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Sara Isabel Lebre de Almeida

LIFE4D: PROGRAMA DE ATIVIDADE FÍSICA NO DOMICÍLIO DE PESSOAS COM DEMÊNCIA

LIFE4D: PHYSICAL ACTIVITY PROGRAMME AT HOME OF PEOPLE WITH DEMENTIA

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Tese apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Doutor em Gerontologia e Geriatria, realizada sob a orientação científica da Doutora Alda Sofia Pires de Dias Marques, Professora Coordenadora da Escola Superior de Saúde da Universidade de Aveiro e sob a coorientação científica da Doutora Madalena Ramos Lopes Gomes da Silva, Professora Coordenadora da Escola Superior de Saúde do Instituto Politécnico de Setúbal.

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Dedico este trabalho à minha família e a todas as pessoas que vivem com demência.

o júri

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palavras-chave Declínio Neurocognitivo, Doença de Alzheimer, Exercício, LiFE4D, Cuidado Centrado na Pessoa.

resumo É internacionalmente recomendado e também um desejo das pessoas com demência que estas vivam em casa o máximo de tempo possível. Manter ou melhorar a sua independência funcional é, portanto, uma prioridade. A aptidão física relacionada com a saúde e outros domínios significativos (p.e., qualidade de vida relacionada com a saúde) ajudam a manter ou melhorar o desempenho nas atividades de vida diária (AVD) e podem influenciar e ser influenciados pela atividade física (AF). No entanto, os programas de AF para pessoas com demência, principalmente domiciliários, são escassos. Assim, o objetivo principal deste trabalho foi desenvolver/adaptar, implementar e avaliar o Lifestyle Integrated Functional Exercise em pessoas com demência (LiFE4D). Os objetivos específicos foram: i) identificar e sintetizar os efeitos de programas de AF no domicílio para pessoas com demência; ii) desenvolver/adaptar o LiFE4D com estratégias envolvidas na rotina diária para manter ou aumentar a aptidão física relacionada com a saúde; iii) examinar a viabilidade, eficácia e efetividade do LiFE4D na aptidão física relacionada com a saúde e medidas significativas adicionais; e iv) explorar os motivadores/ facilitadores, barreiras e impactos do LiFE4D percecionados pelas pessoas com demência e seus cuidadores. Para dar resposta a estes objetivos, foram realizados cinco estudos (revisão sistemática, protocolo e estudos originais I, II e III), um manual e um capítulo de um livro. A revisão sistemática abordou o objetivo específico i). Este estudo demonstrou que, apesar da elevada heterogeneidade nas intervenções e domínios avaliados, a AF no domicílio parece ser segura e eficaz no atraso do declínio da função cognitiva, e na melhoria dos sintomas comportamentais e psicológicos de demência, do desempenho nas AVD, da aptidão física relacionada com a saúde e da sobrecarga do cuidador. O protocolo, o manual e o capítulo do livro abordaram o objetivo ii). Os estudos originais I (estudo piloto) e II (estudo principal) abordaram o objetivo iii). Os resultados demonstraram que o LiFE4D é viável e seguro para ser conduzido no domicílio de pessoas com demência, e é eficaz e efetivo na melhoria da aptidão física e qualidade de vida relacionadas com a saúde nesta população. O estudo original III (estudo qualitativo) deu resposta ao objetivo iv). Este estudo demonstrou que as pessoas com demência e seus cuidadores percecionaram mais motivadores/facilitadores do que barreiras e identificaram apenas impactos positivos da sua participação no LiFE4D. Apesar das diferentes perceções sobre o LiFE4D, tanto as pessoas com demência como os seus cuidadores identificaram os subtemas suporte profissional, facilidade dos exercícios, cansaço e falta de tempo em comum.

Esta investigação oferece informações relevantes para aumentar a confiança dos profissionais de saúde na promoção de AF no domicílio de pessoas com demência, com uma intervenção centrada na pessoa, inovadora e capaz de promover a independência desta população, para que vivam bem e por mais tempo em casa. Esta tese agrega conhecimentos importantes para orientar intervenções futuras, diretrizes e decisões políticas para aumentar o acesso à AF no domicílio de pessoas que vivem com demência.

keywords Neurocognitive Decline, Alzheimer’s Disease, Exercise, LiFE4D, Person-centred Care.

abstract It is internationally recommended and also a wish of people with dementia to live at home for as long as possible. Improving or maintaining their functional independence is therefore a priority. Health-related physical fitness (HRPF) and other meaningful domains (e.g., health-related quality of life) are important to maintain or improve the performance on activities of daily living and can influence and be influenced by being physically active. Nevertheless, physical activity programmes for people with dementia, especially conducted at home, are scarce. Thus, the main aim of this research work was to develop/adapt, implement and evaluate the Lifestyle Integrated Functional Exercise for People with Dementia (LiFE4D). Specifically, it aimed to: i) identify and synthetize the effects of home-based physical activity programmes for people with dementia; ii) design/adapt LiFE4D with daily routine strategies to maintain or increase HRPF; iii) examine the feasibility, efficacy and effectiveness of LiFE4D on HRPF and additional meaningful measures; iv) explore the perceived motivators/facilitators, barriers and impacts of LiFE4D in people with dementia and their carers. Five studies (systematic review, protocol and original studies I, II and III), one manual and one book chapter were conducted. The systematic review addressed the specific aim i). This study showed that, despite high heterogeneity of interventions and domains assessed, home-based physical activity programmes seem to be safe and effective in delaying cognitive function decline, and improving behavioural and psychological symptoms of dementia, activities of daily living performance, HRPF and carer’s burden. The protocol study, manual and book chapter addressed aim ii). Original studies I (pilot study) and II (main study) addressed aim iii). Findings have shown that LiFE4D is feasible and safe to be conducted at home of people with dementia, and it is an efficacious and effective intervention to improve HRPF and health-related quality of life in this population. Original study III (qualitative study) addressed aim iv). This study showed that people with dementia and their carers perceived more motivators/facilitators than barriers, and identified only positive impacts from their participation in LiFE4D. Although different perceptions about LiFE4D existed, both people with dementia and their carers identified the subthemes professional support, easy exercises, tiredness and lack of time in common.

This research offers relevant information to increase the confidence of health professionals into promoting physical activity at home for people with dementia, with a person-centred, innovative intervention, capable of promoting the independence of this population, so they can live well and longer at home. This thesis adds important knowledge to guide future interventions, guidelines and political decisions to increase access to physical activity at home for people living with dementia.

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List of abbreviations and symbols

2MST	2-minute step test
30-s chair stand	30 second sit to stand test
30CST	30-second chair stand
30-s STS	30-second sit-to-stand test
95%CI	95% confidence interval
ACE-III	Addenbrooke’s cognitive examination-III
ACSM	American college of sports medicine
ADCS-ADL	Alzheimer’s disease cooperative study group activities of daily living scale
ADL	Activities of daily living
AVD	Atividades de vida diária
BMI	Body mass index
BPSD	Behavioural and psychological symptoms of dementia
Brief-BESTest	Brief-balance evaluation systems test
Brief-PA	Brief physical activity assessment tool
CG	Control group
cm	Centimetres
CONSORT	Consolidated standards of reporting trials
COPM	Canadian occupational performance measure
COREQ	Consolidated criteria for reporting qualitative research
CSRT	Chair sit-and-reach test
d	Cohen’s d value
DGS	Direção geral de saúde
DSM-5	Diagnostic and statistical manual of mental disorders (5th ed)
EG	Experimental group
ES	Effect size
FFM	Fat-free mass
FRT	Functional reach test
g	Grams
GEE	Generalized estimating equations
GST	Grocery shelving task
HE	Home exercise
HRPF	Health-related physical fitness

HRQoL	Health-related quality of life
IAPTWOP	International association of physical therapists working with older people
ICC	Intraclass correlation coefficient
ICF	International Classification of Functioning, Disability and Health
IQR	Interquartile range
LiFE	Lifestyle integrated functional exercise
LiFE4D	Lifestyle integrated functional exercise for people with dementia
MEP	Maximal expiratory pressures
MET	Equivalentes metabólicos
MET	Metabolic equivalent of task
MIP	Maximal inspiratory pressures
ml	Millilitre
MMSE	Mini-mental status examination
NA	Not available
N.D.	Not determined
NITE-AD	Night time insomnia treatment and education in Alzheimer’s disease
NPI	Neuropsychiatric inventory
OECD	Organisation for Economic Co-operation and Development
OMS	Organização Mundial de Saúde
OT	Occupational therapy
p	P-value
PA	Physical activity
PEM	Pressão expiratória máxima
PEF	Peak expiratory flow
PIM	Pressão inspiratória máxima
PRISMA	Preferred reporting items for systematic reviews and meta-analyses
PROSPERO	Prospective register of systematic reviews
PT	Physiotherapy
PwD	People with dementia
QOL-AD	Qualidade de vida – doença de Alzheimer
QoL-AD	Quality of life in Alzheimer’s disease scale
r	Pearson correlation coefficient
r^2	Coefficient of determination

RCT	Randomised controlled trial
RUD Lite	Resource utilization in dementia scale lite
SNIP	Sniff nasal inspiratory pressure
SOC	Selection, optimisation and compensation
SPIRIT	Standard protocol items: recommendations for interventional trials
SPSS	Statistical package for the social sciences
SWOT	Strengths, weaknesses, opportunities and threats
T0	Baseline
TIDieR	Template for intervention description and replication
TUG	Timed up and go test
USA	United States of America
WebQDA	Web qualitative data analysis
WHO	World Health Organization
ZBI	Zarit burden interview
α	Alpha
β	Beta
%	Percentage

Chapter 1. Introduction

General introduction[1]

Dementia, also designated major neurocognitive disorder, is a neurodegenerative condition characterised by deterioration of the cognitive function with negative impacts on the ability to perform activities of daily living (ADL) (American Psychiatric Association, 2013)[2]. It currently affects approximately 50 million people worldwide, and this number is expected to rise up to 152 million by 2050 (WHO, 2017). Dementia leads to a significant increase in direct and indirect costs, not only for the individuals, their carers, families and friends, but also for communities and society (WHO, 2017). Hence, dementia is a recognised public health priority with global actions now taking place (WHO, 2017, 2018b).

One of the main concerns in dementia is to improve, maintain or delay the deterioration of functional independence of those living with this syndrome (Fazio, Pace, Maslow, Zimmerman, & Kallmyer, 2018). Pharmacological treatments have led to limited effects in the management of dementia symptoms (e.g., cognitive, behaviour and function symptoms) (Hogan et al., 2008; WHO, 2017) whilst, non-pharmacological interventions have shown promising results (e.g., increase functional performance, and relief mood and behaviour concerns) (Hogan et al., 2008). A highly recommended non-pharmacological intervention to manage symptoms of dementia, fostering ADL performance and individuals' independence is physical activity (Forbes, Forbes, Blake, Thiessen, & Forbes, 2015; Hogan et al., 2008; Sallis et al., 2016). Physical activity is an important protective factor for dementia (Livingston et al., 2020; Sallis et al., 2016) but has also relevant impacts after the diagnosis, such as, improvements on health-related physical fitness (HRPF), cognitive function and behaviour (Blankevoort et al., 2010; Forbes et al., 2015; Heyn, Abreu, & Ottenbacher, 2004; Jia, Liang, Xu, & Wang, 2019). Nevertheless, people with dementia remain highly inactive and present lower levels of physical activity when compared with their healthy peers (Hartman, Karssemeijer, van Diepen, Olde Rikkert, & Thijssen, 2018).

The offer of physical activity interventions for people with dementia has been increasing, however, adherence rates vary greatly (16 to 100%) across studies (Di Lorito et al., 2020). Low adherence rates might be related to the physical activity barriers identified in people with dementia, such as, lack of motivation, physical impairments, safety concerns, time-consuming approaches, low self-perception of physical activity benefits, and carer's burden (Hancox et al., 2019; Patel, Schofield, Kolt, & Keogh, 2013; van Alphen, Hortobágyi, & van Heuvelen, 2016).

[1] This thesis is written in British English, but, in some chapters the American English has been used to meet the journals' recommendations. LiFE4D manual and book chapter (both on chapter 4) are written in Portuguese.
[2] Cited publications are referred in this thesis according to the 6th edition of the American Psychological Association style (APA). However, the papers comprising this work might have different referencing styles to meet the journals' recommendations.

Moreover, most available physical activity programmes occur in institutions (e.g., day care centres, nursing homes, hospital or community-based centres) which offer fixed timetables (Forbes et al., 2015). This implies that the attendance of people with dementia becomes dependent on transport and/or on others (Forbes et al., 2015).

It is known that most people with dementia live at home (Wimo, Gauthier, Prince, on behalf of Alzheimer's Disease International's Medical Scientific Advisory Panel, & team, 2018), and it is their wish to continue to do so for as long as possible (Moise, Schwarzinger, & Um, 2004). Home-based physical activity programmes have an enormous potential to enhance people with dementia well-being at home, since they occur in a familiar and meaningful environment, improve the person's ability to perform ADL, and reduce behavioural and psychological symptoms of dementia (BPSD) and carer's burden (Forbes et al., 2015; Jia et al., 2019; Park & Cohen, 2019). Individualised physical activity interventions that fit into each person's daily routine, with a positive emphasis on enjoyment, have been suggested for people with dementia (van Alphen, Hortobágyi, et al., 2016; van der Wardt et al., 2020). These features appear to have a fundamental role overcoming some identified physical activity barriers and engaging people with dementia in physical activity interventions (Hancox et al., 2019; Moise et al., 2004). However, the availability of home-based physical activity programmes for people with dementia is still scarce, especially programmes integrating this intervention within daily routines. For the scope of this thesis, home-based physical activity was defined as a physical activity intervention that occurred at the participants' home.

The Lifestyle Integrated Functional Exercise (LiFE) originally developed in Australia, is a home-based physical activity programme for older people that embed balance and lower limb muscle strength training into daily routines (Clemson et al., 2012). LiFE has shown to reduce the number of falls, whilst maintaining the independence of older people in numerous ADL (Clemson et al., 2012). Conversely to other home-based physical activity programmes, LiFE has demonstrated high adherence rates and high levels of motivation and self-perceived health (Clemson et al., 2012). However, despite these positive results, LiFE has never been explored in people with dementia.

This thesis has focused on developing/adapting, implementing and evaluating a home-based physical activity programme for people with dementia, the Lifestyle Integrated Functional Exercise for People with Dementia (LiFE4D). Specifically, it aimed to:

i) identify and synthetize the effects of home-based physical activity programmes for people with dementia;

ii) design/adapt a physical activity programme (LiFE to LiFE4D) with daily routine strategies to maintain or increase health-related physical fitness (HRPF);

iii) examine the feasibility, efficacy and effectiveness of LiFE4D on HRPF and additional meaningful outcomes (e.g., cognitive function and health-related quality of life);

iv) explore the perceived motivators/facilitators, barriers and impacts of LiFE4D in people with dementia and their carers.

Figure 1 provides a schematic graphic of this thesis rationale to address the proposed aims.

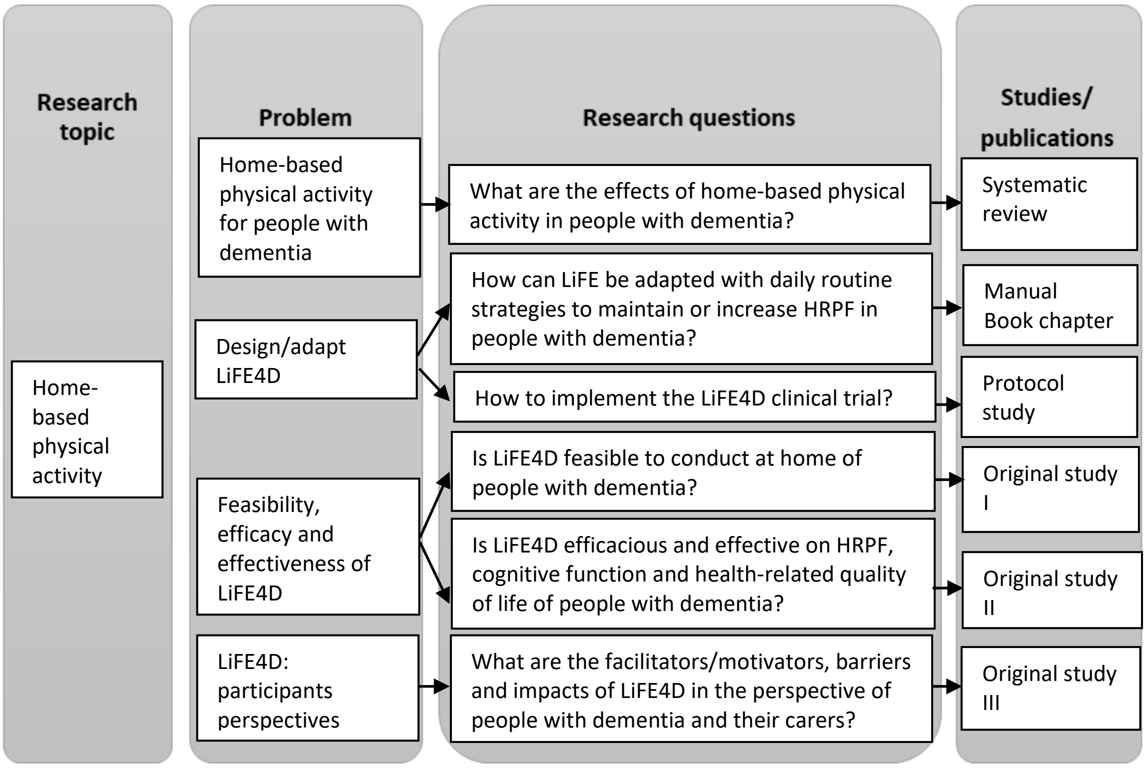

Figure 1. Schematic representation of the rational for this thesis.

Abbreviation: HRPF: Health-related physical fitness; LiFE: Lifestyle Integrated Functional Exercise; LiFE4D: Lifestyle Integrated Functional Exercise for People with Dementia.

This work is presented in 8 chapters. **Chapter 1** (**introduction**) briefly outlines the global impact of dementia and identifies the research problems addressed in this thesis. **Chapter 2** (**background**) presents a deeper overview of dementia impacts and symptoms management, with focus on interventions to promote functional independence of people with dementia at home, namely physical activity, along with a description of the research rationale.

Chapter 3 includes one **systematic review**, which identifies and synthetises the effects of home-based physical activity programmes for people with dementia. **Chapter 4** provides a description of the design/adaptation of a home-based physical activity programme for people with dementia embedded in daily routines (i.e., LiFE4D) through a **manual**, a **book chapter** and a

protocol study to inform the main study, a randomised controlled trial (RCT). **Chapter 5** includes a pilot/feasibility study (**original study I**) and a RCT (**original study II**) to demonstrate the efficacy and effectiveness of LiFE4D on HRPF, health-related quality of life and cognitive function. **Chapter 6** includes a qualitative study to demonstrate the facilitators/motivators, barriers and impacts of LiFE4D in the perspective of participants (**original study III**). The main findings of the studies presented in chapters 3-6 are integrated and discussed in **chapter 7**. Finally, **chapter 8** grants the main conclusions and recommendations for future research and clinical practice.

Chapter 2. Background

This chapter provides an overview of the epidemiology and global impacts, definition, causes, symptoms and time course of dementia. It outlines the general available treatments for people with dementia and the importance of person-centred approaches. Lastly, this background offers an insight into the literature regarding promotion of functional independence in people with dementia. Specifically, it focusses on promoting the functional independence of this population through a home-based physical activity programme involved in daily routines, along with a description of the research problems.

1. Dementia

1.1. Epidemiology

Dementia is a public health priority and global actions are currently being implemented (WHO, 2012, 2017). It is estimated that more than 50 million people live with dementia worldwide, and this number is likely to triplicate, reaching up to 152 million people by 2050 (Patterson, 2018). Currently, nearly two-thirds of people with dementia live in low- and middle-income countries, and these numbers are expected to increase faster than in high-income countries due to increases in life expectancy and higher exposure to modifiable risk factors (Livingston et al., 2020; Patterson, 2018).

In Europe, 9 780 678 (1.57% of the total European population) people lived with dementia in 2018, and this number is expected to rise to 18 846 286 (3.00%) in 2050 (Alzheimer Europe, 2020). Recently, there seems to be a slowdown in the growth foreseen for the prevalence of dementia, which is possibly explained by the implementation of public health policies related with risk and protective factors (e.g., smoking cessation campaigns, more active populations and cardiovascular health) (Alzheimer Europe, 2020).

In Portugal, the prevalence of dementia is above the European average, with the condition affecting 193 516 people (1.88% of the overall Portuguese population) in 2018, and being estimated to increase up to 346 905 people (3.82%) in 2050 (Alzheimer Europe, 2020). This can be explained by the ageing trend of the Portuguese population (e.g., people older than 85 years old are expected to increase more than double between 2018 and 2050), along with an increase in the average life expectancy at birth, a fertility decline and an increase in emigration (Alzheimer Europe, 2020; Instituto Nacional de Estatística, 2020; Ruano et al., 2019). Nevertheless, similar to the European trend, Portugal is also experiencing a slight deceleration in the growth curve (Alzheimer Europe, 2020).

1.2 Definition and risk factors

Dementia or major neurocognitive disorder is a chronic progressive syndrome that leads to a significant decline in at least one cognitive domain (i.e., attention, memory, language, executive function and/or visuo-constructional) and a significant decline from a previous level of functioning, interfering with individuals' independence in activities of daily living (ADL), which is not explained by other conditions (e.g., delirium, depression) (American Psychiatric Association, 2013). Dementia diagnosis usually comprises a medical and family history (including asking a proxy about functional, cognitive and behavioural changes), neurological assessment, blood tests and radiological examination (to exclude other causes, such as tumours or deficits of vitamins). Additionally, in some circumstances it encompasses positron emission tomography, single photon emission computed tomography and lumbar puncture (Alzheimer's Association, 2020; Gale, Acar, & Daffner, 2018). An early and correct diagnosis of dementia and its subtype is essential to support and provide the best care available for people with dementia (WHO, 2017; Winblad et al., 2016). Dementia is, however, a highly underdiagnosed condition since only 20-50% of people living with dementia have a formal diagnosis, which usually occurs already at an advanced stage of the disease (Prince, Bryce, & Ferri, 2011; WHO, 2017).

Ageing is the major non-modifiable risk factor for dementia, with incidence doubling by every 5.9 years of advance in age, and increasing sharply in the oldest old (+85 years old) population (WHO, 2015a). It is however important to highlight that dementia is not a natural consequence of ageing (Livingston et al., 2020; WHO, 2019). Indeed, other non-modifiable risk factors for dementia include sex (with women being more affected than men), genetic factors, race/ethnicity and family history (Prince et al., 2015; WHO, 2019). Twelve possible modifiable risk factors throughout the life course were identified, and their management can actually delay or slow the onset or progression of dementia (Livingston et al., 2020; WHO, 2019). For instance, the early life (i.e., less education), midlife (i.e., hearing loss, traumatic brain injury, hypertension, alcohol >21 units/week [1 unit of alcohol=10 mL or 8 g of pure alcohol] and obesity) and later life (i.e., smoking, depression, social isolation, physical inactivity, air pollution and diabetes) risk factors might prevent or delay up to 40% of dementias (Livingston et al., 2020). In addition, World Health Organisation (WHO) includes diabetes, hypercholesterolemia and cognitive inactivity as potentially risk factors for developing dementia (WHO, 2019).

1.3 Aetiology, symptoms and course of dementia

Dementia is an umbrella term for several diseases and conditions (WHO, 2017). The aetiology of this syndrome includes neurodegenerative (i.e., irreversible) and non-neurodegenerative (i.e., potentially reversible) causes (Gale et al., 2018). The most common type of dementia is associated to Alzheimer's disease (representing around 70% of all dementias), followed by vascular dementia and Lewy bodies dementia (WHO, 2012, 2019). Other major forms include mixed dementia and, more frequent before old age, frontotemporal dementias (WHO, 2019). The reversible dementias represent only around 18% of diagnosis (Srikanth & Nagaraja, 2005), with more than half of them being related to depression, alcohol-induced cognitive impairment, normal pressure hydrocephalus and vitamin B12 deficiency (Chari, Ali, & Gupta, 2015).

As a progressive condition, dementia symptoms and signs are insidious and will gradually get worse, however they will depend on the cause and person's characteristics (Melis, Haaksma, & Muniz-Terrera, 2019). General clinical symptoms and neuropathology of the most common dementia types can be found in Table 1.

Table 1. General clinical symptoms and neuropathology of the most common types of dementia.

Dementia type	Clinical symptoms	Neuropathology	Prevalence of dementia cases
Alzheimer's disease	Slowly progressive brain disease Early stage: memory (i.e., difficulty remembering recent conversations, names or events) and learning impairment, gradual onset of depression, apathy Later symptoms: impaired communication, disorientation, confusion, poor judgment, behavioural changes, social cognition impairment Advanced stage: motor changes, difficulty speaking and swallowing	Plaques (outside neurons): accumulation of the protein fragment beta-amyloid Neurofibrillary tangles (inside neurons): twisted strands of the protein tau	50-80%
Vascular dementia	More common as a mixed pathology, especially concomitant with Alzheimer's disease Similar symptoms to Alzheimer's disease Memory less affected Impaired judgment or ability to make decisions, plan or organise More prominent mood fluctuations, apathy Physical frailty and motor impairment (slow gait, poor balance) Stepwise progression	Cerebrovascular disease Single infarcts in critical regions, or more diffuse multi-infarct disease	10-30%
Lewy bodies	Marked fluctuation in cognitive ability (e.g., alertness) Changes in thinking and reasoning (e.g., executive and attention) Confusion and alertness varying within and between days Early sleep disturbances Visual hallucinations and delusions Visuospatial impairment Memory impairment often occurs (but not always significant) Parkinsonism (slowness, gait imbalance, tremor and rigidity)	Cortical Lewy bodies (abnormal aggregations of the protein alpha-synuclein in neurons)	2-30%
Fronto-temporal dementias	Most people develop symptoms at a younger age (<65 years old) Marked changes in personality, mood and behaviour Disinhibition Language difficulties (producing or understanding)	No single pathology – damage limited to frontal and temporal lobes in the initial stage	5-10%

Based on "Clinical Practice Guidelines for Management of Dementia" by Shaji et al, 2018, "Dementia" by Taylor & Close, 2018 and "2020 Alzheimer's Disease Facts and Figures" by Alzheimer's Association, 2020.

The progression of dementia is heterogeneous and highly variable between and within people with dementia (Melis et al., 2019). Nevertheless, World Health Organization (WHO) and Alzheimer’s association divide dementia in three stages (Figure 1) (Alzheimer's Association, 2020; WHO, 2012).

Early/mild	Middle/morderate	Late/advanced
▪ Require assistance in some ADL to maximize independence and induce safety; ▪ Memory decreases; ▪ Spatiotemporal disorientation (e.g., become lost in familiar places); ▪ Communication impairments are noticed (e.g., difficulty in finding words); ▪ Mood and behaviour changes (e.g., apathy, anxiety and depression, aggressive and angry reactions); ▪ Decision making, handling personal finances or carrying out complex household tasks become difficult.	▪ Need help with routine tasks: basic and instrumental ADL; ▪ Memory decrease prominently (e.g., recent events and names); ▪ Spatiotemporal disorientation worsen (e.g., become lost at home); ▪ Communication difficulties (e.g., comprehension and speech); ▪ Behaviour changes notably (e.g., repetition, sleeping disturbances, hallucinations, suspiciousness, agitation, disinhibition and aggression); ▪ Some incontinent occurrences; ▪ Need considerable support to live alone safer.	▪ Need help in almost every ADL (e.g., assistance to eat); ▪ Need help nearly 24h; ▪ Usually unaware of time and place; ▪ Difficulty understanding what is happening around; ▪ Difficulty recognising familiar people and objects; ▪ May have bladder and bowel incontinence; ▪ Mobility impairment increases (e.g., unable to walk, need a wheelchair or become bedridden); ▪ More behaviour changes (e.g., aggression towards carer, agitation such as kicking, hitting, screaming or moaning).

Figure 1. Schematic representation of the dementia stages.

Independently of the stage, dementia will lead to major impacts on individuals, families and societies.

1.4. Impacts of dementia

Dementia has huge cognitive and functional impacts on the people living with this condition, from an early to an advanced stage. The large number of people affected and the highly complex and demand care that dementia requires results in a huge economic burden to people that are directly affected (people living with dementia and their carers, family and friends) and to societies (Prince et al., 2015; WHO, 2015a).

The global costs to manage dementia already exceed one trillion US dollars/year, worldwide (Patterson, 2018; Wimo et al., 2017). Societal costs of dementia might be divided in direct medical (drugs, therapeutics), direct social care (professional care, and the costs of residential and nursing home care) and informal care (provided by family, friends and the community) costs (WHO, 2015a).

Direct medical costs account for a small proportion of the total costs across the different countries, mainly due to the low diagnosis rate, the limited options of therapeutics and the underutilisation of the evidence-based interventions (WHO, 2015a). Instead, direct social care costs (i.e., professional community care and residential and nursing home care costs) vary between 45.2% in high-income countries and only 12.2% to 14.3% in low- and lower to middle-income countries (WHO, 2015a). This is a serious issue as most people with dementia live in low- and middle-income countries (63%), where access to social protection, services, support and care are very limited (WHO, 2015a). Finally, the informal care cost represent the larger percentage (40.3% to 64.7%) of the costs spent with dementia in almost all world regions, being the cornerstone of the care system (WHO, 2015a). Additionally, people with dementia and their families and friends also face other significant financial impacts, namely the reduction or even loss of their income (Prince et al., 2015).

Nevertheless, the global impact of dementia is not limited to financial strains, but it also represents massive human costs to countries, societies, families and individuals (WHO, 2017). It is worthwhile mentioning that Alzheimer's disease and other dementias are the 7th leading cause of death worldwide (WHO, 2018). Moreover, dementia contributes with more than 11.9% of years lived with disability in people aged 60 years or older (WHO, 2019), being one of the conditions with the largest contribution to the disability adjusted life years (i.e., the sum of years lived with disability and years of life lost) (Prince et al., 2015). It is a major cause of dependence among older people, with the greatest impact on disability and need of care support worldwide (Alzheimer's Disease International, 2013; WHO, 2017).

Despite the previously recognised heterogeneity of the disease progression (Melis et al., 2019), some general impacts on people living with dementia and their carers have been pointed out. Cognitive function is affected, impairing memory, attention, executive function, learning, language, motor perception and social cognition (American Psychiatric Association, 2013). Furthermore, during the time course of dementia, most people experience BPSD, such as apathy, agitation, aberrant motor behaviour, anxiety, irritability, disinhibition, hallucinations and changes on sleep or appetite, with negative impacts on individuals' health (Cerejeira, Lagarto, & Mukaetova-Ladinska, 2012).

Additionally, dementia also affects the HRPF of those living with this condition (Karin Hesseberg, Hege Bentzen, Anette Hylen Ranhoff, Knut Engedal, & Astrid Bergland, 2016). People with dementia have shown worse performance on all five HRPF components (i.e., cardiorespiratory endurance, body composition, muscular endurance, muscular strength and flexibility) (Karin Hesseberg et al., 2016). HRPF performance can be defined as ‘the ability to carry out daily tasks with vigour and alertness, without undue fatigue, and with ample energy to enjoy leisure-time pursuits and respond to emergencies’ (American College of Sports Medicine, 2014; President's Council on Physical Fitness and Sports, 1971). Moreover, skill-related (i.e., balance, agility, coordination, speed, power, reaction time) physical fitness components are also commonly impaired in people with dementia, leading to an increased risk of falls (Taylor & Close, 2018).

All these cognitive, behaviour and physical impacts are experienced by people with dementia in different ways, however, they will all gradually lead to difficulties in ADL performance and, therefore, increased reliance on carers (Gaugler, Zarit, & Pearlin, 2003; Melis et al., 2019; WHO, 2015a). The need for care usually starts with instrumental ADL (e.g., household, financial and social activities) and then progresses to basic ADL (e.g., bathing, dressing, feeding), frequently demanding constant supervision and surveillance (Schulz & Martire, 2004). Therefore, impacts of dementia go far beyond individuals, affecting also carers and families at psychological, physical and social levels and, ultimately, compromising their well-being (Schulz & Martire, 2004). Actually, carers of people with dementia present higher burden, poorer health, higher levels of depressiveness and lower quality of life than carers of people with other health conditions (Karg, Graessel, Randzio, & Pendergrass, 2018; Schulz & Martire, 2004).

The increased burden of dementia for both people living with dementia and their carers highlights the urgent need for effective treatments, namely aiming to reduce dependence of those living with this condition.

2. Treatments for people with dementia

Taking into consideration the extensive impacts previously presented (WHO, 2015a), efficacious (i.e., performance of a treatment under ideal/controlled circumstances) and effective (i.e., performance of a treatment under usual or “real world” clinical practice) (Revicki & Frank, 1999) treatments (pharmacological and non-pharmacological) are needed to overcome the tremendous challenges for all of those who live with dementia and their carers. The heterogeneity of dementia makes treatment and management highly challenging, demanding a deep understanding of aetiology and multiple other factors (e.g., clinical aspects, stage of dementia and support needed) (Vilela, Pacheco, Latorraca, Pachito, & Riera, 2017). We will now discuss some of the available pharmacological and non-pharmacological treatments to manage dementia symptoms and the importance of person-centered approaches.

2.1. Pharmacological treatments

A cure for dementia is currently unavailable. Although large attempts have been made in the last decades to develop an effective drug to treat dementia, mostly targeting Alzheimer's disease, few pharmacological treatments are, so far, available (Patterson, 2018). An effective treatment is clearly difficult to find. One study that examined the pharmacological clinical trials for Alzheimer's disease ongoing between 2002 and 2012, showed a failure rate of 99.6% (Cummings, Morstorf, & Zhong, 2014).

Current available pharmacological interventions for dementia include cholinesterase inhibitors (e.g., donepezil, rivastigmine, galantamine) that prevent the acetylcholinesterase enzyme from breaking down acetylcholine; and the N-methyl-D-aspartate receptor antagonist memantine, that tries to block the effects of glutamate (i.e., excitatory neurotransmitter that may also act as an endogenous neurotoxin) (Cummings et al., 2014; Patterson, 2018; Shaji, Sivakumar, Rao, & Paul, 2018; Winblad et al., 2016). Although these interventions only provide transient symptomatic relief (Cummings et al., 2014; NICE, 2018), they are recommended by the WHO to improve health and well-being of those living with dementia and their carers (WHO, 2015a).

Non-pharmacological treatments for people with dementia are fundamental in the management of any type of dementia since they improve or delay the decline of cognitive function, improve overall quality of life, ability to perform ADL, motor skills and BPSD (e.g., agitation, aggression, hallucinations, uncontrollable emotions) (Alzheimer's Association, 2020; American Psychiatric Association, 2017; Fazio, Pace, Maslow, Zimmerman, & Kallmyer, 2018; Shaji et al., 2018; Vilela et al., 2017). Their development, and implementation, to improve the well-being of those living with dementia and their carers, is urgently warranted.

2.2 Non-pharmacological treatments

Non-pharmacological treatments have been recommended as the first-line approach (compared with the antipsychotic and other psychotropic medications) to manage the BPSD (Scales, Zimmerman, & Miller, 2018). They can and should be delivered in different settings, and have been considered part of the mainstream care of dementia, together with pharmacological treatments (American Psychiatric Association, 2017; Vernooij-Dassen et al., 2019).

Non-pharmacological interventions have shown potential benefits on people with dementia and their carers, are easily accepted, present no adverse events (except for possible frustration in people who receive cognitive-oriented treatments) and require minimal to moderate investment (American Psychiatric Association, 2017; Scales et al., 2018; Vernooij-Dassen et al., 2019; Vilela et al., 2017). However, it is important to note that more robust studies are still needed to confirm the efficacy of such a wide range of treatments (American Psychiatric Association, 2017; Scales et al., 2018; Vernooij-Dassen et al., 2019; Vilela et al., 2017).

The American Psychiatric Association divides non-pharmacological treatments for dementia into four broad groups (American Psychiatric Association, 2007, 2017): 1) behaviour-oriented (e.g., schedule toileting and behaviour management techniques/training for carers); 2) emotion-oriented (e.g., supportive psychotherapy, reminiscence therapy, validation therapy, sensory integration and simulated presence therapy); 3) cognition-oriented (e.g., reality orientation, cognitive retraining, and skills training focused on specific cognitive deficits); and, 4) stimulation-oriented (e.g., physical activity, recreational activities such as crafts, games and pets; art therapy such as music therapy, dance; multisensorial stimulation; aromatherapy).

A single low-cost non-pharmacological intervention that has shown promising results in both prevention (i.e., as a risk reduction strategy) and care of people with dementia, is physical activity (Aarsland, Sardahaee, Anderssen, & Ballard, 2010; Forbes, Forbes, Blake, Thiessen, & Forbes, 2015; Groot et al., 2016; Hamer & Chida, 2009; Livingston et al., 2017). Physical activity is defined as ‘any body movement produced by skeletal muscles that requires energy expenditure’ (Caspersen, Powell, & Christenson, 1985). Some examples of physical activities are sports, household tasks (e.g., cleaning, yarding, home repair), occupation (e.g., work, volunteering) or basic ADL (e.g., bathing, dressing, hair brushing) (Caspersen et al., 1985). Instead, sedentary behaviour is defined as any waking behaviour characterised by an energy expenditure ≤1.5 metabolic equivalent of task (MET) while in a sitting or reclining posture (Tremblay et al., 2017).

Physical activity has been associated with healthy ageing (i.e., a status where functional abilities and well-being are maintained in older age) independently of the presence of disease (WHO, 2015b). Moreover, it has been shown that practicing moderate to vigorous physical activity once or more per week, lowers the risk for cognitive decline and dementia (Soni et al., 2019). This might be explained by the well-known physical activity benefits on reducing risk of dementia, via diminishing age-related comorbidities (i.e., cardiovascular diseases, stroke, diabetes mellitus and depression) and by its underlying neurophysiological mechanisms (i.e., increases cerebral blood flow, and increases brain volume in grey and white matter regions) (Alzheimer's Society, 2019; Cheng, 2016; Colcombe et al., 2006; Erickson, Hillman, & Kramer, 2015; Livingston et al., 2020; Phillips, Baktir, Das, Lin, & Salehi, 2015; R. L. Rogers, Meyer, & Mortel, 1990).

Furthermore, physical activity benefits continue well beyond prevention, with meaningful positive impacts on cognitive function (results comparable to those of medication (Groot et al., 2016)), BPSD, HRPF, daily function (improving ADL performance) and falls prevention (Blankevoort et al., 2010; Burton et al., 2015; Forbes et al., 2015; Heyn, Abreu, & Ottenbacher, 2004; Jia, Liang, Xu, & Wang, 2019). These improvements, consequently, will lead to an increase in independence and autonomy of people with dementia, and in their quality of life. Additionally, physical activity slows down dementia progression and lowers its risk of mortality (Minn et al., 2018; Soni et al., 2019). Considering the absence of specific guidelines for people with dementia, the recommendations for physical activity for older adults from the WHO and the American College of Sports Medicine have been commonly used (Garber et al., 2011; WHO, 2010, 2020). Although the intensity, duration and levels of physical activities that would benefit people with dementia are still unclear, some recommendations are available, such as (Blankevoort et al., 2010; Sallis et al., 2016): offering physical activity in all stages of dementia; multicomponent interventions; length ≥12 weeks; perform physical activity at least 3 times/week; and duration of the sessions between 45 to 60 minutes. Nonetheless, since there is a strict relation between sedentary behaviour and occurrence of adverse health conditions, in addition to increasing physical activity levels, it is also important to reduce the time spent in sedentary activities in both active and inactive individuals (American College of Sports Medicine, 2014; L. Andersen, Mota, & Di Pietro, 2016; WHO, 2020).

'One size fits all' is not an appropriate approach to physical activity interventions for people with dementia, instead, an holistic and personalised approach to involve them in such interventions is mandatory for success (Malthouse & Fox, 2014; van der Wardt et al., 2020). This emphasises the importance of developing and implementing tailored and person-centred physical activity approaches for people living with dementia.

2.3 Person-centred approaches

Person-centred care is placed as the foundation of the quality of care for people with dementia (Fazio, Pace, Maslow, et al., 2018). Yet, the biomedical model has dominated for decades, not just on research, but also on the provision of care (Kitwood, 1997). It is important to recognise that the exponential growth of biomedical research resulted in a better understanding of the ageing brain and dementia, but it also led to a disconnection from the personhood (Vernooij-Dassen et al., 2019). In fact, people with dementia were often excluded from decision-making processes about their lives, and their care was based on standardised protocols that neglected their individual needs, preferences and values (Kelly, 2009; Kitwood, 1997). On the other hand, the biopsychosocial model is an interdisciplinary model that considers the interactions between the biological, psychological and social factors to understand health and to provide care (Engel, 1977).

The concept of person-centred care appeared more than 50 years ago, however, it only reached a major impact in the field of dementia care less than 30 years ago (Kitwood & Bredin, 2008; C. Rogers, 1961). This philosophy of care places the person at the centre of their own care, looking to each person's needs and characteristics instead of focusing just on the disease (Fazio, Pace, Flinner, & Kallmyer, 2018; Mitchell & Agnelli, 2015).

Person-centred care approaches are recommended by the Alzheimer's Association Dementia Care Practice Recommendations, that recently outlined its core principles (Fazio, Pace, Flinner, et al., 2018; Fazio, Pace, Maslow, et al., 2018): knowing the person living with dementia (e.g., past and current values, beliefs, interests, capacities, likes, and dislikes); recognising and accepting his/her reality; identifying and supporting ongoing opportunities for meaningful engagement; building and nurturing authentic, caring relationships; creating and maintaining a supportive community for individuals, families and staff; and evaluating care practices regularly and make appropriate changes.

Creating interventions that are person-centred and able to help people dealing with dementia in daily life is of paramount importance (Vernooij-Dassen et al., 2019), specifically, interventions tailored to maintain or improve their autonomy and independence.

3. Promoting daily living independence in people with dementia

Dementia strictly affects the daily living of those living with the condition, their family and carers (Winblad et al., 2016), thus maintaining their functional independence on ADL is essential to foster their quality of life (C. Andersen, Wittrup-Jensen, Lolk, Andersen, & Kragh-Sørensen, 2004). The progressive functional deterioration that characterises dementia means, however, that maintaining or improving their independence can be highly challenging.

ADL performance is vital to maintain independence of people with dementia and it is influenced by the HRPF (Oppewal, Hilgenkamp, van Wijck, Schoufour, & Evenhuis, 2015; President's Council on Physical Fitness and Sports, 1971). HRPF is a known predictor of mortality in people with dementia (Liu et al., 2012), nonetheless, this population has shown lower HRPF when compared with their peers (K. Hesseberg, H. Bentzen, A. H. Ranhoff, K. Engedal, & A. Bergland, 2016). One intervention that is able to improve or maintain HRPF and, therefore, promote functional independence in people with dementia, is physical activity. However, to achieve and retain an active lifestyle on this population it is important to ascertain which barriers, motivators and facilitators can be modified (Malthouse & Fox, 2014).

Promoting functional independence in people with dementia is recommended on a daily basis (Fazio, Pace, Maslow, et al., 2018), and physical activity, either recreational or non-recreational, might act as a facilitator (Forbes et al., 2015; Heyn et al., 2004; Minn et al., 2018; Pitkälä, Savikko, Poysti, Strandberg, & Laakkonen, 2013; Rao, Chou, Bursley, Smulofsky, & Jezequel, 2014). However, people with dementia present low levels of physical activity and high levels of sedentary behaviour (van Alphen, Volkers, et al., 2016), which seem to be related to the existence of several barriers (e.g., physical and mental health, programmes' structure, safety concerns, time consuming approaches, need of transportation, difficultness finding a way to be more physically active, no routines regarding how and when to do physical activity and carer's burden) (Farina et al., 2020; Hancox et al., 2019; van Alphen, Hortobágyi, & van Heuvelen, 2016). Moreover, challenging daily living environments (e.g., safety concerns with walking and cycling, neighbourhood environments less appropriate to physical activity), along with the stigma of having dementia, demoralisation of disability and overprotective care, might result in lack of confidence to engage in daily activities and further restrain people with dementia from being physically active (Niemann-Mirmehdi, Häusler, Gellert, & Nordheim, 2019; WHO, 2007, 2017). Nevertheless, given the great potential of physical activity to facilitate functional independence in people with dementia, a body of literature regarding strategies, motivators (e.g., acknowledge of emotional and physical well-being, family encouragement, enjoyment, and reduced carer's burden) and facilitators (e.g., tailoring; instructions and pictures; implementing routines of where, when and how to do it; home-based settings; boosting the feeling of being "capable to do it"; goals establishment; verbal feedback and encouragement; and carer support) to engage them in active lifestyles, has been growing (Farina et al., 2020; Hancox et al., 2019; Malthouse & Fox, 2014; Trahan, Kuo, Carlson, & Gitlin, 2014; van Alphen, Hortobágyi, et al., 2016; van der Wardt et al., 2020).

Most people with dementia (around 60%) live at home or at a carer's home (Alzheimer's Association, 2020; Fazio, Pace, Maslow, et al., 2018). From those, 74% live with someone and 26% live alone (Alzheimer's Association, 2020; Fazio, Pace, Maslow, et al., 2018). In fact, most people with dementia and their families want to live at home for as long as possible, following international recommendations (Moise, Schwarzinger, & Um, 2004). Moreover, supporting this population at home costs less than accommodating them in residential care, with ability to perform ADL being the most important predictor of societal costs (Gustavsson et al., 2011; Moise et al., 2004; WHO, 2012). WHO recommends that people with dementia should be empowered to live at home and care interventions should be in line with their wishes and preferences (WHO, 2017). Therefore, by maintaining or improving the HRPF of those living with dementia through home-based physical activity, ADL performance will also be optimised, societal costs will reduce and the population will be empowered to live longer at home (Gustavsson et al., 2011; Moise et al., 2004; WHO, 2012).

Embed physical activity in daily routines of people with dementia, with individually tailored approaches, while including carers to motivate/encourage them, seems to help promoting active lifestyle behaviours in people with dementia. The next section describes the framework used to promote functional independence of people with dementia through a home-based physical activity programme.

4. Framework to promote functional independence of people with dementia at home

Home-based physical activity seems to be a key facilitator towards the involvement of this population in healthy lifestyles (Hancox et al., 2019; Moise et al., 2004). Studies examining the effects of home-based physical activity programmes exist but are widespread in the literature. Thus, a systematic review was conducted to identify and synthetize the effects of home-based physical activity in people with dementia (**systematic review study: chapter 3**). In this systematic review we have found few home-based physical activity programmes for people with dementia. Despite the high heterogeneity retrieved across studies, they showed to be safe and effective in improving HRPF, BPSD, ADL performance, reducing carer's burden and delaying cognitive function decline (Almeida, Gomes da Silva, & Marques, 2019). Nevertheless, as stated by the Alzheimer's Disease International, innovative interventions and more research are still needed in home settings (Alzheimer's Disease International, 2019).

Non-pharmacological interventions for people with dementia should be person-centred, aligned with their wishes and preferences, evidence-based, and feasible in the care setting (Fazio, Pace, Maslow, et al., 2018; Scales et al., 2018; WHO, 2017). Thus, an attempt to reach these recommendations was performed.

LiFE is a home-based physical activity programme designed to prevent falls in older people that includes activities to improve balance and lower limb muscle strength (Clemson et al., 2012). This programme has shown to decrease time spent in sedentary activities and falls, whilst achieving high adherence rates, high levels of motivation and self-perceived health, and most importantly, maintaining the independence of older people in ADL (Clemson et al., 2012). Therefore, LiFE seems to be a promising and successful programme to overcome some of the barriers to physical activity in people with dementia. However, to the present date it has never been adapted to this population.

