Dementia will become the third greatest source of health and residential aged care spending within two decades (AIHW 2004). Home-based care is generally seen as the most humane and cost effective means of providing dementia care. Almost 40% percent of older adults with dementia live in the community in Australia, and most of them have informal caregiver support. The precarious nature of this relationship may be threatened, however, by poor health, isolation, depression, and anxiety in the caregivers, as well as functional decline and behavioural disturbances in their loved ones, all of which contribute to caregiver burden and heightened risk of institutionalisation (Paradise 2015).

Most people want to live at home, despite disability or dementia. Such ageing-in-place is supported by 2.5 million informal caregivers in Australia, who are critical to this goal, as 97% of older adults with disability have informal caregivers. However, increasing cognitive and physical frailty are a threat to ageing-in-place, and exacerbate caregiver burden. Importantly, caregiver depression and stress markedly increase the risk of institutionalisation of their loved one, independently of the actual level of disability or behavioural difficulties encountered. Therefore, optimum preservation of this vulnerable dyad requires innovative, cost-effective and sustainable strategies to attenuate both caregiver stress and functional decline in their loved one.

Some success has been achieved in approaches to dementia caregiver burden with programs offering education, social support, respite services or stress reduction for the caregiver (Brodaty 2007). Increasing interest has been given recently to Mindfulness-Based Stress Reduction (MBSR), which has shown promise for improving caregiver burden in a small number of RCTs, as reviewed by Jaffray (2015). Notably, such stress reduction efforts do not directly address a large component of the strain: the progressive physical dependency or behavioural disturbance of the frail elders themselves (Paradise 2015). Slowing this decline is thus critical. This is the explicit purpose of the HOMeCARE project.

Separate lines of research have demonstrated that exercise programs for those with dementia may improve physical and cognitive function, behavioural disturbance, sleep, and thereby caregiver stress (Teri 2008), although results are mixed and interventions have been varied. One recent study (Lowery 2014), found that promotion of regular walking in dementia caregiver/cared for dyads in the UK did not improve the behavioural and psychological symptoms of dementia, but did attenuate caregiver burden. However, uptake of this community-based walking was suboptimal and not sustained, and further research was recommended.

Our exercise work over the past 30 yrs by contrast has pioneered the use of high intensity progressive resistance training and balance training in this cohort to improve mobility and function (Fiatarone 1994, Morris 1999, Singh, 2012), rather than starting with walking; an approach potentially more appropriate to the deficits and needs of many elders with dementia at high fall risk. In such cohorts, walking only interventions have been shown to increase both falls and fractures. What is missing in clinical practice is an evidence-based, sustainable,

cost-effective program that can integrate these disparate approaches by simultaneously targeting modifiable functional and behavioural disturbances in the individual with dementia, while also providing caregivers with the means to cope with stress and improve their own health and well-being. In other cohorts, Internet delivery of Mindfulness training is efficacious for a variety of mental health outcomes (Hedman, 2012, Krolikowski 2013), although this approach has never been tested in dementia caregivers specifically. Internet delivery would markedly extend reach and viability, given the difficulties inherent in traveling to a centre. Similarly, delivery of robust exercise in the home setting would also be a leap forward in terms of translation of successful exercise trials to the community.

We will conduct the first randomised controlled trial investigating the efficacy of HOMeCARE: a completely novel e-Health system for the dementia caregiver/cared-for dyad. HOMeCare begins with an 8-wk Mindfulness-based Stress Reduction Training program for the caregivers. This will be followed by a 16-wk, home-based, robust strength and balance training intervention, designed to improve functional mobility and psychological wellbeing in the person with dementia, during which time the Mindfulness practice will continue to be reinforced. Together, these 2 complementary, remotely monitored interventions will combine to reduce caregiver burden and improve function in the participants with dementia compared to usual care.

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AIMS

1. Develop HOMeCare: an eHealth system for delivery of robust targeted exercise for older adults living at home with dementia integrated with Mindfulness training for their informal caregivers.
2. Implement a 6-month randomised controlled trial of HOMeCARE in 30 dementia caregiver/cared-for dyads to improve functional mobility in the older adults with dementia and perceived burden and caregiver stress in their caregivers.

