

The START intervention is clinically effective, improving carer mood over six years. It does not increase patient or carer service-related costs and thus should be available. The numbers of people with dementia and the diversity of culture, geographic location and available resources mean that further research is necessary to widen access and optimise implementation. For example, to consider whether the intervention can be delivered remotely (through a skype or similar application), through existing voluntary sector carer support infrastructure (as some carers do not see themselves as patients) and be adapted for ethnic groups, different cultures and different countries.

Word count 3996

Figure 1: CONSORT diagram for long-term outcomes (up to 72 months)*.





* HADS data included in the primary 72 month analysis are collected while the carer was still looking after the patient at home. Prior to 24 months, carers were followed up for HADS even after the patient had died or had been admitted to a care home. After 24 months, follow up was terminated when the patient died or was no longer at home. For the purposes of the six year follow-up analysis, observation of HADS has been censored for all patients if either death or care home admission occurred. ** To be included in the primary long term analysis, the individual must have at least one follow up score available for the HADS total.

Cumulative incidences of care home admission and death (stratified by treatment group)

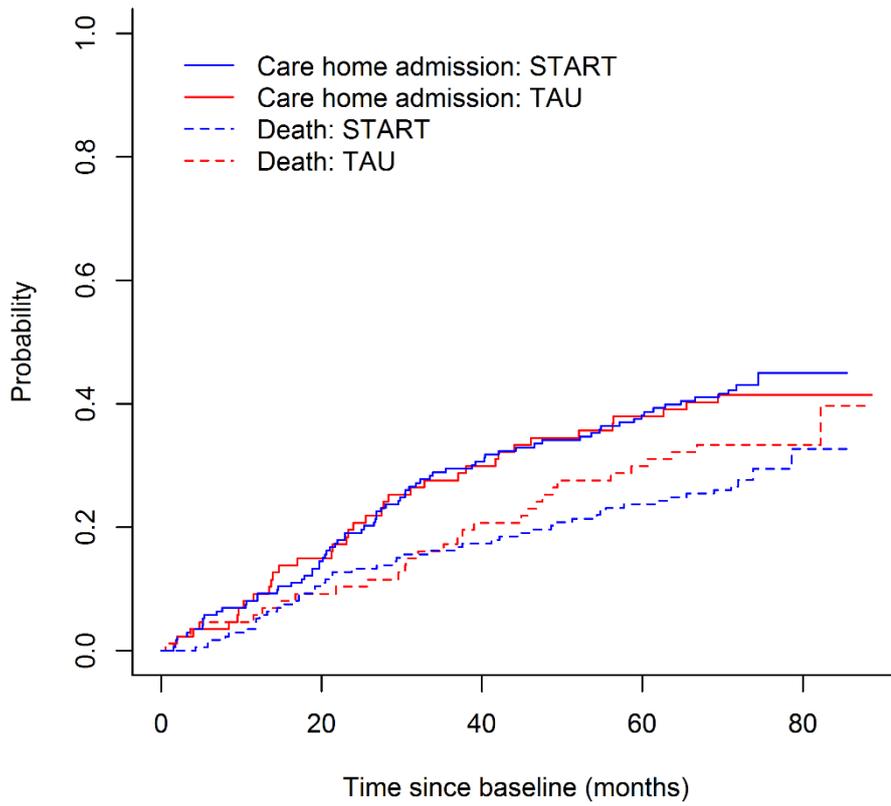


Figure 2: Plot of estimated cumulative incidence functions for the events ‘care home admission’ and ‘death’ over time, stratified by treatment group.