The Lifestyle Integrated Functional Exercise for People with Dementia (LiFE4D) is an individualised programme, adapted from LiFE (Clemson et al., 2012), that fits into people with dementia daily routines (Malthouse & Fox, 2014; van der Wardt et al., 2020). In addition to the activities to improve balance and lower limb muscle strength, LiFE4D also includes activities to improve exercise tolerance, upper limb function, flexibility, and an educational and psychosocial component. It has a duration of 3 months and each session lasts around 1 hour, following the recommendations for people with dementia (Blankevoort et al., 2010). Moreover, LiFE4D has a progressive decrease of the contact with the health professional over time, to gradually promote participants' independence. At the end of the first month, when the face-to-face contact reduces, each participant received a manual (**LiFE4D manual: chapter 4**) with activities that they could continue to perform on their daily routines (Almeida, Marques, & Silva, 2019). More detail about the LiFE4D intervention can be found on its protocol intervention study (**protocol study: chapter 4**) (Almeida, Gomes da Silva, & Marques, 2020).

Nevertheless, adopting an individualised strategy based on personal characteristics (i.e., age- and illness-related, physical and cognitive capacities or functional deficits) and/or physical activity progression (i.e., increase walking time or intensity of activities when one was easy to perform) might not be enough to ensure good adherence rates (2018 Physical Activity Guidelines Advisory Committee, 2018; Nyman, Adamczewska, & Howlett, 2018). Health behaviour changes are influenced by both physical and social environments (i.e., sociocultural and community contexts) (2018 Physical Activity Guidelines Advisory Committee, 2018; Bauman et al., 2012; WHO, 2009). Thus, a tailored approach, that considers the results of each participant assessment and his/her surroundings (i.e., environment and daily routines) in order to adapt and integrate physical activity into daily routines, might be a thriving intervention (2018 Physical Activity Guidelines Advisory Committee, 2018; Rhodes, McEwan, & Rebar, 2019; van der Wardt et al., 2020; Woodbridge et al., 2018). LiFE4D therefore followed an ecological model to allow an integrative and comprehensive understanding of the individuals and their surroundings, in order to promote physical activity into their daily routines (Stokols, 2000). The LiFE4D also respected the International Classification of Functioning, Disability and Health (ICF) definition of function (i.e., umbrella term for body functions and structures, activities and participation), which involves the interaction between the person and his/her context (WHO, 2001).

In practice, after a comprehensive assessment, observation and annotation of relevant characteristics of each participant and his/her surrounding (e.g., routines, available resources, most meaningful activities, limitations and capacities), the different data was systematised and integrated in a strengths, weaknesses, opportunities and threats (SWOT) analysis (Skinner, Hanning, Sutherland, Edwards-Wheesk, & Tsuji, 2012). SWOT is a simple, quick and integrative analysis used as a framework for health professionals to gather, organise and analyse important data into categories (i.e., strengths, weaknesses, opportunities and threats). These categories are then used to inform the individualised approach and guide the decision process (Casebeer, 1993; Weihrich, 1982), by establishing priorities and defining goals and strategies to induce change, following the Selection, Optimisation and Compensation (SOC) model (P. Baltes & Baltes, 1990). SOC focus on maximizing gains and minimizing losses on everyday activities, thus optimising well-being in the context of physical decline (M. Baltes & Carstensen, 2008; Carpentieri, Elliott, Brett, & Deary, 2017). In LiFE4D, after selection of the desired activities, these were optimised during the face-to-face sessions, and if one was not possible to be conducted, compensation strategies (e.g., support hands on a stable surface, do it slowly, replace an activity by other similar) were used (P. Baltes & Baltes, 1990).

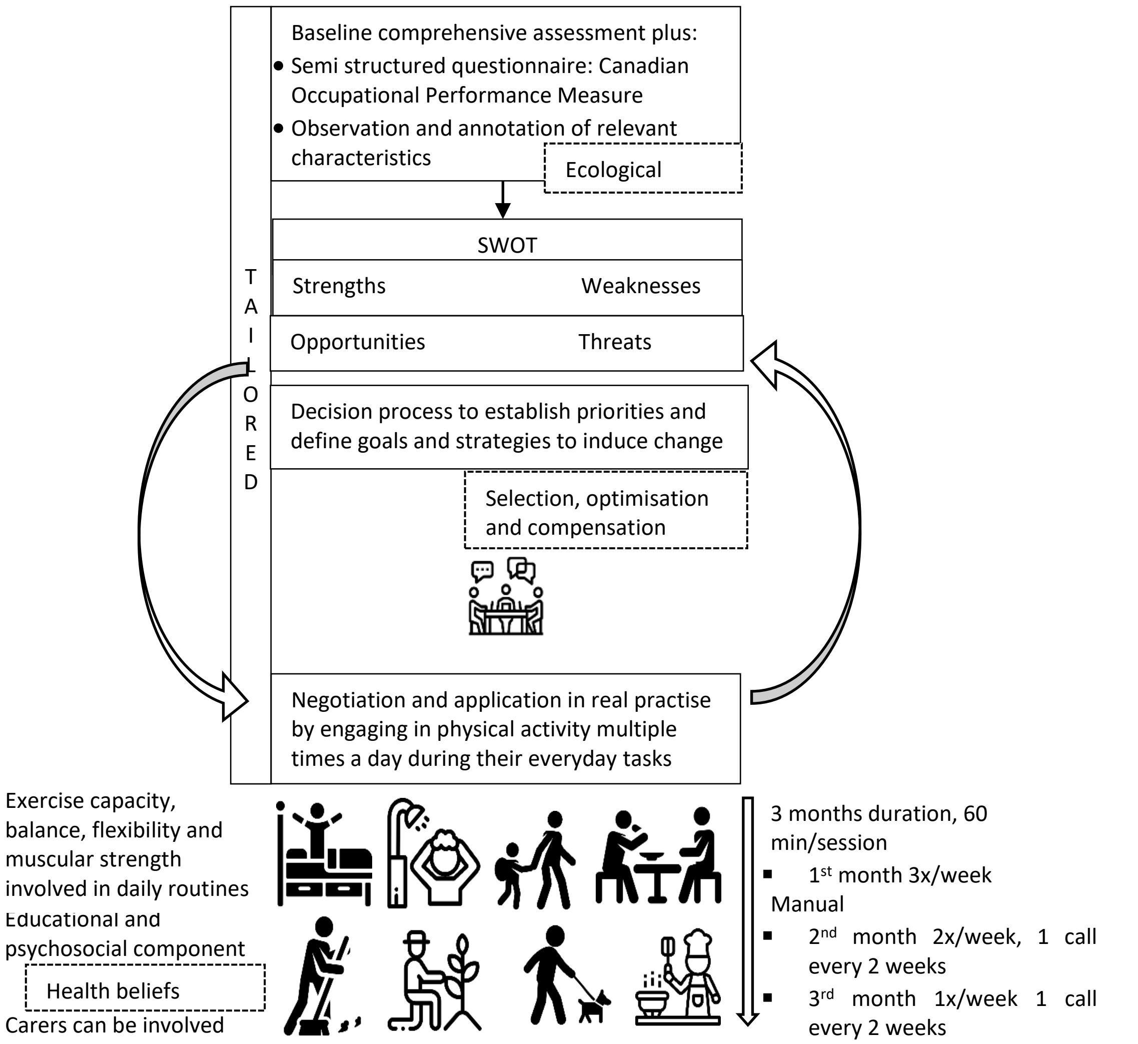

Figure 2. Schematic description of the framework of the lifestyle integrated functional exercise for people with dementia.

The educational and psychosocial component was held during the face-to-face sessions and was based on the health beliefs model (Hochbaum, Rosenstock, & Kegels, 1952). This model suggests that the likelihood of a person to act on his/her health is influenced by demographic, sociopsychological and structural factors, and provides incentive, competence and clear course to take action (Hochbaum et al., 1952). The concepts of the health beliefs model are perceived susceptibility, perceived seriousness, perceived benefits to take action, perceived barriers to take action and cue to action (Hochbaum et al., 1952). A schematic description of this theoretical and the practical framework of LiFE4D can be found on Figure 2.

To explore the feasibility and effectiveness of LiFE4D on HRFP and other meaningful measures, a pilot study was conducted (**original study I**). This study has found that LiFE4D is feasible, safe and has potential to improve the HRPF of people with dementia. Thus, the next step was to conduct a RCT (**original study II**) to examine the efficacy and effectiveness of LiFE4D on HRPF and other meaningful outcomes.

To achieve a more person-centred care in the research field it is important to give voice to participants (Brooks et al., 2017; Kontos et al., 2018). A qualitative approach with thematic analysis (**original study III**) was therefore held to explore the perceptions of people with dementia and their carers about LiFE4D, namely, to identify facilitators/motivators, barriers and impacts of the programme. Table 2 provides a schematic rationale from the topic to the chapters of the main body of this thesis.

Table 2. Representation of the rational from the topic to the chapters of this research work.

Topic	Problem	Research question	Aim	Sample and outcomes	Design and data analysis	Study/ publication	Chapter
Home-based physical activity	Home-based physical for people with dementia	What are the effects of home-based physical activity in people with dementia?	To identify and synthetise the effects of home-based physical activity programmes for people with dementia.	16 studies included	Systematic review with meta-analysis	Systematic review	3
	Design/adapt a home-based physical activity programme for people with dementia: LiFE4D	How to adapt LiFE for LiFE4D in people with dementia?	Design strategies to maintain or increase independence and autonomy of people with dementia during daily routines.	Descriptive manual of LiFE4D		LiFE4D manual	4
			Design strategies to maintain or increase physical activity levels and reduce sedentary behaviour of older people during a pandemic.	Descriptive chapter of physical activity during pandemic		Book chapter	
		How to implement the LiFE4D main clinical trial?	To design an implementation protocol for LiFE4D randomised controlled trial.	Description of the LiFE4D clinical trial protocol		Protocol study	
	Feasibility, efficacy and effectiveness of LiFE4D	Is LiFE4D feasible to conduct at home of people with dementia?	To explore the feasibility, safety and preliminary effectiveness of the LiFE4D on health-related physical fitness, cognitive function, physical activity, and respiratory and upper limb functions.	EG n=6 and CG n=6 Feasibility: ease of recruitment; acceptability of protocol assessment; percentage of adherence; and safety. HRPF: 2MST, BMI, handgrip dynamometer, 30CST, MIP, MEP, SNIP, CSRT, Brief-BESTest, FRT, TUG Cognitive function: ACE-III PA: Brief-PA Respiratory function: PEF Upper limb function: GST	Pilot and feasibility study Quantitative analysis: descriptive statistics and ES between groups (Cohen's d)	Original study I	5
		Is LiFE4D efficacious and effective improving health-related physical fitness, cognitive	To examine the efficacy and effectiveness of the LiFE4D on health-related physical fitness, cognitive function and health-related quality of	EG n=23 and CG n=24 Cardiorespiratory endurance: 2MST (primary outcome measure)	Short-term randomised controlled trial Quantitative analysis: descriptive statistics; per	Original study II	

	function and health-related quality of life in people with dementia?	life.	Body composition: BMI and FFM Muscular strength: handgrip dynamometer and 30CST Flexibility: CSRT Balance: Brief-BESTest Cognitive function: ACE-III Health-related quality of life: QoL-AD	protocol (efficacy) and intention-to-treat (effectiveness) analysis using generalised estimating equations. Unadjusted and adjusted models for efficacy and effectiveness; ES between groups (Cohen's d)		
Impacts of LiFE4D on the participants' perspective	What are the impacts of LiFE4D on the perspective of people with dementia and their carers?	To explore the perceived facilitators/motivators, barriers and impacts of LiFE4D from people with dementia who participated on LiFE4D and their carers.	People with dementia n=15 and their carers n=11 Short semi-structured interviews	Qualitative study with thematic analysis	Original study III	6

Abbreviations: 2MST: 2-minute step test; 30CST: 30-second chair stand; ACE-III: Addenbrooke's cognitive examination-III; BMI: body mass index; Brief-BESTest: brief-balance evaluation systems test; Brief-PA: brief physical activity assessment tool; CG: control group; CSRT: chair sit-and-reach test; EG: experimental group; ES: effect size; FFM: fat-free mass; FRT: functional reach test; GST: grocery shelving task; LiFE: Lifestyle Integrated Functional Exercise; LiFE4D: Lifestyle Integrated Functional Exercise for People with Dementia; MIP: maximal inspiratory pressures; MEP: maximal expiratory pressures; PEF: peak expiratory flow; PwD: people with dementia; QoL-AD: quality of life in Alzheimer's disease scale; SNIP: *sniff* nasal inspiratory pressure; TUG: timed up and go test.

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Chapter 3. Home-based physical activity for people with dementia

Systematic review

Home-based physical activity programs for people with dementia: systematic review and meta-analysis

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Abstract

Background and objectives: Physical activity has the potential to improve health outcomes in people with dementia, namely when living at home. However, the knowledge about home-based physical activity for this population is scarce. Thus, we aimed to identify and synthetize the effects of home-based physical activity for people with dementia.

Research design and methods: A systematic review was conducted. Quality of studies was assessed using the Delphi List. Effect sizes (ES) were calculated with MetaXL 2.0. A meta-analysis was conducted for the Mini-Mental Status Examination (MMSE), Neuropsychiatric Inventory (NPI), Cornell Scale for Depression in Dementia, Alzheimer's Disease Cooperative Study Group Activities of Daily Living Scale (ADCS-ADL), Functional Reach test, Timed Up and Go test (TUG), Short Physical Performance Battery, Dementia Quality of Life, NPI Caregivers sub-scale and Zarit Burden Interview (ZBI).

Results: Sixteen randomised controlled trials were included. Most were of high quality and published after 2015. A large heterogeneity of interventions was found. Meta-analysis showed significant results in MMSE (ES=0.71, 95%CI 0.43, 0.99), NPI (ES=-0.37, 95%CI -0.57, -0.17), ADCS-ADL (ES=0.80, 95%CI 0.53, 1.07), Functional Reach test (ES=2.24, 95%CI 1.80, 2.68), TUG (ES=-2.40, 95%CI -2.84, -1.96), NPI Caregivers sub-scale (ES=-0.63, 95%CI -0.94, -0.32) and ZBI (ES=-0.45, 95%CI -0.77, -0.13). Few minor adverse events and high adherence to intervention were found.

Discussion and implications: Home-based physical activity seems safe and effective in delaying cognitive function decline and improving changes in behavioural and psychological symptoms of dementia, activities of daily living, health-related physical fitness and carer's burden in people with dementia living at home.

Keywords: exercise; nonpharmacological intervention; major neurocognitive disorder.

Introduction

Dementia is a neurodegenerative syndrome that affects approximately 47.5 million people worldwide (Prince et al., 2015). This number is expected to grow to 131.5 million people by 2050 (Prince et al., 2015). Dementia is characterized by a decline in cognition and independence for activities of daily living (WHO, 2012), making it a major cause of incapacity and dependency among older people. Currently, most people with dementia live in their own homes (WHO, 2012), with about one third of them living alone (Ebly, Hogan, & Rockwood, 1999). Therefore, the development of home-based interventions is vital to inform the provision of care for people with dementia (WHO, 2012).

A highly recommended non-pharmacological intervention to manage symptoms of dementia is physical activity (Forbes, Thiessen, Blake, Forbes, & Forbes, 2015; Regier, Hodgson, & Gitlin, 2016; Sallis et al., 2016). Physical activity is defined as ‘‘any body movement produced by skeletal muscles that requires energy expenditure’’ (Caspersen, Powell, & Christenson, 1985).

Although studies looking at the effects of home-based physical activity programs exist, results are widespread in the literature. The published systematic reviews on physical activity in people with dementia found improvements in executive function, activities of daily living, falls prevention, cognitive decline, mobility, physical function, fitness, and positive behavior (Blankevoort et al., 2010; Burton et al., 2015; Forbes et al., 2015; Heyn, Abreu, & Ottenbacher, 2004; Pitkälä, Savikko, Poysti, Strandberg, & Laakkonen, 2013; Potter, Ellard, Rees, & Thorogood, 2011; Rao, Chou, Bursley, Smulofsky, & Jezequel, 2014). However, these reviews included studies conducted in different or undistinguishable settings, hindering comparisons across different settings and consequently, conclusions regarding the effects of physical activity at home (Blankevoort et al., 2010; Burton et al., 2015; Forbes et al., 2015; Heyn et al., 2004; Pitkälä, Savikko, et al., 2013; Potter et al., 2011; Rao et al., 2014). Looking at these effects separately is important to guide personalized interventions and future research in the setting where people with dementia spend more time. Thus, the aim of this systematic review was to identify and synthesize the effects of home-based physical activity in people with dementia.

Methods

Searches in the Cochrane Library and the International Prospective Register of Systematic Reviews (PROSPERO) were conducted prior to the development of the present systematic review to exclude the existence of reviews or protocols with the same purpose as this study.

The protocol for this systematic review was registered at International Prospective Register of Systematic Reviews (registration no. CRD42017059951) and is available on request. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (Moher, Liberati, Tetzlaff, Altman, & The Prisma Group, 2009) can be found in Supplementary Appendix 3.

Search strategy and selection criteria

Literature searches were performed in the Cochrane, PubMed, SCOPUS, LILACS, Web of knowledge, and EBSCOhost databases. Additional searches were performed in weekly automatic updates retrieved from the databases until March 2019. Electronic search was supplemented by hand searching of references lists of the included studies and key articles on the topic. Search strategy can be found in Supplementary Appendix 1, Table 1.

Studies were considered eligible if they: (i) were randomized controlled trials; (ii) were written in Portuguese, English, French, or Spanish languages; (iii) involved physical activity in home-based settings for people with dementia; (iv) included participants diagnosed with dementia; and (v) had at least one measure that assessed the outcomes of the intervention. Studies were excluded if: (i) involved proxy versions, (ii) were non randomized controlled trials, observational studies, qualitative studies, news, research protocols, thesis, dissertations, abstracts, letters to the editor, unpublished work, commentaries, book chapters, systematic reviews (references on the topic checked), guidelines (references on the topic checked), statements (references on the topic checked) and position papers (references on the topic checked), and (iii) were conducted in animals.

Articles were initially screened (title and abstracts) by the first author. The second author was consulted in case of uncertainty. A random sample of 10% of the abstracts was independently screened by the third author to guarantee consistency. Full texts of potentially relevant articles were screened independently by the first and third authors. Disagreements between the reviewers were solved by consensus.

Quality assessment and data extraction

Two reviewers independently assessed the methodological quality of each study using the Delphi-List, which is composed by nine items rated as yes/no (Verhagen et al., 1998). The total score ranges from 0 to 9 points and consists of summing the number of items that are satisfied (e.g., evaluated as yes; Verhagen et al., 1998). The cut-off point defining high-quality studies was set at ≥5 points (Verhagen et al., 1998). The Delphi-List has been used in a previous meta-analysis of the effects of exercise in people with dementia (Heyn et al., 2004).

Data from the included studies were extracted and synthesized in a structured table format that can be found in Supplementary Appendix 1, Table 3. Studies with multiple publications were identified to avoid duplicate reports (e.g., double counting of outcomes and/or number of participants). Corresponding authors of the included studies were contacted via e-mail to request additional data/information when required.

Data analysis and synthesis

Inter-rater agreement was assessed using Cohen's kappa coefficient to explore the consistency of the quality assessment performed by the two authors. The cut-off points of the Cohen's Kappa range from 0 to 1: slight (≤0.20), fair (0.21–0.40), moderate (0.41–0.60), and substantial (≥0.81) agreement (Landis & Koch, 1977). Statistical analysis was performed using IBM SPSS version 24.0 (IBM, Armonk, New York).

Meta-analyses were conducted to evaluate the effects of home-based physical activity on different domains, whenever possible. All eligible studies were kept for meta-analysis independently of their quality score as relatively scarce research has been conducted in the field. For variables that did not fit the meta-analysis, effect sizes (ES) were calculated whenever possible, allowing the quantification of the effectiveness of the intervention. The ES were interpreted as small (≥0.20), medium (≥0.50), or large (≥0.80); Cohen (1988). MetaXL 2.0 was used to calculate the individual and pooled ES. The input was the pooled Cohen's d value and corresponding standard error; and the output was the pooled Cohen's d value and corresponding confidence intervals (CI).

Results

Study selection

A PRISMA Flow Diagram can be found in Figure 1 (Moher et al., 2009), showing the screening process and reasons for exclusion of studies. The search generated 11,160 studies from which 16 studies were included in the final analysis (please see Supplementary Appendix 1, Table 7).

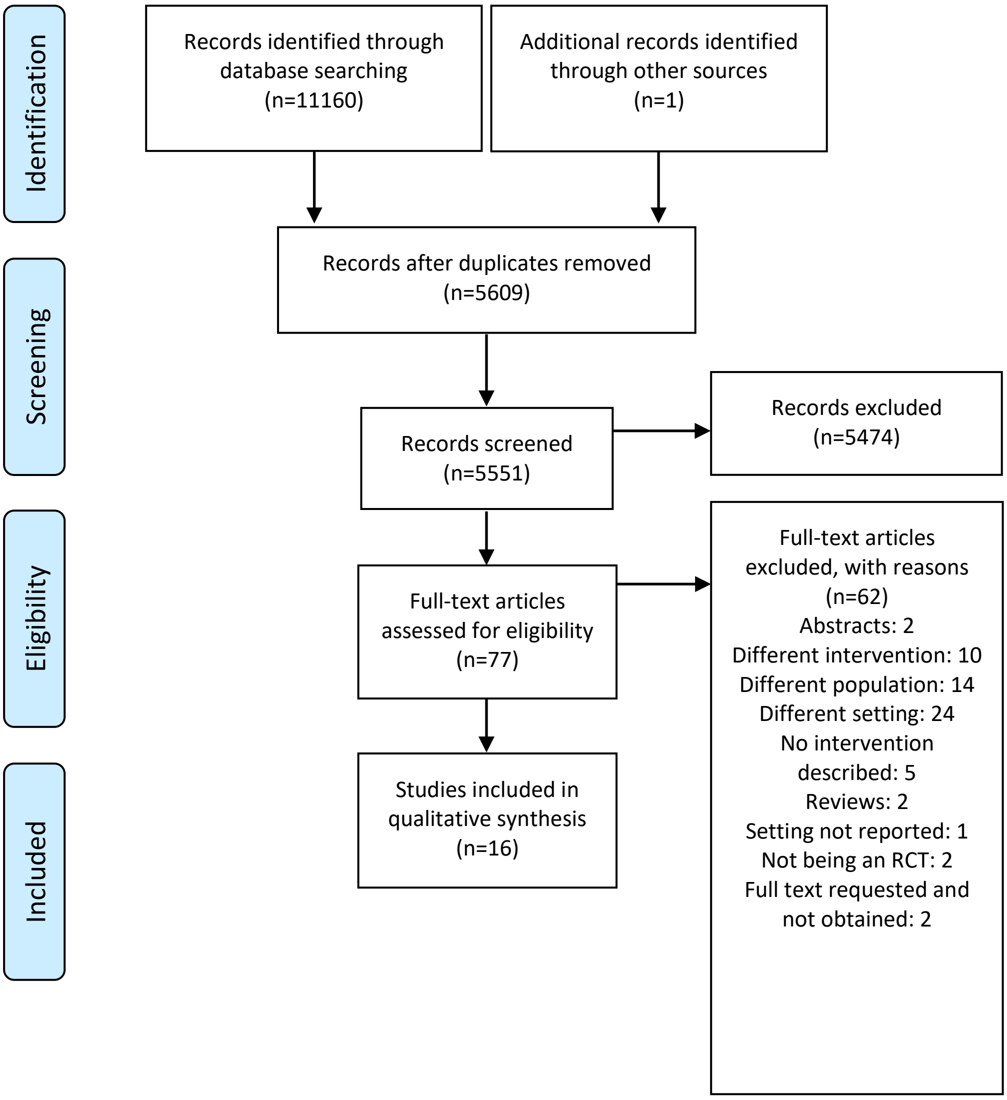

Figure 1. PRISMA flow chart diagram showing the articles screened and included in the study (n=16 – RCTs).

Quality assessment

Thirteen studies were rated as high quality and three studies as low quality (see Supplementary Appendix 1, Table 2). Appendix 1 (Table 2), shows the quality assessment details from the Delphi-list. Inter-rater agreement regarding the quality assessment was substantial - Cohen's Kappa=0.91 (p<0.001); 95%CI [0.74, 1.08].

Study characteristics

Most studies were conducted in the United States of America (USA) and Australia (see Supplementary Appendix 1, Table 3). In Europe, only northern countries (e.g., England (D'Amico et al., 2016; Lowery et al., 2014), Germany (Holthoff et al., 2015), Finland (Öhman et al., 2016, 2017; Pitkälä, Pöysti, et al., 2013), and Netherlands (Prick, de Lange, Scherder, Twisk, & Pot, 2017) reported home-based physical activity for people with dementia.

A total of 1,129 participants with 500 in home-based experimental groups, 137 in other experimental groups (e.g., group exercise, light exposure) and 492 in control groups participated in the reported studies, with sample sizes ranging from 22 (Wesson et al., 2013) to 210 (Öhman et al., 2016, 2017; Pitkälä, Pöysti, et al., 2013) participants. Participants had a mean age of 77.3 ± 7.3 [51, 99] years old, 51.1% (n = 810) were male and presented a Mini-Mental Status Examination (MMSE) mean score of 19.9 ± 5.9 [15.3, 25.6] points. There were only five studies reporting on the type and severity of dementia (D'Amico et al., 2016; Pitkälä, Pöysti et al., 2013; Suttanon et al., 2013; Teri et al., 2003; Vreugdenhil, Cannell, Davies, & Razay, 2012) and results were never differentiated according to these variables. Eight of the 16 studies investigated the medium- and long-term (3, 4, 6, 12, 18 and 24 months) effects of the home-based physical activity (see Supplementary Appendix 1, Table 3). Supplementary Appendix 1, Tables 3 and 4, and Supplementary Appendix 2, Table 1, present details of the included studies.

Design of the programs

Interventions lasted from 2 months (McCurry et al., 2011) to 2 years (Callahan et al., 2017), being 12 weeks (Supplementary Appendix 1, Table 3) the most common duration. Frequencies of the intervention ranged from daily (D'Amico et al., 2016; Lowery et al., 2014; Steinberg, Podewils, & Lyketsos, 2009) to 4–6 times per 2 months (Suttanon et al., 2013) and the length of the sessions ranged from 20 to 30 min (please see Supplementary Appendix 2, Table 1) to 12 hr (Teri et al., 2003). All interventions included home visits, with exception of one study (i.e., phone contacts; Vreugdenhil et al., 2012). Interventions included a wide variety of combinations across cardiorespiratory endurance, muscle strength and endurance, flexibility and neuromotor components (please see Supplementary Appendix 1, Tables 3 and 4). The most common included activity was walking (Supplementary Appendix 2, Table 1). Some studies also added to the physical activity intervention, cognitive training, goal setting, home modification, booklets or brochures, education to improve adherence, psychoeducation, communication training, problem solving, pleasant/meaningful activities, and carer education. Phone calls and dyad involvement were also reported. More details are presented in Supplementary Appendix 1, Table 3.

Outcomes and outcome measures

A total of nine outcome domains, measured by 75 different measurement tools were identified. Each study reported an average of 3.9 [1–8] different outcome domains and 6.4 [2–15] different measurement tools. Reported outcome domains were cognitive function (n = 8), changes in behavioral and psychological symptoms of dementia (n = 10), activities of daily living (n = 6), health-related physical fitness (n = 10), physical activity (n = 3), falls (n = 2), health-related quality of life (n = 5), carer's burden (n = 6), and costs (n = 1); see Supplementary Appendix 1, Tables 3 and 5. Most frequently reported outcome measures in the included studies were Neuropsychiatric Inventory (NPI) (n = 6), MMSE (n = 5), Cornell Scale for Depression in Dementia (n = 5), Zarit Burden Interview (ZBI) (n = 4), Five Times Sit to Stand test (n = 2), Alzheimer's Disease Cooperative Study Group Activities of Daily Living Scale—ADCS-ADL (n = 2), Falls Efficacy Scale (n = 2), Functional Reach test (n = 2), General Health Questionnaire (n = 2), NPI caregiver (n = 2), Lawton & Brody scale (n = 2), Short Physical Performance Battery (n = 2), 8-foot walk test (n = 2), and TUG test (n = 2); see , Supplementary Appendix 1, Tables 3 and 5.

<u>Effectiveness of the home-physical activity</u>

Table 1 synthesises the ES found per domain. For more detail please see Appendix 2 (Details of the effect sizes per domain).

Table 1. Synthesis of the effect sizes per domain.

Domains	**Effect sizes** (Cohen's *d*)					
	Small (≥0.20)		**Medium** (≥0.50)		**Large** (≥0.80)	
	Negative	Positive	Negative	Positive	Negative	Positive
Cognitive function	[-0.35 to -0.2] (Prick et al., 2017)	[0.41 to 0.49] (Öhman et al., 2016; Vreugdenhil et al., 2012)	[-0.58] (Vreugdenhil et al., 2012)	[0.56] (Dawson et al., 2017)	[-4.93] (Holthoff et al., 2015)	[1.11 to 4.75] (Holthoff et al., 2015; Padala et al., 2017)
Changes in BPSD	[-0.49 to -0.2] (Callahan et al., 2017; D'Amico et al., 2016; Öhman et al., 2017; Teri et al., 2003; Vreugdenhil et al., 2012)	-	[-0.42] (McCurry et al., 2011)	[0.6 to 0.62] McCurry et al., 2011; Öhman et al., 2017)	[-8.72 to -1.08] (Holthoff et al., 2015; McCurry et al., 2011; Öhman et al., 2017)	[0.8 to 2.18] (McCurry et al., 2011; Öhman et al., 2017)
ADLs	[-0.32] (Dawson et al., 2017)	[0.33] (Vreugdenhil et al., 2012)	-	[0.62] (Vreugdenhil et al., 2012)	[-1.08] (Padala et al., 2017)	[1.47 to 5.27] (Holthoff et al., 2015; Padala et al., 2017)
Health-related physical fitness	[-0.43 to -0.34] (Suttanon et al., 2013; Wesson et al., 2013)	[0.28 to 0.48] (Dawson et al., 2017; Pitkälä, Pöysti, et al., 2013; Suttanon et al., 2013)	[-0.68 to -0.51] (Suttanon et al., 2013; Vreugdenhil et al., 2012; Wesson et al., 2013)	[0.65 to 0.75] Dawson et al., 2017; Teri et al., 2003; Vreugdenhil et al., 2012)	[-2.2 to -0.86] (Padala et al., 2017; Suttanon et al., 2013)	[0.98 to 7] (Dawson et al., 2017; Padala et al., 2017; Suttanon et al., 2013; Vreugdenhil et al., 2012)
Physical activity	[-0.35] (Teri et al., 2003)	-	-	-	-	0.83 (Wesson et al., 2013)
Falls	[-0.28 to -0.2] (Suttanon et al., 2013; Wesson et al., 2013)	-	[-0.59 to -0.56] (Suttanon et al., 2013)	-	-	-
HRQoL	[-0.23] (Suttanon et al., 2013)	[0.36] (Lowery et al., 2014)	-	-	-	[1.91] (Padala et al., 2017)
Carer's Burden	[-0.26] (D'Amico et al., 2016)	-	[-0.52] (Vreugdenhil et al., 2012)	-	[-3.9] (Holthoff et al., 2015)	-
Costs	[-0.21 to -0.43] D'Amico et al., 2016)	[0.22 to 0.23] (D'Amico et al., 2016)	-	-	-	-

Abbreviations: ADLs: Activities of Daily Living; BPSD: Behavioural and Psychological Symptoms of Dementia; HRQoL: Health-related quality of life.

The overall pooled ES for the i) Mini-Mental Status Examination was medium and positive (ES=0.71, 95%CI 0.43, 0.99); ii) Neuropsychiatric Inventory was small and negative (ES=-0.37, 95%CI -0.57, -017); iii) The overall pooled ES for the ADCS-ADL was large and positive (ES=0.80, 95%CI 0.53, 1.07); iv) Functional Reach test was large and positive (ES=2.24, 95%CI 1.80, 2.68) and v) Timed Up and Go test was large and negative (ES=-2.40, 95%CI -2.84, -1.96) (Figure 2). No significant differences were found for Cornell Scale for Depression in Dementia, Short Physical Performance Battery and Dementia Quality of Life.

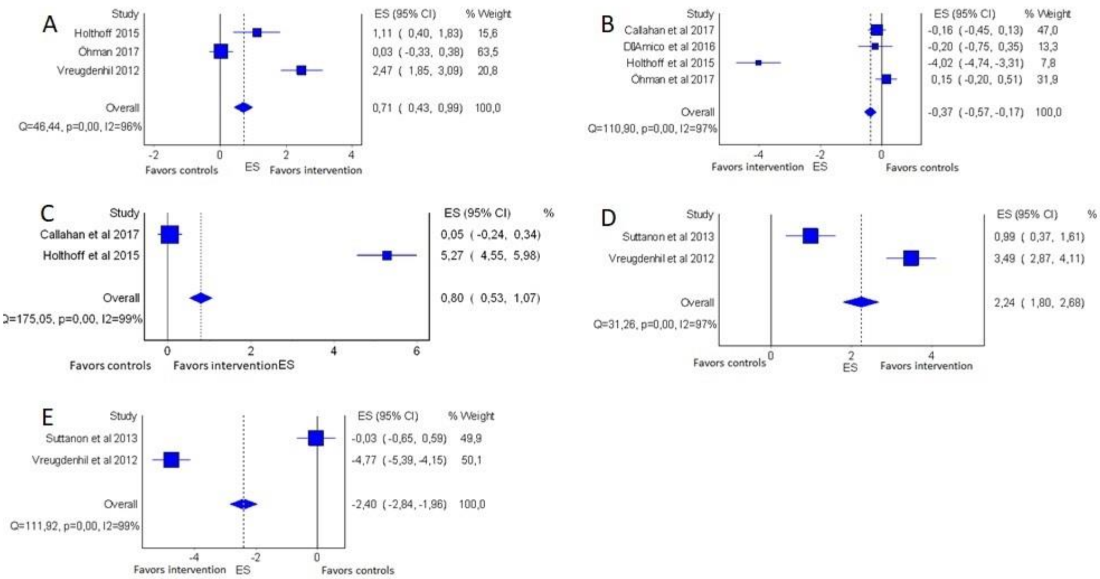

Figure 2. Forest plot of the home-based physical activity programmes on (A) the Mini-Mental Status Examination, (B) Neuropsychiatric Inventory, (C) Alzheimer's Disease Cooperative Study Group Activities of Daily Living scale, (D) Functional Reach test, and (E) Timed Up and Go test in people with dementia.

Carer's burden effectiveness was analysed with the Neuropsychiatric Inventory Caregivers sub-scale and the Zarit Burden Interview. Overall pooled ES was medium and negative (ES=-0.63, 95%CI -0.94, -0.32) for Neuropsychiatric Inventory Caregivers sub-scale and low and negative (ES=-0.45, 95%CI -0.77, -0.13) for Zarit Burden Interview (Figure 3).

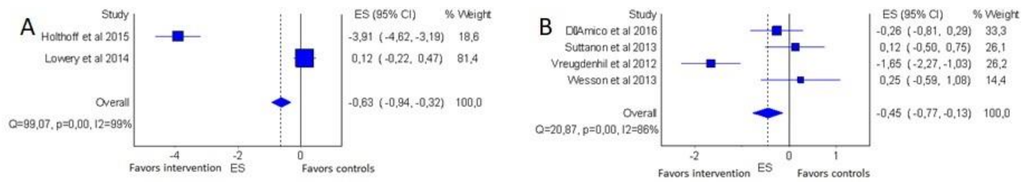

Figure 3. Forest plot of home-based physical activity programs on carer's burden measured with (A) the Neuropsychiatric Inventory Caregivers sub-scale and with (B) the Zarit Burden Interview in people with dementia.

Adverse events

A total of 10 studies (Dawson, Judge, & Gerhart, 2017; Lowery et al., 2014; McCurry et al., 2011; Padala et al., 2017; Pitkälä, Pöysti, et al., 2013; Prick et al., 2017; Steinberg et al., 2009;

Suttanon et al., 2013; Teri et al., 2003; Wesson et al., 2013) explored the adverse events of home-based physical activity programs. Only three studies (Dawson et al., 2017; Steinberg et al., 2009; Wesson et al., 2013) found minor adverse events related or possibly related with intervention. More information about the adverse events can be found in Supplementary Appendix 1, Table 6.

Dropouts and adherence

Five studies (McCurry et al., 2011; Padala et al., 2017; Prick et al., 2017; Suttanon et al., 2013; Teri et al., 2003) reported dropouts, ranging between 8% (Teri et al., 2003) and 27.5% (Suttanon et al., 2013). Reasons reported to dropout were: carers were not able to dedicate the necessary time (Padala et al., 2017), carer found the effort excessive (Suttanon et al., 2013), the carer preferred the participant to be in an exercise group (Suttanon et al., 2013), loss of interest (Padala et al., 2017), health problems (Prick et al., 2017; Suttanon et al., 2013), burden (Prick et al., 2017), institutionalization (Prick et al., 2017; Suttanon et al., 2013; Teri et al., 2003), hospitalization (Prick et al., 2017; Suttanon et al., 2013), and death (Prick et al., 2017; Suttanon et al., 2013).

Eleven studies reported adherence to the intervention (Dawson et al., 2017; Holthoff et al., 2015; Lowery et al., 2014; McCurry et al., 2011; Öhman et al., 2016; Padala et al., 2017; Pitkälä, Pöysti, et al., 2013; Steinberg et al., 2009; Suttanon et al., 2013; Teri et al., 2003; Wesson et al., 2013). Adherence varied between poor (Lowery et al., 2014) and excellent (Dawson et al., 2017; Holthoff et al., 2015; Padala et al., 2017), with six studies reporting good to very high adherence (Öhman et al., 2016; Pitkälä, Pöysti, et al., 2013; Steinberg et al., 2009; Suttanon et al., 2013; Teri et al., 2003; Wesson et al., 2013). This variance across adherence levels could be expected as interventions were heterogeneous and the existing evidence regarding effective adherence strategies is limited (van der Wardt et al., 2017).

Discussion

This systematic review provided a synthesis of the effects of home-based physical activity in people with dementia. Most studies were of high quality and published after 2015 (first article published in 2003), indicating that this is a relatively new topic of research. High heterogeneity of the designs of home-based physical activity interventions was found. Overall, medium to large delay of cognitive function decline and improvements in changes in behavioural and psychological symptoms of dementia, activities of daily living, health-related physical fitness, physical activity, falls, health-related quality of life and carer's burden were observed. Despite the heterogeneous use of measurement tools, it was possible to conduct a meta-analysis for some outcome measures. Home-based physical activity in people with dementia seems to be effective on delaying cognitive function decline, assessed with MMSE (Holthoff et al., 2015; Öhman et al., 2017; Vreugdenhil et al., 2012), improving changes in behavioral and psychological symptoms of dementia with NPI (Callahan et al., 2017; D'Amico et al., 2016; Holthoff et al., 2015; Öhman et al., 2017), activities of daily living with ADCS-ADL (Callahan et al., 2017; Holthoff et al., 2015), health-related physical fitness with Functional Reach test (Suttanon et al., 2013; Vreugdenhil et al., 2012) and TUG test (Suttanon et al., 2013; Vreugdenhil et al., 2012) and carer's burden with NPI Caregivers subscale (Holthoff et al., 2015; Lowery et al., 2014), and ZBI (D'Amico et al., 2016; Suttanon et al., 2013; Vreugdenhil et al., 2012; Wesson et al., 2013). Moreover, home-based physical activity interventions seem to be safe and present high adherence.

The observed high heterogeneity in the designs, outcomes, and outcome measures leads to difficulties in determining which structure is more effective for home-based physical activity interventions in people with dementia. Nevertheless, some similarities were identified across studies, that is, an intervention duration of 12 weeks was commonly (4/13) reported and walking was the physical activity most widely used. Walking is a simple intervention, easily implemented on a home environment, previously recommended to stabilize cognitive function (Venturelli, Scarsini, & Schena, 2011), physical performance, and activities of daily living (Venturelli et al., 2011; Vreugdenhil et al., 2012) in people with Alzheimer's disease. However, it should be acknowledged that walking is just a possible option and more research is still needed on the efficacy and adherence across home-based physical activity programs for people with dementia.

A substantial heterogeneity was found in the reported outcomes and outcome measures. Nevertheless, some outcomes and outcome measures, which have been used in physical activity interventions for people with dementia (Gonçalves, Cruz, Marques, Demain, & Samuel, 2018; Gonçalves, Samuel, Ramsay, Demain, & Marques, 2019), were reported more than once, making it possible to perform meta-analysis for a home-based setting. Although, high heterogeneity and some similarities across studies have been previously reported in other systematic reviews looking at the effects of physical activity on health-related physical fitness (Blankevoort et al., 2010; Lam et al., 2018), activities of daily living (Blankevoort et al., 2010), or functionality (Pitkälä, Savikko, et al., 2013), none have examined the overall effects of home-based physical activity in people with dementia.

Home-based physical activity interventions seem to be effective for people with dementia, that is, delaying cognitive function decline and improving changes in behavioral and psychological symptoms, activities of daily living and health-related physical fitness but also for carers, decreasing their burden. Positive effects on cognitive function and changes in behavioral and psychological symptoms of dementia are controversial in some literature reviews (Barreto, Demougeot, Pillard, Lapeyre-Mestre, & Rolland, 2015; Forbes et al., 2015; Heyn et al., 2004; Potter et al., 2011; Rao et al., 2014). It is possible that this systematic review was able to find positive results because it only included home-based interventions and pooled data from measurement tools consistently used on physical activity programs in people with dementia (i.e., MMSE and NPI; Gonçalves et al., 2018). Previous literature has also showed improvements on activities of daily living (Borges-Machado et al., 2019; Forbes et al., 2015; Lewis, Peiris, & Shields, 2017; Rao et al., 2014), health-related physical fitness (Heyn et al., 2004; Potter et al., 2011; Rao et al., 2014), and carer's burden (Zeng et al., 2016) after physical activity for people with dementia in different settings, which are key factors to maintain their independence (Physical Activity Guidelines Advisory Committee, 2018). This systematic review corroborates these findings indicating that, keeping people with dementia active at home may allow them to stay well at home, which is in line with international policy for dementia care (Burns, 2000; Moïse, Schwarzinger, Um, & Dementia Experts' Group, 2004; WHO, 2012).

Although levels of physical activity (Suttanon et al., 2013; Teri et al., 2003; Wesson et al., 2013), falls (Suttanon et al., 2013; Wesson et al., 2013), health-related quality of life (D'Amico et al., 2016; Lowery et al., 2014; Padala et al., 2017; Steinberg et al., 2009; Suttanon et al., 2013), and costs (D'Amico et al., 2016), are also important outcomes for the wide dissemination of home-based physical activity intervention, a limited number of studies reported on them or used different measures, which impairs comparison of the results. There is a need to identify a minimum set of measures that can contribute to clarify the controversy in the literature and guide future research to enhance our knowledge on the costs as well as the effects of home-based physical activity in people with dementia (Gonçalves et al., 2018; Van Ooteghem et al., 2018).

Overall, this systematic review found mostly good to excellent adherence to home-based physical activity (Dawson et al., 2017; Holthoff et al., 2015; Öhman et al., 2016; Padala et al., 2017; Pitkälä, Pöysti, et al., 2013; Steinberg et al., 2009; Suttanon et al., 2013; Teri et al., 2003; Wesson et al., 2013). Adherence has been found to vary across different studies (van der Wardt et al., 2017) and although good levels have been previously reported (Burton et al., 2015; Rao et al., 2014), it has been acknowledged that physical activity at home and individualized interventions seems to be key factors to improve adherence in people with dementia (Suttanon, Hill, Said, Byrne, & Dodd, 2012; van der Wardt et al., 2017). Individual, biological but also social environmental factors are determinants to physical activity behavior (Bauman et al., 2012). Thus, motivation/willingness of people with dementia to participate in physical activity interventions may be influenced by their individual characteristics, countries (in this review studies were implemented in six different countries), and cultures. Furthermore, very few and minor adverse events were reported, indicating that home-based physical activity is a safe approach. Future research should consider exploring the impact of important variables such as the type and severity of dementia on the results obtained and study the long-term effects of such programs.

Limitations

This systematic review has several limitations that need to be acknowledged. Firstly, there is a possibility of having missed some studies because articles published in other languages than English, Spanish, French, and/or Portuguese were not included. Thorough searches were however conducted in different databases to minimize as much as possible this limitation. Secondly, because the search only included randomized controlled trials, data of other peer-reviewed work, unpublished work, or gray literature were not included. Nevertheless, this is the best design to reduce bias when studying interventions. Finally, although most of the included studies were of high quality, which has minimized some limitations, the large diversity of designs, outcomes, outcome measures and control groups found, hampered the synthesis of results. Due to this difficulty and the relatively scarce research in the field of home-based physical activity interventions for people with dementia, we decided to include one poor-quality study in the meta-analysis. However, this may have affected its quality. Therefore, more research with robust methodologies is recommended so an update of this systematic review and meta-analysis can be conducted in the future and guide strong recommendations of home-based physical activity in people with dementia.

Conclusions

This systematic review identified the designs and synthesized the effects of home-based physical activity in people with dementia. This intervention seems to be effective to delay cognitive function decline and improve changes in behavioral and psychological symptoms of dementia, activities of daily living, health-related physical fitness and carer's burden in people with dementia living at home. Overall, home-based physical activity interventions seem to be safe and present high adherence. This is important for professionals to be confident to encourage physical activity at home in people with dementia. However, there is a need to establish recommendations with the most effective intervention structure and components as well as the minimum set of outcomes and outcome measures to assess home-based physical activity in people with dementia.

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Supplementary material

Appendix 1 is an excel file that can be found on digital support material.

Appendix 2

Home-based physical activity programs for people with dementia: a systematic review and meta-analysis

Table S1: Detailed study characteristics (n=16).