OVERALL STUDY DESIGN

We will conduct the first randomised controlled trial investigating the efficacy of HOMeCARE: a completely novel e-Health system for the dementia caregiver/cared-for dyad. HOMeCARE begins with an 8-wk Mindfulness-based Stress Reduction Training program for the caregivers. This will be followed by a 16-wk, home-based, robust strength and balance training intervention, designed to improve functional mobility and psychological wellbeing in the person with dementia, during which time the Mindfulness practice will continue. Together, these 2 complementary, remotely monitored interventions will combine to reduce caregiver burden and improve function in the participants with dementia compared to usual care.

SPECIFIC AIMS

1. The primary aim of this project is to conduct the first randomised controlled trial of Mindfulness training for informal dementia caregivers combined with robust, evidence-based Resistance and Balance Exercise for older adults with mild-moderate dementia living at home. The goal is to support ageing-in-place for this vulnerable cohort of older adults with mild-moderate dementia, by addressing concomitantly 2 critical risk factors for institutionalisation:
1) caregiver stress and 2) functional mobility impairment, both supported with state-of-the-art eHealth technology allowing cost effective remote supervision and health coaching.
2. The second aim is to translate this knowledge by freely disseminating the HOMeCARE program via a dedicated website and APP and training workshops for consumers, advocacy groups, and aged care service providers.

HYPOTHESES:

1. Mindfulness training via the HOMeCARE system will improve informal caregiver burden as assessed by the Zarit Burden Interview and Mindfulness State (State Mindfulness Scale, SMS) compared to caregivers randomised to usual care at 8 weeks and 6 months.
2. Progressive, home-based strength and balance training delivered via the HOMeCARE system will improve functional mobility as assessed by the Short Physical Performance Battery (SPPB) in older adults with dementia compared to those randomised to continue to receive usual care at 6 months.
3. Change in functional mobility (SPPB) of the participant with dementia as well as change in Mindfulness State (SMS) in their caregiver will each mediate a significant, independent portion of the change in caregiver burden in each dyad at 6 months.

RESEARCH METHODS

Study design:

A two arm, randomised, controlled, single-blind, parallel-group trial of a dyadic intervention for informal caregivers (Mindfulness Training) and older adults in their care with dementia (home-based robust resistance and balance training) over 6 mo.

Sample size calculations:

26 dyads (13 control, 13 experimental) needed based on 1) reduction in caregiver burden via Zarit Burden Interview (OR 0.18; Lowery 2014) and 2) improvement in function in participants with dementia via Short Physical Performance Battery (ES 0.83; LIFE-P, 2006) with alpha 0.05 and beta 0.20. We have increased sample size to 30 dyads to allow for dropout.

Subjects and Sites

Recruitment strategies:

The investigators have substantial established networks in the aged care community from which the dyads will be recruited. This includes Prof Naismith's clinic and The Brain and Mind Centre, Professor Fiatarone Singh's clinical laboratory at USYD Lidcombe campus, volunteer
databases from previous trials, GP referral networks, community aged care service providers, and advertising via CHeBA, Alzheimer's Australia, Hammond Care Dementia Centre, Southern Cross Care and other community advocacy groups and newsletters.

Inclusion/exclusion criteria:

Each dyad will be composed of one caregiver and one participant with mild to moderate dementia for whom they provide care. Participants must be over age 65, living in the community with at least one informal caregiver, have diagnosed mild-moderate dementia of any type (Mini-mental State Exam score 12-24/30), at least mild deficits in functional mobility (walking, balance, chair stand) via the Short Physical Performance Battery [(SPPB) score $\leq$10/12], without unstable disease or rapidly progressive or terminal illness, and ambulatory over short distances without the assistance of a person. The informal caregiver in the dyad (family or friend) must be living with the participant with dementia and/or providing some portion of their daily care including ADLs and/or IADLs in an informal capacity. Ability to speak and understand English and residence within 30 km of the clinic sites are also required. Vision, hearing, cognition and manual dexterity sufficient to use the iPad programs developed for the study are required of the caregiver but not of the participant.

OUTCOME ASSESSMENTS

Primary outcomes:

For adult with dementia- Functional mobility via SPPB at 6 months.
For caregiver: State Mindfulness Scale at 8 wks. and 6 months; Zarit Burden Interview at 8 wks. and 6 months.