Table 1: Summaries of HADS total score at each follow-up time by treatment group.

| Follow-up time (month) | Group | Number of observations (n) | Mean (SD) |
|-------------------------------|--------------|-----------------------------------|------------------|
| 0 | TAU | 87 | 14.8 (7.4) |
| | START | 172 | 13.5 (7.3) |
| 4 | TAU | 70 | 14.3 (7.6) |
| | START | 146 | 12.3 (7.3) |
| 8 | TAU | 67 | 14.9 (8.1) |
| | START | 125 | 12.8 (7.9) |
| 12 | TAU | 57 | 15.1 (9.0) |
| | START | 122 | 12.5 (7.8) |
| 24 | TAU | 44 | 15.6 (8.7) |
| | START | 93 | 12.7 (7.2) |
| 30 | TAU | 33 | 15.5 (7.8) |
| | START | 65 | 13.0 (7.5) |
| 36 | TAU | 28 | 15.6 (7.5) |
| | START | 65 | 12.3 (7.3) |
| 42 | TAU | 27 | 15.7 (8.7) |
| | START | 59 | 13.8 (8.0) |
| 48 | TAU | 22 | 16.5 (8.9) |
| | START | 54 | 13.2 (7.3) |
| 54 | TAU | 20 | 16.2 (7.6) |
| | START | 49 | 12.1 (7.0) |
| 60 | TAU | 18 | 17.3 (10.3) |
| | START | 44 | 12.3 (8.0) |
| 66 | TAU | 15 | 15.1 (9.5) |
| | START | 38 | 13 (7.9) |
| 72 | TAU | 13 | 17.5 (11.1) |
| | START | 34 | 12.5 (9.0) |

Table 2; Estimates of the effect of the START intervention compared with TAU on HADS measures over 6 years.

| HADS measure | Estimates comparing intervention and TAU | |
|-----------------------------|--|--|
| | Adjusted for centre, baseline score and time (n=222) | Adjusted for centre, baseline score, time, age, sex, NPI & Zarit (n=213) |
| | Difference in means (95% CI) | |
| HADS-T (total score) | -1.45 (-2.80 to -0.10) | -2.00 (-3.38 to -0.63) |
| HADS-D | -0.93 (-1.63 to -0.24) | -1.06 (-1.78 to -0.35) |
| HADS-A | -0.58 (-1.39 to 0.22) | -0.97 (-1.78 to -0.15) |
| | Odds ratio (95% CI) | |
| HADS-D caseness | 0.30 (0.13 to 0.71) | 0.20 (0.08 to 0.52) |
| HADS-A caseness | 0.64 (0.31 to 1.32) | 0.50 (0.24 to 1.07) |

Table 3: Annual costs of services used by carers and patients, by year, from 25 to 72 months

| Time period | Services for patient or carer | Intervention | | | Treatment as usual | | |
|-----------------|-------------------------------|--------------|--------|----------------------|--------------------|--------|----------------------|
| | | N | Median | Inter-quartile range | N | Median | Inter-quartile range |
| 25 to 36 months | Carer | 82 | 364 | 132 to 704 | 35 | 269 | 103 to 622 |
| | Patient | 109 | 5764 | 1922 to 18,869 | 54 | 5303 | 1573 to 21,866 |
| 37 to 48 months | Carer | 83 | 402 | 130 to 702 | 35 | 279 | 166 to 601 |
| | Patient | 94 | 6098 | 1767 to 20,219 | 44 | 7200 | 1452 to 22,346 |
| 49 to 60 months | Carer | 73 | 390 | 137 to 666 | 28 | 274 | 178 to 587 |
| | Patient | 83 | 4619 | 1744 to 23,116 | 33 | 16,574 | 1524 to 24,920 |
| 61 to 72 months | Carer | 53 | 377 | 184 to 635 | 24 | 274 | 191 to 587 |
| | Patient | 68 | 5759 | 1892 to 18,254 | 30 | 16,964 | 2369 to 24,077 |

Note: Differences between groups were tested using the non-parametric Wilcoxon rank-sum test. None were statistically significant, although the difference for 61-72 months approached statistical significance (p=0.0717).