Author and Country	Participants	Structure	Intervention components	Outcome domains	Outcome measures	Results
Callahan *et al* 2017(Callahan et al., 2017) USA	n_{Total}=180 N.D. years Female=127 (70.6%) MMSE=N.D. n_{EG}=91 Female=66 (73%) 79.6±8.3 years MMSE=19.4±6.9 points n_{CG}=89 Female=61 (69%) 77.2±9.4 years MMSE=19.0±7.6 points	<u>Duration</u> 2 years <u>Frequency</u> - 16 weeks: 8 visits/week - 32 weeks: 8 visits every 4 weeks - 1 year: 8 visits <u>Sessions duration</u> 90 min	<u>Experimental Group</u> • Care for dementia through the Healthy Aging Brain Centre comanaged with the primary care practice • Goal setting • Home assessment, modification and safety • Meaningful activities • Neuromotor: balance and ADLs • Carer's education and training • Carer's training in ADLs and meaningful activities • Cognitive training • Phone calls: problem solving • Withdrew support over time <u>Control Group</u> * Care for dementia through the Healthy Aging Brain Centre comanaged with the primary care practice	Change in BPSD	NPI	T0 EG 15.6±15.1 vs CG: 16.6±18.9 6month EG 13.51 (9.44-17.57) vs CG 17.80 (13.58-22.02) p=0.09 ES=-0.21 12month EG 13.99 (9.66-18.31) vs CG 18.29 (13.88-22.71) p=0.12 ES=-0.20 18month EG 14.96 (10.75-19.17) vs CG 15.66 (11.30-20.02) p=0.79 ES=-0.01 24month EG 14.68 (9.97-19.38) vs CG 19.13 (14.35-23.90) p=0.14 ES=-0.16
					Patient Health Questionnaire-9	T0 EG 4.1±4.1 vs CG 3.7±3.7 6month EG 3.48 (2.56-4.40) vs CG 4.07 (3.11-5.03) p=0.31

		ES=-0.05 12month EG 3.65 (2.68-4.61) vs CG 4.79 (3.80-5.78) p=0.06 ES=-0.13 18month EG 3.80 (2.81-4.79) vs CG 3.83 (2.80-4.85) p=0.97 ES=-0.29 24month EG 3.72 (2.78-4.67) vs CG 3.70 (2.73-4.67) p=0.97 ES=-0.26
	Generalized Anxiety Disorder 7-item	T0 EG 4.0±4.5 vs CG 3.6±4.5 6month EG 3.22 (2.19-4.24) vs CG 3.37 (2.30-4.43) p=0.82 ES=0.06 12month EG 3.21 (2.14-4.28) vs CG 4.16 (3.07-5.26) p=0.16 ES=-0.02 18month EG 3.46 (2.48-4.44) vs CG 2.75 (1.73-3.77) p=0.25 ES=-0.14 24month EG 2.86 (1.87-3.85) vs CG 2.84 (1.83-3.86) p=0.98 ES=-0.07
ADLs	Alzheimer's Disease Cooperative Study Group ADL	T0 EG 49.4±17.6 vs CG 47.8±15.7 6month EG 45.49 (41.02-49.96) vs CG 43.57 (38.97-48.18) p=0.49 ES=-0.05

				12month EG 43.25 (38.33-48.17) vs CG 39.36 (34.33-44.39) p=0.21 ES=0.02 18month EG 39.10 (33.96-44.24) vs CG 36.32 (31.06-41.58) p=0.40 ES=0.12 24month EG 34.47 (28.60-40.34) vs CG 32.13 (26.17-38.08) p=0.54 ES=0.05
		Health-related physical fitness	Short Physical Performance Battery	T0 EG 4.3±2.7 vs CG: 4.2±3.2 6month EG 3.88 (3.08-4.68) vs CG 4.08 (3.25-4.91) p=0.68 ES=-0.07 12month EG 3.88 (3.04-4.72) vs CG 3.75 (2.88-4.61) p=0.80 ES=0.07 18month EG 3.52 (2.65-4.38) vs CG 3.16 (2.26-4.05) p=0.51 ES=0.03 24month EG 2.45 (1.55-3.35) vs CG 2.78 (1.87-3.69) p=0.57 ES=0
			Short Portable Sarcopenia Measure	T0 EG 3.3±3.5 vs CG 3.6±3.7 6month EG 1.85 (1-2.70) vs CG 2.87 (1.98-3.76) p=0.05

						ES=-0.06 12month EG 2 (1.13-2.87) vs CG 2.26 (1.35-3.16) p=0.64 ES=0.03 18month EG 1.63 (0.72-2.53) vs CG 2.06 (1.11-3) p=0.45 ES=-0.08 24month EG 1.48 (0.56-2.41) vs CG 2.11 (1.15-3.07) p=0.29 ES=-0.14
Dawson *et al* 2017(Dawson et al., 2017) USA	n_{Total}=23 73.9±9.1 years Female=13 (56.5%) MMSE=20.8±5.0 points n_{EG}=13 73.8±8.5 years Female=6 (46.2%) MMSE=19.9±6.1 points n_{CG}=10 74.0±10.4 years Female=7 (70%) MMSE=22.0±3.1 points	<u>Duration</u> 12 weeks <u>Frequency</u> 2x/week <u>Sessions duration</u> N.D.	<u>Experimental Group</u> • Moderate-intense exercise • Review results from the previous session and barriers reported by the dyad • Education to improve adherence • Planning (implementations strategies based on strength-based approach) • Muscle strength and endurance: 8-12 repetitions (60-80% of 1RM), then weight addition • Neuromotor: balance exercises: variation of base of support or compliance of surface	Cognitive function	The Trail Making Test-Part B (s)	T0 EG 4:27±2:01 vs CG 4:44±2:57 EG vs CG p>0.05 12weeks EG 7:42±5:35 vs CG 5:51±3:12 ES=0.56

			<u>Control Group</u> Continuation of current levels of activity			
				ADLs	The 16-item self-reported assessment tool	EG Pre 7.3±5.1 Post EG 6.8±5.1 CG Pre 4.2±3.9 Post 5.4±6.7 EG vs CG p>0.05 ES=-0.32
				Health-related physical fitness	Modified Berg Balance Scale	EG Pre 39.5±3.3 Post 41.5±2.2 CG Pre 38.5±8.0 Post 36.6±8.7 EG vs CG t=4.1 p=0.001 ES=0.65
					The 8-foot walk test	Comfortable gait speed EG Pre 0.7±0.2 Post 0.7±0.1 CG Pre 0.7±0.2 Post 0.6±0.3 EG vs CG t=0.6 p=0.6 ES=0.48 Fast gait speed EG Pre 1.2±0.3 Post 1.6±0.3 CG Pre 1.4±0.6 Post 1.3±0.6 EG vs CG t=2.6 p=0.02 ES=1.08
					30-second chair stand test	EG Pre 14.0±5.8 Post 17.9±6.8 CG Pre 15.7±6.1 Post 13.2±4.9 EG vs CG t=3.3 p=0.004 ES=1.05
D'Amico *et al* 2016(D'Amico et al.,	n_{Total}=52 78.5±8.2 years	<u>Duration</u> 12 weeks	<u>Experimental Group</u> • Cardiorespiratory	Changes in BPSD	NPI	EG Pre 31.6±19.2 vs Post 22.5±18.7

2016) England	Female=29 (55.8%) MMSE=15.3±7.9 points n_{EG}=30 78.6±7.6 years Female=16 (53.3%) MMSE=13.6±7.4 points n_{CG}=22 78.4±9.1 years Female=13 (59.1%) MMSE=17.5±8.2 points	Frequency Daily Sessions duration 20-30min	endurance: individually tailored walking • Withdrew support over time (i.e., 6 weeks) • No support over weeks 7 to 12 • Dyad: exercise to complement the withdrew support Control Group Usual treatment			CG Pre 32.9±19.1 vs Post 27.6±16.7 T0 EG vs CG p=0.79 T1 EG vs CG p=0.32 ES=-0.20
					General Health Questionnaire	EG Pre 17.9±9.1 vs Post 18.0±7.7 CG Pre 19.7±10.9 vs Post 23.2±10.1 T0 EG vs CG p=0.51 T1 EG vs CG p=0.05 ES=-0.36
				HRQoL	DEMQOL-Proxy	EG Pre 103.6±12.5 vs Post 105.6±9.7 CG Pre 100.7±16.3 vs Post 101.3±13.5 T0 EG vs CG p=0.66 T1 EG vs CG p=0.25 ES=0.11
				Carer's burden	Zarit Burden Interview	EG Pre 19.0±9.0 vs Post 18.7±8.3 CG Pre 17.0±7.7 vs Post 18.9±8.5 T0 EG vs CG p=0.37 T1 EG vs CG p=0.33 ES=-0.26
				Costs	Client Receipt Inventory Accommodation	EG Pre 1300.9±3478.1 vs Post 697.0±2361.4 CG Pre 951.7±3080.3 vs Post 632.7±2967.7

	T0 EG vs CG p=0.72 T1 EG vs CG p=0.80 ES=-0.09
Client Receipt Inventory Hospital services	EG Pre 577.5±1248.9 vs Post 146.7±255.9 CG Pre 513.6±747.8 vs Post 461.0±937.2 T0 EG vs CG p=0.83 T1 EG vs CG p=0.08 ES=-0.43
Client Receipt Inventory Community services	EG Pre 682.4±1010.9 vs Post 390.5±782.2 CG Pre 575.5±1108.9 vs Post 270.4±707.0 T0 EG vs CG p=0.72 T1 EG vs CG p=0.65 ES=0.01
Client Receipt Inventory Equipment and adaptations	EG Pre 112.0±158.6 vs Post 89.0±160.3 CG Pre 68.2±135.7 vs Post 103.0±189.7 T0 EG vs CG p=0.30 T1 EG vs CG p=0.25 ES=-0.36
Client Receipt Inventory Day services	EG Pre 259.6±492.5 vs Post 229.1±476.8 CG Pre 270.2±550.0 vs Post 270.5±519.5 T0 EG vs CG p=0.94 T1 EG vs CG p=0.78 ES=-0.06
Client Receipt Inventory Medications	EG Pre 272.8±177.0 vs Post 285.2±172.9 CG Pre 275.7±194.3 vs Post 246.3±169.4 T0 EG vs CG p=0.96 T1 EG vs CG p=0.04 ES=0.23

					Client Receipt Inventory Total health and social care	EG Pre 3205.1±3595.1 vs Post 1837.5±2511.8 CG Pre 2654.8±3756.8 vs Post 1983.8±3080.5 T0 EG vs CG p=0.61 T1 EG vs CG p=0.41 ES=-0.21 Plus intervention EG 2121.5±2509.7 vs CG 1983.8±3080.5 EG vs CG p=0.76 ES=-0.13
					Client Receipt Inventory Unpaid care	EG Pre 7812.1±6273.3 vs Post 8411.6±5727.0 CG Pre 6563.3±4953.9 vs Post 5820.7±6750.9 T0 EG vs CG p=0.42 T1 EG vs CG p=0.24 ES=0.22
					Client Receipt Inventory Total societal	EG Pre 11017±5719.5 vs Post 10533±5890.7 CG Pre 9218.2±5647.8 vs Post 7804.5±6859.0 T0 EG vs CG p=0.24 T1 EG vs CG p=0.31 ES=0.15
Holthoff *et al* 2015(Holthoff et al., 2015) Germany	n_{Total}=30 N.D. years Female=15 (50%) MMSE=N.D. n_{EG}=15 72.4±4.3 years Female=8 (53.3%) MMSE=22.0±0.5 points n_{CG}=15 70.7±5.4 years Female=7 (48.7%) MMSE=22.1±0.6 points	Duration 12 weeks Frequency 3x/week Sessions duration 30min	Experimental Group • Cardiorespiratory endurance • Use of ReckMOTOmed: a computer controlled and individually preassigned training flow • The participants chose an activity level between 2 and	Cognitive function	MMSE	EG Pre 22.05±0.54 vs Post 21.99±0.54 CG Pre 21.95±0.54 vs Post 21.28±0.54 ES=1.11

			4 from the 20 levels of motor resistance • Carer’s encouraging and leave the room after that <u>Control Group</u> • Received the same monthly clinical visits Counselling how to change inactive habits and increase the physical activity level			
					Phonemic verbal fluency test	EG Pre 13.60±0.65 vs Post 15.27±0.65 CG Pre 13.92±0.65 vs Post 12.46±0.65 ES=4.75
					Ruler Drop Test (m)	EG Pre 0.27±0.01 vs Post 0.23±0.01 CG Pre 0.27±0.01 vs Post 0.28±0.01 ES=-4.93
				Change in BPSD	NPI	EG Pre 11.25±1.26 vs Post 10.05±1.26 CG Pre 11.77±1.26 vs Post 15.71±1.26 ES=-4.02
				ADLs	Alzheimer’s Disease Cooperative Study Group ADL	EG Pre 60.55±0.91 vs Post 62.35±0.91 CG Pre 60.53±0.91 vs Post 57.47±0.91 ES=5.27
				Carer’s burden	NPI Caregivers sub-scale	EG Pre 5.58±0.96 vs Post 5.51±0.96 CG Pre 5.82±0.96 vs Post 9.55±0.96 ES=-3.90
Lowery *et al*	n_{Total}=131	The same reported in	The same reported in	Change in BPSD	NPI	6weeks OR=1.27

2014(Lowery et al., 2014) England	N.D. years Female=74 (56.5%) MMSE=N.D. n_{EG}=67 79±6.8 years Female=35 (52.2%) MMSE=16.3±7.4 points n_{CG}=64 78±7.4 years Female=39 (60.9%) MMSE=14.9±8.7 points	D'Amico *et al* 2016(D'Amico et al., 2016)	D'Amico *et al* 2016(D'Amico et al., 2016)			p=0.52 CI [0.61, 2.66] EG 25.7±20.5 vs CG 26.6±17.5 ES=-0.07 12 weeks OR=1.41 p=0.36 CI [0.67, 3.01] EG 23.9±20.6 vs CG 25.6±16.6 ES=-0.13
					General Health Questionnaire	6weeks OR=0.42 p=0.05 CI [0.18, 1] 12weeks OR=0.59 p=0.19 CI [0.24, 1.43]
				HRQoL	DEMQOL	6weeks EG 103.6±11.9 vs CG 101.1±14.9 β=1.27 p=0.49 IC [-2.33, 4.86] ES=0.26 12weeks EG 104±10 vs CG 101±13.5 β=2.62 p=0.09 IC [-0.78, 6.02] ES=0.36
				Carer's burden	Zarit Burden Interview	6weeks OR=0.48 p=0.25 IC [0.14, 1.67] 12weeks OR=0.18 p=0.01 IC [0.05, 0.69]
					NPI Caregivers sub-scale	6weeks EG 11.5±8.5 vs CG 11.07±7.2 β=-0.06 p=0.96 IC [-2.25, 2.14] ES=0.08 12weeks EG 10.9±9.3 vs CG 9.98±5.9 β=1.14 p=0.76 IC [-1.31, 3.58] ES=0.17
McCurry *et al* 2011(McCurry et al.,	n_{Total}=132 N.D. years	<u>Duration</u> 2 months and 6	<u>Walking Group</u> • Cardiorespiratory	Cognitive function	MMSE	Walking Pre 19.2±7.7 Light Pre 17.9±7.0

2011) USA	Female=73 (55.3%) MMSE=N.D. $n_{Walking}$=32 82.2±8.5 years Female=17 (53%) MMSE=19.2±7.7 points n_{Light}=34 80.6±7.3 years Female=19 (56%) MMSE=17.9±7.0 points $n_{NITE\text{-}AD}$=33 80.0±8.2 years Female=20 (61%) MMSE=19.1±5.8 points n_{CG}=33 81.2±8.0 years Female=17 (51%) MMSE=18.7±6.9 points	months follow up <u>Frequency</u> NITE-AD group: 4 weeks: 1x/week 1 week: 2x Walking, Light and Control groups: Weeks 1, 2 and 8: 3x/week Weeks 4 and 6: 2 brief phone calls <u>Sessions duration</u> 1h	endurance • 30min/day self-paced walking • Solve difficulties <u>Light Group</u> • Sat 1h/day in front of a Sunray light box 2h before bed-time • Identify activities to engage participation during light sessions • Reduce light levels in sleeping areas • Solve difficulties <u>NITE-AD Group</u> • Sleep plan • Daily walking as walking group • Light plan as Light group <u>Control Group</u> Nondirective dementia care support			NITE-AD Pre 19.1±5.8 CG Pre 18.7±6.9 ES=N.D.
				Changes in BPSD	Actigraph Total wake time per night (min)	Walking Pre 154.0±16.5 vs Post 28.2±17.6 p=0.05 Light Pre 141.8±14.1 vs Post 110.2±13.9 p=0.04 NITE-AD Pre 121.2±10.8 vs Post 88.8±10.7 p=0.01 CG Pre 115.5±12.9 vs Post 122.9±13.3 $ES_{Walking}$=-8.72 ES_{Light}=-2.86 $ES_{NITE\text{-}AD}$=-3.30
					Actigraph Daytime sleep or inactivity	Walking Pre 151.3±15.1 vs Post 156.0±18.5 p=0.67

	Light Pre 208.4±14.7 vs Post 212.3±20.4 p=0.70 NITE-AD Pre 162.2±16.4 vs Post 168.1±18.5 p=0.73 CG Pre 203.9±20.8 vs Post 217.0±24.2 $ES_{Walking}$=-0.42 ES_{Light}=-0.45 $ES_{NITE-AD}$=-0.36
Actigraph Sleep percentage	Walking Pre 76.0±2.2 vs Post 79.0±2.7 p=0.07 Light Pre 76.1±2.2 vs Post 80.4±2.5 p=0.07 NITE-AD Pre 79.4±1.6 vs Post 84.4±1.9 p=0.02 CG Pre 79.9±2.0 vs Post 78.1±2.2 $ES_{Walking}$=2.09 ES_{Light}=2.72 $ES_{NITE-AD}$=3.49
Actigraph Number of night awakenings	Walking Pre 18.7±1.4 vs Post 16.8±1.6 p=0.07 Light Pre 18.5±1.4 vs Post 17.0±2.0 p=0.17 NITE-AD Pre 15.2±1.2 vs Post 14.1±1.5 p=0.15 CG Pre 16.2± 1.6 vs Post 17.6±1.9 $ES_{Walking}$=-2 ES_{Light}=-1.66 $ES_{NITE-AD}$=-1.58
Actigraph Total sleep per night (min)	Walking Pre 468.1±17.7 vs Post 469.1±19.8 p=0.57 Light Pre 454.1±19.1 vs

	Post 453.4±19.3 p=0.67 NITE-AD Pre 460.4±15.3 vs Post 472.5±15.7 p=0.32 CG Pre 449.2±18.8 vs Post 438.3±19.7 $ES_{Walking}$=0.62 ES_{Light}=0.53 $ES_{NITE-AD}$=1.31
Actigraph Time in bed	Walking Pre 622.1±19.7 vs Post 597.3±18.6 p=0.27 Light Pre 595.9±16.8 vs Post 563.6±18.2 p=0.11 NITE-AD Pre 581.6± 16.6 vs Post 561.3±13.6 p=0.42 CG Pre 564.7±19.4 vs Post 561.2±20.5 $ES_{Walking}$=-1.08 ES_{Light}=-1.53 $ES_{NITE-AD}$=-0.94
Sleep Disorders Inventory	Walking Pre 1.0±0.3 vs Post 0.4±0.1 p=0.32 Light Pre 1.3±0.3 vs Post 0.7±0.1 p=0.29 NITE-AD Pre 1.1±0.2 vs Post 0.4±0.1 p=0.23 CG Pre 0.8±0.2 vs Post 0.6±0.1 $ES_{Walking}$=-2.06 ES_{Light}=-2.05 $ES_{NITE-AD}$=-3.14
Sleep Apnea subscale	Walking Pre 23.6±5.0 Light Pre 24.9±5.3 NITE-AD Pre 23.7±5.9 CG Pre 24.2±5.3 ES=N.D.
Cornell Scale for Depression in	Walking Pre 7.7±6.2 Light Pre 9.7±6.2

					Dementia	NITE-AD Pre 7.6±5.6 CG Pre 8.2±5.7 ES=N.D.
Öhman *et al* 2016(Öhman et al., 2016) Finland	n_{Total}=210 78.1±5.3 years Female=82 (39%) MMSE=18 points n_{HE}=70 77.7±5.4 years Female=30 (42.9%) MMSE=17.8±6.6 points n_{GE}=70 78.3±5.1 years Female=25 (35.7%) MMSE=18.5±6.3 points n_{CG}=70 78.1±5.3 years Female=26 (37.1%) MMSE=17.7±6.2 points	Duration 12 months Frequency 2x/week Sessions duration HE: 1h GE: 4h	Home Exercise • Neuromotor: balance and ADLs • Dual-task exercises • Executive functioning training • Muscle strength and endurance: wrist and ankle weights • Cardiorespiratory endurance: Nordic walking Group Exercise • Door-to-door taxi service and lunches provided • Groups of 10 participants • Dual tasking • Cardiorespiratory endurance: Nordic walking • Muscle strength and endurance: gym • Neuromotor: balance Control Group • Usual treatment • Oral and written advice on nutrition and exercise methods Physiotherapy provided by the community health	Cognitive function	MMSE	HE Pre 17.8±6.6 GE Pre 18.5±6.3 CG Pre 17.7± 6.2 ES_{GE}=0.02 ES_{HE}=0.03

			system			
					Clock Drawing Test	HE Pre 2.3±2.0 vs GE Pre 2.3±2.1 vs CG Pre 2.4±2.1 p=0.99 Mean changes over 12 months HE 0.5 (0.17-1) vs GE 0.1 (-0.38-0.49) vs CG -0.1 (-0.57-0.31) ES_{GE}=0.19 ES_{HE}=0.41
					Verbal Fluency	HE Pre 8.3±4.8 vs GE Pre 8.0±4.3 vs CG Pre 7.9±4.2 p=0.60 Mean changes over 12 months HE -1.0 (-1.62 to -0.20) vs GE -0.8 (-1.4 to -0.1) vs CG -1.0 (-1.54 to -0.24) ES_{HE}=0.02 ES_{GE}=2E-16
				Health-related physical fitness	10-m walking speed	HE Pre 0.8±0.3 GE Pre 0.8±0.2 CG Pre 0.8±0.2 ES=N.D.
Öhman *et al* 2017(Öhman et al., 2017) Finland	n_{Total}=210 77.8 years Female=81 (38.5%) MMSE=N.D. n_{HE}=63 77.4±5.3 years Female=24 (38.1%) MMSE=18.6±6.2 points n_{GE}=57 77.9±5.2 years Female=20 (35.1%) MMSE=18.9±6.5 points	The same reported in Öhman *et al* 2016(Öhman et al., 2016)	The same reported in Öhman *et al* 2016(Öhman et al., 2016)	Change in BPSD	NPI Hyperactivity	GE Pre 4.3±6.3 vs HE Pre 5.1±7.4 vs CG Pre 6.1±7.4 Mean change at 6 months GE -0.2 (-1.7 to 1.0) vs HE 1.4 (0.2 to 2.8) vs CG 0.1 (-1.4 to 1.7) GE vs HE vs CG p=0.13 ES_{GE}=-0.40 ES_{HE}=1.79

n_{CG}=59
78.1±5.3 years
Female=25 (42.4%)
MMSE=17.8±6.0 points

NPI Agitation, aggression	T0 GE 1.2±2.2 vs HE 1.3±2.0 vs CG 1.6±2.4 Mean change at 6 months GE -0.2 (-1.7 to 1.0) vs HE 0.2 (-0.2 to 0.7) vs CG: 0.02 (-0.7 to 0.7) GE vs HE vs CG p=0.27 ES_{GE}=-0.40 ES_{HE}=0.60
NPI Disinhibition	T0 GE 0.8±2.4 vs HE 0.9±2.7 vs CG 0.7±1.8 Mean change at 6 months GE -0.5 (-1.2 to 0.2) vs HE 0.03 (-0.6 to 0.6) vs CG -0.2 (-0.6 to 0.2) GE vs HE vs CG p=0.24 ES_{GE}=-1.03 ES_{HE}=0.88
NPI Irritability	T0 GE 1.3±2.4 vs HE 1.4±2.6 vs CG 1.4±2.2 Mean change at 6 months GE -0.5 (-1.0 to -0.5) vs HE 0.1 (0.2 to 0.7) vs CG: 0.3 (-0.2 to 0.8) GE vs HE vs CG p=0.03 ES_{GE}=-3.87 ES_{HE}=-0.98
NPI Aberrant motor behaviour	T0 GE 1.1±2.0 vs HE 1.5±2.6 vs CG 2.5±3.5 Mean change at 6 months

	GE 0.9 (0.2 to 1.6) vs HE 1.0 (0.3 to 1.9) vs CG 0.03 (-0.9 to 1.0) GE vs HE vs CG p=0.65 ES_{GE}=2.04 ES_{HE}=2.18
NPI Psychosis	T0 GE 1.3±2.3 vs HE 1.6±2.9 vs CG 2.8±5.2 Mean change at 6 months GE 0.5 (-0.7 to 1.1) vs HE 0.7 (0.3 to 1.7) vs CG 0.3 (-1.0 to 1.4) GE vs HE vs CG p=0.81 ES_{GE}=0.37 ES_{HE}=0.80
NPI Delusions	T0 GE 0.9±2.0 vs HE 1.0±2.2 vs CG 1.5±2.8 Mean change at 6 months GE 0.2 (-0.4 to 0.6) vs HE 0.5 (0.2 to 1.0) vs CG 0.5 (-0.2 to 1.3) GE vs HE vs CG p=0.31 ES_{GE}=-0.92 ES_{HE}=0
NPI Hallucinations	T0 GE 0.4±1.0 vs HE 0.6±1.4 vs CG 1.2±2.6 Mean change at 6 months GE 0.3 (-0.03 to 0.7) vs HE 0.2 (-0.2 to 0.7) vs CG -0.2 (-0.8 to 0.4) GE vs HE vs CG p=0.97 ES_{GE}=1.94 ES_{HE}=1.48
NPI Mood and apathy	T0 GE 8.1±5.7 vs HE 8.3±6.2 vs CG 9.6±7.6

	Mean change at 6 months GE 1.2 (-0.6 to 3.2) vs HE 0.4 (-1.2 to 2.0) vs CG 0.3 (-1.4 to 2.1) GE vs HE vs CG p=0.76 ES_{GE}=0.98 ES_{HE}=0.12
NPI Depression	T0 GE 0.9±1.4 vs HE 1.2±1.9 vs CG 1.6±2.6 Mean change at 6 months GE 0.1 (-0.2 to 0.5) vs HE -0.05 (-0.7 to 0.5) vs CG -0.07 (-0.7 to 0.6) GE vs HE vs CG p=0.90 ES_{GE}=0.64 ES_{HE}=0.06
NPI Anxiety	T0 GE 1.0±2.2 vs HE 1.1±2.4 vs CG 1.5±2.3 Mean change at 6 months GE -0.05 (-0.7 to 0.6) vs HE 0.03 (-0.5 to 0.5) vs CG -0.5 (-1.2 to 0.2) GE vs HE vs CG p=0.79 ES_{GE}=1.30 ES_{HE}=1.70
NPI Euphoria	T0 GE 0.2±0.6 vs HE 0.4±1.6 vs CG 0.3±1.6 Mean change at 6 months GE 0.1 (-0.07 to 0.3) vs HE -0.08 (-0.4 to 0.1) vs CG -0.1 (-0.3 to 0.7) GE vs HE vs CG p=0.33 ES_{GE}=1.02 ES_{HE}=0.10

NPI Apathy	T0 GE 4.1±2.3 vs HG 4.2±2.2 vs CG 4.2±2.5 Mean change at 6 months GE 0.4 (-0.2 to 1.0) vs HE 0.7 (0.1 to 1.3) vs CG 0.8 (0.1 to 1.7) GE vs HE vs CG p=0.33 ES_{GE}=-1.10 ES_{HE}=-0.28
NPI Sleeping problems	T0 GE 1.0±2.4 vs HE 0.7±1.7 vs CG 1.0±2.5 Mean change at 6 months GE 0.4 (-0.3 to 1.0) vs HE 0.3 (-0.3 to 1.0) vs CG 0.5 (-0.9 to 1.0) GE vs HE vs CG p=0.84 ES_{GE}=-0.24 ES_{HE}=-0.49
NPI Eating problems	T0 GE 0.8±2.5 vs HE 0.8±2.2 vs CG 0.9±2.3 Mean change at 6 months GE 0.03 (-0.5 to 1.2) vs HE -0.5 (-1.0 to -0.1) vs CG 0.08 (-0.8 to 1.0) GE vs HE vs CG p=0.04 ES_{GE}=-0.11 ES_{HE}=-1.81
NPI Total	T0 GE 12.0±1.0 vs HE 13.4±12.6 vs CG 16.6±15.2 Mean change at 6 months GE 0.9 (-1.3 to 2.8) vs HE 2.7 (1.1 to 5.0) vs CG 0.6 (-2.2 to 3.5)

						GE vs HE vs CG p=0.41 ES_{GE}=0.24 ES_{HE}=1.69
					Cornell Scale for Depression in Dementia	GE Pre 3.9±3.5 HE Pre 4.8±4.7 CG Pre 5.9±5.7 ES_{GE}=0.44 ES_{HE}=0.11
Padala *et al* 2017(Padala et al., 2017) USA	n_{Total}=30 73.0±6.2 years Female=11 (36.7%) MMSE=22.9±2.2 points n_{EG}=15 72.1±5.3 years Female=5 (33.3%) MMSE=23.3±2.2 points n_{CG}=15 73.9±7.1 years Female=6 (40%) MMSE=22.7±2.3 points	<u>Duration</u> 16 weeks 8 weeks of intervention + 8 weeks of detraining <u>Frequency</u> 5x/week <u>Sessions duration</u> 30min	<u>Experimental Group</u> • Muscle strength and endurance • Cardiorespiratory endurance • Neuromotor: balance • Yoga • Use of Wii-Fit games <u>Control Group</u> Walk at self-selected pace, indoor or outdoor	Cognitive function	Modified MMSE	T0 EG 87.5±3.6 vs CG 85.7±7.8; p=0.42 Changes at 8weeks EG -0.4 (-2.6 to 1.7) vs CG -0.6 (-2.7 to 1.6) p=0.95 ES=0.19 Changes at 16 weeks (post) EG 0.4 (-1.8 to 2.6) vs CG -2.0 (-4.2 to 0.2) p=0.12 ES=2.24
					MMSE	T0 EG 23.3±2.2 vs CG 22.7±2.3 p=0.52 Changes at 8 weeks EG 0.7 (-0.3 to 1.7) vs CG -0.1 (-1.1 to 0.9) p=0.26 ES=1.63 Changes at 16 weeks EG 0.6 (-0.5 to 1.6) vs CG -0.5 (-1.6 to 0.5) p=0.15 ES=2.16
				ADLs	Katz's ADL	T0 EG 23.4±1.1 vs CG 23.2±1.4 p=0.66 Changes at 8 weeks EG 0.2 (-0.2 to 0.5) vs CG 0.1 (-0.3 to 0.4)

		p=0.71 ES=0.59 Changes at 16 weeks (post) EG 0.1 (-0.3 to 0.5) vs CG 0.3 (-0.1 to 0.6) p=0.50 ES=-1.08
	Lawton and Brody's scale	T0 EG 18.4±2.4 vs CG 18.3±4.0 p=0.91 Changes at 8 weeks EG 1.7 (0.7 to 2.6) vs CG: 1.0 (0.1 to 1.9) p=0.32 ES=1.56 Changes ate 16 weeks (post) EG 2.0 (1.0 to 3.0) vs CG: 1.3 (0.3 to 2.2) p=0.27 ES=1.47
Health-related physical fitness	Berg Balance Scale	T0 EG 46.5±2.4 vs CG 45.8±2.5; p=0.46 Change at 8 weeks EG 5.8 (4.8 to 6.8) vs CG 1.0 (0.0 to 2.0) p<0.001 ES=9.90 Change at 16 weeks (post) EG 5.4 (4.4 to 6.4) vs CG 1.9 (0.8 to 2.9) p<0.001 ES=7
	Activities-specific Balance Confidence scale	T0 EG 83.2±6.1 vs CG 81.4±7.3 p=0.46 Change at 8 weeks EG 5.6 (3.6 to 7.7) vs

						CG: -0.9 (-2.9 to 1.2) p<0.001 ES=6.50 Change at 16 weeks (post) EG 1.3 (-0.8 to 3.5) vs CG -0.7 (-2.8 to 1.4) p=0.18 ES=1.93
					Falls Efficacy Scale	T0 EG 16.7±3.1 vs CG 16.5±2.9; p=0.81 Changes at 8 weeks EG -3.7 (-5.7 to -1.7) vs CG 1.1 (-0.9 to 3.1) p=0.002 ES=-4.90 Changes at 16 weeks (post) EG 0.5 (-1.6 to 2.5) vs CG 2.7 (0.6 to 4.7) p=0.13 ES=-2.20
				HRQoL	Quality of Life in Alzheimer's Disease	T0 EG 36.8±3.5 vs CG 37.2±3.0; p=0.74 Changes at 8 weeks EG 1.7 (0.6 to 2.8) vs CG 1.1 (0.0 to 2.3) p=0.45 ES=1.09 Changes at 16 weeks EG 0.5 (-0.6 to 1.7) vs CG -0.6 (-1.8 to 0.6) p=0.17 ES=1.91
Pitkälä *et al* 2013(Pitkälä, Pöysti, et al., 2013) Finland	n_{Total}=210 N.D. years Female=81 (38.6%) MMSE=N.D.	The same reported in Öhman *et al* 2016(Öhman et al., 2016)	The same reported in Öhman *et al* 2016(Öhman et al., 2016)	Health-related physical fitness	Functional Independence Measure Total score	3months ES_{GE}=0.04 ES_{HE}=0.06 6months HE -6.5 [95%

	n_{HE}=70 77.7±5.4 years Female=30 (42.9%) MMSE=17.8±6.6 points n_{GE}=70 78.3±5.1 years Female=25 (35.7%) MMSE=18.5±6.3 points n_{CG}=70 78.1±5.3 years Female=26 (37.1%) MMSE=17.7±6.2 points		CI, -4.4 to -8.6] vs GE -8,9 [-6.7 to -11.2] vs CG -11.8 [-9.7 to -14.0] p=0.003 HE vs GE p=0.001; GE vs GC p=0.07 ES_{GE}=0.14 ES_{HE}=0.25 Post (12months) HE -7.1 [95% CI, -3.7 to -10.5] vs GE -10.3 [-6.7 to 13.9] vs CG -14.4 [-10.9 to -18.0] p=0.015 HE vs GE p=0.004; GE vs GC p=0.12 ES_{GE}=0.07 ES_{HE}=0.28
		Functional Independence Measure Motor score	3months ES_{GE}=-9.4E-16 ES_{HE}=0.04 6months HE vs CG p=0.001, GE vs CG p=0.07 ES_{GE}=0.11 ES_{HE}=0.24 12months HE vs CG p=0.004, GE vs CG p=0.12 ES_{GE}=0.06 ES_{HE}=0.32
		Functional Independence Measure Cognitive score	3months ES_{GE}=0.09 ES_{HE}=0.05 6months ES_{GE}=0.14 ES_{HE}=0.18 Post (12 months) ES_{GE}=0.05

						ES_{HE}=0.10
					Short Physical Performance Battery	3months ES_{GE}=-0.07 ES_{HE}=-0.21 6months ES_{GE}=-0.03 ES_{HE}=0.04 Post (12 months) ES_{GE}=-0.06 ES_{HE}=0.01
Prick *et al* 2017(Prick et al., 2017) Netherlands	n_{Total}=111 77±7.5 years Female=41 (36.9%) MMSE=21±5.2 points n_{EG}=57 76±7.6 years Female=25 (45.6%) MMSE=21±4.9 points n_{CG}=54 78±7.2 years Female=15 (27.8%) MMSE=21±5.6 points	<u>Duration</u> 3 months and 6 months follow up <u>Frequency</u> 1st month 1x/week 2nd and 3rd months 1x/2weeks <u>Sessions duration</u> 1h	<u>Experimental Group</u> • Multicomponent dyadic physical exercise training: flexibility, muscle strength and endurance, neuromotor: balance, and cardiorespiratory endurance. • Education and psychosocial support: psycho-education sessions, communication skills training and pleasant activities training. • Dyad involved in physical exercise • Withdrew support over time <u>Control Group</u> • Written information bulletins about general information about dementia (3 in total)	Cognitive function	8 Words Test Immediate	EG Pre 17.5±6.7 vs Post 16.9±8.0 CG Pre 17.4±8.4 vs Post 18.4±8.7 ES=-0.20

Monthly phone calls by one of the coaches to listen and show empathy (3 in total)		
	8 Words Test Delayed	EG Pre 0.8±1.5 vs Post 1.0± 1.8 CG Pre 1.1±1.8 vs Post 1.5±2.3 ES=-0.11
	8 Words Test Recognition	EG Pre 11.7±3.9 vs Post 11.4±3.6 CG Pre 11.3±4.5 vs Post 12.3±2.6 ES=-0.35
	Rivermead Behavioral Memory Test Faces	EG Pre 29.6±6.0 vs Post 30.2±6.1 CG Pre 30.6±4.8 vs Post 30.9±5.7 ES=0.05
	Rivermead Behavioral Memory Test Pictures	EG Pre 67.0±10.6 vs Post 66.0±11.8 CG Pre 66.3±11.2 vs Post 64.3±12.1 ES=0.09
	Behavior Assessment of the Dysexecutive Syndrome	EG Pre 5.9±3.9 vs Post 6.0±3.9 CG Pre 6.6±4.8 vs Post 6.5±4.4 ES=0.05
	Groninger Intelligence Test Fluency Animals	EG Pre 10.5±5.2 vs Post 10.5±5.8 CG Pre 11.2±7.4 vs Post 10.2±6.5 ES=0.16
	Groninger Intelligence Test Fluency Professions	EG Pre 7.0±4.1 vs Post 7.8±5.4 CG Pre 7.8±5.4 vs Post 8.0±6.0

						ES=0.11
					Wechsler Memory Scale-Revised Digit Span Backward	EG Pre 5.5±2.5 vs Post 5.4±2.4 CG Pre 5.6±2.8 vs Post 5.6±2.9 ES=-0.04
					Wechsler Memory Scale-Revised Digit Span Forward	EG Pre 10.6±3.2 vs Post 10.9±3.4 CG Pre 10.5±2.8 vs Post 10.4±2.9 ES=0.13
Steinberg *et al* 2009(Steinberg et al., 2009) USA	n_{Total}=27 N.D. years Female=19 (70.4%) MMSE=N.D. n_{EG}=14 76.5±3.9 years Female=10 (71.4%) MMSE=20.1±5.1 points n_{CG}=13 74.0±8.1 years Female=9 (69.2%) MMSE=15.5±5.4 points	<u>Duration</u> 6 weeks 6 weeks follow-up <u>Frequency</u> Daily <u>Sessions duration</u> N.D.	<u>Experimental Group</u> • Cardiorespiratory endurance: brisk walking • Muscle strength and endurance: major muscle groups utilized resistive bands and ankle weights • Neuromotor balance: shifting centre of gravity, tandem walks, forward and backward walks, and chair sit to stand • Flexibility <u>Control Group</u> • Home safety assessment Review the identified hazards, recommending interventions and evaluating implementation	Cognitive function	Boston Naming Test	β=99 (0.9) p=0.26 ES=N.D.

					Hopkins Verbal Learning Test	β=0.82 (0.6) p=0.19 ES=N.D.
				Change in BPSD	NPI total score	β=0.65 (1.3) p=0.84 ES=N.D.
					NPI Depression	β=1.0 (0.5) p=0.84 ES=N.D.
					NPI Apathy	β=0.8 (0.5) p=0.86 ES=N.D.
					Cornell Scale for Depression in Dementia	β=1.14 (0.4) p=0.01 ES=N.D.
				Health-related physical fitness	Yale Physical Activity Survey	β=0.95 (3.1) p=0.76 ES=N.D.
					Jebsen Total Time	β=-23.39 (11.6) p=0.04 ES=N.D.
					Five Times Sit to Stand	β=-4.4 (3.6) p=0.22 ES=N.D.
					8-foot walk test	β=-0.08 (0.27) p=0.77 ES=N.D.
				HRQoL	The Alzheimer's Disease Quality Related Life Scale	β=-7.80 (6.2) p=0.21 ES=N.D.
				Carer's burden	Screen for Caregiver Burden Objective	β=0.37 (0.5) p=0.48 ES=N.D.
					Screen for Caregiver Burden Subjective	β=0.80 (1.4) p=0.57 ES=N.D.
Suttanon *et al* 2013(Suttanon et al., 2013) Australia	n_{Total}=40 N.D. years Female=25 (62.5%) MMSE=N.D. n_{EG}=19 83.4±5.1 years Female=13 (68.4%) MMSE=20.9±4.7 points n_{CG}=21 80.5±6.0 years Female=12 (57.1%) MMSE=21.7±4.4 points	<u>Duration</u> 6 months <u>Frequency</u> 4-6x/2months and 5 phone calls/6month <u>Sessions duration</u> 1h	<u>Experimental Group</u> • Programme (based on Otago Programme) • Cardiorespiratory endurance • Muscle strength and endurance • Neuromotor: balance • Physical activity	Health-related physical fitness	Functional Reach test	EG Pre 23.5±5.7 vs Post 25.8±5.6 CG Pre 28.5±4.7 vs Post 25.5±5.3 EG vs CG p=0.002 ES=0.98

booklet with illustrations and instructions • Carers encouraged to complete the exercises 5x/week <u>Control Group</u> Education and information sessions on the topic of dementia and ageing		
	Five Times Sit to Stand	EG Pre 13.2±4.2 vs Post 14.6±5.1 CG Pre 13.3±5.0 vs Post 13.3±3.7 EG vs CG p=0.95 ES=0.31
	Sit to stand Raising index, (% body weight)	EG Pre 13.5±4.7 vs Post 14.5±6.1 CG Pre 16.3±4.8 vs Post 17.0±7.9 EG vs CG p=0.72 ES=0.05
	Sit to stand Sway, (degrees/s)	EG Pre 4.0±1.1 vs Post 4.3±1.1 CG Pre 4.2±1.3 vs Post 4.7±1.5 EG vs CG p=0.29 ES=-0.16
	Timed Up and Go Test	EG Pre 16.2±5.0 vs Post 16.2±5.6 CG Pre 16.4±6.6 vs Post 16.6±6.2 EG vs CG p=0.57 ES=-0.03
	Timed Up and Go test Manual test	EG Pre 18.4±5.8 vs Post 18.2±6.6 CG Pre 18.0±6.8 vs

	Post 19.0±7.3 EG vs CG p=0.08 ES=-0.18
Timed Up and Go test Cognitive task	EG Pre 25.4±8.0 vs Post 23.2±7.7 CG Pre 18.1±3.4 vs Post 19.2±6.0 EG vs CG p=0.99 ES=-0.51
Walk across test Step width	EG Pre 16.2±2.3 vs Post 15.6± 2.5 CG Pre 15.6±4.5 vs Post 16.2± 4.0 EG vs CG p=0.12 ES=-0.34
Walk across test Step length	EG Pre 32.5±8.3 vs Post 31.8±10.7 CG Pre 36.8±13.2 vs Post 36.0± 9.5 EG vs CG p=0.91 ES=0.01
Walk across test Speed	EG Pre 39.4±11.6 vs Post 38.9±13.6 CG Pre 40.4±13.5 vs Post 41.7±14.3 EG vs CG p=0.24 ES=-0.13
Modified Clinical Test of Sensory Interaction of Balance	EG Pre 1.9±0.7 vs Post 1.6±0.7 CG Pre 1.5± 0.7 vs Post 1.7±0.8 EG vs CG p=0.09 ES=-0.68
Limits of stability Reaction time (ms)	EG Pre 1.2±0.3 vs Post 1.1±0.2 CG Pre 1.2±0.3 vs Post 1.1±0.2 EG vs CG p=0.36

		ES=0
	Limits of stability Movement velocity (degrees/s)	EG Pre 3.0±1.3 vs Post 2.3±1.1 CG Pre 3.1±1.2 vs Post 3.4±1.0 EG vs CG p=0.016 ES=-0.86
	Limits of stability Maximum excursion (%)	EG Pre 66.3±14.4 vs Post 68.6±15.4 CG 72.4±12.0 vs Post 72.7± 12.1 EG vs CG p=0.82 ES=0.15
	Limits of stability Directional control (%)	EG Pre 60.3±12.3 vs Post 60.7±11.3 CG Pre 64.4±9.9 vs Post 61.3±11.0 EG vs CG p=0.45 ES=0.31
	Step/quick turn Time, worse side (s)	EG Pre 3.8±1.7 vs Post 3.7±2.0 CG Pre 3.3±1.0 vs Post 3.0±1.1 EG vs CG p=0.28 ES=0.13
	Step/quick turn Sway, worse side (degrees)	EG Pre 49.0±11.1 vs Post 48.5±13.0 CG Pre 48.9±8.2 vs Post 47.3±6.7 EG vs CG p=0.45 ES=0.11
	Step Test	EG Pre 12.3±2.4 vs Post 12.3±3.0 CG Pre 13.0±3.2 vs Post 11.8±3.5 EG vs CG p=0.08 ES=0.39
Physical activity	The Human Activity	EG Pre 43.1±13.6 vs

	Profile	Post 42.0±12.7 CG Pre 52.0±14.6 vs Post 49.5±17.5 EG vs CG p=0.44 ES=0.09
Falls	Incidence rate of falls	EG Pre 4.6±6.9 vs Post 3.1±4.3 CG Pre 1.3±3.1 vs Post 2.5±4.0 EG vs CG p=0.995 ES=-0.56
	Falls Risk for Older People - Community	EG Pre 15.4±5.0 vs Post 14.4±4.3 CG Pre 12.6±5.6 vs Post 14.7±5.7 EG vs CG p=0.008 ES=-0.59
	Falls risk score from the Physiological Profile Assessment	EG Pre 1.8±1.2 vs Post 1.9±0.3 CG Pre 1.4±1.2 vs Post 1.8±1.2 EG vs CG p=0.31 ES=-0.28
HRQoL	The Assessment of Quality of Life	EG Pre 26.2±4.9 vs Post 25.6±4.5 CG Pre 24.8±4.6 vs Post 25.4±6.3 EG vs CG p=0.33 ES=-0.23
	Caregiver's Assessment of Quality of Life score	EG Pre 24.6±4.3 vs Post 25.1±4.0 CG Pre 21.6±4.4 vs Post 21.5±4.4 EG vs CG p=0.25 ES=0.14
Carer's burden	Zarit Burden Interview	EG Pre 24.4±16.7 vs Post 28.2±17.4 CG Pre 24.5±11.0 vs

						Post 26.5±11.6 EG vs CG p=0.51 ES=0.12
Teri *et al* 2003(Teri et al., 2003) USA	n_{Total}=153 N.D. years Female=63 (41.2%) MMSE=N.D. n_{EG}=76 78±6 years Female 28 (37%) MMSE=17.6±6.8 points n_{CG}=77 78±8 years Female=35 (45%) MMSE=15.9±7.4 points	<u>Duration</u> 3 months 6, 12, 18 and 24 months follow up <u>Frequency</u> 3 weeks: 2x/week 4 weeks: 1x/week 4 weeks: 1x/2weeks <u>Sessions duration</u> 12h	<u>Experimental Group</u> • Cardiorespiratory endurance • Muscle strength and endurance • Neuromotor: balance • Flexibility • Engage in a minimum of 30min/d of moderate-intensity exercise • Carer's taught to identify and modify patients' behavioural problems • Carer's education and training • Carer's education about dementia <u>Control Group</u> Routine medical care	Changes in BPSD	Cornell Scale for Depression in Dementia	EG Pre 5.7±3.9 Post 5.2±3.6 CG Pre 5.8±4.5 Post 6.2±3.8 EG vs CG p=0.02 ES=-0.23
				Health-related physical fitness	Two subscales of the 36-item Short-Form Health Survey	EG Pre 62.2±36.6 vs Post 72.1±33.0 CG Pre 67.9±35.1 vs Post 50.7±39.1 EG vs CG p<0.001 ES=0.75
					3 subscales of the Sickness Impact Profile	EG Pre 16.3±19.2 Post 16.0±17.1 CG Pre 14.2±13.8 Post 15.2±17.1 EG vs CG p=0.17 ES=-0.08

				Physical activity	Caregiver reports: number of restricted activity days spent in bed during the past 2 weeks	EG Pre 0.6±2.2 Post 0.1±0.4 CG Pre 0.4±2.2 Post 0.6±2.5 EG vs CG p<0.001 ES=-0.35
Vreugdenhil *et al* 2012(Vreugdenhil et al., 2012) Australia	n_{Total}=40 74.1 (range 51-89) years Female=24 (60%) MMSE=22.0 (10-28) points n_{EG}=20 73.5 (range 51-83) years Female=9 (45%) MMSE=22.9 (13-28) points n_{CG}=20 74.7 (range 58-89) years Female=15 (75%) MMSE=21.0 (10-28) points	<u>Duration</u> 4 months <u>Frequency</u> No visits 1 phone call/2weeks and at 2-months Encouraged to daily exercise + walking with carer supervision <u>Sessions duration</u> N.D.	<u>Experimental Group</u> • Based on *Home Support Exercise program* • Cardiorespiratory endurance: brisk walking • Muscle strength and endurance • Neuromotor: balance • Carer's provided supervision • Carer's being trained in the exercise programme • Physical activity booklet containing the exercises • Phone calls: check on their well-being <u>Control Group</u> • Usual treatment Training in the exercise programme was offered at the end of the study	Cognitive function	Alzheimer's Disease Assessment Scale Cognitive Sub-scale	EG Pre 22.7±9.7 Post 18.5±9.8 CG Pre 26.6±16.6 Post 30.6±17.9 EG vs CG p=0.001 ES=-0.58
					MMSE	EG Pre 22.9±5.0 Post 23.9±5.0 CG Pre 21.0±6.3 Post 19.0±7.7 EG vs CG p=0.001

		ES=0.49
Changes in BPSD	The Geriatric Depression Scale – Short Form	EG Pre 2.6±1.7 Post 2.0±1.5 CG Pre 2.3±1.4 Post 2.3±1.4 EG vs CG p=0.071 ES=-0.40
ADLs	The Barthel Index of ADLs	EG Pre 99.5±1.5 Post 99.6±1.2 CG Pre 98.4±5.4 Post 94.2±12.6 EG vs CG p=0.047 ES=0.62
	Lawton and Brody's scale	EG Pre 10.6±4.1 Post 11.0±4.1 CG Pre 8.6±4.2 Post 7.6±4.5 EG vs CG p=0.007 ES=0.33
Health-related physical fitness	Functional reach test	EG Pre 27.6±7.4 Post 30.6±7.0 CG Pre 24.0±6.4 Post 22.1±7.9 EG vs CG p=0.032 ES=0.67
	Timed Up and Go test	EG Pre 9.7±3.7 Post 9.1±3.8 CG Pre 11.1±3.3 Post 12.8±4.1 EG vs CG p=0.004 ES=-0.61
	Sit to Stand test (number)	EG Pre 9.2±2.5 Post 10.8±2.0 CG Pre 8.5±2.9 Post 7.2±3.2 EG vs CG p<0.001 ES=1.07
	Waist/hip ratio	EG Pre 0.90±0.09 Post

						0.89±0.09 CG Pre 0.88±0.05 Post 0.88±0.05 EG vs CG p=0.023 ES=-0.14
					Body mass index (kg/m^2)	EG Pre 24.5±3.7 Post 24.4±3.6 CG Pre 25.4±5.1 Post 25.6±5.0 EG vs CG p=0.473 ES=-0.07
				Carer's burden	Zarit Burden Interview	EG Pre 22.6±14.3 Post 18.2±13.2 CG Pre 29.9±16.2 Post 33.5±17.0 EG vs CG p=0.313 ES=-0.52
Wesson *et al* 2013(Wesson et al., 2013) Australia	n_{Total}=22 N.D. years Female=9 (40.9%) MMSE=N.D. n_{EG}=11 78.7±4.2 years Female=5 (45.5%) MMSE=24.5±3.1 points n_{CG}=11 80.9±5.0 years Female=4 (36.4%) MMSE=22.5±4.3 points	Duration 12 weeks Frequency Week 1: 2x OT visits Week 2: 2x PT visits Weeks 3, 5, 7 and 12: 1x OT visit/week Weeks 4, 6 and 8: 1x PT visit/week Weeks 9, 10 and 11: 1 phone call/week Sessions duration 57.5min (mean duration)	Experimental Group • Base on the *Weight-Bearing Exercise for Better Balance* programme • Muscle strength and endurance • Neuromotor: balance • Home hazard reduction • Brochures of fall prevention and home safety • Withdrew support over time Control Group • Usual care Brochures of fall prevention and home safety	Changes in BPSD	The Cornell Scale for Depression in Dementia	EG Pre 6.4±4.6 Post 8.1±7.3 CG Pre 5.6±5.5 Post 6.3±4.8 EG vs CG p=0.29 ES=0.17

	The Agitated Behavior in Dementia Scale	EG Pre 14.4±14.0 Post 12.3±13.5 CG Pre 14.4±16.3 Post 14.7±15.7 EG vs CG p=0.58 ES=-0.16
ADLs	Interview for Deterioration of Daily Activities in Dementia	EG Pre 46.4±8.2 Post 49.9±11.6 CG Pre 49.4±13.8 Post 53.7±15.9 EG vs CG p=0.40 ES=-0.06
Health-related physical fitness	The Hill Step Test	EG Pre 19.2±6.5 Post 15.0±5.12 CG Pre 14.4±5.0 Post 14.2±7.7 EG vs CG p=0.10 ES=-0.62
	Near tandem eyes closed	EG Pre 5.2±3.6 Post 5.4±3.7 CG Pre 5.7±3.0 Post 6.3±3.7 EG vs CG p=0.32 ES=-0.12
Physical activity	The Incidental and Planned Exercise Questionnaire-weekly	EG Pre 20.8±11.7 Post 33.0±18.5 CG Pre 14.4±10.6 Post 14.5±14.9 EG vs CG p=0.26 ES=0.83
	The Falls Efficacy Scale-International Short Form	EG Pre 10.5±4.4 Post 8.2±1.9 CG Pre 10.0±3.0 Post 9.4±5.4 EG vs CG p=0.71 ES=-0.43
	Iconographical Falls Efficacy Scale-	EG Pre 51.6±21.8 Post 47.3±18.5

	International	CG Pre 51.3±18.9 Post 44.6±12.8 EG vs CG p=0.56 ES=0.13
Falls	The Physiological Profile Assessment – falls risk score	EG Pre 0.8±1.2 Post 1.4±1.6 CG Pre 1.7±1.7 Post 2.6±1.8 EG vs CG p=0.82 ES=-0.20

Abbreviations: ADLs: Activities of Daily Living; BPSD: Behavioural and Psychological Symptoms of Dementia; CG: Control Group; DEMQOL: Dementia Quality of Life; EG: Experimental Group; ES: Effect Size; GE: Group Exercise; HE: Home Exercise; HRQoL: Health-related quality of life; MMSE: Mini-Mental Status Examination; N.D.: Not determined; NITE-AD: Night time Insomnia Treatment and Education in Alzheimer's Disease; NPI: Neuropsychiatric Inventory; OT: Occupational therapy; PT: Physiotherapy; T0: baseline; USA: United States of America.