Secondary outcomes and covariates:

For adult with dementia- depressive symptoms by Geriatric Depression Scale (GDS), KATZ Index of ADLs, Bayer IADLs, Quality of Life (DEMQUAL-Carer), Life-Space Assessment (proxy report), sleep quality and quantity (Actigraph accelerometer over 1 week), Cognition (Mini-metal State Exam, Trail Making A and B, Hopkins Verbal Learning Test, NIH TOOLBOX adult cognition battery of 8 tests) one repetition maximum muscle strength testing of upper and lower body muscle groups (leg press, knee extension, chest press, triceps, hip abduction), habitual and maximal gait velocity with and without dual tasking.

For caregiver: Depression (Hospital Anxiety and Depression Scale), sleep quality and quantity (Actigraph accelerometer over 1 week), Pittsburgh Sleep Quality Index, Insomnia Severity Scale, Life Satisfaction, PANAS mood states, Telephone Interview for Cognition (TICS).

STUDY PROTOCOL

Recruitment and Screening:
Interested dementia caregivers identified via referrals and targeted advertisements will be interviewed on the telephone by the research assistant to ascertain potential eligibility. Second stage screening will occur in person in the clinic of Prof Fiatarone Singh where she and research team will interview all caregivers and examine all participants with dementia to ensure eligibility and appropriateness for the trial. A research assistant will then measure outcomes in the dyad. Both members of eligible dyads will be fitted with wrist Actigraphs for measurement of sleep quality and quantity over the next week.

Experimental intervention protocol:
Dyads will be randomised after baseline assessment, stratified by level of SPPB (<8; 8-10) by an offsite statistician and concealed until allocation by interventionist. The experimental program consists of an adaptation of an 8-wk Mindfulness Training Program for the caregiver followed by a 16-wk home-based balance and strength training program for the
participant with dementia, during which time the Mindfulness practice will continue to be reinforced and monitored. All experimental dyads will have a home visit by the interventionist after the baseline assessment is complete, at which time they will receive an iPad, and detailed in-person instruction in use of the iPad for viewing the instructional materials, downloading videos and written materials, and Face Time videoconferencing. The materials will all be accessible via a single HOMeCARE website which has been purpose-built for this study, with the needs of the older adults caregiver specifically in mind. All software and hardware and Internet data packages needed for the delivery and monitoring of the intervention components will be supplied to the participants at no cost for the duration of the trial.

Mindfulness Training:
The Mindfulness training course will utilise the internet-based Palouse Mindfulness Based Stress Reduction (MBSR) course materials and home practice program. This online MBSR training course has been modelled on the program founded by Jon Kabat-Zinn in 1979 at the University of Massachusetts Medical School, and similar programs have been successfully implemented in many cohorts internationally since that time, including caregivers for patients with dementia or frailty (Brown, 2015). Due to the specific and significant stressors imposed by dementia caregiving, the basic Palouse course will be supplemented by targeted materials developed for the unique stresses experienced by dementia caregivers by the investigators of this project as well as others with experience in delivering such interventions in the community. In addition, although internet delivery of mindfulness training has been shown to be

equipotent to in-person delivery in head-to-head comparisons as well as a systematic review, we will augment the internet course with Face Time interaction with a trained Mindfulness facilitator on a weekly basis during the first 8 weeks, and fortnightly during the next 16 weeks to maximally support longterm adherence to Mindfulness practice. In addition, caregivers will be asked to log their daily Mindfulness practice into the HOMeCARE website on their iPads, and these logs will be set for automatic uploading to the study interventionist so hat adoption and adherence are optimised and relapse prevented.

Exercise program:
The caregivers will be trained in the delivery of the HOMeCARE exercise program to their loved ones once they have finished the 8-wk Mindfulness course, so that they are in an optimal mental and emotional frame of mind to be able to facilitate this activity without undue stress. The purpose of the exercise is to provide the necessary strength and balance required to improve functional mobility, lower fall risk, reduce caregiver burden, physical stress and potential for injuries from lifting, and ultimately support the goal of ageing-in-place. Free weights and resistance bands will be provided as well as online pictures and instructional booklets, which can be downloaded along with video demonstrations of all exercises.