Competing interests: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: the submitted work was supported by NIHR HTA, no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work. GL, ZW and CC are supported by the UCLH NIHR Biomedical Research Centre. GL and PR were in part supported by the National Institute for Health Research (NIHR) Collaboration for Leadership in Applied Health Research and Care (CLAHRC) North Thames at Bart's Health NHS Trust. The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health.

Dr Walker reports during the conduct of the study; personal fees from GE Healthcare, grants from GE Healthcare, grants from Lundbeck, other from GE Healthcare, outside the submitted work. All other authors declare no conflicts of interest.

Transparency declaration: The lead author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

Details of contributors: GL, CC, JH, ZW, CM, PR, MK contributed to the conception and design of the study and acquisition of funding, JB, GL, A O'K, MK, DK, RR contributed to the analytic plan. JB and A O'K analysed the clinical data. MK, DK and RR analysed the economic data. GL, CC, ZW, JH and CM led recruitment from their trusts. MM collected follow-up data to 6 years. GL drafted the article and all authors revised it critically for important intellectual content and gave final approval of the version to be published. The researchers/therapists Monica Manela, Ryan Li, Elanor Lewis-Holmes, Ruth Shanley, Amy Waugh, Lynsey Kelly, Allana Austin, Peter Keohane, Shilpa Bavishi, Amanda Shulman and Jonathan Bradley collected and entered the baseline and follow-up data to 2 years and implemented the manual. Shirley Nurock gave advice throughout as an expert family carer. GL will act as guarantor

The trial was conducted in accordance with Good Clinical Practice guidelines, the Declaration of Helsinki, the Clinical Trials Regulations and local laws and regulations. We obtained written ethics approval for the study from East London and the City Research Ethics Committee 1 for the trial (ID: 09\H0703\84) and Research and Development permission from the local trusts. All participants gave written informed consent.

Funding statement: This project was funded by the National Institute for Health Research Health Technology Assessment (NIHR HTA) Programme (project number 08/14/06). The authors analysed results and prepared this manuscript independently of the funding body.

The views and opinions expressed therein are those of the authors and do not necessarily reflect those of the HTA programme, NIHR, NHS or the Department of Health. The study was sponsored by UCL. Neither funders nor sponsors had a role in the study design and the collection, analysis, and interpretation of data and the writing of the article and the decision to submit it for publication. The researchers were independent from funders and sponsors. All researchers could access all the data.

All authors, external and internal, had full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