Details of the effect sizes per domain

Effect sizes for cognitive function domain [-0.20 to -4.93] were pooled for Mini-Mental Status Examination,(Holthoff et al., 2015; Öhman et al., 2016; Padala et al., 2017; Vreugdenhil et al., 2012) modified Mini-Mental Status Examination,(Padala et al., 2017) Trail Making Test-Part B,(Dawson et al., 2017a) Phonemic verbal fluency test,(Holthoff et al., 2015) Ruler Drop test,(Holthoff et al., 2015) Clock drawing test,(Öhman et al., 2016) verbal fluency,(Öhman et al., 2016) 8 Words test (e.g., immediate, delayed and recognition),(Prick et al., 2017) Rivermead Behavioural Memory test (e.g., faces and pictures),(Prick et al., 2017) Behavioural assessment of the Dysexecutive Syndrome,(Prick et al., 2017) Groninger Intelligence test fluency (e.g., animals and professions),(Prick et al., 2017) Wechsler Memory Scale - Revised Digit Span (e.g., backward and forward),(Prick et al., 2017) and Alzheimer's Disease Assessment Scale cognitive sub-scale.(Vreugdenhil et al., 2012)

Effect sizes for changes in Behavioural and Psychological Symptoms of Dementia domain [-0.20 to -8.72] were pooled for Actigraph (e.g., sleep information's),(McCurry et al., 2011) Neuropsychiatric Inventory (e.g., total and sub scores),(Callahan et al., 2017; D'Amico et al., 2016; Holthoff et al., 2015; Lowery et al., 2014; Öhman et al., 2017) Cornell Scale for Depression in Dementia,(Teri et al., 2003; Wesson et al., 2013) Patient Health Questionnaire-9,(Callahan et al., 2017) General Health Questionnaire,(Callahan et al., 2017; D'Amico et al., 2016) Generalized Anxiety Disorder,(Callahan et al., 2017) the Agitated Behaviour in Dementia Scale,(Wesson et al., 2013) and the Geriatric Depression Scale short form.(Vreugdenhil et al., 2012)

Effect sizes for activities of daily living domain [-0.32 to 5.27] were pooled for ADCS-ADL,(Callahan et al., 2017; Holthoff et al., 2015) Katz Index,(Padala et al., 2017) Lawton & Brody scale,(Padala et al., 2017; Vreugdenhil et al., 2012) Barthel Index,(Vreugdenhil et al., 2012) the 16-item self-reported assessment tool(Dawson et al., 2017a) and the Interview for deterioration of daily activities in dementia.(Wesson et al., 2013)

Effect sizes for health-related physical fitness domain [-0.34 to 7.00] were pooled for the Short Physical Performance Battery,(Callahan et al., 2017; Pitkälä, Pöysti, et al., 2013) Short Portable Sarcopenia Measure,(Callahan et al., 2017) Modified Berg Balance Scale,(Dawson et al., 2017a) the 8-foot walk test,(Dawson et al., 2017a) 30 second chair stand test,(Dawson et al., 2017a) Berg Balance Scale,(Padala et al., 2017) Activities-specific Balance Confidence Scale,(Padala et al., 2017) Falls Efficacy Scale,(Padala et al., 2017; Wesson et al., 2013) Iconographical Falls Efficacy Scale,(Wesson et al., 2013) Functional Independence Measure (total, motor, cognitive)(Pitkälä, Pöysti, et al., 2013), 5 Times Sit to Stand test,(Suttanon, Hill, et al., 2013) Functional Reach test,(Suttanon, Hill, et al., 2013; Vreugdenhil et al., 2012) Sit to Stand Raising Index,(Suttanon, Hill, et al., 2013) Sit to Stand Sway,(Suttanon, Hill, et al., 2013) Timed Up and Go test,(Suttanon, Hill, et al., 2013; Vreugdenhil et al., 2012) Timed Up and Go manual test,(Suttanon, Hill, et al., 2013) Timed Up and Go cognitive task,(Suttanon, Hill, et al., 2013) Walk across test (step width, step length, speed)(Suttanon, Hill, et al., 2013), Modified Clinical Test of Sensory Interaction of Balance,(Suttanon, Hill, et al., 2013) Limits of Stability (reaction time, movement velocity, maximum excursion, directional control),(Suttanon, Hill, et al., 2013) Step/Quick turn (time, degree),(Suttanon, Hill, et al., 2013) Step test,(Suttanon, Hill, et al., 2013) Two subscales of the 36-item Short-Form Health survey,(Teri et al., 2003) 3 subscales of the Sickness Impact Profile,(Teri et al., 2003) Sit to Stand (number),(Vreugdenhil et al., 2012) Waist/hip ratio,(Vreugdenhil et al., 2012) Body mass index,(Vreugdenhil et al., 2012) The Hill Step test,(Wesson et al., 2013) Near Tandem Eyes Closed.(Wesson et al., 2013)

Effect sizes for physical activity domain [-0.35 to 0.83] were pooled for the Human Activity Profile,(Suttanon, Hill, et al., 2013) caregiver reports: number of restricted activity days spent in bed during the past 2 weeks,(Teri et al., 2003) the Incidental and Planned Exercise Questionnaire.(Wesson et al., 2013)

Effect sizes for falls domain [-0.20 to -0.59] were pooled for the Incidence Rate of Falls,(Suttanon, Hill, et al., 2013) Falls Risk for Older People – community,(Suttanon, Hill, et al., 2013) Psychological Profile Assessment (e.g., falls risk score).(Suttanon, Hill, et al., 2013; Wesson et al., 2013) No positive ES were found for falls.

Effect sizes for Health-related Quality of Life domain [-0.23 to 1.91] were pooled for the Dementia Quality of Life – Proxy,(D'Amico et al., 2016) Dementia Quality of Life,(D. Lowery et al., 2014) Quality of Life in Alzheimer's Disease,(Padala et al., 2017) the Assessment of Quality of Life,(Suttanon, Hill, et al., 2013) and Caregiver’s Assessment of Quality of Life.(Suttanon, Hill, et al., 2013)

Effect sizes for carer’s burden domain [-0.26 to -3.90] were pooled for Zarit Burden Interview(D'Amico et al., 2016; P. Suttanon, Hill, et al., 2013; Vreugdenhil et al., 2012) and Neuropsychiatric Inventory caregiver.(Holthoff et al., 2015; Lowery et al., 2014)

Effect sizes for costs domain [-0.21 to 0.23] were pooled for the total and different domains of the Client receipt inventory.(D'Amico et al., 2016)

Chapter 4. Design/adapt a home-based physical activity programme for people with dementia: LiFE4D

LiFE4D manual

LiFE4D: Manual de apoio para a atividade física em pessoas com défice cognitivo ligeiro ou com demência

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Introdução [Introduction]

Bem-vindo ao programa *Lifestyle Integrated Functional Exercise for People with Dementia* (LiFE4D). O LiFE4D é um programa de atividade física no domicílio desenhado especialmente para pessoas com défice cognitivo ligeiro ou com demência.

O défice cognitivo ligeiro é um estadio, antes da demência, que causa declínio cognitivo mas a pessoa mantem a sua capacidade para as atividades diárias(1).

A demência é uma condição progressiva/degenerativa que causa deterioração cognitiva (p.e., memória, atenção, linguagem), pode causar alterações no comportamento e diminui a capacidade para a pessoa realizar as atividades de vida diárias(2). Representa uma das principais causas de incapacidade e dependência nas pessoas idosas, e estima-se que em 2050 esta condição afetará cerca de 115.4 milhões de pessoas em todo o mundo(2).

A inatividade física é responsável por 3.5% das doenças e 10% das mortes na Europa(3). A Organização Mundial de Saúde propõe que se reduza a inatividade física em 10% até ao ano 2025(4, 5). As pessoas com demência têm apresentado baixos níveis de atividade física, sabendo-se que passam 66% do seu dia em atividades sedentárias ou de baixa intensidade(6). A atividade física regular, nesta população, promove a independência e a capacidade para realizar atividades da vida diária, previne o desenvolvimento de comorbilidades (i.e., outras doenças), melhora a função cognitiva, a qualidade de vida relacionada com a saúde e atrasa a necessidade de institucionalização(2, 3, 7). Assim, é importante desenvolver e incentivar a atividade física das pessoas com défice cognitivo ligeiro ou com demência. Um programa de atividade física no domicílio, ajustado às rotinas diárias e com o envolvimento dos cuidadores, pode ser uma motivação para tornar estas pessoas fisicamente mais ativas(8).

A atividade física é definida como qualquer movimento corporal produzido pelos músculos esqueléticos que resulta em gasto energético(4, 9). Além de englobar o exercício e o desporto, também engloba atividades básicas e funcionais do dia-a-dia, como o cuidado pessoal, o trabalho doméstico ou as ocupações/*hobbies*.

Este manual foi criado para os profissionais de saúde que trabalham com pessoas com défice cognitivo ligeiro ou com demência e para os próprios participantes do LiFE4D. Inclui a descrição de um programa de atividade física no domicílio e as instruções necessárias para que o profissional de saúde ou o utilizador o possa implementar no domicílio, nas rotinas diárias. Algumas sugestões para aumentar os níveis de atividade física que serão abordadas durante o programa, são(10):

- Dar duas voltas ao quarteirão antes de entrar no café.

- Mudar de canal na própria televisão ou deixar o comando mais longe para se obrigar a levantar.
- Usar as escadas em vez do elevador.
- Carregar um saco das compras em cada mão.
- Guardar objetos em locais mais altos ou mais baixos.
- Fazer jardinagem/horta.
- Envolver-se em atividades locais, como caminhadas em grupo.
- Ir à padaria comprar pão em vez de pedir que o deixem em casa.

LiFE4D

O *Lifestyle Integrated Functional Exercise* (LiFE) foi originalmente desenvolvido por Lindy Clemson, Jo Munro e Maria Fiatarone Singh em 2007[10]. O LiFE é um programa que pretende diminuir as quedas das pessoas idosas, ao integrar os princípios subjacentes à melhoria do equilíbrio e da força dos membros inferiores nas atividades de vida diárias (AVD)[10]. Este programa tem demonstrado resultados positivos na diminuição do sedentarismo e dependência nas AVD[10], contudo nunca foi adaptado a pessoas com défice cognitivo ligeiro ou com demência. Assim, surge o LiFE4D, um programa de promoção de atividade física no domicílio de pessoas com défice cognitivo ligeiro ou com demência, com o envolvimento dos cuidadores/pessoa significativa. O LiFE4D é uma abordagem de estilo de vida saudável que ajudará a alterar hábitos sedentários e de inatividade física no dia-a-dia. Estas alterações ocorrem gradualmente e têm em consideração as características de cada participante.

Objetivos

O LiFE4D tem como objetivo principal manter e/ou aumentar os níveis de atividade física das pessoas com défice cognitivo ligeiro ou com demência.

Avaliação e monitorização [Assessment and monitoring]

O LiFE4D inicia-se e finaliza com uma avaliação abrangente do participante, bem como, caso exista, do seu cuidador/pessoa significativa. Esta avaliação, embora possa ser ligeiramente modificada em função das necessidades dos participantes e dos profissionais de saúde, normalmente integra dados sociodemográficos, antropométricos e história clínica[11], função cognitiva[12], atividade física (objetiva e subjetiva)[13, 14], fadiga/falta de ar[15], pico de fluxo expiratório[16], força dos músculos respiratórios[17], força de preensão[18], força dos membros inferiores[19], tolerância ao esforço[19], equilíbrio[20], flexibilidade[21], funcionalidade[22, 23], funcionalidade dos membros superiores[24], qualidade de vida relacionada com a saúde[25], tempo de cuidado informal[26] e sobrecarga do cuidador[27, 28] (Tabela 1).

Nas primeiras sessões presenciais das semanas 2, 4, 6 e 8 do programa, deverá ser aplicado um protocolo de monitorização, para ajuste das atividades. Na tabela 1 sugere-se um protocolo de monitorização bastante abrangente, mas pode ser ligeiramente modificado em função das necessidades do participante, cuidador/pessoa significativa e/ou profissional de saúde.

Uma estratégia para monitorizar a intensidade da atividade física, que pode ser utilizada ao longo de todo o programa, é o *Talk test*[29, 30]:

- Atividade física de intensidade ligeira – capaz de manter uma conversa.

- Atividade física de intensidade moderada – capaz de manter uma conversa, apesar do ligeiro aumento da frequência cardíaca e respiratória.
- Atividade física de intensidade vigorosa – não é capaz de dizer mais do que algumas palavras sem pausa para respirar.

Na avaliação inicial e final, o participante e, caso exista, o cuidador/pessoa significativa utilizarão um acelerómetro (p.e., *ActiGraph*) por 7 dias consecutivos durante todo o dia, exceto a dormir e a tomar banho, uma semana antes e uma semana depois do LiFE4D(31). Será facultado um pedómetro para os participantes usarem no bolso frontal das calças(32) durante todo o programa, como fator motivacional, na medida em que fornece *feedback* do número de passos no momento(31).

Tabela 1. Sugestão de medidas para os protocolos de avaliação.

	Início	Monitorização	Final
Dados sociodemográficos	✓	-	-
Dados antropométricos e história clínica	✓	✓	✓
ACE-III	✓	-	✓
Actigraph – atividade física	✓	-	✓
Brief-PA	✓	✓	✓
Escala de Borg Modificada	✓	✓	✓
Talk test	✓	✓	✓
PEF	✓	✓	✓
PIM e PEM	✓	✓	✓
Handgrip	✓	✓	✓
30-s chair stand	✓	✓	✓
2-min step	✓	✓	✓
Brief-BESTest	✓	✓	✓
CRS	✓	✓	✓
GST	✓	✓	✓
QOL-AD	✓	-	✓
RUD *Lite*	✓	-	✓
Zarit	✓	-	✓

Brief-PA: Brief Physical Activity; ACE-III: Addenbrooke's Cognitive Examination III; PEF: Peak Flow Meter; PIM/PEM: Pressão inspiratória/expiratória máxima; Brief-BESTest: Brief-Balance Evaluation System Test; 30-s chair stand: 30 second sit to stand test; GST: Grocery Shelving Test; CRS: Chair Sit-and-Reach Test; 2-min step: 2 Minutes Step Test; QOL-AD: Qualidade de Vida – Doença de Alzheimer; RUD Lite: Resource Utilization in Dementia Scale Lite.

O profissional de saúde (com formação específica na área da atividade física), após a avaliação abrangente, irá ajudar o participante a encontrar oportunidades nas tarefas do dia-a-dia para realizar atividade física de forma segura.

As informações obtidas através da aplicação do protocolo de avaliação inicial, observação e anotação de características relevantes, permitem avaliar o estado biopsicossocial, as rotinas, os recursos disponíveis, as atividades com mais significado e as limitações de cada participante. A observação também permite avaliar as limitações e as oportunidades do espaço e recursos disponíveis. Assim, deve realizar-se uma análise SWOT, para distinguir as forças, oportunidades, fraquezas e ameaças, de forma a sintetizar a informação para criar/desenhar um programa individualizado que vá ao encontro das expectativas e necessidades de cada participante. Exemplo ilustrativo de uma análise SWOT:

Forças	**Fraquezas**
Vive com a filha e o genro. A filha presta apoio no autocuidado. Sobe e desce as escadas apenas com supervisão.	Diagnóstico de Alzheimer. Bronquite asmática. Idas frequentes à casa de banho. Possível quadro de ansiedade. Colesterol. Gosta muito de estar parada. Sempre praticou uma vida sedentária.
Oportunidades	**Ameaças**
Casa ampla e com boas condições. Pátio com piso regular. Frequenta Centro de Dia. Auxilia a dobrar a roupa.	Dificuldade em dormir. Ouve com alguma dificuldade. Medo de cair. Há poucas semana deixou de auxiliar a pôr a mesa.

Esta análise irá auxiliar a criação de um programa individualizado que, sempre que possível, desenvolva ainda mais as forças, reverta as fraquezas, aproveite as oportunidades e contorne as ameaças. Por exemplo, neste caso seria importante preservar a capacidade para subir e descer escadas independentemente, treinar competências para conseguir realizar/ajudar no autocuidado, diminuir o tempo em atividade sedentária, incentivar a caminhadas no pátio e retomar a tarefa de pôr a mesa. Neste caso, poderia também propor-se uma componente educacional e psicossocial para a redução de barreiras arquitetónicas e para o treino de levantar de quedas.

A apresentação do programa individualizado ao participante realiza-se na sessão 1 como parte da componente educacional e psicossocial para a atividade física. Nesta sessão será possível negociar e reajustar o programa com o participante e com o seu cuidador/pessoa significativa, criando objetivos/metas a curto e a médio prazo.

Ao longo do programa realizar-se-á a sua monitorização de modo a ajustar a atividade física e o nível de dificuldade das tarefas, de acordo com a evolução de cada participante e recursos disponíveis. Nas sessões de monitorização será possível renegociar objetivos/metas.

Implementação [Implementation]

A atividade física será integrada nas tarefas do dia-a-dia (p.e., nas tarefas domésticas, no jardim, na ida às compras ou enquanto passeia). Não é necessário definir um momento ou uma hora apenas para a atividade física. Além disso o participante será incentivado a diminuir o tempo em que está sentado ou deitado, para passar a estar mais ativo. Para isso, é importante que o profissional de saúde ajude a encontrar oportunidades nas tarefas do dia-a-dia para realizar atividade física de forma segura.

O LiFE4D tem a duração de 12 semanas. No final desse tempo é expectável que o participante seja capaz de realizar a atividade física de forma autónoma, ou seja, sem o auxílio do profissional de saúde que o está a acompanhar.

No primeiro mês o profissional de saúde (com formação específica na área da atividade física, p.e., fisioterapeuta), irá ao domicílio do participante 3 vezes por semana. No segundo mês irá ao domicílio 2 vezes por semana e fará 1 telefonema a cada duas semanas ao participante. No último mês o profissional de saúde irá 1 vez por semana ao domicílio do participante e telefonar-lhe-á 1 vez a cada duas semanas.

As sessões presenciais têm a duração aproximada de 1 hora e os contactos telefónicos duram no máximo 15 minutos.

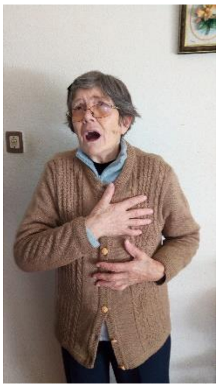
As sessões presenciais têm como objetivos: i) adaptar a atividade física às tarefas do dia-a-dia do participante, aumentando progressivamente a dificuldade das mesmas e monitorizando o seu nível de exigência; ii) conversar sobre aspetos que preocuparão ou incapacitarão o participante e/ou a sua família, de forma a lidar melhor com os impactos do défice cognitivo ligeiro ou da demência (componente educacional e psicossocial[(33)]); iii) clarificar dúvidas, motivar e gerir as expectativas do participante, bem como as das pessoas que lhe estão mais próximas. Os contactos telefónicos servem para motivar, monitorizar a evolução e clarificar dúvidas.

Espera-se com este programa que o participante diminua o tempo em comportamento sedentário e se torne fisicamente mais ativo. Antecipa-se que estas mudanças de estilo de vida tenham repercussões positivas na aptidão/condição física (nomeadamente na tolerância ao esforço, na força muscular, na flexibilidade e no equilíbrio), na marcha, na agilidade e nos níveis de energia dos participantes, o que promoverá a sua independência.

Atividade física: benefícios e precauções [Physical activity: benefits and precautions]

São inúmeros os benefícios da atividade física em pessoas com demência, como melhorar a função cognitiva (função executiva), a capacidade para realizar as atividades da vida diária, o equilíbrio, a mobilidade, a saúde física e mental, reduzir o risco de queda, melhorar o sono, reduzir a sobrecarga do cuidador e melhorar a qualidade de vida de ambos[(34-44)]. Contudo, devemos ter em consideração algumas precauções para que o participante não sofra nenhuma lesão. O participante não deve sentir dor, nem desconforto, em nenhuma das atividades planeadas.

Assim, o participante deve **PARAR IMEDIATAMENTE** a atividade se sentir dor no peito, tonturas, falta de ar ou outros sintomas graves, como náuseas, dores nas costas e/ou dores musculares fortes[10].


Para manter sempre a segurança:

- ✓ Progredir nas atividades físicas ao ritmo de cada um, sem pressas, de acordo com a proposta e o parecer do profissional de saúde e do *feedback* deste;
- ✓ Nunca experimentar novas atividades físicas em locais desconhecidos. Primeiro, o participante deve ganhar confiança nas atividades realizadas nos locais que conhece;
- ✓ A segurança está sempre em primeiro lugar, seja em casa ou na rua. Por isso, se em algum momento o participante não se sentir confiante, não deve fazê-lo;
- ✓ Inspirar e expirar durante as atividades físicas. Ao realizar uma tarefa com maior esforço deve expirar e nunca reter o ar;
- ✓ Manter sempre a coluna direita e realizar os movimentos lentamente;
- ✓ Se o participante não tiver a certeza de como se realiza uma atividade física, deve perguntar ao profissional de saúde que o está a acompanhar antes de fazer.

Como fazer?

A intensidade da atividade física é expressa em equivalentes metabólicos (METs), em que 1 MET (1 MET=3.5mL $O_2 \cdot kg^{-1} \cdot min^{-1}$) corresponde à estimativa do gasto energético em repouso[45]. Por outro lado, o comportamento sedentário refere-se a qualquer comportamento, fora do período de sono, que se caracterize por um baixo gasto energético (≤1.5METs), enquanto está numa posição sentada, reclinada ou deitada (dormir não é considerada atividade sedentária)[46].

A atividade física pode ser dividida em atividades ligeiras, moderadas ou vigorosas:

- Atividade física ligeira: 1.6 a 2.9 METs[47, 48].
- Atividade física moderada: 3 a 5.9 METs[49].
- Atividade física vigorosa: ≥ 6 METs[49].

Ainda não existem recomendações específicas para pessoas com alteração cognitiva, contudo as recomendações para que pessoas idosas sejam fisicamente ativas são[49-51]:

- Realizar, pelo menos 30 minutos de atividade física moderada (3 a 5.9 METs) por dia, pelo menos 5 dias por semana (total 150 minutos/semana) **OU** realizar, pelo menos 25 minutos de atividade física vigorosa (≥6METs) por, pelo menos 3 dias por semana (total 75 minutos/semana). O tempo de atividade física moderada pode ser dividido ao longo do dia em 3 blocos de 10 minutos (não menos), caso sinta dificuldades em realizar todo o tempo recomendado seguido, e ao longo dos dias da semana para evitar sobrecarga no sistema musculoesquelético.
- Realizar atividade (moderada a intensa) de fortalecimento muscular, pelo menos 2 dias por semana.
- Participantes com baixos níveis de mobilidade devem realizar atividade física que promova uma melhoria do equilíbrio e diminua o risco de quedas, pelo menos 3 dias por semana.
- Caso não seja possível cumprir as recomendações devido à condição de saúde, o participante deve ser o mais fisicamente ativo possível.
- Considerando a condição dos participantes, deve-se perceber como e quando é que a sua condição pode afetar a capacidade para realizar atividade física regular e com segurança.

Uma ótima forma de aumentar a atividade física diária é através das caminhadas. Caminhar representa um momento de atividade, mas também de lazer e, muitas vezes, de socialização. As caminhadas em grupo, com um familiar, um amigo ou um vizinho são muito agradáveis. As caminhadas podem ser feitas no bairro, num jardim, na praia ou à beira rio. O participante pode fazer uma caminhada em família no final do jantar, substituir os passeios de carro ao domingo por caminhadas, ou caminhar no centro comercial[52]. A caminhada deve ser feita todos os dias por 30 minutos, que podem ser repartidos em blocos de 10 minutos (p.e., 10 minutos de manhã, 10 minutos ao início da tarde e 10 minutos ao final do dia), caso sinta dificuldades em caminhar os 30 minutos seguidos.

Uma forma de controlar a atividade física é realizar, pelo menos 7500 passos por dia ou realizar 100 passos/minuto, ou seja, 3000 passos em 30 minutos, que tem vindo a ser associada com intensidade moderada (3METs)[30, 53]. O pedómetro é um instrumento útil para a contagem dos passos. Gradualmente, o participante pode progredir até aos 10000 passos, ou mais, por dia[52]. Para que isso aconteça o participante pode:

- Passear o animal de estimação diariamente, de manhã e/ou ao final do dia;
- Levantar-se e mover-se de 6 em 6 páginas, quando lê um livro, jornal ou revista;
- Levantar-se e movimentar-se nos intervalos, quando vê televisão;
- Levantar-se e movimentar-se, quando atende o telemóvel;
- Subir escadas em vez de usar os elevadores;
- Fazer alguma coisa que goste que implique movimento, como dançar;
- Brincar com as crianças (p.e., netos) 15-30 minutos por dia.

Algumas das estratégias para aumentar a atividade física ligeira, moderada e/ou vigorosa nas tarefas do dia-a-dia[45, 52] encontram-se nas tabelas 2, 3 e 4 seguintes:

Tabela 2. Estratégias para aumentar a atividade física ligeira.

	Atividades	METs
Ligeira	Sentado, a mexer os pés.	1.8
	De pé, a mexer os pés.	1.8
	Sentado, a fazer artesanato, escultura de madeira, tecelagem.	1.8
	De pé, a desenhar, escrever ou pintar.	1.8
	De pé, a falar pessoalmente, ao telefone, no computador ou por mensagem de texto.	1.8
	Passar a roupa a ferro.	1.8
	Lavar a louça, em pé.	1.8
	Atividade de retiro/ reunião familiar, que envolva sentar, relaxar, falar, comer.	1.8
	Sentado a cantar.	2.0
	De pé, cantar na igreja, ir à cerimónia (missa), participação ativa.	2.0
	Caminhar em casa.	2.0
	Tarefas de esforço leve, em pé (p.e. mudar uma lâmpada).	2.0
	Cozinhar ou preparar a comida, de pé ou sentado.	2.0
	Lavar a roupa, dobrar ou pendurar roupas, colocar as roupas na máquina (lavar ou secar), arrumar a roupa, lavar a roupa manualmente, que implique estar parado.	2.0
	De pé, a falar e comer ou apenas a comer.	2.0
	De pé ou sentado, a fazer a higiene: lavar as mãos, fazer a barba, lavar os dentes, maquilhar.	2.0
	De pé, tomar banho, limpar-se.	2.0
	Esfregar o chão, apoio nas mãos e joelhos; esfregar a banheira na casa de banho.	2.0
	De pé, com a criança ao colo.	2.0
	Cuidar da criança, sentado/ajoelhado (p.e., vestir, banho, higiene, alimentação, levantar a criança ocasionalmente).	2.0
	Lavar o carro.	2.0
	Plantar, transplantar.	2.0
	Sentado, a brincar com a criança.	2.2
	De pé a cantar.	2.3
	De pé, a preparar-se para ir para a cama.	2.3
	Varrer, lentamente.	2.3
	Limpar o pó dos móveis.	2.3
	Lavar a roupa, arrumar roupas, reunir roupas para guardar, guardar as roupas, com caminhada implícita.	2.3
	Cuidar dos animais domésticos.	2.3
	Jardinagem, com uso de contentores.	2.3
	Compras com ou sem carrinho de compras, parado ou a caminhar.	2.3
	Sentado ou de pé, vestir e despir.	2.5

	De pé, pentear o cabelo.	2.5
	Cuidar da criança, no geral.	2.5
	Servir a comida, pôr a mesa, com caminhada implícita ou parado.	2.5
	Cozinhar ou preparar a comida, com caminhada.	2.5
	Lavar os pratos, limpar os pratos da mesa, com caminhada.	2.5
	Esfregar o chão, de pé.	2.5
	Colocar/guardar alimentos (p.e. carregar mantimentos, compras sem carrinho de compras), carregar sacos/pacotes/caixas de compras.	2.5
	Limpeza, geral (arrumar/organizar, alinhar a roupa, levar o lixo).	2.5
	Sentado, brincar com o animal.	2.5
	Alimentar os animais domésticos.	2.5
	Regar as plantas.	2.5
	Acender a lareira.	2.5
	Caminhar até casa dos vizinhos ou dos familiares por razões sociais (p.e., conversar).	2.5
	Caminhar de casa para o carro ou autocarro e do carro ou autocarro para outros locais.	2.5
	Observação de pássaros, em marcha lenta.	2.5
	De pé, brincar com o animal.	2.8
	De pé, brincar com a criança.	2.8
	Múltiplas tarefas domésticas ao mesmo tempo.	2.8
	Costurar com máquina.	2.8

Tabela 3. Estratégias para aumentar a atividade física moderada.

	Atividades	METs
Moderada	De pé, cuidar da criança (p.e., vestir, banho, higiene, alimentar, pegar na criança ocasionalmente).	3.0
	Arrumar ou deitar fora utensílios domésticos, com caminhada implícita.	3.0
	Brincar com o animal, caminhar/correr.	3.0
	Passear o cão (caminhar).	3.0
	Retiro/reunião familiar que envolva jogos com crianças.	3.0
	Limpar/lavar as janelas, no geral.	3.2
	Fazer a cama, mudar os lençóis.	3.3
	Limpeza, varrer carpetes ou chão, no geral.	3.3
	Limpar a casa, geral.	3.3
	Aspirar, geral.	3.3
	Atividades na cozinha, geral (p.e., cozinhar, lavar os pratos, arrumar).	3.3
	Ir o quintal escolher flores ou vegetais para apanhar, com caminhada implícita.	3.3
	Transportar madeira.	3.3
	Descer as escadas.	3.5
	Múltiplas tarefas domésticas ao mesmo tempo.	3.5
	Limpeza, pesada (p.e., lavar o carro, lavar as janelas, limpar a garagem).	3.5
	De pé, esfregar o chão.	3.5
	Esfregar o chão, apoio nas mãos e joelhos; esfregar a banheira.	3.5
	Cozinhar ou preparar a comida.	3.5
	De pé, embalar/desembalar caixas, levantar utensílios domésticos leves ocasionalmente, carregar/descarregar itens do carro.	3.5
	Brincar com a criança, caminhar/correr.	3.5
	De pé, dar banho ao cão.	3.5
	Cortar a relva, desbastar o jardim.	3.5
	Apanhar fruta das árvores, apanhar frutos/vegetais.	3.5
	Na quinta, alimentar pequenos animais.	3.5
	Sair de casa, fechar/trancar portas, fechar janelas, caminhada implícita.	3.5
	Caminhar por prazer.	3.5
	Limpeza, varrer lentamente.	3.8
	Jardinagem geral.	3.8
	Subir escadas, passada lenta.	4.0
	Lavandaria, lavar as roupas à mão.	4.0
	Brincar com o animal, caminhar/correr.	4.0
	Plantar, inclinar-se.	4.0
	Varrer a garagem e os passeios da casa.	4.0

	Múltiplas tarefas domésticas ao mesmo tempo.	4.3
	Colocar/remover os tapetes.	4.5
	Caminhar a um ritmo normal na terra ou areia.	4.5
	Plantar árvores.	4.5
	Organizar/arrumar o quarto/sala.	4.8
	Brincar com o animal, caminhar/correr.	5.0
	Mover, elevação de cargas leves.	5.0
	Caminhar pelos campos ou encostas.	5.3
	Brincar com a criança, caminhar/correr.	5.8
	Mover o mobiliário, utensílios domésticos, caixas de transporte.	5.8

Tabela 4. Estratégias para aumentar a atividade física vigorosa.

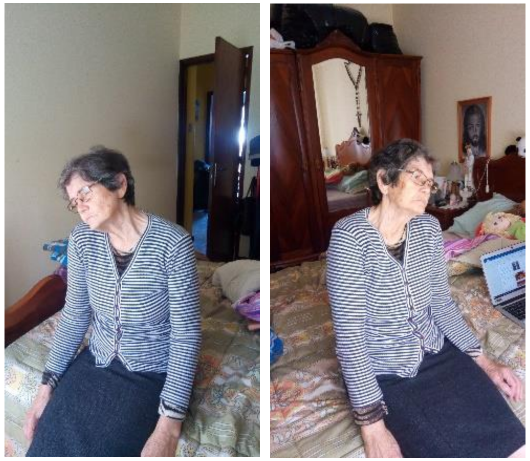
	Atividade	METs
Vigorosa	Caminhar para trás (~1.56m/s).	6.0
	Subir colinas, sem carga.	6.3
	Esfregar o chão, apoio nas mãos e joelhos; esfregar a banheira na casa de banho.	6.5
	Preparar uma mochila de viagem.	7.0
	Ciclismo, geral.	7.5
	Carregar mercearias pelas escadas.	7.5
	Dança geral.	7.8
	Carregar utensílios para o andar de cima, geral.	8.3
	Subir escadas, marcha rápida.	8.8
	Mover itens domésticos para o andar de cima, carregar caixas ou móveis.	9.0

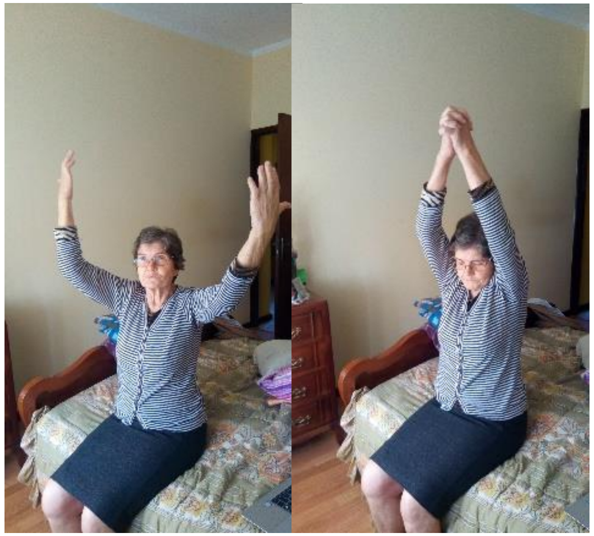
Podem ser encontradas mais atividades, com os respetivos METs, em https://sites.google.com/site/compendiumofphysicalactivities/Activity-Categories.

De seguida será apresentada uma pequena explicação das atividades que o participante pode realizar ao longo do dia, com exemplos práticos. Contudo, o participante pode entrar em contacto com o profissional de saúde que o está a acompanhar sempre que tiver dúvidas. Cada atividade tem imagens ilustrativas associadas e um texto de orientação. No entanto, enfatizamos que este é um manual geral, cada participante deverá ter atividades ajustadas à sua capacidade de desempenho e com uma progressão específica para cada atividade, dada pelo profissional de saúde.

NOTA: Nas respirações descritas nas atividades, todas as inspirações devem ser realizadas pelo nariz e as expirações pela boca.

Atividades que posso fazer de manhã

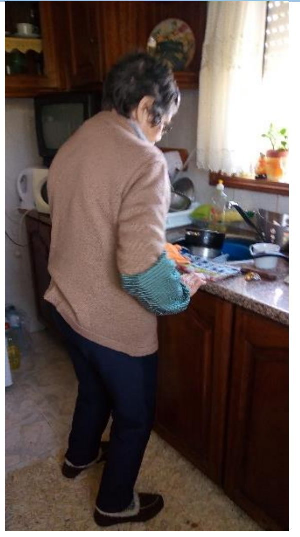
Profissional de saúde	Participante	
Ao acordar:		
Movimento: Sentar na beira da cama com o tronco alinhado e os ombros relaxados. Realizar inclinação lateral da cervical e aproximar a orelha do ombro, sem sentir dor. Não rodar a cabeça nem elevar o ombro. Manter a posição durante alguns segundos. Regressar à posição inicial. **Respiração:** Antes de iniciar o movimento, inspirar. Enquanto realiza a inclinação, expirar. Enquanto mantem a posição, respirar normalmente. Enquanto regressa à posição inicial, inspirar. **Progressão:** Manter a posição por mais tempo, enquanto for confortável.	**Atividade:** Sente-se na beira da cama com as costas e o pescoço direitos e alinhados. Inspire sem mexer a cabeça. Enquanto aproxima a orelha do ombro, expire. Enquanto mantem a posição durante alguns segundos, respire normalmente. Enquanto volta à posição inicial, inspire. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável.	 **METs: 1.8**

Profissional de saúde	Participante	
Ao acordar:		
Movimento: Sentar na beira da cama com o tronco e a cervical alinhados. Realizar flexão dos membros superiores. Entrelaçar os dedos acima da cabeça. Alongar o máximo que conseguir. Manter a posição durante alguns segundos. Regressar à posição inicial. **Respiração:** Enquanto realiza flexão dos membros superiores, inspirar. Enquanto mantem a posição, respirar normalmente. Enquanto regressa à posição inicial expirar. **Progressão:** Aumentar o número de repetições. Manter a posição durante mais tempo, enquanto for confortável.	**Atividade:** Sente-se na beira da cama com as costas e o pescoço direitos e alinhados. Enquanto levanta os braços, inspire. Entrelace os dedos em cima da cabeça, mantendo os braços esticados. Afaste as mãos da sua cabeça o máximo que conseguir, como se quisesse tocar com os dedos no teto. Enquanto mantem a posição durante alguns segundos, respire normalmente. Enquanto baixa os braços, expire. **Progressão:** Aumente o número de repetições. Mantenha a posição durante mais tempo, enquanto lhe for confortável.	 **METs: 1.8**

Profissional de saúde	Participante	
Ao calçar:		
Movimento: Sentar com o tronco e a cervical alinhados. Realizar flexão do joelho esquerdo e extensão do joelho direito. Realizar flexão do tronco e calçar/apertar os cordões. **Respiração:** Enquanto realiza a flexão do tronco expirar. Enquanto se calça/aperta os cordões, respirar normalmente. Enquanto volta à posição inicial, inspirar. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável.	**Atividade:** Sente-se com as costas e o pescoço direitos e alinhados. Estique o joelho da perna direita e mantenha o da perna esquerda dobrado. Enquanto se inclina para a frente, expire. Enquanto se calça/aperta os cordões, respire normalmente. Enquanto sobe, inspire. **Progressão:** Mantenha a posição durante mais tempo, enquanto for confortável.	 **METs: 2.5**

Profissional de Saúde	Participante	
Ao vestir:		
Movimento: Guardar alguns objetos (p.e., roupa) em locais que se encontrem a baixo do nível da cintura. Realizar agachamento para alcançar os locais mais baixos. Não realizar flexão do tronco. Manter a posição durante alguns segundos. Se tiver de manter a posição por algum tempo apoiar as nádegas nos calcanhares ou num banco pequeno. **Respiração:** Enquanto realiza agachamento, inspirar. Enquanto mantem a posição, respirar normalmente. Enquanto volta à posição inicial, expirar. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável.	**Atividade:** Guarde alguns objetos (p.e., roupa) em locais baixos. Enquanto se agacha para chegar aos locais mais baixos, inspire. Não incline/dobre as costas. Enquanto mantem a posição durante alguns segundos, respire normalmente. Se tiver de ficar na posição por algum tempo (p.e, a escolher a roupa) apoie as nádegas nos calcanhares ou num banco pequeno. Enquanto sobe, expire. **Progressão:** Mantenha a posição durante mais tempo, enquanto for confortável.	 **METs: 2.0 a 2.3**

Profissional de saúde	Participante	
Ao pequeno-almoço, enquanto espera que o micro-ondas acabe de aquecer:		
Movimento: Colocar ao lado de uma parede ou superfície estável (p.e., mesa ou bancada da cozinha). Afaste ligeiramente os membros inferiores. Transferir o peso do corpo para o membro inferior direito. Realizar inclinação máxima do tronco para o lado direito sem perder o equilíbrio. Manter a posição durante alguns segundos. Alternar o lado. **Respiração:** Enquanto realiza a inclinação, expirar. Enquanto mantém a posição, respirar normalmente. Enquanto volta à posição inicial, inspirar. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável.	**Atividade:** Coloque-se ao lado de uma parede, ou superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Afaste ligeiramente as pernas. Transfira o peso do corpo para a perna direita e incline o tronco o mais que conseguir para o lado direito sem perder o equilíbrio. Enquanto se inclina, expire. Enquanto mantem a posição durante alguns segundos, respire normalmente. Enquanto volta à posição inicial, inspire. Alterne o lado. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável.	 **METs: 1.8**

Profissional de saúde	Participante	
Ao pequeno-almoço, enquanto espera que o micro-ondas acabe de aquecer:		
Movimento: Apoiar as mãos numa superfície estável (p.e., mesa ou bancada da cozinha). Afastar ligeiramente os pés. Manter o tronco e a cervical alinhados e os ombros relaxados. **Respiração:** Normal. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável. Apoiar uma mão, um dedo e sem apoio. Realizar a atividade com os pés juntos.	**Atividade:** Apoie as mãos numa superfície estável (p.e., mesa ou bancada da cozinha). Afaste ligeiramente os pés. Mantenha as costas e o pescoço direitos e alinhados, com os ombros relaxados. Respire normalmente durante toda a atividade. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Apoiar uma mão, um dedo e sem apoio. Realizar a atividade com os pés juntos.	 **METs: 1.8**

Profissional de saúde	Participante	
Ao pequeno-almoço, enquanto espera que o micro-ondas acabe de aquecer:		
Movimento: Apoiar as mãos numa superfície estável (p.e., mesa ou bancada da cozinha). Alinhar um pé à frente do outro. Manter o tronco e a cervical alinhados e os ombros relaxados. Manter a posição durante alguns segundos. Alternar o pé da frente com o de trás. **Respiração:** Normal. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável. Apoiar uma mão, um dedo e sem apoio.	**Atividade:** Apoie as mãos numa superfície estável (p.e., mesa ou bancada da cozinha). Coloque um pé à frente do outro na mesma linha. Mantenha as costas e o pescoço direitos e alinhados e os ombros relaxados. Mantenha a posição durante alguns segundos. Alterne o pé da frente com o de trás. Respire normalmente durante toda a atividade. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Apoie uma mão, um dedo e sem apoio.	 **METs: 1.8**

Profissional de saúde	Participante	
Ao pequeno-almoço, enquanto espera que o micro-ondas acabe de aquecer:		
Movimento: Apoiar as mãos numa superfície estável (p.e., mesa ou bancada da cozinha). Manter o tronco e a cervical alinhados. Realizar ligeira abdução do membro inferior direito. Alternar o lado. **Respiração:** Enquanto realiza abdução do membro inferior, expirar. Enquanto volta à posição inicial, inspirar. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável. Realizar máxima abdução do membro inferior. Apoiar uma mão, um dedo e sem apoio.	**Atividade:** Apoie as mãos numa superfície estável (p.e., mesa ou bancada da cozinha). Mantenha as costas e o pescoço direitos e alinhados. Enquanto eleva ligeiramente a perna direita lateralmente, expire. Enquanto pousa a perna, inspire. Alterne o lado. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Realize a máxima elevação da perna que conseguir. Apoie uma mão, um dedo e sem apoio.	 **METs: 1.8**