The exercise will involve 3 sessions per week of progressive moderate-to-high intensity resistance training for 8 major muscle groups of whole body, as well as progressively challenging static and dynamic balance training exercises suitable to their current level of stability. Since 1988, we have successfully and safely used a similar regimen in nursing home residents, patients after hip fracture, recurrent fallers, and home care clients up to 103 yrs of age, many of whom have had significant cognitive impairment and severe frailty. The exercises may be broken up into sessions as short as 1 minute over the course of the day, and to enhance feasibility, integration into daily activities will be encouraged. For example, while watching TV, leg lifts and chair stands may be inserted during commercial breaks, and progressively increased in difficulty. One-legged stands can be practiced while standing in front of kitchen and bathroom counters during hygiene and meal preparation activities. Caregivers will be encouraged to perform the movements with their loved one, so that mimicking movements is all that is needed. One session per week will be viewed in real time by the remote trainer using Face Time on the iPad to allow direct feedback on form, triage questions, and provide health coaching. Daily exercise activities will also be logged on the HOMeCARE website on the iPad by the caregiver, which will have been programed for automatic upload to the trainer.

Potential risks and plans to mitigate risk:
Risk of adverse events during exercise will be mitigated by through in-person screening of all participants (including caregiver and their loved one), communication with GPs and referring specialists, and real-time video monitoring and feedback on exercise sessions. In addition, weekly health status checks will be obtained during the Face Time call to the caregiver by the trainer to capture any acute changes in health status or new behavioural, physical or

psychological symptoms in both members of the dyad. If an acute question or symptom arises, there is an alert button on the HOMeCARE website which the caregiver can press to either email or call the research team, including the study physician, Prof Fiatarone Singh.

Statistical rationale & analysis:
An intention-to-treat analytic strategy will be used, allowing inclusion of all participants regardless of adherence or dropout without need for imputation. A mixed model analysis of covariance will be used to assess the main effects of changes over time and group x time interactions in both members of dyads, adjusted for age, gender, baseline function and burden and any other characteristics found to be related to the variable of interest. Effect sizes and confidence intervals will be calculated. Relationships between variables of interest will be assessed via univariate and multiple regression models. Statistical significance will be accepted at an alpha of 0.05.

Timeframe:
Study protocols will be developed and ethics approval completed by 30 Oct 2016. Research staff and students will be recruited and fully trained between June and October 2016. Recruitment and screening of caregiver dyads will begin in December 2016 and all dyads will be recruited by February 2017. Training interventions will begin in January 2017, and the final dyad will complete the 6-month intervention in August 2017. Dissemination and training materials will be developed throughout the study and finalised by August 2017 and made available to community providers and consumers via our HOMeCARE website beginning in September 2017.

Capacity Building/Knowledge Translation:
We will train students who will assist in the delivery of the HOMeCARE Mindfulness and Exercise program. We will develop a completely novel, freely available, web-based interface and App which will include cognitive and physical testing batteries, print and video packages including the training modules, and a system for remote monitoring of exercise fidelity, recording of training and Mindfulness practice logs, and provision of feedback to users. We will conduct training seminars for health care professionals in aged care, geriatric medicine, neurology, and exercise physiology, as well as for consumers and caregiver support agencies.

The HOMeCARE program will be produced as an educational multi-media training package that will be advertised widely, publically available for free on our dedicated website, and disseminated to home care agencies, dementia support groups, allied health training programs, geriatric medicine trainees and others. Prof Fiatarone Singh has had experience doing this for her other exercise programs via the Fit For Your Life Foundation, Ltd and website, and has successfully disseminated training packages for older adults and their caregivers in the community and in residential care in the USA, Canada, Australia, Germany, Japan, and other countries using this mechanism. The funding of this proposal

will support the development and maintenance of the professional website with its integration of videos, supplementary reading, and step-by-step instructions with illustrations for both the Mindfulness and the Exercise components of the program. During the final months of this one year project, we will seek additional funding from the private sector, NGOs and government sources in order to continue hosting the HOMeCARE website beyond 2017, and to allow updating of its content as new research emerges in the field.