Data sharing: no additional data available

Reference List

1. Mahoney R, Regan C, Katona C, Livingston G. Anxiety and depression in family caregivers of people with Alzheimer disease: the LASER-AD study. *Am J Geriatr Psychiatry*. 2005;13(9):795-801.
2. Cooper C, Balamurali TB, Livingston G. A systematic review of the prevalence and covariates of anxiety in caregivers of people with dementia. *Int Psychogeriatr*. 2007;19(2):175-95.
3. Goren A, Montgomery W, Kahle-Wroblewski K, Nakamura T, Ueda K. Impact of caring for persons with Alzheimer's disease or dementia on caregivers' health outcomes: findings from a community based survey in Japan. *BMC Geriatr*. 2016;16(1):122.
4. Livingston G, Sommerlad A, Orgeta V, Costafreda SG, Huntley J, Ames D, et al. Dementia prevention, intervention, and care. *Lancet*. 2017;390(10113):2673-734.
5. Prince M, Wimo A, Guerchet M, Ali G, Wu YT, M P. World Alzheimer Report 2015 - The Global Impact of Dementia: An analysis of prevalence, incidence, cost and trends. London; 2015 2015.
6. Winblad B, Amouyel P, Andrieu S, Ballard C, Brayne C, Brodaty H, et al. Defeating Alzheimer's disease and other dementias: a priority for European science and society. *Lancet Neurol*. 2016;15(5):455-532.
7. Livingston G, Barber J, Rapaport P, Knapp M, Griffin M, King D, et al. Clinical effectiveness of a manual based coping strategy programme (START, STRategies for RelaTives) in promoting the mental health of carers of family members with dementia: pragmatic randomised controlled trial. *BMJ*. 2013;347:f6276.
8. Knapp M, King D, Romeo R, Schehl B, Barber J, Griffin M, et al. Cost effectiveness of a manual based coping strategy programme in promoting the mental health of family carers of people with dementia (the START (STRategies for RelaTives) study): a pragmatic randomised controlled trial. *British Medical Journal*. 2013;347:f6342.
9. Livingston G, Barber J, Rapaport P, Knapp M, Griffin M, King D, et al. Long-term clinical and cost-effectiveness of psychological intervention for family carers of people with dementia: a single-blind, randomised, controlled trial. *Lancet Psychiatry*. 2014;1(7):539-48.
10. Sorensen S, Duberstein P, Gill D, Pinquart M. Dementia care: mental health effects, intervention strategies, and clinical implications. *Lancet Neurol*. 2006;5(11):961-73.
11. Mittelman MS, Roth DL, Coon DW, Haley WE. Sustained benefit of supportive intervention for depressive symptoms in caregivers of patients with Alzheimer's disease. *Am J Psychiatry*. 2004;161(5):850-6.
12. Mittelman MS, Roth DL, Clay OJ, Haley WE. Preserving health of Alzheimer caregivers: impact of a spouse caregiver intervention. *Am J Geriatr Psychiatry*. 2007;15(9):780-9.
13. Li R, Cooper C, Barber J, Rapaport P, Griffin M, Livingston G. Coping strategies as mediators of the effect of the START (strategies for RelaTives) intervention on psychological morbidity for family carers of people with dementia in a randomised controlled trial. *J Affect Disord*. 2014;168C:298-305.
14. Sommerlad A, Manela M, Cooper C, Rapaport P, Livingston G. START (STRategies for RelaTives) coping strategy for family carers of adults with dementia: qualitative study of participants' views about the intervention. *BMJ Open*. 2014;4(6):e005273.
15. Gallagher-Thompson D, Solano N, McGee JS, Krisztal E, Kaye J, Coon DW, et al. Coping with Caregiving: Reducing Stress and Improving Your Quality of Life.; 2002 2002.
16. Knapp M, King D, Romeo R, Schehl B, Barber J, Griffin M, et al. Cost effectiveness of a manual based coping strategy programme in promoting the mental health of family carers of people with dementia (the START (STRategies for RelaTives) study): a pragmatic randomised controlled trial. *Bmj-British Medical Journal*. 2013;347.
17. Morris JC. Clinical dementia rating: a reliable and valid diagnostic and staging measure for dementia of the Alzheimer type. *Int Psychogeriatr*. 1997;9 Suppl 1:173-6.
18. Cummings JL, Mega M, Gray K, Rosenberg-Thompson S, Carusi DA, Gornbein J. The Neuropsychiatric Inventory: comprehensive assessment of psychopathology in dementia. *Neurology*. 1994;44(12):2308-14.
19. Bjelland I, Dahl AA, Haug TT, Neckelmann D. The validity of the Hospital Anxiety and Depression Scale. An updated literature review. *J Psychosom Res*. 2002;52(2):69-77.
20. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr Scand*. 1983;67(6):361-70.
21. Spinhoven P, Ormel J, Sloekers PPA, Kempen GIJM, Speckens AEM, VanHemert AM. A validation study of the Hospital Anxiety and Depression Scale (HADS) in different groups of Dutch subjects. *Psychological Medicine*. 1997;27(2):363-70.
22. Beecham J KM. Costing psychiatric intervention. In: Thornicroft C BC, Wing J, . editor. *Measuring Mental Health Needs*. London: Gaskell; 1992.
23. Lawlor B, Segurado R, Kennelly S, Olde Rikkert MGM, Howard R, Pasquier F, et al. Nilvadipine in mild to moderate Alzheimer disease: A randomised controlled trial. *PLoS Med*. 2018;15(9):e1002660.