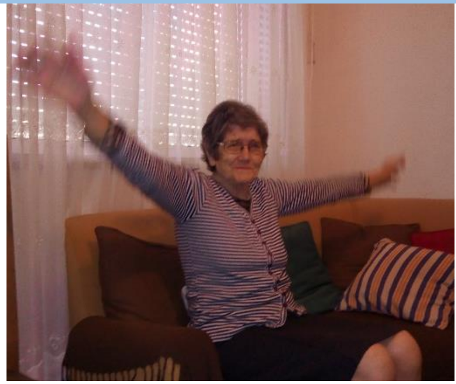
Profissional de saúde	Participante	
Enquanto toma o café/chá de manhã:		
Movimento: Sentar com o tronco alinhado. Apoiar os pés no chão. Se possível, colocar um peso no membro inferior (p.e., saco de arroz). Realizar extensão do joelho esquerdo e ligeira flexão da anca. Manter a posição durante alguns segundos. Regressar à posição inicial. Alternar o lado. **Respiração:** Enquanto realiza a extensão do joelho e a flexão da anca, expirar. Enquanto mantem a posição, respirar normalmente. Enquanto regressa à posição inicial, inspirar. **Progressão:** Realizar o movimento mais vezes, enquanto for confortável. Aumentar o peso.	**Atividade:** Sente-se com as costas direitas. Apoie os pés no chão. Coloque um peso na perna (p.e., saco de arroz). Enquanto expira, estique o joelho esquerdo para a frente e para cima. Enquanto mantém a posição durante alguns segundos, respire normalmente. Enquanto volta à posição inicial, inspire. Alterne o lado. **Progressão:** Realize o movimento mais vezes, enquanto lhe for confortável. Aumente o peso.	 **METs: 1.8**

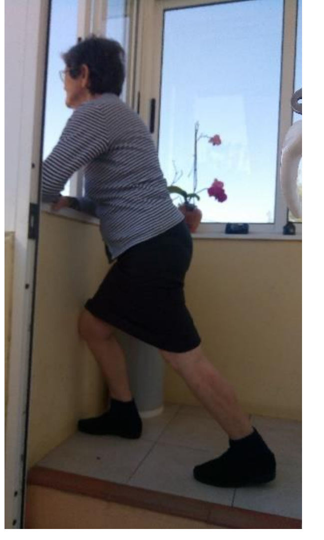
Profissional de saúde	Participante	
Ao ver televisão:		
Movimento: Mudar o canal da televisão na própria televisão como opção à utilização do comando remoto. Ou deixar o comando longe para "se obrigar" a levantar quando for mudar de canal. **Respiração:** Normal. **Progressão:** Deixar o comando cada vez mais longe.	**Atividade:** Mude o canal da televisão na própria televisão em vez de utilizar o comando. Ou deixe o comando longe para "se obrigar" a levantar quando for mudar de canal. Respire normalmente enquanto realiza a atividade. **Progressão:** Deixe o comando cada vez mais longe.	 **METs: 2.0**

Profissional de saúde	Participante	
Ao ver televisão:		
Movimento: Sentar, com os cotovelos fletidos. Entrelaçar os dedos das mãos em frente ao peito. Realizar a rotação dos pulsos para a direita. Realizar a rotação dos pulsos para a esquerda. **Respiração:** Normal. **Progressão:** Realizar o movimento mais vezes, enquanto for confortável.	**Atividade:** Sente-se e entrelace os dedos das mãos em frente ao peito. Rode as mãos em movimentos circulares para a direita. Rode as mãos em movimentos circulares para a esquerda. Enquanto realiza os movimentos circulares, respire normalmente. **Progressão:** Realize o movimento mais vezes, enquanto lhe for confortável.	 **METs: 1.8**

Profissional de saúde	Participante	
Ao ver televisão:		
Movimento: Sentar com o tronco alinhado. Realizar a rotação anterior dos ombros. Realizar a rotação posterior dos ombros. **Respiração:** Normal. **Progressão:** Realizar o movimento mais vezes para cada lado, enquanto lhe for confortável.	**Atividade:** Sente-se. Rode os ombros para a frente. Rode os ombros para trás. Respire normalmente enquanto realiza os movimentos. **Progressão:** Realize o movimento mais vezes para cada lado, enquanto lhe for confortável.	 **METs: 1.8**

Profissional de saúde	Participante	
Quando acaba de ver a televisão:		
Movimento: Sentar, com o tronco alinhado. Realizar adução horizontal do membro superior direito. Colocar a mão esquerda no cotovelo direito para auxiliar o movimento de adução horizontal. Manter o cotovelo direito em extensão. Manter a posição durante alguns segundos. Alternar o lado. **Respiração:** Antes de iniciar o movimento, inspirar. Enquanto mantem a posição, respirar normalmente. Durante o alongamento, expirar. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável.	**Atividade:** Sente-se, com as costas e a cabeça direitas. Antes de iniciar o movimento, inspire. Coloque a mão esquerda no cotovelo direito e empurre o braço direito (esticado) contra o peito. Enquanto começa a esticar o braço direito para a frente e durante todo o movimento, expire. Mantenha a posição alguns segundos enquanto respira normalmente. Alterne o lado. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável.	 **METs: 1.8**

Profissional de saúde	Participante	
Enquanto espera por algo ou alguém (p.e., pelo transporte do Centro de Dia):		
Movimento: De pé ou sentado. Realizar abdução dos membros superiores à altura dos ombros (90º). Realizar circundação anterior e posterior, com os cotovelos em extensão. **Respiração:** Normal. **Progressão:** Realizar mais vezes os movimentos (anteriores e posteriores), enquanto for confortável.	**Atividade:** De pé ou sentado. Afaste os braços à altura dos ombros. Rode-os para a frente e para trás, mantendo-os esticados. Respire normalmente enquanto realiza os movimentos. **Progressão:** Realize mais vezes os movimentos para a frente e depois para trás, enquanto lhe for confortável.	 **METs: 2.0**

Profissional de saúde	Participante	
Enquanto espera por algo ou alguém (p.e., pelo transporte do Centro de Dia):		
Movimento: De pé, apoiar os antebraços no parapeito de uma janela. Colocar o pé direito à frente e o esquerdo atrás, afastados um do outro. Realizar flexão do joelho direito. Manter o joelho esquerdo em extensão. Manter a posição durante alguns segundos. Alternar o lado. **Respiração:** Antes de iniciar o movimento, inspirar. Enquanto mantem a posição, respirar normalmente. Durante o alongamento, expirar. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável. Manter o calcanhar do membro inferior que fica mais atrás no chão.	**Atividade:** De pé, apoie os antebraços no parapeito de uma janela. Antes de iniciar o movimento, inspire. Com o pé direito à frente e o esquerdo atrás, afastados um do outro, dobre o joelho direito e mantenha o joelho esquerdo esticado. Mantenha a posição durante alguns segundos enquanto respira normalmente. Ao começar a esticar o joelho de trás e durante todo o movimento, expire. Alterne o lado. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. "Empurrar" o calcanhar esquerdo na direção do chão.	 **METs: 1.8**

Profissional de saúde	Participante	
Na lavandaria:		
Movimento: Realizar agachamento para tirar a roupa da máquina. Não realizar flexão do tronco. Regressar à posição inicial fazendo extensão dos joelhos. Sacudir a roupa molhada. Realizar flexão dos membros superiores para estender a roupa. Se tiver de manter a posição por algum tempo apoiar as nádegas nos calcanhares ou num banco pequeno. Dobrar a roupa seca. **Respiração:** Durante o agachamento, inspirar. Durante a extensão dos joelhos e flexão dos membros superiores, expirar. **Progressão:** Manter o agachamento por mais tempo. Retirar mais peças de roupa de cada vez.	**Atividade:** Enquanto se agacha para tirar a roupa da máquina, inspire. Enquanto se levanta, expire. Sacuda a roupa molhada. Enquanto levanta e estica os braços para estender a roupa, expire. Se tiver de ficar na posição por algum tempo (p.e, a escolher a roupa) apoie as nádegas nos calcanhares ou num banco pequeno. Dobre a roupa seca. **Progressão:** Mantenha o agachamento por mais tempo. Retire mais peças de roupa de cada vez.	 **METs: 2.0 a 4.0**

Atividades que posso fazer à hora das refeições

Profissional de saúde	Participante	
Ao pôr a mesa:		
Movimento: Afastar os membros inferiores à largura dos ombros. Realizar agachamento parcial; e simultaneamente flexão dos membros superiores. Pousar a toalha na mesa. **Respiração:** Expirar ao levantar a toalha e inspirar ao pousar a toalha. **Progressão:** Pés juntos.	**Atividade:** Estenda a toalha da seguinte forma: Afaste as pernas à largura dos ombros. Agache-se parcialmente. Estique os braços à frente. Enquanto levanta a toalha, expire. Enquanto pousa a toalha na mesa, inspire. **Progressão:** Pés juntos.	  **METs: 2.5**

Profissional de saúde	Participante	
Ao pôr a mesa:		
Movimento: Levar menos louça de cada vez para a mesa/bancada. Ao deslocar-se entre os armários e a mesa mais vezes, o participante aumenta a atividade física. **Respiração:** Normal. **Progressão:** Realizar a atividade mais vezes.	**Atividade:** Leve menos louça de cada vez para a mesa/bancada. Assim, vai deslocar-se entre os armários e a mesa mais vezes, aumentando a sua atividade física. Respire normalmente. **Progressão:** Realize esta atividade mais vezes.	 **METs:2.5**

Profissional de saúde	Participante	
Enquanto espera pela comida:		
Movimento: De pé, ao lado de uma parede, móvel ou bancada e com uma cadeira à frente, apoiar as mãos na cadeira. Colocar o pé esquerdo à frente do direito (com o calcanhar do pé esquerdo encostado à frente dos dedos do pé direito). Colocar o peso do corpo no pé de trás e depois transferir o peso para o pé da frente. Realizar a atividade lentamente e aguentar alguns segundos nesta posição. Alternar o lado. **Respiração:** Normal. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável. Apoiar uma mão, um dedo, sem apoio.	**Atividade:** De pé, ao lado de uma parede, móvel ou bancada e com uma cadeira à sua frente, apoie as mãos na cadeira. Coloque o pé esquerdo à frente do pé direito (com o calcanhar pé esquerdo encostado à frente dos dedos do pé direito). Coloque o peso do corpo no pé direito e depois mude o peso para o pé esquerdo. Realize a atividade lentamente e aguente alguns segundos nesta posição. Alternar o lado. Respire normalmente. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Apoie uma mão, um dedo, sem apoio.	 **METs: 1.8**

Profissional de saúde	Participante	
Guardar/tirar a louça da máquina de lavar ou de um armário baixo:		
Movimento: Retirar/colocar a louça da/na máquina de lavar ou da/na bancada e guardá-la. Realizar agachamento para tirar a louça da máquina ou dos armários mais baixos. Levantar. Extensão para arrumar a louça nos armários mais altos. **Respiração:** Enquanto realiza agachamento, inspirar. Enquanto levanta e ao realizar extensão, expirar. **Progressão:** Realizar a atividade mais vezes.	**Atividade:** Enquanto se agacha para retirar/colocar a louça da/na máquina ou dos/nos armários mais baixo, inspire. Enquanto se levanta, expire. Enquanto se estiva para arrumar a louça nos armários mais altos, expire. **Progressão:** Realize a atividade mais vezes.	 **METs: 1.8 a 2.5**

Profissional de saúde	Participante	
Depois de comer:		
Movimento: Afastar ligeiramente os pés. Pegar no centro de mesa (p.e., jarra). Realizar flexão dos membros superiores e ligeira flexão do tronco à frente. Pousar o centro de mesa. **Respiração:** Enquanto pega no centro de mesa, expirar. Enquanto pousa o centro de mesa, inspirar. **Progressão:** Pés juntos.	**Atividade:** Coloque o centro de mesa da seguinte forma: Afaste ligeiramente os pés. Enquanto pega no centro de mesa (p.e., vaso), expire. Estique os braços à frente. Enquanto pousa o centro de mesa, expire. **Progressão:** Pés juntos.	 **METs: 2.0**

Profissional de saúde	Participante	
Ao varrer:		
Movimento: Em pé, com os membros inferiores ligeiramente afastados segurar a vassoura, na horizontal, com as mãos e cotovelos em extensão. Realizar flexão dos membros superiores até ao nível dos ombros. Manter a posição durante alguns segundos. Regressar à posição inicial. **Respiração:** Enquanto realiza flexão dos membros superiores, expirar. Enquanto mantem a posição, respirar normalmente. Ao voltar à posição inicial, inspirar. **Progressão:** Realizar o movimento mais vezes, enquanto lhe for confortável. Manter a posição por mais tempo. Fletir os membros superiores acima da cabeça.	**Atividade:** De pé, com as pernas ligeiramente afastadas, segure o cabo da vassoura com as mãos, na horizontal. Enquanto estica os braços ao segurar vassoura e os eleva até ao nível dos ombros, expire. Mantenha a posição por alguns segundos enquanto respira normalmente. Enquanto desce os braços para voltar à posição inicial, inspire. **Progressão:** Realize o movimento mais vezes, enquanto lhe for confortável. Mantenha a posição por mais tempo. Eleve os braços acima da cabeça.	 **METs: 2.3 a 3.8**

Atividades que posso fazer quando volto das compras

Profissional de saúde	Participante	
Ao guardar objetos utilizados com frequência em armários altos:		
Movimento: Em pé, com os pés ligeiramente afastados. Pegar num saco do arroz (ou outra mercearia). Realizar flexão dos membros superiores acima da cabeça. Transferir o peso do corpo para os dedos dos pés, fazendo flexão plantar e elevando o calcanhar. Regressar à posição inicial ao apoiar os calcanhares no solo e estender os membros superiores. **Respiração:** Enquanto flete os membros superiores, inspirar. Enquanto estende os membros superiores, expirar. **Progressão:** Realizar a atividade com objetos progressivamente mais pesados.	**Atividade:** Em pé com os pés ligeiramente afastados. Enquanto estica os braços para cima, inspire. Coloque o peso do corpo nos dedos dos pés ("em bicos dos pés"). Pegue no saco do arroz (ou outra mercearia). Enquanto desce da posição dos "bicos dos pés" e baixa os braços, expire. **Progressão:** Realize a atividade com objetos mais pesados.	 **METs: 2.0 a 3.3**

Profissional de saúde	Participante	
Ao guardar objetos utilizados com frequência ou quando chega das compras:		
Movimento: De pé ou sentado. Afastar ligeiramente os membros inferiores. Segurar uma garrafa de água de meio litro em cada mão. Realizar abdução dos membros superiores até à altura dos ombros. Realizar adução dos membros superiores. **Respiração:** Enquanto realiza abdução, expirar. Enquanto realiza adução, inspirar. **Progressão:** Realizar o movimento mais vezes, enquanto lhe for confortável. Trocar as garrafas de meio litro por garrafas de um litro ou um saco de arroz, em cada mão.	**Atividade:** De pé ou sentado. Afaste ligeiramente as pernas. Segure uma garrafa de água de meio litro em cada mão. Enquanto afasta os braços esticados e os sobe até à altura dos ombros, inspire. Enquanto baixa os braços, expire. **Progressão:** Realize o movimento mais vezes, enquanto lhe for confortável. Troque as garrafas de meio litro por garrafas de um litro ou um saco de arroz, em cada mão.	 **METs: 3.3**

Profissional de saúde	Participante
Se um objeto estiver no caminho ou se cair ao chão, passar por cima dele antes de o apanhar:	
Movimento: Apoiar as mãos numa superfície estável (p.e., mesa ou bancada da cozinha). Realizar flexão da anca e joelho para passar por cima do objeto de forma segura e controlada, em vez de o contornar. Voltar-se e realizar agachamento para apanhar o objeto. **Respiração:** Enquanto realiza agachamento, expirar. Enquanto se levanta, inspirar. **Progressão:** Realizar a atividade mais vezes, enquanto for confortável. Apoiar uma mão, um dedo, sem apoio. <u>Atenção:</u> se o objeto for muito alto ou o chão estiver molhado, não deve realizar esta atividade.	**Atividade:** Apoie as mãos numa superfície estável (p.e., mesa ou bancada da cozinha). Dobre e levante bem a perna para passar por cima do objeto. Enquanto se vira e se agacha para apanhar o objeto, inspire. Enquanto se levanta, expire. **Progressão:** Realize a atividade mais vezes, enquanto lhe for confortável. Apoie uma mão, um dedo, sem apoio.

METs: 2.0

Profissional de saúde	Participante	
Se um objeto estiver no caminho ou se cair ao chão, passar por cima dele antes de o apanhar:		
Movimento: Apoiar as mãos numa superfície estável (p.e., mesa ou bancada da cozinha). Passar por cima do objeto a andar lateralmente de forma segura e controlada. Realizar agachamento para apanhar o objeto. **Respiração:** Enquanto realiza agachamento, inspirar. Enquanto se levanta, expirar. **Progressão:** Realizar a atividade mais vezes, enquanto for confortável. Apoiar uma mão, um dedo, sem apoio. <u>Atenção:</u> se o objeto for muito alto ou o chão estiver molhado, não deve realizar esta atividade.	**Atividade:** Apoie as mãos numa superfície estável (p.e., mesa ou bancada da cozinha). Passe por cima do objeto a andar de lado. Enquanto se agacha para apanhar o objeto, inspire. Enquanto se levanta, expire. **Progressão:** Realize a atividade mais vezes, enquanto lhe for confortável. Apoie uma mão, um dedo, sem apoio.	   **METs: 2.0**

Profissional de saúde	Participante
Se um objeto estiver no caminho ou se cair ao chão, passar por cima dele antes de o apanhar:	
Movimento: Apoiar as mãos numa superfície estável (p.e., mesa ou bancada da cozinha). Passar por cima do objeto a andar para trás de forma segura e controlada. Realizar agachamento para apanhar o objeto. **Respiração:** Enquanto realiza agachamento, inspirar. Enquanto se levanta, expirar. **Progressão:** Realizar a atividade mais vezes, enquanto for confortável. Apoiar uma mão, um dedo, sem apoio. <u>Atenção:</u> se o objeto for muito alto ou o chão estiver molhado, não deve realizar esta atividade.	**Atividade:** Apoie as mãos numa superfície estável (p.e., mesa ou bancada da cozinha). Passe por cima do objeto a andar para trás. Enquanto se agacha para apanhar o objeto, inspire. Enquanto se levanta, expire. **Progressão:** Realize a atividade mais vezes, enquanto lhe for confortável. Apoiar uma mão, um dedo, sem apoio. <u>Atenção:</u> se o objeto for muito alto ou o chão estiver molhado não deve realizar esta atividade.

METs: 2.0

Profissional de saúde	Participante	
Enquanto espera por algo ou alguém:		
Movimento: Apoiar as mãos numa superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Afastar os membros inferiores à largura dos ombros. Realizar agachamento lentamente. Regressar à posição inicial. Manter a cervical e o tronco alinhados. **Respiração:** Enquanto realiza agachamento, inspirar. Enquanto realiza a extensão, expirar. **Progressão:** Realizar o movimento mais vezes e mais lentamente.	**Atividade:** Apoie as mãos numa superfície segura superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Afaste as pernas à largura dos ombros. Enquanto dobra os joelhos lentamente, inspire. Enquanto estica os joelhos, expire. Mantenha as costas sempre direitas. **Progressão:** Realize o movimento mais vezes e mais lentamente.	 **METs: 2.0**

Atividades que posso fazer à tarde

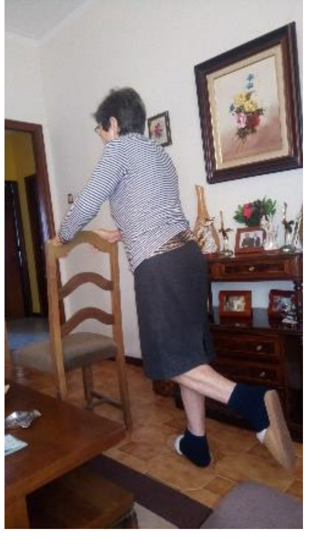
Profissional de saúde	Participante	
À tarde, enquanto vê televisão, lê uma revista, um livro ou jornal:		
Movimento: Sentado, realizar dorsiflexão da tibiotársica e flexão plantar. Aguentar alguns segundos em cada posição. **Respiração:** Normal. **Progressão:** Manter a posição durante mais tempo. Realizar o movimento mais vezes, enquanto lhe for confortável.	**Atividade:** Sente-se, com o calcanhar apoiado no chão. Levante os dedos o mais que conseguir em direção ao teto. De seguida levante o calcanhar e estique os pés até ficar a tocar no chão com a ponta dos dedos. Respire normalmente enquanto realiza a atividade. **Progressão:** Mantenha o pé dobrado ou esticado durante mais tempo. Realize o movimento mais vezes, enquanto lhe for confortável.	 **METs: 1.8**

Profissional de saúde	Participante	
À tarde, enquanto vê televisão, lê uma revista, um livro ou jornal:		
Movimento: Sentado com a cervical e o tronco alinhados e as costas apoiadas na cadeira. Apoiar os pés no chão. Realizar flexão dos joelhos a 90º. Colocar um saco de arroz em cima das pernas ou dos pés. Realizar extensão dos joelhos e dorsiflexão da tibiotársica. Regressar à posição inicial. **Respiração:** Enquanto estende os membros inferiores, expirar. Enquanto flete os membros inferiores, inspirar. **Progressão:** Realizar o movimento mais vezes, enquanto for confortável.	**Atividade:** Sente-se com as costas direitas e encostadas à cadeira. Apoie os pés no chão. Coloque um saco de arroz em cima das pernas ou dos pés com os joelhos dobrados. Enquanto estica as pernas e os pés, expire. Enquanto dobra novamente os joelhos e baixa as pernas, inspire. **Progressão:** Realize o movimento mais vezes, enquanto lhe for confortável.	 **METs: 2.8**

Profissional de saúde	Participante	
Enquanto espera por algo ou alguém ou enquanto vê TV ou ouve rádio:		
Movimento: Apoiar as mãos no sofá ou cadeira ao lado de uma parede ou superfície estável (p.e., mesa, bancada da cozinha ou móvel). Afastar ligeiramente os pés. **Respiração:** Normal. **Progressão:** Manter a posição durante mais tempo, enquanto lhe for confortável. Apoiar uma mão, um dedo e sem apoio. Diminuir base de sustentação.	**Atividade:** Apoie as mãos no sofá ou cadeira, ao lado de uma parede ou superfície estável (p.e., mesa, bancada da cozinha ou móvel). Afaste ligeiramente os pés. Respire normalmente durante a atividade. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Apoie uma mão, um dedo e sem apoio. Pés juntos.	 **METs: 1.8**

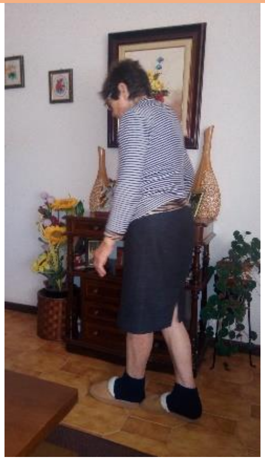
Profissional de saúde	Participante	
À tarde, enquanto lê uma revista, um livro ou jornal:		
Movimento: Apoiar as mãos no sofá ou cadeira ao lado de uma parede ou superfície estável (p.e., mesa, bancada da cozinha ou móvel). Alinhar um pé à frente do outro. **Respiração:** Normal. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável. Apoiar uma mão, um dedo e sem apoio.	**Atividade:** Apoie as mãos no sofá ou cadeira, ao lado de uma parede ou superfície estável (p.e., mesa, bancada da cozinha ou móvel). Coloque um pé à frente do outro na mesma linha. Respire normalmente. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Apoie uma mão, um dedo e sem apoio.	 **METs: 1.8**

Profissional de saúde	Participante	
À tarde, enquanto lê uma revista, um livro ou jornal:		
Movimento: Apoiar as mãos no sofá ou cadeira ao lado de uma parede ou superfície estável (p.e., mesa, bancada da cozinha ou móvel). Realizar flexão da anca e do joelho esquerdos. Colocar o pé em flexão plantar. Manter a posição durante alguns segundos. Alternar o lado. **Respiração:** Enquanto realiza flexão expirar. Enquanto mantém a posição, respirar normalmente. Enquanto realiza extensão, inspirar. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável. Apoiar uma mão, um dedo e sem apoio.	**Atividade:** Apoie as mãos no sofá ou cadeira ao lado de uma parede ou superfície estável (p.e., mesa, bancada da cozinha ou móvel). Enquanto dobra o joelho esquerdo e o sobe, expire. Respire normalmente enquanto mantem a posição durante alguns segundos. Enquanto volta a colocar o pé no chão, inspire. Alterne o lado. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Apoie uma mão, um dedo e sem apoio.	 **METs: 2.0**

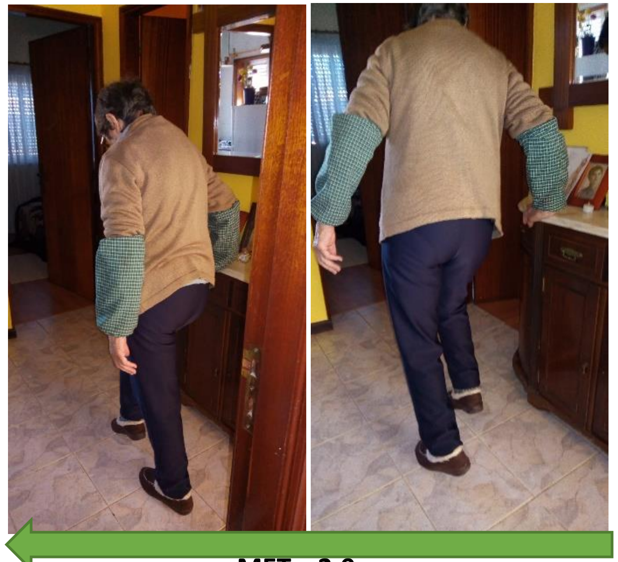
Profissional de saúde	Participante	
À tarde, enquanto lê uma revista, um livro ou jornal:		
Movimento: Apoiar as mãos no sofá ou cadeira ao lado de uma parede ou superfície estável (p.e., mesa, bancada da cozinha ou móvel). Com a anca em posição neutra, realizar flexão do joelho. Manter a posição durante alguns segundos. Alternar o lado. **Respiração:** Enquanto realiza flexão expirar. Enquanto mantém a posição respire normalmente. Enquanto realiza extensão do joelho, inspirar. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável. Apoiar uma mão, um dedo e sem apoio.	**Atividade:** Apoie as mãos no sofá ou cadeira ao lado de uma parede ou superfície estável (p.e., mesa, bancada da cozinha ou móvel). Enquanto dobra joelho e puxa a perna para trás, expire. Respire normalmente enquanto mantem a posição durante alguns segundos. Enquanto baixa a perna, inspire. Alterne o lado. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Apoie uma mão, um dedo e sem apoio.	 **METs: 2.0**

Profissional de saúde	Participante	
À tarde, enquanto espera por alguém, ouve rádio ou vê televisão:		
Movimento: Apoiar uma mão numa parede. Afastar ligeiramente os pés. Realizar flexão do tronco transferindo o peso do corpo para a ponta dos pés. Manter a posição por breves segundos. **Respiração:** Normal. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável.	**Atividade:** Apoie uma mão numa parede. Afaste ligeiramente os pés. Incline-se para a frente colocando o peso do seu corpo sobre a ponta dos pés. Mantenha a posição por breves segundos. Respire normalmente durante a atividade. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável.	 **METs: 1.8**

Profissional de saúde	Participante	
À tarde, enquanto espera por alguém, ouve rádio ou televisão:		
Movimento: Apoiar uma mão numa parede. Afastar ligeiramente os pés. Realizar extensão do tronco transferindo o peso do corpo para os calcanhares. Manter a posição por breves segundos. **Respiração:** Normal. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável.	**Atividade:** Apoie uma mão numa parede. Afaste ligeiramente os pés. Incline-se ligeiramente para trás colocando o peso do seu corpo sobre os calcanhares. Mantenha a posição por breves segundos. Respire normalmente durante a atividade. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável.	 **METs: 1.8**

Profissional de saúde	Participante	
No corredor quando muda de divisão:		
Movimento: Apoiar uma mão numa superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Caminhar com o calcanhar de um pé encostado à frente dos dedos do outro pé. **Respiração:** Normal. **Progressão:** Realizar a atividade durante mais tempo, enquanto for confortável. Apoiar um dedo, sem apoio.	**Atividade:** Apoie uma mão numa superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Caminhe com o calcanhar de um pé encostado à frente dos dedos do outro pé. Respire normalmente durante a atividade. **Progressão:** Realize a atividade durante mais tempo, enquanto lhe for confortável. Apoie um dedo, sem apoio.	  **METs: 2.0**

Profissional de saúde	Participante	
No corredor quando muda de divisão:		
Movimento: Apoiar uma mão numa superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Caminhar em flexão plantar, para a frente. **Respiração:** Normal. **Progressão:** Realizar a atividade durante mais tempo, enquanto for confortável. Apoiar um dedo, sem apoio.	**Atividade:** Apoie uma mão numa superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Caminhe sobre os bicos dos pés para a frente. Respire normalmente durante a atividade. **Progressão:** Realize a atividade durante mais tempo, enquanto lhe for confortável. Apoie um dedo, sem apoio.	 **METs: 2.0**

Profissional de saúde	Participante	
No corredor quando muda de divisão:		
Movimento: Apoiar uma mão numa superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Caminhar em flexão plantar, para trás. **Respiração:** Normal. **Progressão:** Realizar a atividade durante mais tempo, enquanto for confortável. Apoiar um dedo, sem apoio.	**Atividade:** Apoie uma mão numa superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Caminhe sobre os bicos dos pés para trás. Respire normalmente durante a atividade. **Progressão:** Realize a atividade durante mais tempo, enquanto lhe for confortável. Apoie um dedo, sem apoio.	 **METs: 2.0**

Profissional de saúde	Participante	
No corredor quando muda de divisão:		
Movimento: Apoiar uma mão numa superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Caminhar em flexão dorsal, para a frente. **Respiração:** Normal. **Progressão:** Realizar a atividade durante mais tempo, enquanto for confortável. Apoiar um dedo, sem apoio.	**Atividade:** Apoie uma mão numa superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Caminhe sobre os calcanhares para a frente. Respire normalmente durante a atividade. **Progressão:** Realize a atividade durante mais tempo, enquanto lhe for confortável. Apoie um dedo, sem apoio.	 **METs: 2.0**

Profissional de saúde	Participante	
No corredor quando muda de divisão:		
Movimento: Apoiar uma mão numa superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Caminhar em flexão dorsal, para trás. **Respiração:** Normal. **Progressão:** Realizar a atividade durante mais tempo, enquanto for confortável. Apoiar um dedo, sem apoio.	**Atividade:** Apoie uma mão numa superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Caminhe sobre os calcanhares ,para trás. Respire normalmente durante a atividade. **Progressão:** Realize a atividade durante mais tempo, enquanto lhe for confortável. Apoie um dedo, sem apoio.	 **METs: 2.0**

Profissional de saúde	Participante	
Caminhar de lado enquanto prepara o lanche:		
Movimento: Apoiar as mãos numa superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Caminhar lateralmente para a direita. Caminhar lateralmente para a esquerda. **Respiração:** Normal. **Progressão:** Realizar a atividade durante mais tempo, enquanto for confortável. Apoiar uma mão, um dedo, sem apoio.	**Atividade:** Apoie as mãos numa superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Caminhe de lado para a direita. Caminhe de lado para a esquerda. Respire normalmente durante a atividade. **Progressão:** Realize a atividade durante mais tempo, enquanto lhe for confortável. Apoie uma mão, um dedo, sem apoio.	   **METs: 2.0**

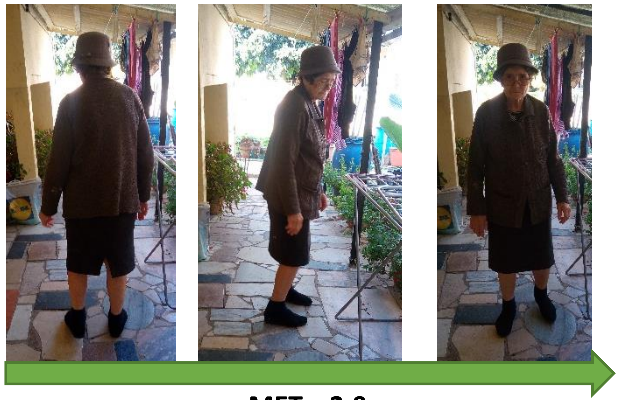
Atividades que posso fazer no pátio, quintal, varanda ou jardim durante o dia

Profissional de saúde	Participante	
Ao deslocar-se fora de casa enquanto apanha sol:		
Movimento: Apoiar a mão numa parede. Caminhar em flexão plantar, para a frente. **Respiração:** Normal. **Progressão:** Realizar a atividade durante mais tempo, enquanto for confortável. Apoiar um dedo, sem apoio.	**Atividade:** Apoie a mão numa parede. Caminhe em bicos dos pés para a frente. Respire normalmente durante a atividade. **Progressão:** Realize a atividade durante mais tempo, enquanto lhe for confortável. Apoie um dedo, sem apoio.	 **METs: 2.0**

Profissional de saúde	Participante	
Ao deslocar-se fora de casa enquanto apanha sol:		
Movimento: Apoiar a mão numa parede. Caminhar em flexão plantar, para trás. **Respiração:** Normal. **Progressão:** Realizar a atividade durante mais tempo, enquanto for confortável. Apoiar um dedo, sem apoio.	**Atividade:** Apoie a mão numa parede. Caminhe sobre os bicos dos pés para trás. Respire normalmente durante a atividade. **Progressão:** Realize a atividade durante mais tempo, enquanto lhe for confortável. Apoie um dedo, sem apoio.	 **METs: 2.0**

Profissional de saúde	Participante	
Ao deslocar-se fora de casa enquanto apanha sol:		
Movimento: Apoiar a mão numa parede. Caminhar em flexão dorsal, para a frente. **Respiração:** Normal. **Progressão:** Realizar a atividade durante mais tempo, enquanto for confortável; apoiar um dedo, sem apoio.	**Atividade:** Apoie a mão numa parede. Caminhe sobre os calcanhares para a frente. Respire normalmente durante a atividade. **Progressão:** Realize a atividade durante mais tempo, enquanto lhe for confortável. Apoie um dedo, sem apoio.	 **METs: 2.0**

Profissional de saúde	Participante	
Ao deslocar-se fora de casa enquanto apanha sol:		
Movimento: Apoiar a mão numa parede. Caminhar em flexão dorsal, para trás. **Respiração:** Normal. **Progressão:** Realizar a atividade durante mais tempo, enquanto for confortável. Apoiar um dedo, sem apoio.	**Atividade:** Apoie a mão numa parede. Caminhe sobre os calcanhares para trás. Respire normalmente durante a atividade. **Progressão:** Realize a atividade durante mais tempo, enquanto lhe for confortável. Apoie um dedo, sem apoio.	 **METs: 2.0**

Profissional de saúde	Participante	
Quando pretende virar e mudar de sentido:		
Movimento: Apoiar a mão numa parede. Caminhar em frente normalmente. Virar lentamente. Continuar a caminhar no outro sentido. **Respiração:** Normal. **Progressão:** Realizar a atividade mais vezes. Apoiar uma mão, um dedo, sem apoio.	**Atividade:** Apoie a mão numa parede. Caminhe para a frente andando normalmente. Vire-se lentamente. Continue a andar no outro sentido. Respire normalmente durante a atividade. **Progressão:** Realize a atividade mais vezes. Apoie uma mão, um dedo, sem apoio.	 **METs: 2.0**

Profissional de saúde	Participante	
Quando pretende virar e mudar de sentido:		
Movimento: apoiar as mãos numa parede. Caminhar lateralmente. Virar-se lentamente. Continuar a caminhar lateralmente no outro sentido. **Respiração:** Normal. **Progressão:** Realizar a atividade mais vezes. Apoiar uma mão, um dedo, sem apoio.	**Atividade:** Apoie as mãos numa parede. Caminhe de lado. Vire-se lentamente. Continue a andar de lado no outro sentido. Respire normalmente durante a atividade. **Progressão:** Realize a atividade mais vezes. Apoie uma mão, um dedo, sem apoio.	 **METs: 2.0**

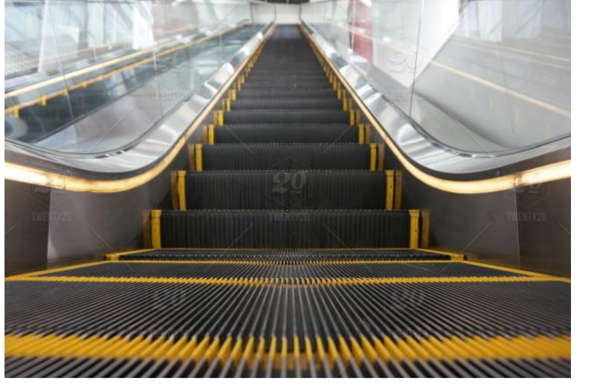
Profissional de saúde	Participante	
Quando pretende virar e mudar de sentido:		
Movimento: Apoiar a mão numa parede. Caminhar para trás. Virar-se lentamente. Continuar a caminhar para trás no outro sentido. **Respiração:** Normal. **Progressão:** Realizar a atividade mais vezes. Apoiar uma mão, um dedo, sem apoio.	**Atividade:** Apoie a mão numa parede. Caminhe para trás. Vire-se lentamente. Continue a andar para trás no outro sentido. Respire normalmente durante a atividade. **Progressão:** Realize a atividade mais vezes. Apoie uma mão, um dedo, sem apoio.	 **METs: 2.0 a 6.0**

Profissional de saúde	Participante	
Jardinagem:		
Movimento: De pé ou sentado. Tratar dos vasos numa mesa. **Respiração:** Normal. Se for necessário realizar agachamento: ao agachar, inspirar e ao levantar, expirar. **Progressão:** Realizar a atividade mais vezes.	**Atividade:** De pé ou sentando. Trate dos vasos numa mesa. Respire normalmente. Se tiver de se agachar para apanhar as folhas: ao agachar, inspire e ao levantar, expire. **Progressão:** Realize a atividade mais vezes.	 **METs: 1.8**

Profissional de saúde	Participante	
Jardinagem:		
Movimento: Agachar para tratar das ervas ou plantas no chão. **Respiração:** Enquanto realiza agachamento, inspirar. Enquanto se levanta, expirar. **Progressão:** Manter a posição por mais tempo. Realizar a atividade mais vezes.	**Atividade:** Agache-se para tratar das ervas ou plantas no chão. Enquanto se agacha, inspire. Enquanto se levanta, expire. **Progressão:** Mantenha-se mais tempo na posição. Realize a atividade mais vezes.	 **METs: 4.0**

Atividades que posso fazer no exterior durante o dia

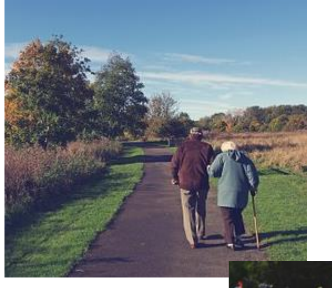
Profissional de saúde	Participante	
Subir escadas:		
Movimento: Utilizar a força dos membros inferiores para subir as escadas. Apoiar a mão no corrimão sem fazer força. Realizar flexão da anca e do joelho ao subir o degrau. **Respiração:** Normal. **Progressão:** Realizar a atividade mais vezes. Preferir as escadas em vez dos elevadores.	**Atividade:** Utilize a força das pernas para subir as escadas. Apoie a mão no corrimão sem fazer força. Eleve bem o joelho ao subir o degrau. Respire normalmente durante a atividade. **Progressão:** Realize a atividade mais vezes. Prefira as escadas em vez dos elevadores.	 **METs: 4.0**

Profissional de saúde	Participante	
Subir escadas:		
Movimento: Nos serviços ou centros comerciais usar as escadas em vez dos elevadores. Caminhar nas escadas/tapetes rolantes se o participante sentir confiança em fazê-lo. **Respiração:** Normal. **Progressão:** Realizar a atividade mais vezes.	**Atividade:** Nos serviços ou centros comerciais use as escadas em vez dos elevadores. Caminhe nas escadas/tapetes rolantes se sentir confiança em fazê-lo. Respire normalmente durante a atividade. **Progressão:** Realize a atividade mais vezes.	 **METs: 4.0 a 8.8**

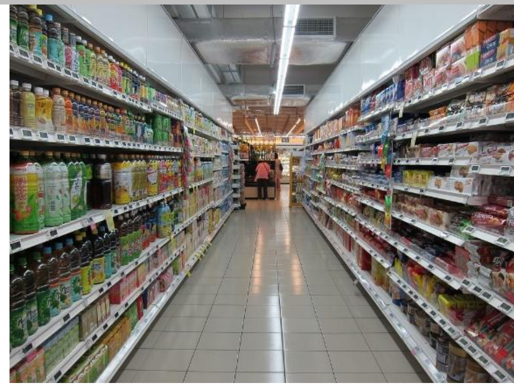
Profissional de saúde	Participante	
Passear com o animal de estimação:		
Movimento: Caminhar com o cão, numa zona tranquila e com trela. Esta atividade só pode ser realizada se o participante e o cão tiverem uma boa relação e o cão estiver bem domesticado. **Respiração:** Normal. **Progressão:** Realizar a atividade mais vezes.	**Atividade:** Caminhe com o cão, numa zona tranquila e com trela. Esta tarefa só pode ser realizada se tiver uma boa relação com o cão, e o cão estiver bem domesticado. Respire normalmente durante a atividade. **Progressão:** Realize a atividade mais vezes.	 **METs: 4.0 a 5.0**

Profissional de saúde	Participante	
Lazer:		
Movimento: Dançar é sempre uma boa opção, sozinho ou acompanhado. Para além de ser uma atividade física divertida faz bem à saúde e aumenta a tolerância ao esforço. **Respiração:** Normal. **Progressão:** Realizar a atividade mais vezes.	**Atividade:** Dançar é sempre uma boa opção, sozinho ou acompanhado, ligue a música e dance. Para além de ser uma atividade física divertida faz bem à saúde e aumenta a sua tolerância ao esforço. **Progressão:** Realize a atividade mais vezes.	 **METs: 5.0**

Profissional de saúde	Participante	
Caminhadas:		
Movimento: Caminhar até um café mais longe, ou dar duas voltas ao quarteirão antes de ir ao café habitual. **Respiração:** Normal. **Progressão:** Realize a atividade mais vezes.	**Atividade:** Vá a um café mais longe, ou dê duas voltas ao quarteirão antes de ir ao café habitual. Respire normalmente durante a atividade. **Progressão:** Realize a atividade mais vezes.	 **METs: 2.5**

Profissional de saúde	Participante	
Caminhadas:		
Movimento: Caminhada acompanhado ou passeio nos jardins locais. Caminhar com um familiar, vizinho ou amigo/a. **Respiração:** Normal. **Progressão:** Realizar a atividade mais vezes. Aumentar progressivamente o tempo de passeio.	**Atividade:** Passeie nos jardins locais. Caminhe com um familiar, vizinho ou amigo/a. Respire normalmente durante a atividade. **Progressão:** Realize a atividade mais vezes. Passeie durante mais tempo.	  **METs: 2.5 a 5.3**

Profissional de saúde	Participante	
Caminhadas:		
Movimento: Caminhar na praia. **Respiração:** Normal. **Progressão:** Realizar a atividade mais vezes. Inicialmente caminhar nos passadiços e quando sentir confiança fazer caminhadas na areia.	**Atividade:** Caminhe na praia. Respire normalmente durante a atividade. **Progressão:** Realize a atividade mais vezes. Inicialmente caminhe nos passadiços e quando sentir confiança faça as caminhadas na areia.	 **METs: 4.5**

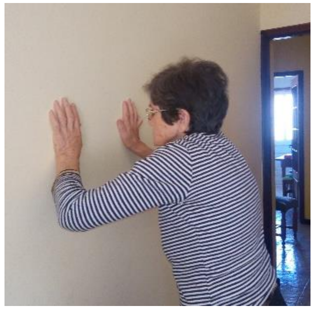
Profissional de saúde	Participante	
Caminhadas:		
Movimento: Acompanhar e ajudar nas compras do supermercado. Carregar um saco de compras em cada mão. **Respiração:** Normal. **Progressão:** Realizar a atividade mais vezes.	**Atividade:** Acompanhe e ajude nas compras do supermercado. Carregue um saco de compras em cada mão. Respire normalmente durante a atividade. **Progressão:** Realize a atividade mais vezes.	 **METs: 2.3 a 2.5**

Profissional de saúde	Participante	
Caminhadas:		
Movimento: Caminhar até à padaria para comprar o pão em vez de optar que o levem a casa. **Respiração:** Normal. **Progressão:** Realizar a atividade mais vezes.	**Atividade:** Vá à padaria comprar o pão em vez de optar que o tragam a casa. Respire normalmente durante a atividade. **Progressão:** Realize a atividade mais vezes.	  **METs: 2.5**

Profissional de saúde	Participante	
Caminhadas:		
Movimento: Envolvimento em atividades locais com alguém conhecido (p.e., caminhadas em grupo). **Respiração:** Normal. **Progressão:** Realizar a atividade mais vezes.	**Atividade:** Envolva-se em atividades locais com alguém conhecido (p.e., caminhadas em grupo). Respire normalmente durante a atividade. **Progressão:** Realize a atividade mais vezes.	 **METs: 2.5 a 5.3**

Atividades que posso fazer à noite

Profissional de saúde	Participante	
Enquanto espera pelo jantar:		
Movimento: De pé, apoiar a mão direita numa superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Realizar flexão do joelho esquerdo. Com o auxílio da mão esquerda, segurar o pé esquerdo em direção ao glúteo. Manter a posição durante alguns segundos. Regressar à posição inicial. Alternar o lado. **Respiração:** Enquanto realiza flexão do joelho, expirar. Respirar normalmente enquanto mantem a posição. Enquanto realiza extensão da perna, inspirar. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável e sem perder o equilíbrio. Apoiar um dedo, sem apoio.	**Atividade:** De pé, apoie a mão direita numa superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Dobre o joelho esquerdo para trás até ao máximo que conseguir. Puxe o pé esquerdo em direção à nádega com o auxílio da mão esquerda enquanto expira. Mantenha a posição durante alguns segundos enquanto respira normalmente. Baixe a perna enquanto inspira. Alterne o lado. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável e sem perder o equilíbrio. Apoie um dedo, sem apoio.	 **METs: 2.0**

Profissional de saúde	Participante	
Enquanto espera pelo jantar:		
Movimento: Em pé, em frente a uma parede. Afastar ligeiramente os membros inferiores. Apoiar as mãos na parede. Realizar flexão dos cotovelos com retração/adução das omoplatas. Realizar extensão dos membros superiores e protração/abdução das omoplatas. **Respiração:** Enquanto realiza a flexão, inspirar. Enquanto realiza a extensão, expirar. **Progressão:** Realizar o movimento mais vezes, enquanto for confortável.	**Atividade:** De pé, em frente a uma parede. Afaste ligeiramente os braços. Estique os braços contra e apoie bem as mãos na parede. Enquanto dobra os braços, inspire. Enquanto estica os braços, expire. **Progressão:** Realize o movimento mais vezes, enquanto lhe for confortável.	  **METs: 2.0**

Profissional de saúde	Participante	
Enquanto espera pelo jantar:		
Movimento: Sentado numa cadeira. Apoiar os pés no chão com os membros inferiores ligeiramente afastados. Cruzar os membros superiores sobre o peito. sentar numa cadeira. Levantar e sentar sucessivamente. **Respiração:** Enquanto se levanta, expirar. Enquanto se senta, inspirar. **Progressão:** Realizar a atividade mais vezes, ao ritmo de cada um.	**Atividade:** Sente-se no meio de uma cadeira. Apoie os pés no chão. Afaste ligeiramente as pernas e os pés. Cruze os braços em frente ao peito. Enquanto se levanta, expire. Enquanto se senta, inspire. **Progressão:** Realize a atividade mais vezes, ao seu ritmo.	 **METs: 3.5 a 4.0**

Profissional de saúde	Participante	
Enquanto espera pelo jantar:		
Movimento: Em pé, com os membros superiores ao longo do corpo ou ligeiramente à frente. Levantar e sentar sucessivamente. **Respiração:** Enquanto se levanta, expirar. Enquanto se senta, inspirar. **Progressão:** Realizar a atividade mais vezes, ao ritmo de cada um. Segurar uma garrafa de água de meio litro ou um saco de arroz em cada mão.	**Atividade:** De pé, com os braços esticados de lado ou à frente. Enquanto se levanta, expire. Enquanto se senta, inspire. **Progressão:** Realize a atividade mais vezes, ao seu ritmo. Segure uma garrafa de água de meio litro ou um saco de arroz em cada mão.	 **METs: 3.5 a 4.0**