In addition to presentation at professional scientific conferences and publication in peer-reviewed journals, we will offer on-line training webinars where health care professionals and organizations can receive training in the use of the techniques we have developed via this project. This webinar approach will allow health care professionals who cannot attend face-to face seminars to learn and adopt these programs in their practices. We will also conduct face-to-face training workshops for a variety of allied health professions to learn both the MBSR techniques, as well as the high intensity resistance and balance training protocols, and the eHealth behavioural program of education, logging and feedback that will be critical to long term sustainability. Both informal and formal caregivers in home and residential aged care settings will be able to take advantage of this evidence-based program, as we will market it directly to consumers as well as through agencies who deliver government-supported aged care service packages in the community (Home Care Packages Program). Finally, we will strongly advocate for revision of current guidelines and position stands as appropriate, to incorporate robust, evidence-based strategies such as MBSR and progressive resistance and balance training into approaches to the care of the person with cognitive impairment as well as to their caregivers in the community setting.

Outcomes and Significance:

Cognitive and physical frailty are not contraindications to exercise, but conversely, some of the most important reasons to prescribe it, particularly if the goal is to support ageing-in-place, as it is for most of those afflicted with dementia and their families. Unfortunately, current home care services and providers do not generally offer the robust, long-term exercise advice or programs needed to address progressive cognitive and physical frailty. In particular, there is a lack of evidence-based strength and balance training which can support this goal, both by improving mobility, fall risk, sleep disturbance and negative affect in the client while simultaneously reducing the caregiver burden associated with these impairments. Simple advice to 'walk more' is insufficient, often impossible, without first addressing deficits in strength and balance; yet most informal and formal caregivers are inadequately trained to provide such exercise advice and support in a safe and effective manner. Thus, many older adults with dementia spend most of the day sitting, even when caregivers are present, and such activity restriction worsens their mobility impairment and quality of life.

Caregiver health is also critical to maximising ageing-in-place for dementia sufferers, yet paradoxically the very act of caring for someone with dementia

may undermine this goal and produce strain. In addition, such caregiver strain increases risks of mortality, cardiovascular disease, depression, insomnia, obesity, injuries from lifting, and poor lifestyle choices. Current aged care practice often includes measures that are intended to either improve function in the older adult with dementia or address burden in the caregiver in ways that are not fully integrated or cognizant of the opportunities to enhance both simultaneously. By contrast, giving the caregiver tools to deal with the daily physical and emotional stressors of their role, as well as lessening the actual burden as their loved one becomes happier, stronger, and more mobile may have the best chance of success. It is this significant, critical gap in current practice that HOMeCARE is designed to explicitly and uniquely address. HOMeCARE will provide a novel, evidence-based Exercise and Mindfulness program uniquely targeted to the dual, entwined needs of the caregiver/cared-for dyad. The exercise for the client with dementia will include progressive strength and balance training, which we, and others, have shown to reduce mortality, nursing home utilisation, falls, depression, cognitive decline, mobility impairment, and morbidity from cardiometabolic disease in those up to 103 years of age.

Although evidence of efficacy has been accumulating since the pioneering studies of CIA Fiatarone Singh in 1990, the application of such robust exercise to frail elders has been limited to date by lack of training amongst caregivers, difficulty prescribing and monitoring robust exercise in the home setting, fear of injury, lack of appropriate equipment, and insufficient of appreciation of the capacity for improvement even among very frail individuals. The addition of Mindfulness training for the caregiver will complement the improved physical and mobility function in their loved one, by enhancing their ability to accept and adapt to the daily struggles inherent in their caregiving role, thus reducing the risk for negative consequences of caregiver roles such as stress, depression and poor physical health. It is anticipated that the Mindfulness training will also allow the caregiver to have the patience, confidence and optimism necessary to encourage and instruct their loved one in the home-based exercises. This realisation that the dyad itself requires primary consideration and nurturing is at the core of the HOMeCARE program, and defines it as a significant advance beyond current practice in home care for this cohort. Our remote delivery model will allow potential dissemination to rural and under-resourced communities, where health care professionals are not always available for face-to-face consultations on a frequent basis, and access to suitable exercise facilities for frail elders or support groups or Mindfulness training seminars for caregivers are minimal or non-existent. Once the trial results are successfully demonstrated, we plan to make this program freely available on the internet on a dedicated HOMeCARE website via webinars, downloadable videos and other training aids, as well as continuing education seminars and workshops for physicians and allied health professional training both in Australia and internationally.