24. Curtis L. The Unit Costs of Health and Social Care 2010 2011 [updated 1/1/2011. Available from: www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_123459).
25. NICE. *Guide to the methods of technology appraisal*. London; 2013 2004.
26. Henderson R, Diggle P, Dobson A. Joint modelling of longitudinal measurements and event time data. *Biostatistics*. 2000;1(4):465-80.
27. Rizopoulos D. JM:An R package for the joint modelling of longitudinal and time-to-event data. *Journal of Statistical Software*.35(9).
28. Meira-Machado L, de Una-Alvarez J, Cadarso-Suarez C, Andersen PK. Multi-state models for the analysis of time-to-event data. *Stat Methods Med Res*. 2009;18(2):195-222.
29. Wilcoxon F. Individual comparisons of grouped data by ranking methods. *J Econ Entomol*. 1946;39:269.
30. Puhan MA, Frey M, Buchi S, Schunemann HJ. The minimal important difference of the hospital anxiety and depression scale in patients with chronic obstructive pulmonary disease. *Health Qual Life Outcomes*. 2008;6:46.
31. Farran CJPOCFECDRKBEANaM. Impact of an Individualized Physical Activity Intervention on Improving Mental Health Outcomes in Family Caregivers of Persons with Dementia: A Randomized Controlled Trial. *AIMS Medical Science*. 2015;- 3(- 1):- 31.
32. Charlesworth G, Shepstone L, Wilson E, Reynolds S, Mugford M, Price D, et al. Befriending carers of people with dementia: randomised controlled trial. *BMJ*. 2008;336(7656):1295-7.
33. Waldorff FB, Buss DV, Eckermann A, Rasmussen ML, Keiding N, Rishoj S, et al. Efficacy of psychosocial intervention in patients with mild Alzheimer's disease: the multicentre, rater blinded, randomised Danish Alzheimer Intervention Study (DAISY). *BMJ*. 2012;345:e4693.
34. Moore RC, Chattillion EA, Ceglowski J, Ho J, von Känel R, Mills PJ, et al. A randomized clinical trial of Behavioral Activation (BA) therapy for improving psychological and physical health in dementia caregivers: Results of the Pleasant Events Program (PEP). *Behaviour Research and Therapy*. 2013;51(10):623-32.
35. Selwood A, Johnston K, Katona C, Lyketsos C, Livingston G. Systematic review of the effect of psychological interventions on family caregivers of people with dementia. *Journal of Affective Disorders*. 2007;101(1-3):75-89.
36. Dickinson C, Dow J, Gibson G, Hayes L, Robalino S, Robinson L. Psychosocial intervention for carers of people with dementia: What components are most effective and when? A systematic review of systematic reviews. *Int Psychogeriatr*. 2017;29(1):31-43.
37. Knapp M, Lemmi V, Romeo R. Dementia care costs and outcomes: a systematic review. *International Journal of Geriatric Psychiatry*. 2012:n/a-n/a.
38. Clarkson P, Davies L, Jasper R, Loynes N, Challis D. A Systematic Review of the Economic Evidence for Home Support Interventions in Dementia. *Value in Health*. 2017.
39. Donnelly NA, Hickey A, Burns A, Murphy P, Doyle F. Systematic review and meta-analysis of the impact of carer stress on subsequent institutionalisation of community-dwelling older people. *PLoS One*. 2015;10(6):e0128213.
40. Spijker A, Vernooij-Dassen M, Vasse E, Adang E, Wollersheim H, Grol R, et al. Effectiveness of nonpharmacological interventions in delaying the institutionalization of patients with dementia: A meta-analysis. *Journal of the American Geriatrics Society*. 2008;56(6):1116-28.