Profissional de saúde	Participante	
No corredor, quando muda de divisão:		
Movimento: Apoiar uma mão na parede ou numa superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Afastar ligeiramente os pés. **Respiração:** Normal. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável. Apoiar um dedo e sem apoio. Base de sustentação estreita.	**Atividade:** Apoie uma mão na parede ou superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Afaste ligeiramente os pés. Respire normalmente durante a atividade. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Apoie um dedo e sem apoio. Pés juntos.	 **METs: 1.8**

Profissional de saúde	Participante	
No corredor, quando muda de divisão:		
Movimento: Apoiar uma mão na parede ou superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Alinhar um pé à frente do outro. Alternar o pé da frente com o de trás. **Respiração:** Normal. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável. Apoiar um dedo e sem apoio.	**Atividade:** Apoie uma mão na parede ou superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Coloque um pé à frente do outro na mesma linha. Respire normalmente durante a atividade. Alterne o pé da frente com o de trás. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Apoie um dedo e sem apoio.	 **METs: 1.8**

Profissional de saúde	Participante	
No corredor, quando muda de divisão:		
Movimento: Apoiar uma mão na parede ou superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Transferir o peso do corpo para o membro inferior esquerdo. Realizar flexão do joelho direito com a anca em posição neutra. Alternar o lado. **Respiração:** Normal. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável. Apoiar um dedo e sem apoio.	**Atividade:** Apoie uma mão na parede ou superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Apoie-se na perna esquerda e dobre o joelho da perna direita para trás. Respire normalmente durante a atividade. Alterne o lado. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Apoie um dedo e sem apoio.	 **METs: 2.0**

Profissional de saúde	Participante	
No corredor, quando muda de divisão:		
Movimento: Apoiar uma mão na parede ou superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Transferir o peso do corpo para o membro inferior esquerdo. Realizar flexão da anca e do joelho direito. Colocar o pé direito em flexão plantar. Alternar o lado. **Respiração:** Normal. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável. Apoiar um dedo e sem apoio.	**Atividade:** Apoie uma mão na parede ou superfície estável (p.e., mesa, bancada da cozinha, corrimão ou móvel). Apoie-se na perna esquerda. Dobre o joelho direito para a frente até à altura que conseguir estar confortavelmente. Estique o pé direito. Respire normalmente durante a atividade. Alterne o lado. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Apoie um dedo e sem apoio.	 **METs: 2.0**

Profissional de saúde	Participante	
Ao ver televisão ou ao ouvir rádio:		
Movimento: Sentado, numa cadeira sem braços. Apoiar os pés no chão ligeiramente afastados. Colocar o membro superior esquerdo na axila direita, com a mão esquerda a segurar na zona das costelas. Realizar inclinação lateral do tronco para o lado direito. Manter a posição durante alguns segundos. Alternar o lado. **Respiração:** Antes de iniciar o movimento, inspirar. Enquanto realiza o movimento, expirar. Respirar normalmente enquanto mantem a posição. **Progressão:** Manter a posição durante mais tempo enquanto for confortável e sem perder o equilíbrio.	**Atividade:** Sente-se numa cadeira sem braços. Apoie os pés no chão ligeiramente afastados. Coloque o braço esquerdo na axila direita, com a mão direita a segurar na zona das costelas. Antes de iniciar o movimento, inspire. Enquanto leva a mão direita em direção ao chão, o mais longe que conseguir, sem cair, expire. Mantenha a posição durante alguns segundos enquanto respira normalmente. Alterne o lado. **Progressão:** Mantenha a posição durante mais tempo enquanto lhe for confortável e sem perder o equilíbrio.	 **METs: 1.8**

Profissional de saúde	Participante	
Ao ver televisão ou ao ouvir rádio:		
Movimento: Apoiar os pés no chão, ligeiramente afastados. Cruzar os membros superiores sobre o peito. Realizar inclinação lateral máxima direita do tronco, mantendo o limite de estabilidade. Regressar à posição inicial. Alternar o lado. **Respiração:** Enquanto se inclina, expirar. Enquanto regressa à posição inicial, inspirar. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável.	**Atividade:** Sente-se com os pés bem assentes no chão e ligeiramente afastados. Cruze os braços em frente ao peito. Enquanto inclina o tronco para a direita, o máximo que conseguir, sem cair, expire. Enquanto regressa à posição inicial, inspire. Alterne o lado. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável.	 **METs: 1.8**

Profissional de saúde	Participante	
Quando acaba de ver televisão, à noite:		
Movimento: Sentado com o tronco e a cervical alinhados. Realizar extensão do membro superior direito com extensão do punho. A mão esquerda ajuda ao movimento. Manter a posição durante alguns segundos. Alternar o lado. **Respiração:** Antes de iniciar o movimento, inspirar. Ao iniciar o movimento, expirar. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável.	**Atividade:** Sente-se com as costas e a cabeça direitas. Antes de iniciar o movimento, inspire. Ao esticar o braço direito com a palma da mão virada para cima, expire. Estique a mão direita para baixo, com ajuda da mão esquerda. Enquanto mantem a posição durante alguns segundos, respire normalmente. Alterne o lado. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável.	 **METs: 1.8**

Profissional de saúde	Participante	
Quando acaba de ver televisão, à noite:		
Movimento: Sentado com o tronco e a cervical alinhados. Realizar extensão do membro superior direito com flexão do punho. A mão esquerda ajuda ao movimento. Manter a posição durante alguns segundos. Alternar o lado. **Respiração:** Antes de iniciar o movimento, inspirar. Ao iniciar o movimento, expirar. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável.	**Atividade:** Sente-se com as costas e a cabeça direitas. Antes de iniciar o movimento, inspire. Enquanto estica o braço direito com as costas da mão virada para cima, expire. Dobre a mão direita para baixo com ajuda da mão esquerda. Mantenha a posição durante alguns segundos enquanto respira normalmente. Alterne o lado. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável.	 **METs: 1.8**

Profissional de saúde	Participante	
Quando acaba de ver televisão, à noite:		
Movimento: Sentado, com o tronco e a cervical alinhados. Realizar flexão do membro superior e cotovelo esquerdos, de forma a colocar a mão esquerda atrás da cabeça. A mão direita ajuda a estabilizar o cotovelo esquerdo. Manter a posição durante alguns segundos. Alternar o lado. **Respiração:** Antes de iniciar o movimento, inspirar. Ao iniciar o movimento, expirar. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável.	**Atividade:** Sente-se com as costas e a cabeça direitas. Antes de iniciar o movimento, inspire. Enquanto empurra o cotovelo esquerdo para chegar com a mão atrás da cabeça, expire. A mão direita ajuda a empurrar o cotovelo esquerdo. Mantenha a posição durante alguns segundos enquanto respira normalmente. Alterne o lado. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável.	 **METs: 1.8**

Profissional de saúde	Participante	
Passar a guardar alguns objetos em locais baixos como p.e. a pasta e a escova de dentes:		
Movimento: Apoiar as mãos no lavatório. Afastar os membros inferiores à largura dos ombros. Realizar flexão dos joelhos para alcançar os objetos mais baixos. Regressar à posição inicial. **Respiração:** Enquanto realiza flexão dos joelhos, inspirar. Enquanto regressa à posição inicial, expirar. **Progressão:** Manter a posição por mais tempo. Apoiar uma mão, um dedo, sem apoio.	**Atividade:** Apoie as mãos no lavatório. Afaste as pernas à largura dos ombros. Enquanto se agacha para alcançar os objetos mais baixos, inspire. Enquanto se levanta, expire. **Progressão:** Mantenha a posição por mais tempo. Apoie uma mão, um dedo, sem apoio.	 **METs: 2.0**

Profissional de saúde	Participante
Ao escovar os dentes, lavar a loiça, ver televisão/ouvir rádio ou enquanto espera por algo/alguém:	
Movimento: Apoiar as mãos no lavatório. Afastar ligeiramente os pés. Manter a posição durante alguns segundos. **Respiração:** Normal. **Progressão:** Manter posição durante mais tempo, enquanto for confortável. Apoiar uma mão, um dedo e sem apoio. Pés juntos.	**Atividade:** Apoie as mãos no lavatório. Afaste ligeiramente os pés. Mantenha a posição durante alguns segundos enquanto respira normalmente. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Apoie uma mão, um dedo e sem apoio. Pés juntos.

METs: 1.8

Profissional de saúde	Participante	
Ao escovar os dentes, lavar a loiça, ver televisão/ouvir rádio ou enquanto espera por algo/alguém:		
Movimento: Apoiar as mãos no lavatório. Alinhar os pés um à frente do outro. Manter a posição durante alguns segundos. Alternar o pé da frente com o de trás. **Respiração:** Normal. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável. Apoiar uma mão, um dedo e sem apoio.	**Atividade:** Apoie as mãos no lavatório. Coloque um pé à frente do outro na mesma linha. Mantenha a posição durante alguns segundos enquanto respira normalmente. Alterne o pé da frente com o de trás. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Apoie uma mão, um dedo e sem apoio.	 **METs: 1.8**

Profissional de saúde	Participante	
Ao escovar os dentes, lavar a loiça, ver televisão/ouvir rádio ou enquanto espera por algo/alguém:		
Movimento: Apoiar as mãos no lavatório. Transferir o peso do corpo para o membro inferior direito. Realizar flexão máxima do joelho esquerdo. Manter a posição durante alguns segundos. Alternar o lado. **Respiração:** Normal. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável. Apoiar uma mão, um dedo e sem apoio.	**Atividade:** Apoie as mãos no lavatório. Apoie-se na perna direita. Dobre o joelho esquerdo para trás. Mantenha a posição durante alguns segundos enquanto respira normalmente. Alterne o lado. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Apoie uma mão, um dedo e sem apoio.	 **METs: 2.0**

Profissional de saúde	Participante	
Ao escovar os dentes, lavar a loiça, ver televisão/ouvir rádio ou enquanto espera por algo/alguém:		
Movimento: Apoiar as mãos no lavatório. Afastar ligeiramente os pés. Transferir o peso do corpo para os dedos dos pés, colocando-se em flexão plantar. **Respiração:** Normal. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável. Apoiar uma mão, um dedo e sem apoio. Base de sustentação estreita.	**Atividade:** Apoie as mãos no lavatório. Afaste ligeiramente os pés. Coloque-se sobre os bicos dos pés. Mantenha a posição enquanto respira normalmente. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Apoie uma mão, um dedo e sem apoio. Pés juntos.	 **METs: 2.0**

Profissional de saúde	Participante	
Ao escovar os dentes, lavar a loiça, ver televisão/ouvir rádio ou enquanto espera por algo/alguém:		
Movimento: Apoiar as mãos no lavatório. Afastar ligeiramente os pés. Transferir o peso do corpo para os calcanhares, colocando-se em flexão dorsal. **Respiração:** Normal. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável. Apoiar uma mão, um dedo e sem apoio. Base de sustentação estreita	**Atividade:** Apoie as mãos no lavatório. Afaste ligeiramente os pés. Coloque o peso do seu corpo sobre os calcanhares. Mantenha a posição durante alguns segundos enquanto respira normalmente. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável. Apoie uma mão, um dedo e sem apoio. Pés juntos.	 **METs: 2.0**

Profissional de saúde	Participante	
À noite, antes de se deitar:		
Movimento: Sentar na beira da cama com o tronco e a cervical alinhados. Unir as mãos. Entrelaçar os dedos. Realizar flexão dos membros superiores à altura dos ombros. Levar as mãos para a frente, como se quisesse chegar à parede durante alguns segundos, com os cotovelos esticados. Manter a posição durante alguns segundos. Baixar os membros superiores. **Respiração:** Enquanto realiza flexão dos membros superiores, expirar. Enquanto mantem a posição, respirar normalmente. Enquanto baixa os membros superiores, inspirar. **Progressão:** Manter a posição durante mais tempo, enquanto for confortável.	**Atividade:** Sente-se na beira da cama com as costas e a cabeça alinhados. Una as mãos. Entrelace os dedos. Enquanto estica os braços à altura dos ombros, expire. Puxe as mãos para a frente, como se quisesse chegar à parede. Mantenha a posição durante alguns segundos enquanto respira normalmente. Enquanto baixa os braços, inspire. **Progressão:** Mantenha a posição durante mais tempo, enquanto lhe for confortável.	 **METs: 1.8**

Conclusão [Conclusion]

A atividade física traduz-se em muitos benefícios para a saúde, mesmo pequenos aumentos no nível de atividade física podem ter um impacto positivo na saúde. É imperativo diminuir o tempo em atividade sedentária e aumentar a atividade física das pessoas com défice cognitivo ligeiro ou com demência. Para que isso aconteça, é importante existir uma abordagem centrada no participante e no cuidador/pessoa significativa que o acompanha, que permita adaptar a atividade física a cada pessoa.

Este manual demonstra como é possível aumentar a atividade física e reduzir o tempo em atividade sedentária através das rotinas diárias. Assim, os participantes, com a orientação do profissional de saúde, podem praticar atividade física no seu dia-a-dia, fazendo simples e pequenas alterações, que irão promover um estilo de vida mais saudável.

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Book chapter

A importância da atividade física no período de distanciamento social In "Pensar e compreender o envelhecimento em emergência de pandemia"

Marques A, Gomes da Silva M., Almeida S.

A importância da atividade física no período de distanciamento social [The importance of physical activity in the period of social distance]

Este capítulo aborda brevemente a problemática atual que vivemos, enquadrando a (in)atividade física na pandemia do COVID-19 e os seus possíveis efeitos para a população idosa. São deixadas ao leitor algumas sugestões para promover a prática de atividade física, com exemplos dirigidos para a população idosa, que esperamos serem úteis a todos.

Atividade física em tempo de pandemia

As restrições sociais associadas à pandemia pelo coronavírus 2019 (COVID-19) tiveram como objetivo proteger a saúde e a vida. No entanto, o distanciamento físico e social pode ter impactos devastadores na saúde física e mental da população idosa. [2]

O distanciamento social está associado à redução de atividade física diária e ao aumento do comportamento sedentário nas pessoas idosas.[3] Não é, pois, surpreendente que estas alterações se tenham agravado, uma vez que as pessoas passam mais tempo sentadas, reclinadas ou deitadas (p.e., a ver televisão, a ouvir rádio, a ler ou no computador, tablet, telemóvel ou outro aparelho),[4 5] alteraram as suas rotinas e viram-se limitadas, ou até mesmo impossibilitadas, de praticar atividade física ou desportiva, individual ou em grupo. Durante a pandemia do COVID-19, a Fitbit revelou por exemplo, dados de um declínio de 25% no número de passos em Portugal, entre os dias 15 e 22 de março de 2020.[6]

Atividade física

A atividade física é definida como qualquer movimento produzido pelo sistema musculosquelético que exija gasto energético.[7] Assim, a atividade física integra o exercício físico ou desporto, mas também atividades de lazer (p.e., jardinagem ou dançar) ou ocupacionais (p.e., trabalho) e atividades da vida diária (p.e., tomar banho, arrumar ou fazer compras).[7 8]

A Organização Mundial de Saúde (OMS) recomenda que as pessoas idosas realizem, pelo menos 30 minutos (podem ser divididos por 3 blocos de 10 minutos ao longo do dia) de atividade física moderada por dia, pelo menos cinco dias por semana (total 150 minutos/semana) ou realizem pelo menos 25 minutos de atividade física vigorosa, pelo menos 3 dias por semana (total 75 minutos/semana).[8 9] Atividades de fortalecimento muscular, resistência e flexibilidade devem ser realizadas, pelo menos dois dias por semana.[9 10] Pessoas com baixos níveis de mobilidade devem realizar atividades que promovam melhoria do equilíbrio/força e diminuam o risco de quedas, pelo menos três dias por semana.[8] Caso não seja possível cumprir as recomendações devido às condições de saúde, a pessoa deve ser o mais fisicamente ativa possível.[5]

Sabe-se que a atividade física tem inúmeros benefícios para a saúde das pessoas idosas.[8] A evidência científica demonstra que a atividade física nesta população tem impacto na redução do risco de todas as causas de mortalidade, no desenvolvimento de cancro da próstata ou da mama e no número de fraturas; melhora a qualidade do sono, a capacidade para realizar atividades da vida diária e o estado funcional diário, diminui o risco de queda e o declínio cognitivo e depressão.[10] Em suma, as pessoas idosas fisicamente ativas melhoram a sua qualidade de vida e promovem um envelhecimento saudável,[10] pelo que, em tempo de pandemia, uma reflexão sobre a limitação da atividade física nesta população e possíveis soluções inovadoras são urgentes, de forma a minimizar os impactos negativos que possam vir a ser demostrados num futuro próximo.

Recomendações para a prática de atividade física em tempo de pandemia

A COVID-19 disseminou-se mundialmente com efeitos particularmente severos nos mais idosos, e para os sujeitos com determinadas condições clínicas também comuns nesta faixa etária (p.e., hipertensão, diabetes mellitus e doenças respiratórias, crónicas renais e cardiovasculares).[11] A atividade física através dos seus benefícios físicos e mentais, já referidos, nomeadamente em pessoas com doenças crónicas[9 12] tem o potencial de promover a saúde e o bem estar no período de pandemia.[10 13 14]

A OMS recomenda a prática de atividade física durante o período de isolamento, referindo que é importante fazer planos diários para se ser mais ativo e para reduzir o tempo sentado.[15] Interrupções dos períodos sentados, 3 a 5 minutos, para praticar algum movimento (p.e., caminhar ou alongar) podem fazer a diferença, pois, qualquer atividade física é melhor do que nenhuma.[15] Assim, mesmo que a pessoa não tenha por hábito ser fisicamente ativa, deve começar por pequenas atividades e, gradualmente, aumentar a duração, frequência e intensidade das mesmas.[15]

Num estudo publicado na sequência da pandemia COVID-19, foram sugeridas alterações nas orientações da atividade física para pessoas idosas durante os períodos de isolamento,[16] recomendando-se atualmente: adaptação no volume e intensidade das atividades físicas durante cinco a sete dias por semana; exercícios de resistência muscular, 200-400 minutos por semana, dois a três dias por semana; treino diário da mobilidade articular e; treino de equilíbrio e coordenação, pelo menos dois dias por semana. Os autores recomendam que a atividade física seja moderada (formas de monitorizar a intensidade são abordadas mais à frente) para benefício do sistema imunitário, uma vez que as atividades vigorosas podem inibir este sistema, principalmente em pessoas sedentárias.[16]

A International Association of Physical Therapists working with Older People (IAPTWOP), a American College of Sports Medicine (ACSM) bem como a Direção Geral de Saúde (DGS), através do Programa Nacional para a Promoção da Atividade Física, compilaram nas suas páginas web um conjunto de fontes/recursos, infográficos e recomendações com estratégias para se ser mais fisicamente ativo em tempo de pandemia.

Cuidados a ter [Precautions]

O encorajamento à prática de atividade física não dispensa a segurança pessoal. As recomendações para manter a distância de segurança devem ser mantidas e as atividades em grupo têm de ser pensadas com ponderação e de acordo com as recomendações do momento. Sabe-se que o vírus pode permanecer ativo nas superfícies por um período prolongado, sendo importante desinfetar superfícies e equipamentos. A par destas preocupações, a OMS[15] explica como manter a segurança durante a prática de atividade física em período de pandemia:

- No caso de febre, tosse ou dificuldade respiratória é recomendado ficar em casa e descansar, pedir opinião médica e cumprir as recomendações das autoridades de saúde.

- Se existir autorização para sair de casa para praticar atividade física, deve manter a distância das outras pessoas, lavar as mãos com água e sabão (ou solução à base de álcool), antes de sair de casa, no local da prática da atividade e assim que chegar a casa. Seguir as recomendações das autoridades de saúde sobre se os locais públicos (p.e., jardins) e os equipamentos de exercício existentes podem ser utilizados e sobre o número máximo de pessoas e a distância entre elas.

- No caso de não ser uma pessoa fisicamente ativa, deve começar lentamente, com atividades de baixa intensidade. Começar com períodos de atividade física de 5 a 10 minutos e, gradualmente aumentar para 30 minutos ou mais.

- A pessoa deve ser capaz de respirar normalmente e manter uma conversa enquanto realiza as atividades físicas ligeiras a moderadas.

Além das recomendações mais específicas para o período de confinamento, há outros cuidados a ter na prática da atividade física. Deve considerar-se as especificidades de cada pessoa, de forma a compreender como e quando é que a condição de cada um pode afetar a capacidade para realizar atividade física regular e com segurança. A pessoa deve parar a atividade se sentir dor no peito, tonturas, falta de ar, náuseas, dores nas costas e/ou dores musculares fortes. É importante que seja considerado também:

- O aquecimento antes e o arrefecimento depois da prática de atividade física, bem como manter uma postura correta durante as atividades são muito importantes para evitar lesões.

- A hidratação é importante. Beber água antes, durante e depois da prática de atividade física.

- Roupa e calçado devem ser confortáveis, de tamanho ajustado e adequados à temperatura.

- Deve ter ao alcance uma superfície estável (p.e., balcão, cadeira encostada à parede ou um móvel), no caso ser necessário um apoio.

- Cada pessoa deve realizar as atividades físicas ao seu ritmo e fazer pausas sempre que necessário. Algumas condições (p.e., doença cardíaca grave, hipertensão resistente e alterações respiratórias) podem carecer de ajuste nas atividades físicas. Se houver dúvidas sobre o que se deve ou não fazer, o mais sensato é procurar aconselhamento profissional.

- Se possível, a atividade física deve ser monitorizada.

Há várias formas de monitorizar a atividade física. O *Talk test* pode ser utilizado para monitorizar a intensidade da atividade física de acordo com o descrito na Figura 1.[17 18]

Atividade física de intensidade:
i) ligeira será capaz de manter uma conversa,
ii) moderada será capaz de manter uma conversa, mas com ligeiro aumento da frequência cardíaca e respiratória, e
iii) vigorosa não será capaz de dizer mais do que algumas palavras sem fazer uma pausa para respirar

Figura 1. Exemplificação do Talk test e respetiva interpretação para monitorizar a intensidade de atividade física.

A contagem do número de passos é outra forma de monitorização simples que pode ser utilizada por exemplo, através do uso de uma aplicação móvel ou pedómetro e a interpretação da contagem deve ser de acordo com o descrito na Figura 2.[19] Para se ser suficientemente ativo, com uma intensidade moderada, são necessários 3000 passos em 30 minutos.[17 19] Gradualmente, deve progredir-se até aos 10000 passos por dia, ou mais.[9]

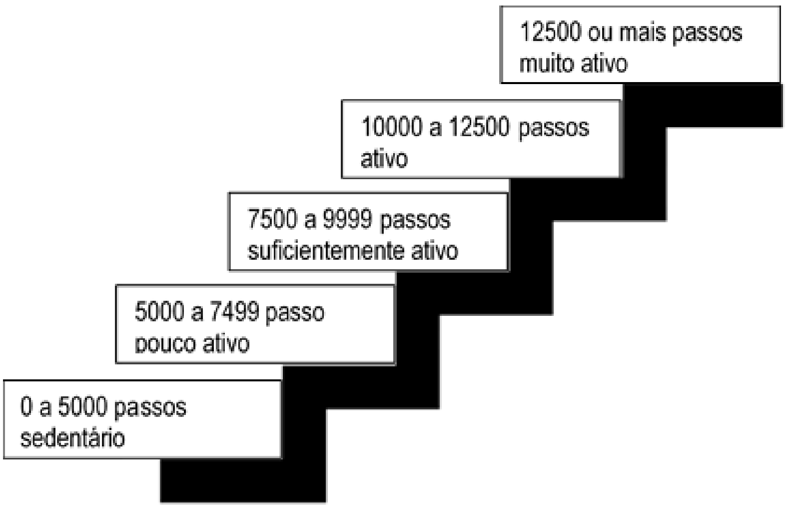
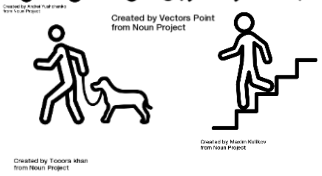


Figura 2. Interpretação da contagem do número de passos por dia através de uma aplicação móvel ou pedómetro.

Praticar atividade física fora de casa [Practicing physical activity outdoor]

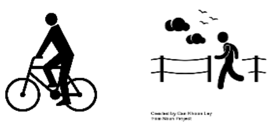
O plano para a prática de atividade física deve estar de acordo com as recomendações locais, da autoridade de saúde e do governo. A maneira mais segura de ser fisicamente ativo ao ar livre é ir sozinho ou com alguém com quem vive, ficar em zonas perto de casa e evitar espaços com muita gente. Deve manter-se a distância das outras pessoas, realizar todos os cuidados de desinfeção e não tocar em nada que outras pessoas possam ter tocado (p.e., bebedouros e equipamentos de treino). Quem vive perto de um parque, da praia ou da montanha, onde possa cumprir o distanciamento social, poderá ser uma opção utilizar essas zonas para praticar atividade física.[20] Exemplos de atividades físicas para praticar fora de casa:

- Caminhar sozinho ou com alguém com que vive, por prazer
- Caminhada rápida em piso regular
- Caminhar nos trilhos, se viver perto da montanha
- Caminhada com inclinação, subir e descer rua inclinada
- Caminhar na areia, se viver perto da praia e a mesma não estiver interdita



- Subir e descer escadas no percurso da caminhada
- Passear com o animal de estimação

- Se tiver de se deslocar (p.e., supermercado, farmácia) optar por um caminho mais longo
- Transportar um saco de compras em cada mão se for ao supermercado



- Correr
- Andar de bicicleta

Se não for seguro ou permitido sair de casa há opções disponíveis para praticar atividade física no domicílio.

Como praticar atividade física em casa [How to practice physical activity at home]

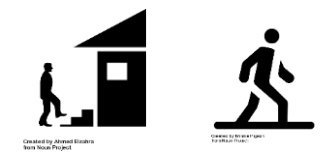
Na sequência do COVID-19, praticar atividade física regularmente em casa, num ambiente seguro parece ser uma estratégia para viver de forma mais saudável durante este período.[21] Para que as pessoas procurem manter-se fisicamente ativas em casa a OMS recomenda[15]:

- Reduzir longos períodos sentados, seja a trabalhar, estudar, ver televisão, ler, utilizar as redes sociais ou a jogar. Fazer uma pausa dos períodos de sentado a cada 20-30 minutos para alongar, caminhar pela casa ou no jardim/pátio ou subir e descer escadas.

- Realizar atividade física com os familiares (p.e., jogos com os filhos e netos) e amigos (por telefone ou online) ajuda a aumentar o contacto com os outros e o bem-estar físico.

- Planear a rotina diária de atividade física, sozinho ou com a família. Escolher a atividade física, a hora do dia e quanto tempo vai praticar por dia.

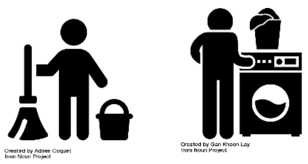
Apesar de algumas atividades poderem ser feitas com equipamento (p.e., bicicleta, passadeira, pedaleira, pesos)[20] há inúmeras opções para praticar um estilo de vida mais ativo, sem recurso a material e que podem facilmente ser incluídos nas rotinas diárias[4]:



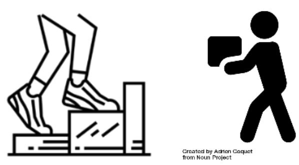
- Caminhar pela casa (p.e., quando atende o telemóvel)
- Andar em cima de uma linha no chão
- Andar na ponta dos pés ou nos calcanhares
- Passar por cima de objetos

- Mudar de canal na própria televisão ou deixar o comando mais longe, para se levantar
- Levantar e movimentar nos intervalos do programa de tv
- Levantar e movimentar, ao ler (p.e., de 6 em 6 páginas ou quando acaba uma secção)

- Sentar e levantar da cadeira
- Agachamentos segurando-se numa cadeira
- Guardar objetos em locais mais altos ou baixos

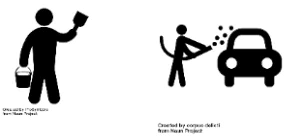


- Arrumar a casa (p.e., fazer a cama, limpar o pó, varrer, aspirar)
- Tratar das roupas (p.e., lavar, estender a roupa, passar a ferro, dobrar a roupa)

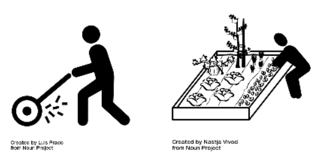


- Carregar itens com peso leve e moderado (p.e., saco de arroz, garrafa de água)
- Subir e descer um degrau/escadas
- Usar as escadas em vez do elevador

- Fazer uma atividade movimentada (p.e., dançar, brincar com o animal de estimação)
- Quem tem crianças em casa, brincar com elas 15 a 30 minutos por dia



- Bricolage (p.e., pintar, arranjar peça da mobília)
- Tratar do carro (p.e., lavar, aspirar)



- Tratar do jardim e das plantas em vaso (p.e., arrancar ervas, envasar, transplantar)
- Tratar do pátio (p.e., varrer as folhas, lavar)
- Tratar do quintal/horta (p.e., cavar, semear, colher legumes/frutas)

Existem outras opções, como programas de exercício desenhados que podem ser praticados em casa.[2 22]

Como praticar atividade física na instituição [How to practice physical activity in the institution]

O confinamento social nas instituições (p.e., estruturas residenciais para pessoas idosas, hotéis séniors, casas assistidas) tem levado a um reajuste das dinâmicas institucionais e das rotinas dos seus residentes.[23] Sabe-se que as pessoas idosas institucionalizadas são menos ativas e mais sedentárias que os seus pares.[24] É expectável que, em período de pandemia estes números agravem, sendo crucial criar estratégias para aumentar a atividade física destas pessoas.[23]

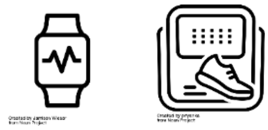
Nas instituições podem-se aplicar as atividades físicas sugeridas para o domicílio, desde que se adotem as devidas medidas de segurança (higiene, desinfeção e distanciamento físico), quer a pessoa esteja confinada ao seu quarto ou existam zonas comuns que possam ser utilizadas.

No entanto, o fator social pode representar um valor adicional importante. Na literatura encontram-se diferentes programas de atividade física para reproduzir nas instituições.[22] Além disso, em contexto de não isolamento, muitas instituições têm já estabelecidos planos de atividade física e exercício para os seus residentes, que podem ser adaptados. A adaptação de novos programas ou dos que previamente já existiam na instituição pode consistir em: grupos mais reduzidos, respeitar a distância de segurança entre todas as pessoas e desinfeção do material antes e depois do programa (sem trocas de material entre as pessoas sem que esse seja desinfetado). Alertar os residentes para praticar as normas higiene e desinfeção, distanciamento e de etiqueta respiratória é também importante durante o desenvolvimento da atividade física.

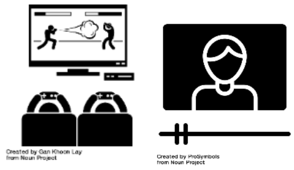
O papel das tecnologias [The role of technologies]

O distanciamento social físico implica um ajuste à forma como comunicamos com o outro. As tecnologias têm um papel predominante para manter as pessoas em contacto umas com as outras e podem também ser utilizadas para aumentar a atividade física. O uso das tecnologias na atividade física tem demonstrado potencial nas pessoas idosas.[25 26] Algumas sugestões para usar as tecnologias na atividade física consistem em:

- Caminhar enquanto liga a um amigo/familiar
- Praticar atividade física com amigos/familiares durante uma chamada de vídeo
- Acompanhar aulas de exercício na internet
- Seguir páginas web com planos de exercícios



- Partilhar os planos/conquistas de atividades físicas
- Utilizar aplicações (p.e., Google Fit, Strava ou Fitbit) com dispositivos de monitorização da atividade física, como *smartphone* ou *smartwatch*



- Utilizar jogos de vídeo de atividade física em casa

Se já praticava atividade física antes da pandemia com algum instrutor, o feedback remoto pode ser uma opção[1]

Estão disponíveis várias fontes gratuitas na internet para ajudar as pessoas idosas a ser fisicamente mais ativas (Tabela 1).

Tabela 1. Exemplos de atividades físicas gratuitas disponíveis online.

Programa/fonte	Recurso	Link
Diabetes em Movimento	Vídeo	https://diabetesemmovimento.wordpress.com/videos/
Grupo de interesse em fisioterapia cardiorrespiratória	Vídeo	https://www.youtube.com/channel/UCl4m2AxpZF960MSJwoKbHRQ?view_as=subscriber&fbclid=IwAR0IcJaB2THucTylY2FoMn25GQ8a4q-AiJ09aelrDPaFDV264AD-Pz5pYhM
UpFit	Vídeo	https://www.youtube.com/watch?v=mxB9NcfjjUQ&list=PLSfAz8S5k5V6oVZVQnj1h1ihg4mE2WMDW&index=28
Active Ageing Canada	Vídeo	https://www.youtube.com/c/ActiveAgingCanada
British Gymnastics Foundation	Vídeo	https://britishgymnasticsfoundation.org/lovetomove/
Exercise Plan for Seniors	Página web	https://www.healthline.com/health/everyday-fitness/senior-workouts
Generation Games Age UK	Vídeo	https://www.generationgames.org.uk/
Go4Life	Vídeo	https://www.youtube.com/watch?v=8E8iCYG16ho&list=PLmk21KJuZUM7kDgg7EOsXqPKAoOnD5Q8N
International Association of Physical Therapists working with Older People	Página web	https://www.wcpt.org/covid19/practice
Moves50+	Vídeo	https://move50plus.ca/bougez/#tout
National Center on Health, Physical Activity and Disability	Vídeo	https://www.youtube.com/watch?list=PLwMObYmlSHaPIArTOC4JBZfeuU7LN7KVJ&v=eLClKvN9Qag https://www.youtube.com/watch?v=PGhMIr_guNI&list=PLwMObYmlSHaPIArTOC4JBZfeuU7LN7KVJ&index=3
National Health Service - NHS	Página web	https://www.nhs.uk/live-well/exercise/physical-activity-guidelines-older-adults/?tabname=fitness-guides
Organização Mundial de Saúde	Página web	http://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/novel-coronavirus-2019-ncov-technical-guidance/stay-physically-active-during-self-quarantine
Otago	Manual e vídeo	https://www.livestronger.org.nz/assets/Uploads/acc1162-otago-exercise-manual.pdf https://www.youtube.com/watch?v=RmZO_EPoB4k
Royal Osteoporosis Society	Vídeo	https://theros.org.uk/information-and-support/living-with-osteoporosis/exercise-and-physical-activity-for-osteoporosis

Ymca health & fitness videos	Vídeo	https://ymca360.org/on-demand/category/14

Motivação para a atividade física [Physical activity motivation]

A motivação é fundamental para que as pessoas se mantenham fisicamente ativas. Os fatores de motivação para a prática de atividade física mais referidos pelas pessoas idosas são a prevenção do declínio da saúde, gostar dos exercícios, as outras pessoas enquanto motivadores, sentirem-se mais ativos comparativamente com gerações mais novas e estar fora de casa durante a luz do dia.[27]

O apoio dos outros e estabelecer objetivos são fortes componentes motivacionais.[9] Se cada membro da família/amigo definir o seu próprio objetivo (p.e., aumentar o número de passos), e registar e partilhar a evolução, pode ser um desafio que aumente a motivação. No período de confinamento, praticar atividade física regularmente pode ajudar a reestruturar a rotina diária e é uma forma de estar em contacto com os familiares e amigos, mesmo que à distância.

Conclusão [Conclusion]

A prática de atividade física pode ajudar a manter a saúde física e mental das pessoas idosas, especialmente importantes em período de confinamento e isolamento social. É possível e recomendado continuar a praticar, ou iniciar, um estilo de vida mais ativo e menos sedentário, mesmo neste período. Neste capítulo são deixadas algumas sugestões de fácil implementação para a prática e monitorização da atividade física na população idosa.

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Protocol study

Lifestyle integrated functional exercise for people with dementia: study protocol for a home-based randomised controlled trial

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Abstract

Background/aims: Physical activity is effective in people with dementia. Most people with dementia live at home, however few home-based physical activity programmes have been developed. The aim of this protocol is to determine the feasibility, effectiveness and cost-effectiveness of the Lifestyle Integrated Functional Exercise for People with Dementia (LiFE4D).

Methods: A randomised, controlled trial will be implemented. Experimental group will receive LiFE4D and control group will maintain usual treatment. LiFE4D is a 3-month programme adjusted to daily routines and involving carers, with decreased face-to-face contact over time. The primary outcome measure is exercise capacity assessed with the 2-Minute Step Test. Secondary outcomes include cognitive function, physical activity, health-related physical fitness, respiratory function, functionality, quality of life, carers' burden and costs.

Results: Findings from this study will improve knowledge and provide guidance on home-based physical activity for people with dementia.

Conclusions: If effective, the trial will provide a model of home-based physical activity and inform international guidelines for dementia care.

Key words: Community-dwelling; Daily living; Individualised intervention; LiFE4D; Major neurocognitive impairment

Introduction

Dementia is expected to affect 131.5 million people worldwide by 2050 (Prince et al, 2015). The costs spent to manage dementia are about a trillion US dollars/year, worldwide (Wimo et al, 2017). Thus, dementia has been considered a public health priority (World Health Organization [WHO], 2012), with global actions taking place (WHO, 2017).

Physical inactivity is responsible for economic costs (€910 million/year for 10 million people) but also health-related costs (3.5% of the disease burden and 10% of deaths in Europe) (WHO, 2007). People with dementia present poor levels of physical activity, spending 66% of their day in sedentary or lower intensity activities (van Alphen et al, 2016). Physical activity is a cost-effective intervention as it prevents falls, the development of further comorbidities, delays the decline of cognitive function, improves the ability to perform activities of daily living and stimulates positive behaviours, thus enhancing health-related quality of life of those living with dementia and their carers (Heyn et al, 2004; Blankevoort et al, 2010; Potter et al, 2011; Pitkälä et al, 2013; Rao et al, 2014; Burton et al, 2015; Forbes et al, 2015; Almeida et al, 2019a). Health-related physical fitness is composed of five components (cardiorespiratory endurance, body composition, muscular endurance, muscular strength and flexibility) and is fundamental for physical activity (American College of Sports Medicine et al, 2009). Nevertheless, people with dementia have shown low performance in these components (Karin et al, 2016).

People with dementia want to live at home for as long as possible. Supporting this population at home costs less than accommodation in residential care (WHO, 2012) but preserving their independence in the performance of activities of daily living is fundamental (Moise et al, 2004; WHO, 2012). Economic costs and health-related impact in people with dementia could be minimised if interventions aimed at increasing physical activity at home become available.

Low adherence and large dropout rates to physical activity programmes have been reported in older people and in people with dementia (Forbes et al, 2015; van Alphen et al, 2016). This may be related to lack of motivation, low self-perception of physical activity benefits, deaths and/or misdiagnosis of dementia (Patel et al, 2013; van Alphen et al, 2016; Sposito et al, 2017). Moreover, current daily living environments (e.g., transport, housing and some leisure settings) have become less conducive to physical activity (WHO, 2007). For these reasons, it is important to innovate and develop home-based physical activity programmes, adjusted to daily routines and settings, and involving carers/significant persons who can motivate people with dementia to become more physically active.

The Lifestyle Integrated Functional Exercise (LiFE) is a home-based physical activity programme embedding balance and lower limb strength training into daily routines (Clemson et al, 2012). This programme has been shown to decrease sedentary activity time and number of falls while maintaining the independence of older people in activities of daily living (Clemson et al, 2012). LiFE has demonstrated high adherence rates and high levels of motivation and self-perceived health (Clemson et al, 2012). It might be a promising intervention as it focuses on establishing new positive behaviours within selected contexts to stimulate physical activity at home and its design promotes autonomy from the health professional, gradually decreasing their presence throughout the programme (Clemson et al, 2012). However, it does not include other important health-related physical-fitness components such as exercise capacity, muscle strength for whole body and flexibility, and has never been explored in people with dementia. Thus, a home-based physical activity programme, LiFE4D, including activities to improve exercise capacity, balance, muscle strength and flexibility, and an educational and psychosocial component will be implemented and evaluated in community-dwelling people with dementia. Carers/significant people will be invited to integrate the programme.

Objectives

The primary aim of this study is to assess the impact of LiFE4D on exercise capacity. The following secondary aims are to:

- Establish the feasibility of LiFE4D and adherence to the intervention
- Explore the impact of the LiFE4D on exercise capacity, cognitive function, physical activity levels, balance, muscle strength, flexibility, functionality, respiratory function, health-related quality of life and carers’ burden
- Assess the cost-effectiveness of the LiFE4D on the number of falls, healthcare resources utilisation, length of hospital stay, number of respiratory infections and informal care time provision.

Methods

Design

A randomised controlled trial will be conducted. LiFE4D is registered with the ClinicalTrials. gov database (NCT03757806). This trial has been designed according to the CONsolidated Standards Of Reporting Trials (CONSORT) statement (Schulz et al, 2010), is reported according to the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) statement (Chan et al, 2013), and with reference to the Template for Intervention Description and Replication

(TIDieR) checklist (Hoffmann et al, 2014). A pilot study was performed to inform the design of the randomised controlled trial.

Participants

People with dementia will be considered eligible if they are:

■ Diagnosed with minor to major neurocognitive impairment (e.g., dementia) according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (American Psychiatric Association, 2013)

■ Living at their own home or living with a carer

■ Sedentary during a regular day (e.g., spending ≥4 h/day sitting quietly, reclining, lying quietly, without counting the night sleeping hours) (Ainsworth et al, 2000, 2011; Dogra and Stathokostas, 2012)

■ Able to follow basic instructions, with or without physical cues (e.g., stand up, raise your arms).

Exclusion criteria will be:

■ Hospitalisation in the previous month

■ Presence of some clinical condition that precludes them from being involved in physical activity.

For the purpose of this study, the following definition of sedentary behaviour will be used: any behaviour during waking time characterised by an energy expenditure of ≤1.5 metabolic equivalents (METs) in a sitting, reclining or lying posture, such as resting in a reclined position while taking care of a baby (1.5 METs); lying in bed awake (1.0 MET); sitting quietly (1.0 MET); sitting doing arts and crafts with light effort (1.5 METs); retreat/family reunion activities involving sitting, relaxing, talking, eating (1.5 METs); taking medication (1.0 MET) (Ainsworth et al, 2000, 2011; Sedentary Behaviour Research Network, 2012). A consensus defining a cut off for self-reported sedentary behaviour has not been established and a large variety of cut offs (i.e., 3–12 hours a day) can be found in the literature (Chau et al, 2013; Harvey et al, 2013; Matthews et al, 2014). Therefore, for the purpose of this study a cut-off of ≥4 hours a day was considered, since it has been previously used to self-report sedentary behaviour in older people (Dogra and Stathokostas, 2012; Harvey et al, 2013). Moreover, a systematic review about sedentary behaviour showed that around 60% of older people reported to be sitting for more than 4 hours a day, but on a sample objectively measured 67% showed to be sedentary for more than 8.5 hours a day (Harvey et al, 2013). Thus, an under-reporting of sedentary behaviour might occur comparing with objective measures (Celis-Morales et al, 2012).

Potential participants in the community will be identified and contacted via institutions (e.g., day care centres). If the identified people share interest in participating, a meeting will be scheduled with the researcher to further explain the study. Informed consents will be obtained from participants and/or legal representatives/significant person before any data collection. A written consent to publish photographs will also be obtained.

Randomisation procedures

Sequentially numbered, opaque, sealed envelopes randomisation (Schulz and Grimes, 2002) will be used as allocation concealment, following the CONSORT guidelines (Schulz et al, 2010). Each envelope will receive a number in advance, and will be opened sequentially, only after participant details are written on the appropriate envelope. The inside of the envelope will not be visible, even when lightened. Once a person with dementia and/or carer/significant person consent to participate, an envelope will be opened, and the person will then be allocated to the experimental group or the control group.

Data collection

Table 1 shows data collection domains, measures and who will be assessed in each measure: sociodemographic (age and gender), anthropometric (height, weight, body mass index and fat-free mass) and general clinical data (e.g., number of respiratory infections, healthcare use, falls and length of hospital stay) will be acquired with a structured questionnaire according to the International Classification of Functioning, Disability and Health checklist (WHO, 2001). Body mass index and fat-free mass will be assessed with bioimpedance analysis (Omron body fat monitor BF306).

Table 1. Outcomes and outcome measures assessed in people with dementia and/or their carers or significant people within the Lifestyle Integrated Functional Exercise for People with Dementia.

			Data from	
	Domain	**Measure**	**Person with dementia**	**Carer/significant person**
Primary	Exercise capacity	2-Minute Step Test	Y	
Secondary	Sociodemographic, anthropometric, and clinical data	Structured questionnaire based on International Classification of Functioning, Disability and Health	Y	Y
	Fatigue	Modified Borg scale	Y	
	Cognitive function	Addenbrooke's Cognitive Examination III	Y	
	Self-reported physical activity	Brief Physical Activity Assessment tool	Y	Y
	Physical activity	Accelerometer –	Y	Y

		Actigraph wGT3X+		
	Balance	Brief-Balance Evaluation Systems Test	Y	
	Hand and forearm strength	Handgrip	Y	
	Lower limb strength	30 Second Sit-to-Stand Test	Y	
	Flexibility	Chair Sit-and-Reach Test	Y	
	Upper limb functionality	Grocery Shelving Task	Y	
	Functional mobility	Timed Up and Go Test	Y	
	Overall physical functional	Physical Performance Test	Y	
	Lung function	Peak Flow Meter	Y	
	Respiratory muscle strength	Maximal Inspiratory/ Expiratory Pressures	Y	
	Respiratory muscle strength	Sniff Nasal Inspiratory Pressure	Y	
	Health-related quality of life	Quality of Life in Alzheimer's Disease	Y	Y
	Self-perception of performance in everyday living	Canadian Occupational Performance Measure	Y	Y
	Carers' burden	Short Form Zarit Burden Interview		Y
	Costs-Informal time provision	Resource Utilisation in Dementia – Lite	Y	Y

The primary outcome measure will be exercise capacity, assessed with the 2-Minute Step Test (Jones et al, 1999). This outcome measure has been chosen because exercise capacity (cardiorespiratory endurance) is fundamental for health-related physical fitness, to maintain functional capacity (American College of Sports Medicine et al, 2009) and the 2-Minute Step Test is free and easy to apply and interpret (Bohannon and Crouch, 2019). This measure requires that the participant march in the same place for 2 minutes, raising the knees to a mark on the wall (the midpoint between the kneecap and the iliac crest) (Jones et al, 1999). The number of times that the right knee reaches the mark is scored (Jones et al, 1999). Participants are asked to walk for 1 minute at a comfortable pace after performing the test to prevent injury (Jones et al, 1999). The 2-Minute Step Test has been shown a moderate and positive correlation with the 6-Minute Walking Test (r=0.36; P=0.04) and a moderate and negative correlation with the Timed Up and Go test (r=-0.66; P<0.001) in older woman with hypertension (Pedrosa and Holanda, 2009). This measure has been used in people with dementia, but its clinimetric properties are still unclear (Bohannon and Crouch, 2019).

The Modified Borg scale will be used to measure lower limb fatigue, after the 2-Minute Step Test performance (Borg, 1982). The use of this measure is intended to ensure participants' safety during exercise, and is a common procedure during physical activity and exercise interventions (Williams, 2017).

Additionally, the following secondary domains (measures) will be collected:

■ Cognitive function (Addenbrooke's Cognitive Examination III) (Hsieh et al, 2013)

■ Self-reported physical activity (Brief Physical Activity Assessment Tool) (Marshall et al, 2005)

■ Physical activity levels (GT3X+ ActiGraph) to measure the number of steps/day and daily energy expenditure during one week (Galik et al, 2008; Erickson et al, 2013)

■ Balance (Brief-Balance Evaluation Systems Test) (Padgett et al, 2012)

■ Hand and forearm muscle strength (Handgrip Dynamometer) (Mathiowetz et al, 1984; Alencar et al, 2012)

■ Lower limb muscle strength (30-Second Sit-to-Stand Test) (Jones et al, 1999)

■ Flexibility (Chair Sit-and-Reach Test) (Jones et al, 1998)

■ Functionality (Functional Reach Test) (Weiner et al, 1992)

■ Upper limbs functionality (Grocery Shelving Task) (Hill et al, 2008)

■ Functional mobility (Timed Up and Go Test) (Podsiadlo and Richardson, 1991)

■ Overall physical function (Physical Performance Test) (Reuben and Siu, 1990)

■ Lung function (Peak Flow Metre using a MicroPeak, CareFusion, Basingstoke, United Kingdom – Standard range, EU (EN 23747) scale) (Quanjer et al, 1997; Vaz Fragoso et al, 2007)

■ Respiratory muscle strength (Maximal inspiratory and expiratory pressures and Sniff Nasal Inspiratory Pressure using a respiratory pressure gauge – MicroRPM, CareFusion, Kent, United Kingdom) (European Respiratory Society and American Thoracic Society, 2002; Sawan et al, 2016)

■ Health-related quality of life (Quality of Life in Alzheimer's Disease) scale (Logsdon et al, 1999)

■ Self-perception of performance in everyday living (Canadian Occupational Performance Measure [COPM]) (Law et al, 1990)

■ Carers' burden (Short Form Zarit Burden Interview) (Zarit and Jm, 1983; Bédard et al, 2001)

■ Costs-informal time provision (Resource Utilisation in Dementia-Lite) (Wimo et al, 2010).

Adherence to LiFE4D and number/reasons for dropouts will also be collected.

The protocol will take approximately 90 minutes. Data will be collected (in both experimental and control groups at baseline and after 12 weeks (post), and at 3 and 6 months after the intervention. Additionally, at baseline the experimental group will be assessed with observation and a semi-structured questionnaire (i.e., COPM) on their daily routines to adjust the intervention to each participant's needs. A strengths, weaknesses, opportunities and threats (SWOT) analysis (Hill and Westbrook, 1997) will be used as a planning tool to individualise the LiFE4D to each participant of the experimental group.

Details of the intervention

The experimental group will receive the LiFE4D while the control group will continue their usual care (i.e., pharmacological treatment). The LiFE4D is an individualised home-based physical activity programme for people with dementia to engage in physical activity multiple times a day during their everyday tasks with the support/supervision of their carers/significant people (whenever possible). LiFE4D will last for 12 weeks, with a progressive decrease of face-to-face contact over time with the health professional but replaced by the involvement of carers/significant people, in order to stimulate behaviour change independent from the presence of the health professional. Specifically, it includes:

- Week 0: baseline assessment
- Weeks 1–4: three face-to-face sessions/week
- Weeks 5–8: two face-to-face sessions/week and a phone call every 2 weeks
- Weeks 9–11: one face-to-face session/week and a phone call every 2 weeks
- Week 12: post-assessment
- Follow-ups at 3 and 6 months after the end of the programme.

The face-to-face sessions are aimed to adapt the physical activity to everyday tasks, increase tasks frequency and/or intensity, monitor progress, clarify doubts, motivate higher daily energy expenditure and manage expectations. Telephone contacts aim to monitor motivation/evolution and clarify doubts of people with dementia and carers/significant people.

Data from the COPM, observation and annotation of relevant characteristics (during baseline assessment) will allow health professionals to assess routines, meaningful activities and limitations of each participant. Observation also allows them to assess limitations and opportunities of the surroundings and available resources. After this assessment, the health professional will perform a SWOT analysis in order to synthesise the information and to plan the individualised programme. Table 2 shows an illustrative example of a SWOT analysis.

The individualised/personalised programme will be presented, negotiated and readjusted together with the participant and their carer/significant person to create short- and medium-term goals in the first session, as a component of the educational and psychosocial support for physical activity.

Table 2. Example of a SWOT analysis of a participant of the Lifestyle Integrated Functional Exercise for People with Dementia.

Strengths	**Weaknesses**
Lives with a granddaughter, two great grandchildren and a grandson in law Granddaughter helps in the instrumental activities of daily living Lives near the sons with whom keeps a close relationship Good humour	Diagnosed with Alzheimer's disease Recurrent respiratory crisis Respiratory muscles weakness Confusional episodes when walking on the street Fear of falling
Opportunities	**Threats**
Lives on the ground floor Plays with the two great grandchildren Another great grandchild is coming Helps cleaning the dishes and folding clothes Wants to help to do the laundry outside Wants to help the granddaughter now that the baby is coming Really wants to maintain walking visits to her sons	Architectural barriers (carpets) History of frequent falls – especially on the entry step Cold house with humidity Balance impairment Sedentary behaviour (spends most of the day sitting) Fear of falling Very difficult to perform dual tasking Feels difficult to climb stairs

It is anticipated that people with dementia will engage in activity and movement strategies to improve exercise capacity, balance, muscle strength and flexibility multiple times/day in their everyday tasks with the support/supervision of their carers/significant people (Clemson et al, 2012). These strategies include bending the knees, standing/walking on toes, climbing stairs, standing/walking on heels, sit to stand, walking sideways, tighten muscles, reduce base of support, move to limits of sway, shift weight from foot to foot, step over objects and turning and changing direction (Clemson et al, 2012). These strategies also include flexion, extension, abduction and adduction of the upper and lower limbs, trunk and, sometimes, one or more of those combined with rotation movements. Examples of physical activities included in daily living of the LiFE4D are presented in Table 3.

Table 3. Examples of physical activities included in daily living of the Lifestyle Integrated Functional Exercise for people with dementia programme.

Examples of physical activities	
Morning	After you wake up, sit on the edge of the bed with your back straight and shoulders relaxed. Incline your neck and try to reach your shoulder with the ear, without feeling pain. Do not rotate your head or raise your shoulder. Hold the position for a few seconds. Return to the starting position.
	Sit with your back and neck straight. Bend your left knee and extend your right knee. Bend forward and put your shoes on and/or tighten the laces. Return to the starting position. Switch side.
	Store objects (e.g., clothes) in places below your waist level. Perform squats to reach the lowest location. Try not to bend your back.
	While taking the morning coffee, sit with your back straight. Extend forward one leg. Switch side.
Mealtime	Set the table. Keep your lower limbs apart at shoulder width and perform partial squats, and simultaneously bend your arms above your shoulder level. Put the towel on the table.

	While waiting for the food, stand with a chair in front of you, and your hands on the back of the chair. Place your left foot in front of your right foot (with the heel of your left foot against the toes of your right foot). Put the weight of your body on the back foot and then transfer the weight to the front foot. Perform the activity slowly and hold the position for a few seconds. Switch side.
	After the meal, cleaning the table. Place your feet slightly apart from each other. Take the centrepiece of the table (e.g., fruit vase). Bend your arms and move your back slightly forward. Place the centrepiece on the table.
	While sweeping. Stand with your legs slightly apart, hold the broom horizontally, with your hands and elbows extended. Bend your arms to the shoulder level.
Back from shopping	Stand, with your feet slightly apart. Take a bag of rice or another grocery. Take your arms above the head and transfer the weight of the body to your toes, and raise your heels. Put the bag of rice on the shelf. Return to the starting position by resting your heels on the floor and relaxing your arms.
	Stand or sit with your legs slightly apart from each other. Hold a half-litre water bottle, or other similar object, in each hand. Extend your arms laterally to the shoulder level.
	If an object falls on the ground. Support your hands on a stable surface (e.g., table or kitchen counter). Step over the object in a safe and controlled manner. Turn around and do a squat to pick up the object.
Afternoon	While watching television, reading a magazine, book or newspaper. Sit with your neck straight and your back resting on a chair. Support your feet on the floor. Extend forward both of your legs. Place a bag of rice on the top of your legs or feet. Extend both legs again with the extra weight on top.
	While watching television or listening to music. Rest your hands on the back of a chair, next to a wall or stable surface (e.g., table, kitchen counter or furniture). Bend a leg with your toes pointing to the floor. Put your foot in plantar flexion. Hold the position for a few seconds and switch side.
	While waiting for someone or listening to music. Support a hand on a wall with a straight elbow. Place your feet slightly apart from each other. Then, transfer some body weight to your heels. Hold the position for a few seconds and relax.
	When walking to another room/area. Support your hand on a stable surface (e.g., table, handrail, furniture). Walk in a straight line, with the heel of one foot against the toes of the other foot.
Garden/yard	When you want to turn and change direction. Support your hand on a wall. Walk forward normally, turn slowly and continue to walk in the other direction.
	Gardening. Standing or sitting. Take care of the vase/jar on a table.
	Gardening. Squat to treat the herbs or plants on the ground.
Outside	Climb the stairs. Use the strength of your legs to climb the stairs. Support your hand on the handrail. Bend your legs when stepping.
	Dance. Dancing is always a good option, alone or accompanied.
	Pet walking. Walk with your dog (if the dog is used to go for a walk), in a quiet area.
	Go for a walk. Walk with a family member, neighbour or friend in local gardens.
Night	While waiting for dinner. Support your right hand on a stable surface (e.g., table, kitchen counter, handrail or furniture). Bend your leg backwards. With the help of your left hand, hold your left foot towards your buttock. Hold the position for a few seconds. Return to the starting position. Switch side.
	While waiting for dinner. Sit on a chair, support your feet on the floor with your legs slightly apart. Cross your arms over the chest. Get up and sit successively.
	When stop watching television at night. Sit with your back and neck straight turn your hand upwards and with the other hand put some additional pressure to extend your arm. Hold the position for a few seconds. Switch side.
	When brushing your teeth. Support your hands on the sink. Slightly spread your feet apart. Transfer your body weight to your toes.

Participants of the experimental group will be monitored biweekly (except for the last month) to adjust physical activities and the level of difficulty of the tasks, according to the individual's progress and available resources.

During the sessions, the Talk Test will be used as it is a practical and inexpensive tool to monitor physical activity (Persinger et al, 2004; Reed and Pipe, 2016).

At the end of the first month, the experimental group will receive a manual including the necessary instructions to continue with physical activity at home, in the daily routines (Almeida et al, 2019b). LiFE4D also includes an educational and psychosocial component (Van't Leven et al, 2013), with talks, flyers and practical issues about different aspects that concern the participant and/or their family and friends, to help them to better manage the impacts of dementia (Table 4).

Table 4. Examples of the education and psychosocial support included in the Lifestyle Integrated Functional Exercise for People with Dementia.

Themes	Flyers
Healthy lifestyles: nutrition	Food and nutrition: healthy food to consider and unhealthy food to avoid Hydration Mealtime tips
Community support	Community and social support Contact of associations Support groups and programmes
Manage behaviour and communication	Possible communication changes with dementia Communication tips: verbal and non-verbal How to deal with challenging behaviours: tips
Breathing control	Breathing control techniques: examples with positions descriptions
What is dementia	Dementia patterns Signs and symptoms Risk factors Diagnosis process Treatments
Cognitive exercises	Simple activities to implement in daily routine How to do it (i.e., prepare the space) Tips for different activities
Falls prevention	Risk factors for falls How to reduce risk of falling: tips
What to do in case of a fall	Step by step instructions for what to do if a fall occur and: ■ I have or do not have an injury ■ I am alone: can I stand up? ■ Someone can help me
Carers' burden	Signs of burden Strategies and tips to deal with burden

Sample size calculation

Data from the pilot study were used to calculate the sample size, assuming a nonparametric distribution. A sample size estimation with 95% power (α=0.05) was calculated to detect significant differences between the experimental group and control group in the exercise capacity using the 2-Minute Step Test. A total sample size of 24 participants (i.e., 12 per group) will be needed. In home-based physical activity programmes for people with dementia, dropout rates range between 8% and 50% (Mackintosh et al, 2005; Almeida et al, 2019a). Therefore, a sample of at least 36 participants will be recruited. Sample size calculation was performed using G*Power 3.1.3 (Universität Düsseldorf, Düsseldorf, Germany).

Statistical analysis

Descriptive statistics will be used to describe the sample and inferential statistics will be applied to compare results between the two groups. Normality of data distribution will be tested with the Shapiro–Wilk test (Field, 2009). Paired t-test for normally distributed continuous variables, Wilcoxon signed-rank test for non-normally distributed continuous variables and McNemar test for categorical variables will be used for comparisons within groups (Field, 2009). Differences between the two groups at baseline will be explored with independent t test for continuous normally distributed data and Mann–Whitney U test for ordinal/non-normally distributed variables and Chi square test for categorical variables (Field, 2009). Effect sizes estimations will be calculated for each outcome measure, via eta squared ($\eta 2$), with an interpretation of a small (≥0.1), medium (≥0.3), and large (≥0.5) effect (Fritz et al, 2012).

Efficacy and effectiveness of LiFE4D will be analysed, using a 'per protocol' and an 'intention-to-treat' analysis (McCoy, 2017). Generalised estimating equations will be used to analyse efficacy and effectiveness, and to deal with missing values (Liang and Zeger, 1986; Ma et al, 2012). Generalised estimating equations will establish the significant effect of group, time and interaction time*group (Liang and Zeger, 1986; Ma et al, 2012). Crude and adjusted models (ie age, type of dementia, gender, living with whom, formal education and medication) will be performed for efficacy and effectiveness with generalised estimating equations (Liang and Zeger, 1986; Ma et al, 2012).

A cost-effective analysis on the number of falls, respiratory infections, healthcare use, length of hospital stay and informal time provision will be conducted. A cost-effectiveness ratio will be calculated by dividing costs by units of effectiveness alongside with a sensitivity analysis (Wholey et al, 2010). Data analysis will be undertaken using statistical software packages (Statistical Package for the Social Sciences and GraphPad). A significance level of 0.05 will be used.

Ethics

This project will be conducted according to the Declaration of Helsinki (World Medical Association, 2018) and respecting the European Union General Data Protection Regulation (Council of the European Union and European Parliament, 2016). Furthermore, this trial received approval from the ethics committee (reference number: P437–06/2017) and from the National Data Protection Committee (approval number: 7897/2017).

Discussion

This study describes the protocol of a randomised controlled trial of LiFE4D, a home-based physical activity programme for people with dementia.

Physical activity programmes for people with dementia are supported by strong evidence (Heyn et al, 2004; Blankevoort et al, 2010; Potter et al, 2011; Pitkälä et al, 2013 Rao et al, 2014; Burton et al, 2015; Forbes et al, 2015). Although, physical activity is a widely known and well-established intervention, adherence of people with dementia has been shown to be poor (Forbes et al, 2015; van Alphen et al, 2016). A home-based physical activity programme involved in people's daily routine with the supervision of their loved ones may be the key to engaging people with dementia, thus improving their adherence to this intervention. The LiFE4D offers an individualised/personalised home-based physical activity programme, engaged in daily routines, decreasing the health professional face-to-face contact over time, which is replaced by the supervision of carers/significant person (whenever possible).

This randomised clinical trial will provide evidence about the effectiveness and cost-effectiveness of LiFE4D. If effectiveness is showed, it is expected that people with dementia improve their exercise capacity, muscle strength, balance and flexibility hopefully becoming less sedentary and more physically active. These changes in health-related physical fitness and lifestyle behaviours of people with dementia might have a positive impact on their cognitive function, functionality and health-related quality of life and also in reducing carers' burden, further promoting the independence of people with dementia to live at home for as long as possible, as recommended (Moise et al, 2004; WHO, 2012). Additionally, positive effects are expected from the cost-effectiveness analysis. An economic evaluation is needed to increase knowledge of home-based physical activity programmes for people with dementia among decision makers. If cost-effective, the dissemination of physical activity programmes at home might increase. Thus, if effectiveness and cost-effectiveness is showed, LiFE4D will have a positive impact for people with dementia, carers/significant person, but also for society.

Limitations

Some limitations of this study are anticipated. First, the collaboration of people with dementia to complete the sessions may, sometimes, be a challenge. To prevent these situations, the programme will be adapted to consider the needs and the expectations of each participant and every time that the person is not able to follow the session, this session will be rescheduled. Second, a heterogeneous population is anticipated, as an extended range of dementia types exists (American Psychiatric Association, 2013), thus it probably will not be possible to separate participants by groups of different types of dementia. Third, the recruitment of carers may be a limitation; because of the lack of time to care for themselves and the burden that they already experience, it is anticipated that some of them might not want to be included in the programme. It is also anticipated that a larger sample will be needed for cost-effectiveness analysis. However, limited funding is available for the study. Finally, participants will not be blinded to group assignment. However, a random assignment with allocation concealment minimises this bias.

Conclusions

It is crucial to encourage people with dementia to partake in physical activity. LiFE4D will engage people with dementia in home-based physical activity multiple times per day, thus improving their health-related physical fitness, which can help to delay cognitive function decline, improve physical activity, respiratory function, functionality and health-related quality of life and decreasing the burden on carers.

Continuing to live at home is a wish of most people with dementia and also an international recommendation by the World Health Organization and Organisation for Economic Co-operation and Development. LiFE4D has the potential to contribute to help people with dementia living at home.

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Chapter 5. Feasibility, efficacy and effectiveness of LiFE4D

Original study I – pilot study

Lifestyle Integrated Functional Exercise for People with Dementia: A pilot study

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Abstract

Objectives: To explore the feasibility and preliminary effectiveness of the Lifestyle Integrated Functional Exercise for People with Dementia (LiFE4D) on health-related physical fitness (HRPF), cognitive function, physical activity (PA), and respiratory and upper limb functions.

Methods: A randomised controlled pilot study was conducted (control group: usual care; experimental group: usual care and LiFE4D). Feasibility of LiFE4D was determined considering recruitment, protocol acceptability, adherence, and safety. Measures of HRPF, cognitive function, PA, and respiratory and upper limb functions were assessed at baseline and 3-months.

Results: Twelve participants (8 [66.7%] female, 82 [72.2-84] years) were included, six per group. Recruitment was challenging. LiFE4D was acceptable with excellent adherence and no major adverse events. Cardiorespiratory endurance (effect size [ES]=1.64 [0.33; 2.95] 95% confidence interval [CI]), and balance (ES=1.46 [0.19; 2.73] 95%CI) improved after LiFE4D.

Conclusions: LiFE4D seems to be feasible, safe and shows potential to improve significantly the HRPF of people with dementia.

Keywords: LiFE4D; activities of daily living; neurocognitive disorder.

Introduction

Physical activity (PA) is a protective factor for dementia (Sallis et al., 2016). It improves executive function, activities of daily living (ADL), physical function and health-related physical fitness, prevents falls and cognitive decline and encourages positive behaviour, in people diagnosed with dementia (Blankevoort et al., 2010; Burton et al., 2015; Forbes, Forbes, Blake, Thiessen, & Forbes, 2015; Heyn, Abreu, & Ottenbacher, 2004; Potter, Ellard, Rees, & Thorogood, 2011). However, people with dementia (PwD) are reported to spend 66% of their day in sedentary or low intensity activities (Sallis et al., 2016; van Alphen, Volkers, et al., 2016). PA is recommended for this population (Sallis et al., 2016), but low adherence and large dropout rates to PA programmes have been observed. Memory problems, no exercise routine, lack of motivation, low self-perception of PA benefits, carers' burden, physical limitations and unknown diagnosis are identified barriers to PA in PwD (Forbes et al., 2015; Hancox et al., 2019; van Alphen, Volkers, et al., 2016; van der Wardt et al., 2017). Moreover, most available PA programmes occur in institutions with fixed timetables with attendance of PwD being dependent on transportation and/or on others (Forbes et al., 2015). Meaningful PA programmes embedded in each person daily routines, conducted at home, where PwD wish to live (Moise, Schwarzinger, & Um, 2004), may enhance motivation and literacy about PA in this population.

Individualised PA interventions that fit into each person's daily routine, with a positive emphasis on enjoyment have been suggested for PwD (Prizer & Zimmerman, 2018; van Alphen, Hortobagyi, & van Heuvelen, 2016; van der Wardt et al., 2019). The Lifestyle Integrated Functional Exercise (LiFE) was developed in 2012 in Australia (Clemson et al., 2012). The LiFE is a home-based PA programme embedded in the daily routines of older people and showed to reduce the sedentary activity and number of falls whilst maintaining the independence of older people in ADL (Clemson et al., 2012). The LiFE has demonstrated high adherence rates and high levels of motivation and self-perceived health in older people (Clemson et al., 2012), showing potential to overcome some of the drawbacks identified in other PA interventions in PwD. However, it has never been adapted for PwD. The Lifestyle Integrated Functional Exercise for People with Dementia (LiFE4D), includes activities to improve balance and lower limb strength following the original LiFE programme (Clemson et al., 2012), and also includes activities to improve upper limb functionality, flexibility and exercise tolerance, and an educational and psychosocial component since multicomponent interventions have been recommended for PwD (Blankevoort et al., 2010).

This pilot study explored the feasibility and preliminary effectiveness of LiFE4D on health-related physical fitness of PwD. Preliminary effects of LiFE4D on cognitive function, self-reported PA levels, respiratory function and upper limb function were also explored.

Methods

Design and Participants

A randomised controlled trial - pilot study was conducted. Seven institutions, from two regions sharing similar characteristics, which work with/have access to PwD living at home (e.g., day care centres and community centres), were contacted for recruitment and two engaged in the study. A meeting with the managers of the institutions was scheduled to further explain the study. Professionals selected by those managers identified and contacted potential participants. When individuals showed interest to participate, a meeting was scheduled with the researcher. Written informed consents were obtained from participants and/or a proxy decision-maker (Alzheimer Europe, 2012). Verbal assent to continue to be part of the study was asked at each session and assessment time point (at baseline and 3-months).

Inclusion criteria were: diagnosed with minor to major neurocognitive impairment (e.g., dementia) according to Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (American Psychiatric Association, 2013); living in their own home or living with a carer; being sedentary during a regular day (e.g., spending ≥4 h/day lying down or sitting quietly, without counting night sleeping hours) (Dogra & Stathokostas, 2012; Ekelund et al., 2016); being able to understand simple instructions (e.g., to raise the arm); and being able to walk autonomously, with or without an assistive device or human assistance. Exclusion criteria were: to have been hospitalised in the previous month; to have a condition which precluded their participation in PA (i.e., advised by the medical doctor); and being involved in another PA programme.

After identification and acceptance to participate, PwD were randomly assigned to the experimental (EG) or the control group (CG). The randomisation process was performed through sequentially numbered, opaque, sealed envelopes by a project researcher (Schulz & Grimes, 2002). Ethical approval from a University Research Ethics Committee and national data protection were first obtained.

Intervention

The CG received the usual care (i.e., prescribed medication) while the EG, alongside with the usual care, received the LiFE4D intervention. Participants were not blinded due to the nature of the intervention. Nevertheless, at the end of the study, the CG could receive the LiFE4D intervention if interest was shown.

LiFE4D is a home-based PA programme for PwD to promote engagement in PA and to reduce sedentary behaviour during daily living activities. PwD were encouraged to perform daily PA, multiple times a day. This intervention was adapted from LiFE with regards to duration and weekly frequency of sessions; was tailored to each participant; included activities focussing not just on balance and muscle strength but also on flexibility and endurance; included an educational and psychosocial component; and provided the opportunity for carers to get involved. LiFE4D had a duration of three months, including face-to-face sessions and phone calls. The frequency of LiFE4D was three times/week in the first month, two times/week in the second month and once a week in the last month (except for the last week where only two phone calls took place). Participants received a phone call per week in the second and third months (Figure 1).

Figure 3. Description of the Lifestyle Integrated Functional Exercise for People with Dementia (LiFE4D).

Face-to-face sessions lasted approximately 1h and aimed to adapt the PA to everyday tasks, increase task frequency and/or intensity, monitor progress, clarify doubts, motivate energy expenditure, and manage expectations. Phone calls had a maximum duration of 15 minutes and aimed to motivate and monitor progress as well as to clarify doubts.

The programme was adapted to each participant based on the baseline assessment, individual routines, available resources, and surroundings. During the baseline visit, the daily routines of the EG were assessed through observation and a semi structured questionnaire (i.e., Canadian Occupational Performance Measure). This information, together with the comprehensive assessment of physical measures were used to tailor the intervention. A planning tool (i.e., strengths, weaknesses, opportunities and threats (SWOT) analysis) was used to tailor the LiFE4D to each participant of the EG (Hill & Westbrook, 1997). The tailoring process of PA to each participant aimed to improve balance (e.g., reduce the base of support, step over objects), flexibility (e.g., flexion, extension, abduction and adduction of the upper and lower limbs), muscle strength (e.g., lift objects, bend the knees) and endurance (e.g., climbing stairs, gardening, walking) with different intensities (e.g., light to vigorous) (Almeida, Gomes da Silva, & Marques, 2020). Participants started with light activities and progressed to moderate and vigorous activities (when possible), and reduced base of support during balance activities. At the end of the first month, the EG received a manual with the activities that they could continue to perform on their own (Almeida, Marques, & Gomes da Silva, 2019). This manual included a description of activities and how to perform them throughout the day (e.g., store toothpaste in the bathroom cabinet below your waist level; perform squats to reach the toothpaste; and try not to bend your back; while waiting for dinner; support your right hand on a stable surface; and walk in a straight line, with the heel of one foot against the toes of the other foot). During the three months, the EG also received an educational and psychosocial component, with talks, flyers and demonstration of practical strategies (e.g., dementia, falls prevention, communication and community support). This component took place during the face-to-face sessions lasting between 15 to 30 minutes, depending on the theme, the expressed doubts and interaction of each participants. Three to six themes of the educational and psychosocial component were proposed considering the needs and capacities of each participant (identified in the SWOT analysis), and their inclusion (or replacement) in the programme was discussed with participants in the first session. When, throughout the programme participants showed interest in a specific theme (i.e., related with dementia or PA), it was included. Carers were present during the educational and psychosocial component and were encouraged to get involved in support/supervision of PA. The role of the carers was to motivate the PwD to be as physically active and as less sedentary as possible during their day, using the strategies that they trained during the LiFE4D in their daily routines. However, it was up to the carer to become involved.

This study was carried out by a team of physiotherapists and gerontologists, however this intervention can be implemented by different professionals and/or even carers, who have had simple training in PA. The professional who performed the intervention at home also performed the phone calls to facilitate responses of participants.

Outcome Measures

Data were collected between November 2017 and October 2018 at participant's home. The total time for data collection was expected to be approximately 1h15. The researcher conducting the assessment was different from that who implemented the intervention. The assessor was blinded to the group that participants were included in.

Feasibility of LiFE4D was assessed by the ease of recruitment, by the total number of institutions and PwD approached who agreed to participate; acceptability of protocol assessment was measured by the time taken to complete the assessment and by the number of full missing protocols; percentage of adherence was determined by the total number of attended face-to-face sessions and the number of dropouts; and safety was determined by the number of adverse events (e.g., pain, falls and injuries) that occurred during the face-to-face sessions.

Sociodemographic (e.g., age and gender), anthropometric (e.g., height and weight) and general clinical data (e.g., number of medications and dementia type) were assessed with a structured questionnaire (WHO, 2001) at baseline to characterise the sample.

All outcome measures were collected (in both EG and CG) at baseline and three months after (post) the intervention as described below. A practical demonstration of the physical measures was performed and time to rest between measurements was given.

The primary outcome measure was the cardiorespiratory endurance component, i.e., exercise tolerance, assessed using the 2-minute step test (2MST) (Jones & Rikli, 2002). The 2MST was applied once at each point in time. The 2MST has a moderate and positive correlation with the mini-mental state examination test (r^2=0.35; p<0.001) in people with mild cognitive impairment and mild to moderate Alzheimer's disease (Plácido et al., 2019).

Body composition was determined with the body mass index (BMI) (Nagaya, Yoshida, Takahashi, Matsuda, & Kawai, 1999). Good correlation between BMI and body fat (r=0.74 to 0.92; p<0.001) measured with a bioimpedance equipment has been found (Nagaya et al., 1999).

Muscular strength included measurements of the upper and lower limb, and respiratory muscle strength. Upper limb muscle strength was collected with the handgrip dynamometer (BASELINE® Hydraulic Hand Dynamometer, Fabrication Enterprises, New York, USA), measured in kilograms (Mathiowetz, Weber, Volland, & Kashman, 1984). Three repetitions were performed at each point in time in the dominant hand of each participant and the best value obtained was used for analysis (Mathiowetz et al., 1984). Handgrip strength is reliable in people with mild (ICC=0.97; p=0.002) and moderate (ICC=0.96; p=0.001) dementia (Alencar, Dias, Figueiredo, & Dias, 2012). Lower limb muscle strength was collected using the 30-second chair stand (30CST) (Jones, Rikli, & Beam, 1999). The 30CST has a good correlation with the one-repetition maximum leg press test (r=0.77; 95% confidence interval [CI]=0.64-0.85; p<0.05) in community-dwelling older people (Jones et al., 1999).

Respiratory muscle strength was measured with the maximal inspiratory and expiratory pressures (MIP and MEP) at the mouth and *sniff* nasal inspiratory pressure (SNIP) using a respiratory pressure gauge (MicroRPM, CareFusion, Kent, United Kingdom) (ERS & ATS, 2002). The highest value of five repetitions of each measure (at each point in time) was considered for analysis (ERS & ATS, 2002). Higher values (cmH_2O) indicate better performance (ERS & ATS, 2002). Excellent reliability has been shown for MIP ($ICC_{1,1}$=0.90) and MEP ($ICC_{1,1}$=0.86) in people with Parkinson's disease and a good correlation with PA (r_{MIP}=0.87, p=0.001; r_{MEP}=0.64, p=0.032) in older adults (Haas, Trew, & Castle, 2004). Excellent reliability ($ICC_{3,1}$=0.76) has been shown for SNIP in healthy older people (Barnes, Agyapong-Badu, Walsh, Stokes, & Samuel, 2014).

Flexibility was measured with the chair sit-and-reach test (CSRT) (Jones, Rikli, Max, & Noffal, 1998). The distance (cm) between the tip of the fingers and the toes was measured. If the participant did not reach the toes the score was negative and, if overlapped the score was positive (Jones et al., 1998). Higher scores indicated better performance (Jones et al., 1998). The CSRT was applied twice at each point in time and the best performance was considered for analysis (Jones et al., 1998). The CSRT correlates with measures of hamstring flexibility (r_{male}=0.76, $ICC_{(1)}$=0.57-0.88 and r_{female}=0.81, $ICC_{(1)}$=0.69-0.89; p<0.05) in older people (Jones et al., 1998).

Balance was assessed with the brief-balance evaluation systems test (Brief-BESTest) (Padgett, Jacobs, & Kasser, 2012), the functional reach test (FRT) (Weiner, Duncan, Chandler, & Studenski, 1992), and the timed up and go test (TUG) (Podsiadlo & Richardson, 1991). The Brief-BESTest has an excellent interrater reliability ($ICC_{(3,k)}$=0.99) and internal consistency ($\alpha_{Cronbach}$=0.92) in people with and without a neurological diagnosis (Padgett et al., 2012). The FRT has a good correlation with the Lawton & Brody instrumental ADL scale (r=0.66; p<0.001) in community-dwelling older people (Weiner et al., 1992). The TUG is a reliable outcome measure ($ICC_{(2,2)}$=0.98–0.99; p<0.001) to be used in people with Alzheimer's disease (Ries, Echternach, Nof, & Gagnon Blodgett, 2009).

Cognitive function was assessed with the Addenbrooke's cognitive examination-III (ACE-III) (Hsieh, Schubert, Hoon, Mioshi, & Hodges, 2013). The ACE-III consists of 19 items and distinguishes five different cognitive domains (i.e., attention, memory, fluency, language and visuospatial) (Hsieh et al., 2013). Items within each domain are summed and a total score (/100 points) is obtained with the sum of the five domain scores (Hsieh et al., 2013). Higher scores indicate healthier cognitive functioning (Hsieh et al., 2013). A cut-off of 74 points has been proposed for dementia diagnosis (Peixoto et al., 2018). The ACE-III is a valid measure for cognitive deficit assessment, screened in people with Frontotemporal dementia and Alzheimer's disease (Hsieh et al., 2013). The ACE-III has shown to be a reliable measure ($\alpha_{Cronbach}$=91), with an excellent correlation with the Montreal cognitive assessment test (r=0.91; p<0.001) (Peixoto et al., 2018).

Self-reported PA levels were assessed with the brief PA assessment tool (Brief-PA) (Marshall, Smith, Bauman, & Kaur, 2005). The Brief-PA consists of 2 questions assessing the frequency and duration of vigorous and moderate PA undertaken in a usual week (Marshall et al., 2005). A total score was calculated, with higher scores (0 to 8 points) corresponding to higher PA levels (i.e., <4 points: insufficiently active; ≥4 points: sufficiently active) (Marshall et al., 2005). The Brief-PA has shown a moderate reliability ($ICC_{2,1}$=0.53) in patients assessed in primary care (Marshall et al., 2005). If the participant was not sure or could not remember, a proxy was asked.

Respiratory function was assessed with the peak expiratory flow (PEF), via a peak flow meter (MicroPeak, CareFusion, Basingstoke, United Kingdom - Standard range, EU (EN 23747) scale) (Vaz Fragoso, Gahbauer, Van Ness, & Gill, 2007). Three repetitions were performed at each point in time, and the highest value was recorded for analysis (Vaz Fragoso et al., 2007). Higher values indicate better performance (Vaz Fragoso et al., 2007). This measure has excellent reliability ($ICC_{3,1}$=0.92) in older people (Vaz Fragoso et al., 2007).

Upper limb function was assessed with the grocery shelving task (GST) (Hill, Denehy, Holland, & McDonald, 2008). Lower time to complete the task indicates better performance (Hill et al., 2008). The best of 3 performances (at each point in time) was kept for analysis (Hill et al., 2008). The GST is a simple and easy measure to determine the upper limb function in ADL (Hill et al., 2008). The GST has a good correlation with the unsupported upper-limb exercise test ($r \geq 0.69$; $p<0.01$) and an excellent reliability ($ICC_{(3,K)}$=0.97, $p<0.05$), in people with chronic obstructive pulmonary disease (Hill et al., 2008).

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 24.0 (IBM Corporation, Armonk, NY, USA). Plots were created using GraphPad Prism, version 5.01 (GraphPad Software, San Diego, CA). Descriptive statistics were used to describe the sample. Normality of the data distribution was explored with the Shapiro-Wilk test (Field, 2009). Effect sizes (ES) between groups were calculated as Cohen’s d via the mean differences in each group, and interpreted as small (≥0.2), medium (≥0.5) or large (≥0.8) (Field, 2009). The estimated 95% CI of ES was calculated according the following formula (Lee, 2016): $[d - 1.96 \times \sigma(d), d + 1.96 \times \sigma(d)]$, where d is the Cohen’s d value.

Results

Feasibility of the LiFE4D

Recruitment

From the seven institutions approached, three did not respond, one declined to participate, and three agreed to collaborate with the study. Recruitment was found to be challenging as only two (28.6%) institutions, who accepted to participate, identified people to be part of the study. Thirteen PwD were referred for possible inclusion in the study. From these, one person was excluded due to the diagnosis of depression instead of dementia. Twelve PwD were invited and accepted to participate in the study and were randomly allocated to the EG or CG. There were no dropouts during this pilot study (Figure 2).

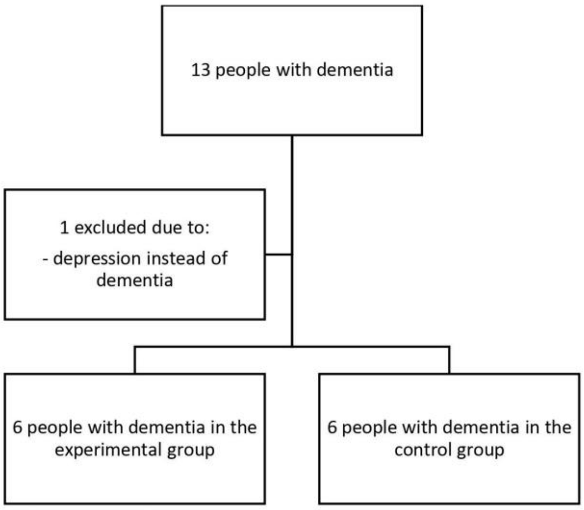

Figure 2 – Flow diagram of participants through the study.

Figure 4. Flow diagram of participants through the study.

A total of 12 participants, 8 (66.7%) female, with a median age of 82 [72.2-84] years old, and a median score on ACE-III of 47 [17.5-53] points were enrolled in this study. A detailed description of the sample is provided in Table 1.

Table 1. Sample characterisation of the participants on the Lifestyle Integrated Functional Exercise for people with dementia (n=12).

Characteristics	Experimental Group (n=6)	Control Group (n=6)
Age, years	82.5 [78.5-86.2]	80 [68.8-87.8]
Gender (female), n (%)	4 (66.7)	4 (66.7)
Height (cm)	154 [149.5-163]	156.5 [143.8-172.5]
Weight (Kg)	60 [59-78]	67.5 [58.5-79.5]
ACE-III (points)	36.5 [6.2-60.2]	47.5 [24.3-53.5]
Dementia type		
Alzheimer's disease	3 (50)	1 (16.7)
Lewy Body	-	1 (16.7)
Parkinson	1 (16.7)	-
Unspecified	2 (33.3)	4 (66.7)
Number of medications, n (%)		
0	-	-
1-5	2 (33.3)	3 (50)
6-10	2 (33.3)	2 (33.3)
>11	2 (33.3)	1 (16.7)
Formal education, n (%)		
No formal education	1 (16.7)	-
Primary education	4 (66.7)	3 (50)
Secondary education	-	3 (50)
Higher education	1 (16.7)	-
Marital status, n (%)		
Married	1 (16.7)	2 (33.3)
Single	-	1 (16.7)
Widower	5 (83.3)	3 (50)
Living with, n (%)		
Alone	-	1 (16.7)
Husband/Wife	1 (16.7)	1 (16.7)
Son/Daughter	4 (66.7)	4 (66.7)
Other	1 (16.7)	-

Values are presented as median [interquartile range], unless otherwise stated.
Legend: ACE-III: Addenbrooke's cognitive examination-III.

Acceptability of Data Collection Protocol

Administration of the data collection protocol was well tolerated by all participants and lasted approximately 1h30. Measures were collected in one single session; therefore, data collection protocol was found acceptable.

Acceptability of Intervention

Three participants in the EG completed the full 23 sessions of the programme (range: 19–23 sessions). The remaining three missed respectively, three (reasons: flu and diarrhoea), two (reasons: Christmas holidays and flu) and one (reason: fall) sessions. On average, participants of the EG adhered to 95.6% of the sessions. The total number of phone calls seemed to be a burden for PwD, leading to no answers or short conversations. Although carers were present during the first PA sessions and during the educational and psychosocial component, during some of the PA sessions, carers took advantage of the time that their loved ones were with the health professional to do things for themselves or to do housework. From the six participants in the EG, only one carer got involved in the PA sessions.

Safety

No major adverse events were reported. Two participants reported fatigue during the programme and one reported leg muscle pain during the first sessions.

Preliminary effectiveness of the LiFE4D

After the LiFE4D programme, potential clinically significant results between groups were found on exercise tolerance (2MST: ES=1.64 [0.33; 2.95] 95%CI), and balance (Brief-BESTest: ES=1.46 [0.19; 2.73] 95%CI). No other potential clinically significant differences were observed between groups (Table 2 and Figure 3). Detailed results of the percentage of predicted values can be found in Table S1 in the supplementary material.

Table 2. Results at baseline and at 3-month after the Lifestyle Integrated Functional Exercise for people with dementia (n=12).

		Experimental Group (n=6)		**Control Group (n=6)**		**Between groups**
Outcome	**Outcome measure**	**Pre**	**Post**	**Pre**	**Post**	**ES [95%CI]**
Cardiorespiratory	2MST (no of repetitions)	13 [6 to 20.2]	39.5 [21.8 to 53]	23 [7.5 to 42.8]	10 [2.2 to 34.8]	1.64 [0.33; 2.95]
Body composition	BMI (kg/m^2)	25.8 [24.3 to 31.7]	26.6 [26 to 30.6]	23.6 [22.2 to 31]	23.4 [21.9 to 33]	0.11 [-1.16; 1.37]
Muscle strength Upper limb muscle strength	Handgrip (kg)	14.5 [12.8 to 25]	17 [9.5 to 27.8]	14.5 [10.8 to 17.8]	14 [12.8 to 21.5]	-0.21 [-1.34; 0.93]
Lower limb muscle strength	30CST (no of repetitions)	5 [3 to 8.2]	7.5 [3 to 10.8]	6 [4.2 to 9.8]	6.5 [1.5 to 8.2]	0.68 [-0.48; 1.85]
Respiratory muscle strength	MIP (cmH_2O)	-39 [-44 to -29]	-42 [-56 to -30]	-23 [-28 to -18]	-30 [-46 to -15]	0.13 [-1.3; 56]
	MEP (cmH2O)	73 [61.5 to 89]	84 [58 to 97.5]	40 [7 to 60]	46 [20 to 65]	-0.17 [-1.6; 1.26]
	SNIP (cmH2O)	-42 [-53.8 to -22.8]	-46 [-56.5 to -23.5]	-23 [-18 to -28]	-17 [-36 to -3]	0.62 [-0.84; 2.08]
Flexibility	CSRT (cm)	-12 [-19.5 to 2.5]	-10.5 [-19.2 to 0.8]	-16.5 [-21.5 to -5.8]	-20.5 [-25.5 to -10.2]	0.38 [-0.76; 1.52]
Balance	Brief-BESTest (points)	4 [1.5 to 5.5]	8 [1.5 to 12]	7.5 [3.5 to 10.2]	5 [1.5 to 7.5]	1.46 [0.19; 2.73]
	FRT (cm)	11 [9.5 to 22]	22 [17 to 26.5]	11 [2.5 to 12.6]	17 [6.8 to 22.2]	0.97 [-0.23; 2.16]
	TUG (s)	24 [22 to 43.5]	21 [17.5 to 31.5]	19.7 [17.4 to 30]	29 [16 to 42.3]	-0.94 [-2.18; 0.31]
Cognitive function	ACE-III total (points)	36.5 [6.3 to 60.3]	37 [10 to 69.5]	47.5 [24.2 to 53.5]	38.5 [22.8 to 54.2]	0.24 [-0.9; 1.37]
	Attention (points)	6 [0.8 to 11.5]	7.5 [3 to 14]	9 [6.8 to 12]	9 [3.8 to 13]	0.44 [-0.71; 1.58]
	Memory (points)	6 [1.5 to 13.8]	5 [0 to 15.5]	8.5 [0.8 to 11.5]	8.5 [1.5 to 10]	0.05 [-1.08; 1.18]

	Fluency (points)	2.5 [0 to 6]	1.5 [0 to 7.2]	2.5 [0.8 to 3.5]	1.5 [0.8 to 3]	0.17 [-0.96; 1.31]
	Language (points)	13 [3 to 21.5]	15 [5.5 to 23]	15 [7.2 to 20.2]	15 [11 to 20.2]	0.06 [-1.07; 1.19]
	Visuospatial (points)	7 [1.5 to 10.5]	8 [2.5 to 9.8]	8 [6.2 to 10]	6 [3.8 to 9.8]	0.56 [-0.59; 1.71]
Self-reported physical activity	Brief-PA (points)	0 [0 to 0.5]	2.5 [0 to 4.2]	0 [0 to 3]	1 [0.5 to 2]	1.22 [-0.07; 2.51]
	Sufficiently active score ≥4 (n, %)	-	3, 50%	1, 16.7%	-	
	Insufficiently active score 0-3 (n, %)	6, 100%	3, 50%	5, 83.3%	6, 100%	
Respiratory function	PEF (L/min)	150 [90 to 275]	135 [110 to 272.5]	210 [100 to 330]	240 [97.5 to 307.5]	0.06 [-1.17; 1.3]
Upper limb function	Grocery shelving task (s)	99 [84 to 431.5]	89 [61.5 to 212]	154 [108.5 to 335]	168 [118.5 to 414.8]	-0.74 [-2.02; 0.54]

Values are presented as median [interquartile range], unless otherwise stated.

Legend: 2MST: 2-minute step test; 30CST: 30-second chair stand; ACE-III: Addenbrooke's cognitive examination-III; BMI: body mass index; Brief-PA: brief physical activity assessment tool; Brief-BESTest: brief balance evaluation systems test; CI: confidence interval; CSRT: chair sit-and-reach test; ES: effect size; FRT: functional reach test; MEP: maximal expiratory pressure; MIP: maximal inspiratory pressure; PEF: peak expiratory flow; SNIP: sniff nasal inspiratory pressure; TUG: timed up and go test.

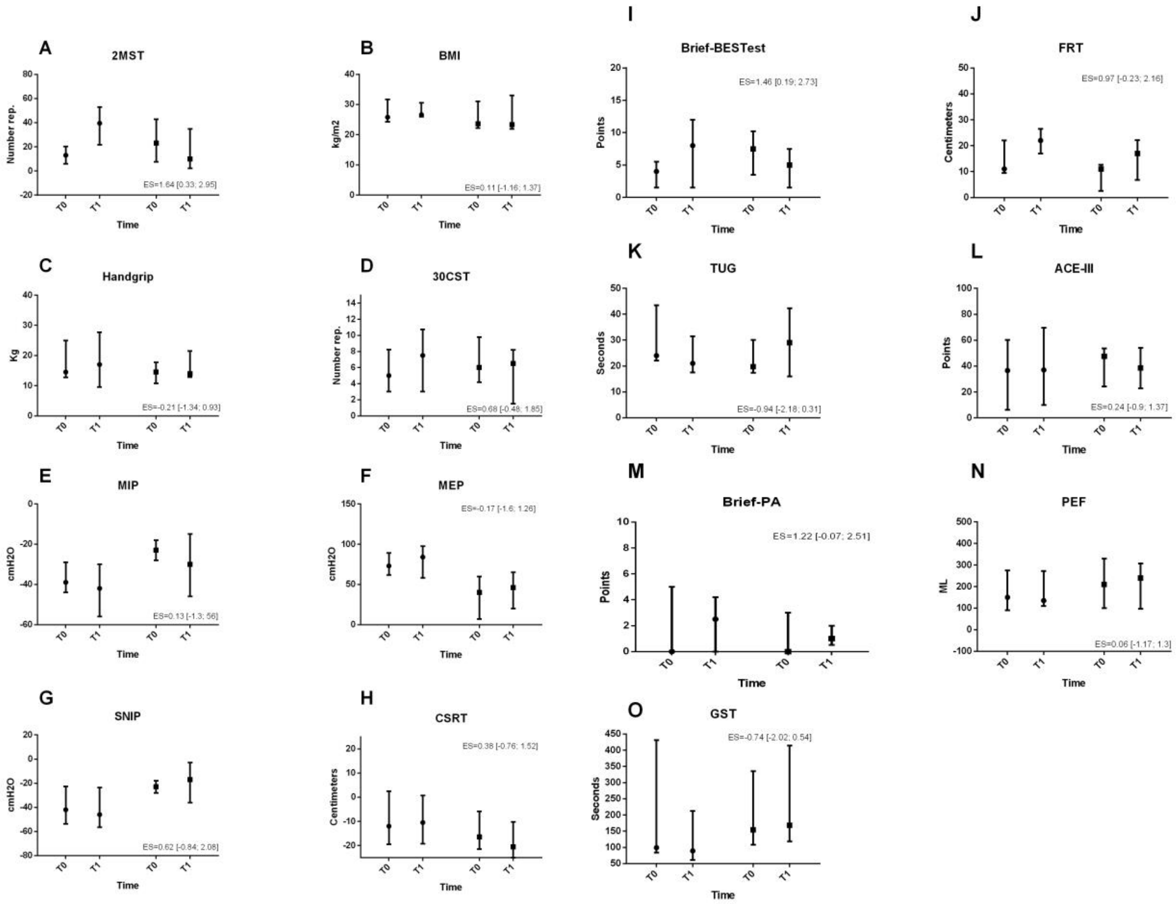

Figure 5. Graphs show each group (experimental vs control) performance on 2-minute step test: A; BMI: B; handgrip: C; 30-second chair stand: D; maximal inspiratory pressure: E; maximal expiratory pressure: F; and sniff nasal inspiratory pressure: G; chair sit-and-reach test: H; brief balance evaluation systems test: I; functional reach test: J; timed up and go test: K; Addenbrooke's cognitive examination-III: L; brief physical activity assessment tool: M; peak expiratory flow: N; and grocery shelving task: O (n = 12).

Legends: ● Experimental group; ■ control group; 2MST: 2-minute step test; 30CST: 30-second chair stand; ACE-III: Addenbrooke's cognitive examination-III; BMI: body mass index; Brief-BESTest: brief balance evaluation systems test; Brief-PA: brief physical activity assessment tool; CG: control group; CSRT: chair sit-and-reach test; EG: experimental group; ES: effect size; FRT: functional reach test; GST: grocery shelving task; MEP: maximal expiratory pressure; MIP: maximal inspiratory pressure; PEF: peak expiratory flow; SNIP: *sniff* nasal inspiratory pressure; TUG: timed up and go test

Discussion

According to the authors' best knowledge, this is the first tailored home-based PA programme for PwD that promotes PA multiple times/day in daily routines. LiFE4D programme seemed to be a feasible and safe intervention with promising results to improve health-related physical fitness, namely the cardiorespiratory and balance components of PwD, with an excellent adherence.

The results of this pilot study seem to be promising and important lessons were learnt. Recruitment was found to be challenging, not due to difficulties in engaging but in identifying PwD in the community. Regardless of all efforts to include PwD, reasons for recruitment difficulties for research purposes have been described in the literature, such as lack of awareness about research opportunities, the idea that research may not be of benefit for the PwD, lack of time and resources, and stigma or difficulty accepting the diagnosis (Connell, Shaw, Holmes, & Foster, 2001; Grill & Galvin, 2014). Some recruitment strategies might be useful to consider in the future, such as, establishing protocols with community leaders and specific organisations and increase awareness towards participation in research to reach larger samples (Boada et al., 2018; Grill & Galvin, 2014). To achieve these strategies in the main study all organisations in the region that work with/for PwD will be contacted. Establishing strong partnerships with community leaders and organisations in the field (i.e., community centres, national associations, day care centres) has been recommended (Boada et al., 2018). The most effective and least expensive recruitment strategy of community-based PwD has shown to be day care centres contacting family carers via e-mail (Boada et al., 2018). This approach will also be used. Furthermore, we will raise awareness among the gatekeepers (i.e., social/health professionals, carers) for the importance of including PwD in research and the importance of PA in this population. Based on the results obtained in this pilot study we expect to achieve the needed sample size for the main study in one year.

The data collection protocol used in this study included quick and easy measures previously used in PwD, allowing the acceptability of the protocol (Goncalves, Cruz, Marques, Demain, & Samuel, 2018). Adherence has been varying between 25% and 90% (van der Wardt et al., 2017) in PA programmes for PwD. LiFE4D was tailored to each participant (van der Wardt et al., 2017); occurred at home, in a familiar environment, without the need of transportation (Boada et al., 2018; van Alphen, Hortobagyi, et al., 2016); was composed of easy and adapted tasks to fit daily routines (Hancox et al., 2019); included information for participants (Boada et al., 2018; van der Wardt et al., 2017); and provided telephone support (van der Wardt et al., 2017). These are possible reasons to justify the excellent adherence obtained (van der Wardt et al., 2017). Nevertheless, the number of phone calls was perceived as somewhat overwhelming by some participants and although phone calls have been considered to be helpful and support adherence (van der Wardt et al., 2017), in this study most PwD had difficulties using the telephone (Nygård & Starkhammar, 2003). In the future, the number of phone calls need to be considered carefully and eventually reduced, e.g., 1 phone call in the middle and the end of the second and third months. To overcome the burden of having several phone calls in the main study, participants will be encouraged to call researchers every time they have a question or a doubt about the LiFE4D and carers involved will be asked to motivate PwD to be more physically active.

In this pilot study, carers had the opportunity to choose if they wanted to be or not be involved since their involvement is an important factor to motivate the person with dementia (van Alphen, Hortobagyi, et al., 2016). However, most carers were not present during the PA sessions. This might be explained by the well-described burden that carers of PwD experience and lack of time to accomplish personal tasks (Sequeira, 2013).

No major adverse events were reported, which is in line with previous studies (Forbes et al., 2015), emphasising the safety of the LiFE4D. Additionally, this pilot study showed preliminary evidence of potential clinically significant improvements on the cardiorespiratory and balance components of health-related physical fitness, similarly to previous literature involving structured exercises or running in institutions (Blankevoort et al., 2010; Heyn et al., 2004; Potter et al., 2011). Regarding PA results, a tendency for improvement was observed in the EG, with half of the group achieving a sufficiently active score. Careful interpretation of this findings is however needed as the Brief-PA tool is a self-report measure of PA, and the additional use of objective measures (e.g., accelerometer) are recommended to corroborate these findings.

A PA programme implemented in a familiar environment, fitting daily routines and without the need of use of transports, might have the potential to achieve clinically relevant and/or similar results to those of structured programmes, thus being a promising intervention to help PwD living well at home.

This study has some limitations that need to be acknowledged. The small sample size of this pilot study reduced the power to identify significant effects, nevertheless, two significant improvements were observed, and trends of improvement were identified on some of the other outcome measures. A more robust methodology is now required. Specifically, it is recommended to reduce the heterogeneity of the sample (e.g., Alzheimer's disease or vascular dementia), since the symptoms and progression varies between types of dementia; to explore the impacts of carers involvement; and to conduct a randomised controlled trial with a larger sample and an objective measure of PA. This study can be used to calculate the sample size of a larger study.

Conclusion

This pilot trial provided rich information for engaging and recruiting PwD; designing future research with adequate sample sizes; and implementing home-based PA interventions in PwD. The LiFE4D, seems to be a feasible and safe intervention with promising results to improve exercise tolerance and balance of PwD, with an excellent adherence. A randomised controlled trial with a larger sample is being prepared to corroborate these findings.

Data availability statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of interest: authors statement: The authors confirm to have no conflict of interests to declare.

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Supplementary material

Table S1. Percentage of predicted values at baseline and at 3-month after the Lifestyle Integrated Functional Exercise for People with Dementia (n=12).

		Experimental Group (n=6)		**Control Group (n=6)**		**Between groups**
Outcome	**Outcome measure**	**Pre**	**Post**	**Pre**	**Post**	**ES [95%CI]**
Cardiorespiratory	2MST (% predicted)	16.3 [10.3 to 24.8]	50.3 [35.3 to 67.8]	25.9 [12.6 to 49.4]	13.2 [2.2 to 43.3]	1.65 [0.34; 2.96]
Upper limb muscle strength	Handgrip (% predicted)	75.9 [50 to 98.8]	81 [41.5 to 108.6]	55.5 [43.5 to 72.3]	63.5 [55.3 to 76.9]	-0.22 [-1.34; 0.92]
Lower limb muscle strength	30CST (% predicted)	55.6 [39.9 to 84.2]	77.6 [38.2 to 120.4]	44.3 [28.7 to 109.1]	47.6 [17.4 to 91.7]	0.54 [-0.61; 1.7]
Respiratory muscle strength	MIP (% predicted)	68.1 [47.6 to 91.8]	79.4 [55.1 to 102]	49 [22.1 to 53.1]	52.5 [34.6 to 56.6]	0.13 [-1.3; 1.56]
	MEP (% predicted)	59 [51.6 to 98.6]	60.8 [53.5 to 106.6]	34.6 [4 to 75.4]	39.8 [11.6 to 81.7]	-0.06 [-1.49; 1.37]
	SNIP (% predicted)	47.8 [23.5 to 69.4]	42.8 [24.8 to 70.9]	25.3 [16.3 to 21.9]	12.5 [2.7 to 16.3]	0.51 [-1.21; 2.23]
Flexibility	CSRT (% predicted)	83.9 [-22.6 to 139.2]	42 [-17.2 to 119]	184 [37 to 249.4]	204.2 [68.6 to 318.7]	-0.54 [-1.75; 0.67]
Neuromotor component (Balance)	Brief-BESTest (% predicted)	43 [10.5 to 59.1]	86 [10.5 to 129]	48.4 [21.7 to 110.2]	29.8 [15.4 to 80.6]	1.26 [0.02; 2.5]
	TUG (% predicted)	173.9 [148.6 to 187.3]	140.8 [118 to 266.4]	184.1 [138.6 to 257.7]	226.7 [164.1 to 337.7]	-0.56 [-1.9; 0.78]
Cognitive function	ACE-III (% predicted)	44.7 [7.3 to 72.6]	45.2 [12 to 84.2]	57.9 [29.5 to 62.9]	45.2 [27.6 to 65.4]	0.24 [-0.89; 1.38]
	Attention (% predicted)	35.9 [4.5 to 68.8]	44.9 [18 to 83.8]	53.9 [40.4 to 71.8]	53.9 [22.4 to 77.8]	0.44 [-0.71; 1.58]
	Memory (% predicted)	28.6 [6.6 to 63.2]	23.4 [0 to 71.8]	38.8 [3.5 to 52.8]	36.3 [7.2 to 45.2]	0.05 [-1.08; 1.19]
	Fluency (% predicted)	21 [0 to 49.5]	12.6 [0 to 60.3]	21.1 [5.9 to 29.1]	12.4 [5.7 to 24.4]	0.19 [-0.95; 1.32]
	Language (% predicted)	53.1 [12.2 to 87.7]	61.2 [22.4 to 93.9]	61.2 [29.6 to 82.6]	61.2 [44.9 to 82.6]	0.06 [-1.07; 1.2]
	Visuospatial (% predicted)	69.9 [13.6 to 102.8]	80.4 [24.3 to 95.4]	77.5 [54.1 to 101.2]	55.9 [38.4 to 92.6]	0.56 [-0.59; 1.71]
Respiratory function	PEF (% predicted)	41.4 [21.7 to 78.6]	46.5 [26.2 to 74.4]	63.1 [22.2 to 76.8]	63.3 [21.2 to 67.6]	0.22 [-0.92; 1.35]

Values are presented as median [interquartile range], unless otherwise stated.
Legend: 2MST: 2-minute step test; 30CST: 30-second chair stand; ACE-III: Addenbrooke's cognitive examination-III;

Brief-BESTest: brief-balance evaluation systems test; CSRT: chair sit-and-reach test; MEP: maximal expiratory pressure; MIP: maximal inspiratory pressure; PEF: peak expiratory flow; SNIP: sniff nasal inspiratory pressure; TUG: timed up and go test.

Notes. Reference equations or normative values were used to determine the predicted percentage of:

2MST - Jones CJ, Rikli RE. Measuring functional fitness of older adults. The Journal on Active Aging. 2002:24-30

Handgrip - Novaes RD, Miranda ASd, Silva JdO, Tavares BVF, Dourado VZ. Equações de referência para a predição da força de preensão manual em brasileiros de meia idade e idosos. Fisioterapia e Pesquisa. 2009;16:217-22.

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Original study II – main study

Lifestyle Integrated Functional Exercise for People with Dementia: A randomized controlled trial

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Abstract

Background and purpose: Health-related physical fitness, cognitive function and health-related quality of life are essential for living well at home and can be influenced by physical activity. This study examined the efficacy and effectiveness of the Lifestyle Integrated Functional Exercise for People with Dementia (LiFE4D) on health-related physical fitness, cognitive function, and health-related quality of life.

Methods: A randomized controlled trial was conducted with people with dementia. The experimental group (EG) received the LiFE4D at home for 3 months, while the control group (CG) continued with usual care (e.g., pharmacological treatment). The health-related physical fitness was assessed with the 2-minute step test (2MST), body mass index, fat-free mass, handgrip, 30-second sit-to-stand test, chair sit-and-reach test and brief-balance evaluation systems test (Brief-BESTest). Cognitive function was assessed with the Addenbrooke's cognitive examination-III (ACE-III) and health-related quality of life with the quality of life in Alzheimer's disease scale (QoL-AD). Efficacy and effectiveness of LiFE4D were analyzed with *per protocol* and *intention-to-treat* analysis, using generalized estimating equations. Effect sizes (ES) were calculated as Cohen's d.

Results: Forty-seven (30, 63.8% female, 80.7±6.7 years, ACE-III: 44.1±21.4 points) people with dementia (n_{EG} =23, n_{CG} =24) participated in the study. Interactions time*group showed that the LiFE4D was efficacious and effective improving the 2MST ($p_{efficacy}$=0.001, ES=2.3; $p_{effectiveness}$=0.003, ES=2.9), Brief-BESTest ($p_{efficacy}$=0.001, ES=3; $p_{effectiveness}$<0.001, ES=3.3) and QoL-AD ($p_{efficacy}$=0.005, ES=3; $p_{effectiveness}$ =0.003, ES=3.1), with 82% of adherence. No other significant interactions were observed. No major adverse events were reported.

Conclusions: The LiFE4D program is an efficacious and effective intervention to improve the health-related physical fitness (cardiorespiratory and neuromotor components) and health-related quality of life in people with dementia. The LiFE4D should be applied in the clinical practice with confidence.

Key words: exercise; functional performance; physical activity; physical performance.

Introduction

Dementia is characterized by deterioration in cognitive function with negative impacts on functional ability to perform activities of daily living (ADL).[1] Performance of ADL is crucial to maintain independency, and it is intimately associated with the health-related physical fitness performance[2] and health-related quality of life of those living with dementia.[3, 4] In fact, people with dementia have shown lower health-related physical fitness,[5] cognitive function[6] and health-related quality of life[3] compared with their peers.

Pharmacological treatments for people with dementia have led to limited effects and the need for non-pharmacological interventions (e.g., individualized physical activity) to manage dementia symptoms has been highlighted.[7] Physical activity has shown to improve health-related physical fitness[7-9] and improve or delay cognitive decline in people with dementia,[9] although controversy still exists.[7, 10] Moreover, the literature regarding the effects of physical activity on health-related quality of life of people with dementia remain scarce, stressing the need to explore its impacts on such a meaningful domain.[7, 11]

People with dementia present lower levels of physical activity than their healthy peers.[12] The offer of physical activity interventions for people with dementia has been increasing worldwide, however adherence rates vary between 16 to 100% across studies.[13] Several barriers to physical activity in people with dementia have been identified (e.g., physical impairments, safety concerns, time-consuming approaches and caregivers' burden).[14, 15] A tailored home-based physical activity program, embed in daily routines, seems to facilitate the involvement of people with dementia.[14, 16] Nevertheless, home-based physical activity programs for people with dementia are still scarce. Thus, implementing and evaluating physical activity programs at home is urgently needed.

The Lifestyle Integrated Functional Exercise for People with Dementia (LiFE4D) is a home-based intervention adapted from a successful program designed for older people.[17] It seems to be a promising intervention to involve people with dementia in physical activity and ultimately impact on their health-related physical fitness, cognitive function and health-related quality of life.[17] Therefore, this study aimed to examine the efficacy and effectiveness of LiFE4D on health-related physical fitness. Secondary aims included to explore the efficacy and effectiveness of LiFE4D on other meaningful outcomes (i.e., cognitive function and health-related quality of life).

Methods

Design and ethics

A two-arm, parallel group randomized controlled trial (RCT) was conducted. The full protocol study can be found elsewhere.(Almeida, Gomes da Silva, & Marques, 2020)

This study was conducted according to the Declaration of Helsinki, received ethical approval (P437-06/2017) and national data protection (nº 7897/2017) and was registered in the ClinicalTrials.gov (ID: NCT03757806). Written informed consents were provided by participants and/or a proxy decision-maker (if applicable). Verbal assent to continue the study was asked at each session and assessment appointment. Consolidated standards of reporting trial (CONSORT) and template for intervention description and replication (TIDieR) guidelines were followed (Hoffmann et al., 2014; Schulz, Altman, & Moher, 2010).

Setting and participants

A total of 32 institutions (e.g., community centers, day care centers, home-care services), which work with/have access to people with dementia living at home were contacted. Twenty did not respond, 2 declined and 10 accepted to participate in the study, however only 9 identified eligible people with dementia and collaborated with the recruitment. A meeting with the managers of the institutions was first arranged to explain the study. Then, a member of the staff of each institution was indicated to identify possible participants and explain the study. If people with dementia and their caregivers showed interest to participate, a meeting was scheduled with the researcher to provide further information about the study and collect the written informed consents. Data collection and intervention were carried out at participants' home.

Inclusion criteria were to: i) have a diagnosis of major neurocognitive disorder (e.g., dementia);(American Psychiatric Association, 2013) ii) live in their own home or at a caregiver's home; iii) be sedentary (i.e., spending ≥4 h/day sitting, reclining or lying quietly, without counting the night sleeping hours), and iv) be able to understand simple instructions. Exclusion criteria were: i) had been hospitalization in the previous month; ii) presence of some clinical condition which precluded their participation in physical activities; and iii) involvement in other physical activity programs.

Intervention

The LiFE4D is a 3-month home-based physical activity program embedded in daily routine activities which was adapted to people with dementia from the Lifestyle Integrated Functional Exercise (LiFE).(Clemson et al., 2012) The LiFE4D included activities to improve balance and lower limb strength (as the original LiFE), and also activities to improve exercise tolerance, upper limb function, flexibility, and an educational and psychosocial component.(Almeida et al., 2020; Almeida, Marques, & Gomes da Silva, 2019; Clemson et al., 2012) This is an individualized program that fit into people with dementia daily routines, with a duration of 3 months and a sessions' duration of around 1 hour. Caregivers had the opportunity to be involved in the study to support and motivate people with dementia and to receive the educational and psychosocial component, however it was up to them to get or not involved. In total, participants received 23 face-to-face sessions and 4 phone calls, with a progressive decrease in the contact with the health professional over time (3, 2 and 1 session per week in the 1st, 2nd and 3rd months, respectively). At the end of the first month, participants of the EG received a manual with activities that they could continue to perform on their daily routines.(Almeida, Marques, et al., 2019) During the face-to-face sessions, participants were motivated and trained on how to be more physically active and less sedentary during their daily routines and received the educational and psychosocial support component with information about different topics (i.e., healthy lifestyles, community support, falls prevention, caregiver's burden). Detailed information about the LiFE4D intervention can be found elsewhere.(Almeida et al., 2020)

Outcomes

Participants were assessed at baseline and at 3-months in their homes. Adherence rate was calculated (total number of attended face-to-face sessions/total number of face-to-face sessions offered*100). A cutoff of 70% adherence was considered.(Armijo-Olivo, Warren, & Magee, 2009)

Sociodemographic, anthropometric and general clinical data were assessed with a structured questionnaire to characterize the sample. Major (i.e., falls and injuries) and minor (i.e., musculoskeletal pain and fatigue) adverse events were assessed during face-to-face sessions to monitor safety of the LiFE4D. Additionally, at post assessment, both EG and CG were asked about non-schedule healthcare visits (i.e., number of hospitalizations and emergency service) or other health-related events (i.e., falls) during the previous 3 months.

Primary outcome measure. Cardiorespiratory endurance component, i.e., exercise tolerance, was assessed with the 2-minute step test (2MST).(C. Jones & Rikli, 2002) The 2MST was performed next to a wall with a tape mark at the level of the middle point between the patella and iliac crest. Participants were asked to lift their knees to the level of the mark on the wall, stepping in place, as many times as possible but not running.(C. Jones & Rikli, 2002) The maximum number of steps (i.e., number of times that the right knee achieved the mark on the wall) in place within 2 minutes was registered.(C. Jones & Rikli, 2002) A higher number of valid liftings with the right knee indicates better exercise tolerance performance.(C. Jones & Rikli, 2002) The 2MST has shown a moderate and positive correlation with the mini mental state examination performance

(r^2=0.35; $p<0.001$) in people with mild cognitive impairment and mild to moderate Alzheimer's disease.(Plácido et al., 2019)

Secondary outcome measures. The remaining health-related physical fitness domains were assessed with the:

- body mass index (BMI) (weight/height^2) and fat-free mass (FFM) (%), assessed with a bioimpedance equipment (Omron body fat monitor BF306) for body composition;(Nagaya, Yoshida, Takahashi, Matsuda, & Kawai, 1999)
- handgrip dynamometer (BASELINE® Hydraulic Hand Dynamometer, upper limb muscular strength Fabrication Enterprises, New York, USA) and 30-second sit-to-stand test (30-s STS) for muscular strength/endurance;(C. J. Jones, Rikli, & Beam, 1999)
- chair sit-and-reach test (CSRT) for flexibility;(C. Jones, Rikli, Max, & Noffal, 1998)
- brief-balance evaluation systems test (Brief-BESTest) for neuromotor component.(Padgett, Jacobs, & Kasser, 2012)

Cognitive function was assessed with the Addenbrooke's cognitive examination-III (ACE-III)(Peixoto et al., 2018) and the health-related quality of life was assessed with the quality of life in Alzheimer's disease scale (QoL-AD).(Logsdon, 1999)

Sample size

Sample size calculation was performed using G*Power 3.1.3 (Universität Düsseldorf, Düsseldorf, Germany). A sample size estimation with 95% power (α=0.05) was calculated to detect significant differences between the EG and CG in exercise tolerance, using the 2MST, assuming a non-parametric distribution. Mean changes of the 2MST from the pilot study were used (EG: 24.2±16; CG: -4.5±21.8). The power calculation resulted in a total sample size of 24 participants (i.e., 12 per group) plus 12 participants considering a 50% dropout rate. Therefore, a minimum of 36 participants should be recruited in this randomized controlled trial. A high sample power and overall level of dropouts were considered as participants will be assessed for follow-up after the program (future analysis), and more dropouts can be anticipated during the follow-up period (3- and 6-months after the end of the program).

Randomisation

A random assignment process to the experimental (EG) and control (CG) groups was performed with 1:1 allocation ratio. The EG received the LiFE4D program, additionally to their usual care. The CG continued their usual care (i.e., pharmacological treatment).

Randomization concealed process was performed with sequentially numbered, opaque, and sealed envelopes. More details about assignment can be found elsewhere.(Almeida et al., 2020)

Recruitment

Period of recruitment, intervention and assessment occurred between November 2018 and February 2020. Recruitment stopped after achieving the required sample size. At that point, participants that were already identified were also included in the study.

Blinding

This study was not blinded to participants due to the nature of the intervention. Nevertheless, the opportunity to receive the LiFE4D after participating in the study was given to the CG. The assessor (i.e., researchers completing the assessments) and care provider were independent. The researchers completing the assessments were blinded. Each participant had the same assessor through the study (baseline and post). The person delivering intervention, participant, person entering/analyzing data were not blinded.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics version 24.0 (IBM Corporation, Armonk, NY, USA). Plots were performed with GraphPad Prism, version 5.01 (GraphPad Software, San Diego, CA). The level of significance was set at 0.05.

Descriptive statistics were used to describe the sample. Normality of data distribution was assessed with the Shapiro-Wilk test.(Field A, 2009) Independent t-test for normally distributed data, and Mann-Whitney U test for non-normally distributed data for continuous variables, and Chi^2 test for categorical variables were used to explore differences between the two groups (EG vs CG) at baseline, and between included participants at 3 months and lost to follow-up at baseline.(Field A, 2009)

A *per protocol* (i.e., performance of a treatment under ideal/controlled circumstances) and an *intention-to-treat* (i.e., performance of a treatment under usual or “real world” clinical practice) analyses were used to assess efficacy and effectiveness of LiFE4D, respectively.(McCoy, 2017) Participants from the EG were included in the efficacy analysis if they had an adherence of at least 70%.(Armijo-Olivo et al., 2009; Di Lorito et al., 2020) Generalized estimating equations (GEE) analysis were used to assess the effect of group, time and interaction time*group for the efficacy and effectiveness analysis.(Liang & Zeger, 1986) Moreover, GEE were used to assess pairwise tests (i.e., Wald test) to compare baseline and 3-months assessments for each outcome measure and assigned group and to deal with missing values.(Liang & Zeger, 1986) Unadjusted (supplementary material) and adjusted (i.e., for age categorized by decades, years of formal education, marital status, and cognitive function) models were performed with GEE for both efficacy and effectiveness analysis. For cognitive function variables the model was adjusted for age (categorized by decades), years of formal education and marital status. Effect sizes (ES) were calculated as Cohen's d for the significant measures, and interpreted as small (≥0.2), medium (≥0.5) or large (≥0.8).(Field A, 2009)

Results

Fifty-six people with dementia were identified and assessed for eligibility. After screening, 47 participants were randomly allocated to the EG or CG however, nine participants were lost to post assessment. Significant baseline differences between people with dementia participating at 3 months and lost to post assessment were found for age, 2MST and 30-s STS in the total sample, and for age in those of the EG. No other significant differences were found. More details can be found in supplementary material (Table S1 in the Supplement). A flow diagram provides detailed information about the enrolment of participants (Figure 1).

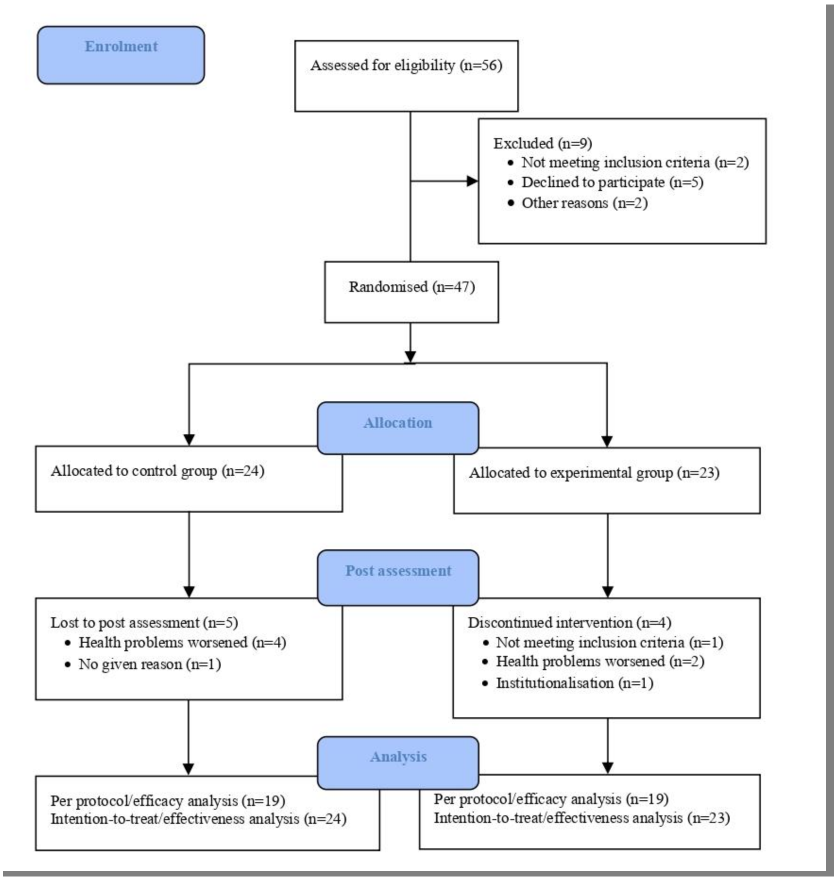

Figure 2. CONSORT 2010 flow diagram showing the enrolment process of the participants included in this randomized controlled study.

Thirty-eight (EG=19, CG=19) participants were included in the per protocol analysis (i.e., efficacy analysis). Forty-seven (EG=23, CG=24) participants were included in the intention-to-treat analysis (i.e., effectiveness analysis).

Characterization of the Sample

Forty-seven people with dementia participated in this study. Participants had a mean age of 80.7±6.7 years old, 30 (63.8%) were female and had a mean of 44.1±21.4 points on ACE-III. No significant differences between groups were found at baseline, except for the QoL-AD (Table 1).

Table 1. Descriptive characteristics of experimental and control groups per protocol (n=38) and per intention-to-treat (n=47) analysis.

	Per protocol analysis				Intention-to-treat analysis			
	All (n=38)	EG (n=19)	CG (n=19)	p	All (n=47)	EG (n=23)	CG (n=24)	p
Age (years)	79.5±6.5	81.5±5.8	77.5±6.6	0.059	80.7±6.7	82.7±6.3	78.7±6.5	0.058
Gender (female) n, %	23 (60.5)	14 (73.7)	9 (47.4)	0.097	30 (63.8)	17 (73.9)	13 (54.2)	0.159
Formal education (years) n, %				0.270				0.393
0	6 (15.8)	4 (21.1)	2 (10.5)		10 (21.3)	6 (26.1)	4 (16.7)	
1-4	26 (68.4)	11 (57.9)	15 (78.9)		31 (66)	13 (56.5)	18 (75)	
5-6	1 (2.6)	1 (5.3)	-		1 (2.1)	1 (4.3)	-	
7-9	2 (5.3)	1 (5.3)	1 (5.3)		2 (4.3)	1 (4.3)	1 (4.2)	
10-12	2 (5.3)	2 (10.5)	-		2 (4.3)	2 (8.7)	-	
+12	1 (2.6)	-	1 (5.3)		1 (2.1)	-	1 (4.2)	
Marital status n, %				0.871				0.987
Single	2 (5.3)	1 (5.3)	1 (5.3)		2 (4.3)	1 (4.3)	1 (4.2)	
Married	19 (50)	9 (47.4)	10 (52.6)		24 (51.1)	12 (52.2)	12 (50)	
Widow	17 (44.7)	9 (47.4)	8 (42.1)		21 (44.7)	10 (43.5)	11 (45.8)	
Dementia type n, %				0.192				0.208
Alzheimer's Disease	11 (28.9)	2 (10.5)	9 (47.4)		16 (34)	4 (17.4)	12 (50)	
Vascular dementia	6 (15.8)	4 (21.1)	2 (10.5)		7 (14.9)	4 (17.4)	3 (12.5)	
Frontotemporal dementia	2 (5.3)	1 (5.3)	1 (5.3)		2 (4.3)	1 (4.3)	1 (4.2)	
Parkinson's Disease	4 (10.5)	3 (15.8)	1 (5.3)		5 (10.6)	4 (17.4)	1 (4.2)	

Creutzfeldt-Jakob	1 (2.6)	1 (5.3)	-		1 (2.1)	1 (4.3)	-	
Non specified	14 (36.8)	8 (42.1)	6 (31.6)		16 (34)	9 (39.1)	7 (23.2)	
Day care services n, %	21 (55.3)	10 (52.6)	11 (57.9)	0.744	29 (61.7)	13 (56.5)	16 (66.7)	0.474
Number of comorbidities	2 [2]	2 [1]	2 [1]	0.062	2 [1.8]	2 [1]	2 [1]	0.081
Number of medications	7.8±3.2	7.7±3.1	7.9±3.3	0.817	7.7±3.1	7.3±3.2	8.1±3	0.409
Outcome measures								
2MST (number of repetitions)	27.5 [39.8]	19.5 [24]	31 [58]	0.221	24 [34.2]	17 [23]	31 [57.5]	0.118
BMI (kg/m^2)	27.6±3.3	27.7±3.7	27.4±2.9	0.811	27.4±3.3	27.7±3.6	27.2±3.1	0.687
FFM (%)	36.6±7.6	36.8±8.7	36.3±6.6	0.874	36.6±7.3	36.7±8.4	36.5±6.3	0.951
Handgrip (Kg)	19.8±9.7	17.1±10.4	22.4±8.3	0.096	19.1±9.4	17±9.9	21.1±8.6	0.156
30-s STS (number of repetitions)	7.2±4.6	6.4±4.2	8±5	0.266	6.5±4.7	5.8±4.1	7.3±5.2	0.291
CSRT (cm)	-15 [13.2]	-11.5 [17]	-17 [10.2]	0.203	-15 [11]	-12 [15]	-15.5 [10]	0.340
Brief-BESTest (points)	4.5 [10]	4 [8]	5 [11]	0.070	4 [10]	3 [8]	5 [13]	0.081
ACE-III total (points)	44.7±2	43.8±19.6	45.6±22.9	0.803	44.1±21.4	43.4±20.8	45±22.5	0.814
ACE-III attention (points)	9.7±4.5	9.5±4.4	10±4.6	0.776	9.8±4.5	9.5±4.5	10.1±4.6	0.643
ACE-III memory (points)	7.5 [7]	7 [9]	8 [7]	0.665	7 [8]	7 [9]	8 [24]	0.677
ACE-III fluency	2 [2]	2 [3]	2 [4]	0.773	2 [4]	2 [3]	2.5 [4]	0.514

(points)								
ACE-III language (points)	17 [9]	17 [7]	17 [14]	0.708	17 [10]	17.5 [8]	16 [13]	0.570
ACE-III visuospatial (points)	8.5 [4]	8 [5]	9 [2]	0.583	8 [5]	8 [6]	8.5 [4]	0.621
QoL-AD (points)	27.5±7.6	23.6±5.2	31.6±7.7	0.001 *	27.5±7.4	23.7±5	31.8±7.5	<0.001*

Data are presented as mean ± standard deviation, median [interquartile range] or numbers (%). Abbreviation: 2MST: 2-minute step test; 30-s STS: 30-second sit-to-stand test; ACE-III: Addenbrooke's cognitive examination-III; BMI: body mass index; Brief-BESTest: brief-balance evaluation systems test; CG: control group; CSRT: chair sit-and-reach test; EG: experimental group; FFM: fat-free mass; QoL-AD: quality of life in Alzheimer's disease scale. *p<0.05

Health-Related Physical Fitness

At post assessment, only participants of the EG increased significantly ($p_{efficacy}$=0.003, $p_{effectivenes}$=0.001) their cardiorespiratory endurance. A significant interaction between group*time was found in the 2MST for efficacy (p=0.001, ES=2.3) and effectiveness (p=0.003, ES=2.9) of LiFE4D (Table 2, Table 3, and Figure 2).

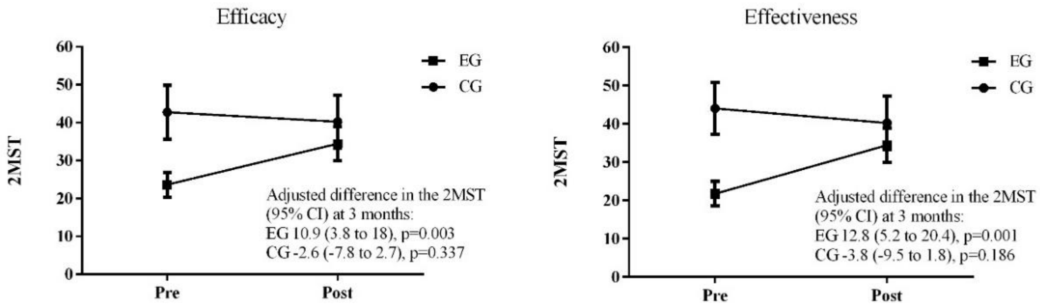

Figure 3. Efficacy (n=38) and effectiveness (n=47) of the Lifestyle Integrated Functional Exercise for People with Dementia on the 2-minute step test (primary outcome measure) at 3 months.
Data are presented as mean and standard error of mean at pre- and post-assessments. p≤0.05.
Abbreviation: 2MST: 2-minute step test; CI: confidence interval; CG: control group; EG: experimental group; LiFE4D: Lifestyle Integrated Functional Exercise for People with Dementia.

The neuromotor component improved significantly only in the EG ($p_{efficacy}$<0.001, $p_{effectiveness}$<0.001) at post assessment. A significant interaction between group*time was found in the Brief-BESTest for efficacy (p=0.001, ES=3) and effectiveness (p<0.001, ES=3.3) of LiFE4D. No other significant interactions were found for the remaining secondary health-related physical fitness measures (Table 2 and Table 3).

Other Meaningful Outcomes

A significant improvement on the memory of the EG (p=0.047) was found in the efficacy analysis. No other significant differences within groups, neither interactions between group*time were found for cognitive function (Table 2 and Table 3).

After LiFE4D, a significant improvement in participants of the EG ($p_{efficacy}$=0.042, $p_{effectiveness}$=0.044) and decline in those of the CG ($p_{efficacy}$=0.047, $p_{effectiveness}$=0.027) were observed for the heath-related quality of life. However, these results should be interpreted cautiously as significant differences at baseline were found for QoL-AD. A significant interaction between group*time was found in QoL-AD for efficacy (p=0.005, ES=3) and effectiveness (p=0.003, ES=3.1) of LiFE4D (Table 2 and Table 3).

Similar results were found for the efficacy and effectiveness of LiFE4D on health-related physical fitness, cognitive function, and health-related quality of life with the unadjusted model (Table S2 and Table S3 in the Supplement).

Within the EG, total mean adherence was 82%. One participant never participated, three adhered between 13% and 39% of the sessions and the others adhered between 87% and 100% of the sessions. Ten participants adhered to 100% of the face-to-face sessions.

During face-to-face sessions, participants of the EG reported minor events, such as musculoskeletal pain (n=4) and fatigue (n=6). No major adverse events were reported. Regarding to the non-schedule healthcare visits there were no hospitalizations, and 4 participants (3 in the EG vs 1 in the CG) used the emergency service for reasons not related with the study. Other health-related events (i.e., falls) were reported during the period of the study (3 months), with 9 participants (5 in the EG vs 4 in the CG) reporting at least 1 fall, with a maximum of 4 falls. None of the falls occurred during the sessions of the LiFE4D program.

Table 2. Efficacy of the Lifestyle Integrated Functional Exercise for people with dementia (per protocol analysis, n=38).

Outcomes	Outcome measure	EG (n=19)		CG (n=19)		Adjusted model β (95% CI)	Interaction group*time p
		Pre	Post	Pre	Post		
Primary outcome							
Cardiorespiratory endurance	2MST (number of repetitions)	23.6±3.3 (17.8 to 31.3)	34.4±4.5* (26.7 to 44.5)	42.7±7.1 (30.8 to 59.2)	40.2±6.9 (28.6 to 56.4)	3.7• (3.4 to 4)	0.001Ŧ
Secondary outcomes							
Body composition	BMI (kg/m^2)	27.7 ±.8 (26.1 to 29.4)	27.4±1.1 (25.4 to 29.6)	27.4±.7 (26.2 to 28.7)	27.5±.7 (26.1 to 29)	3.3 (3.3 to 3.4)	0.560

	FFM (%)	36.8±2.3 (32.5 to 41.6)	32.9±1.7 (29.7 to 36.4)	36.3±1.8 (32.9 to 40)	36.2±1.8 (32.7 to 40)	3.6 (3.5 to 3.7)	0.245
Muscular strength	Handgrip (Kg)	18.1±2.4 (13.9 to 23.4)	17.7±2 (14.3 to 22)	23.4±1.9 (20 to 27.5)	22.4±2.3 (18.4 to 27.3)	3.1 (2.9 to 3.3)	0.708
Muscular endurance	30-s STS (number of repetitions)	7.4±.9 (5.7 to 9.5)	8±.9 (6.3 to 10)	9±1.1 (7.1 to 11.5)	9.2±1.2 (7.1 to 12)	2.2 (2 to 2.5)	0.656
Flexibility	CSRT (cm)	-13.1±2.7 (-18.4 to -7.7)	-10.8±2.6 (-15.8 to -5.7)	-15.8±2.2 (-20.2 to -11.5)	-17.8±2.7 (-23 to -12.6)	-17.8 (-23 to -12.6)	0.153
Neuromotor	Brief-BESTest (points)	5.7±1 (4 to 8.1)	9.2±1.1* (7.3 to 11.5)	8.8±1.3 (6.6 to 11.8)	8.7±1.3 (6.5 to 11.7)	2.2• (1.9 to 2.5)	0.001Ŧ
Exploratory outcomes							
Cognitive function	ACE-III Total (points)	44.8±4.4 (37 to 54.3)	46.7±4.8 (38.1 to 57.2)	46.6±5.1 (37.6 to 57.8)	45.1±5.3 (35.8 to 56.8)	3.8 (3.6 to 4)	0.090
	ACE-III Attention (points)	10.5±1 (8.8 to 12.6)	10.4±.9 (8.7 to 12.4)	11±1 (9.1 to 13.2)	11±1.1 (9 to 13.4)	2.4 (2.2 to 2.6)	0.886
	ACE-III Memory (points)	9.4±1.3 (7.1 to 12.3)	10.7±1.6* (8 to 14.3)	10.5±1.5 (8 to 13.9)	10.3±1.4 (7.9 to 13.6)	2.3 (2.1 to 2.6)	0.082
	ACE-III Fluency (points)	3.7±.6 (2.7 to 5.1)	3.6±.6 (2.6 to 5)	4±.7 (2.9 to 5.6)	3.5±.6 (2.4 to 5)	1.2 (0.9 to1.6)	0.423
	ACE-III Language (points)	16.8±1.5 (14.2 to 20)	17.2±1.5 (14.5 to 20.4)	15.5±1.7 (12.5 to 19.2)	15.3±1.8 (12.1 to 19.2)	2.7 (2.5 to 3)	0.456
	ACE-III Visuospatial (points)	8.4±0.8 (7 to 10.1)	8.8±0.9 (7.3 to 10.7)	9±1 (7.3 to 11.1)	9.1±1 (7.3 to 11.3)	2.2 (2 to 2.4)	0.660
Health-related quality of life	QoL-AD (points)	23.6±1.2 (21.3 to 26.1)	26.3±1.5* (23.6 to 29.4)	31.6±1.9 (28.2 to 35.5)	29.5±1.7* (26.3 to 33.1)	3.4Δ (3.3 to 3.5)	0.005Ŧ

Values of the pre- and post-assessments are presented as mean ± standard error of mean (95% CI).

*p-value of post vs pre assessment ≤0.05. Δ p-value for group differences ≤.05 • p-value for time differences ≤.05 Ŧ p-value for interaction between group and time ≤.05.

Abbreviations: 2MST: 2-minute step test; 30-s STS: 30-second sit-to-stand test; ACE-III: Addenbrooke's cognitive examination-III; BMI: body mass index; Brief-BESTest: brief-balance evaluation systems test; CG: control group; CI: confidence interval; CSRT: chair sit-and-reach test; EG: experimental group; FFM: fat-free mass; QoL-AD: quality of life in Alzheimer's disease scale. For the health-related physical fitness and health-related quality of life variables the model was adjusted for age (categorized by decades), years of formal education, marital status, and cognitive function. For cognitive function variables the model was adjusted for age (categorized by decades), years of formal education and marital status.

Table 3. Effectiveness of the Lifestyle Integrated Functional Exercise for people with dementia (intention-to-treat analysis, n=47).

Outcomes	Outcome measure	EG (n=23)		CG (n=24)		Adjusted model β (95% CI)	Interaction group*time p
		Pre	Post	Pre	Post		
Primary outcome							
Cardiorespiratory endurance	2MST (number of repetitions)	21.7±3.2 (16.2 to 29)	34.4±4.5* (26.7 to 44.5)	44±6.8 (32.4 to 59.7)	40.2±6.9 (28.6 to 56.4)	3.7Δ• (3.4 to 4)	<0.001Ŧ
Secondary outcomes							
Body composition	BMI (kg/m²)	27.5±.8 (25.9 to 29.2)	27.4±1.1 (25.4 to 29.6)	27.4±.6 (26.2 to28.6)	27.5±.7 (26.1 to 29)	3.3 (3.3 to 3.4)	0.724
	FFM (%)	36.7±2.2 (32.7 to 41.2)	32.9±1.7 (29.7 to 36.4)	36.5±1.7 (33.3 to 39.9)	36.2±1.8 (32.7 to 40)	3.6 (3.5 to 3.7)	0.267
Muscular strength	Handgrip (kg)	18±2.2 (14.2 to 22.7)	17.7±2 (14.3 to 22)	23.2±1.8 (19.8 to 27)	22.4±2.3 (18.4 to 27.3)	3.1 (2.9 to 3.3)	0.763
Muscular endurance	30-s STS (number of repetitions)	7±.9 (5.4 to 8.9)	7.9±.9 (6.3 to10)	9.2±1.1 (7.3 to 11.5)	9.2±1.2 (7.1 to 12)	2.2 (2 to 2.5)	0.325
Flexibility	CSRT (cm)	-13.4±2.3 (-18 to -8.8)	-10.8±2.6 (-15.8 to -5.7)	-14.5±2.5 (-19.4 to -9.6)	-17.8±2.7 (-23 to -12.6)	-17.8 (-23 to -12.6)	0.061
Neuromotor	Brief-BESTest (points)	5.6±1 (4 to 7.8)	9.2±1.1* (7.3 to 11.5)	9±1.3 (6.9 to 11.9)	8.7±1.3 (6.5 to 11.7)	2.2• (1.9 to 2.5)	<0.001Ŧ
Exploratory outcomes							
Cognitive function	ACE-III Total (points)	44.4±4.3 (36.6 to 53.7)	46.7±4.8 (38.1 to 57.2)	46±4.9 (37.3±56.6)	45.1±5.3 (35.8 to 56.8)	3.8 (3.6 to 4)	0.304
	ACE-III Attention (points)	10.5±.9 (8.8 to 12.5)	10.4±.9 (8.7 to 12.4)	11.1±1 (9.4 to 13.2)	11±1.1 (9 to 13.4)	2.4 (2.2 to 2.6)	0.900
	ACE-III Memory (points)	9.4±1.4 (7.1 to 12.5)	10.7±1.6 (8 to 14.3)	10.2±1.5 (7.7 to 13.5)	10.3±1.4 (7.9 to 13.6)	2.3 (2.1 to 2.6)	0.347
	ACE-III	3.5±.5	3.6±.6	4.2±.6	3.5±.6	1.2	0.207

	Fluency (points)	(2.6 to 4.7)	(2.6 to5)	(3 to 5.6)	(2.4 to 5)	(.9 to 1.6)	
	ACE-III Language (points)	16.7±1.5 (14 to 19.8)	17.2±1.5 (14.5 to 20.4)	15.4±1.6 (12.5 to 18.9)	15.3±1.8 (12.1 to 19.2)	2.7 (2.5 to 3)	0.587
	ACE-III Visuospatial (points)	8.3±.8 (6.9 to 10)	8.8±.9 (7.3 to 10.7)	8.8±.9 (7.2 to 10.9)	9.1±1 (7.3 to 11.3)	2.2 (2 to 2.4)	0.690
Health-related quality of life	QoL-AD (points)	23.7±1.1 (21.6 to 26)	26.3±1.5* (23.6 to 29.4)	31.8±1.8 (28.5 to 35.5)	29.5±1.7* (26.3 to 33.1)	3.4Δ (3.3 to 3.5)	0.003Ŧ

Values of the pre- and post-assessments are presented as mean ± standard error of mean (95% CI).

*p-value of post vs pre assessment ≤0.05. Δ p-value for group differences ≤0.05 • p-value for time differences ≤0.05 Ŧ p-value for interaction between group and time ≤0.05.

Abbreviations: 2MST: 2-minute step test; 30-s STS: 30-second sit-to-stand test; ACE-III: Addenbrooke's cognitive examination-III; BMI: body mass index; Brief-BESTest: brief-balance evaluation systems test; CG: control group; CI: confidence interval; CSRT: chair sit-and-reach test; EG: experimental group; FFM: fat-free mass; QoL-AD: quality of life in Alzheimer's disease scale.

For the health-related physical fitness and health-related quality of life variables the model was adjusted for age (categorized by decades), years of formal education, marital status, and cognitive function. For cognitive function variables the model was adjusted for age (categorized by decades), years of formal education and marital status.

Discussion

This study found that LiFE4D is efficacious and effective in improving the cardiorespiratory endurance and neuromotor components of the health-related physical fitness, as well as the health-related quality of life in people with dementia. No significant differences were found for body composition, muscular strength, muscular endurance, and flexibility components of the health-related physical fitness nor for cognitive function.

Although previous literature involving different physical activity programs, including structured exercise, in different settings, has shown health-related physical fitness improvements in people with dementia,(Heyn et al., 2004; Park & Cohen, 2019; Potter et al., 2011) this study adds to the existing body of knowledge an effective tailored program (i.e., LiFE4D) focus on ADL conducted at participants' homes during their daily routines.

Cardiorespiratory endurance is an important domain of health-related physical fitness since it is a predictor of ADL decline in people with dementia.(Oppewal et al., 2015) Previous literature has found improvements of this domain with physical activity programs conducted in institutions.(Heyn et al., 2004; Park & Cohen, 2019) To the authors' best knowledge, there was only one exercise program (i.e., 6-month duration with 6 visits based on Otago program) conducted at home of people with Alzheimer's disease however, non-significant improvements on cardiorespiratory endurance were found.(Suttanon et al., 2012) The LiFE4D seems to be the first home-base physical activity program for people with dementia showing to be able to significantly improve their cardiorespiratory endurance. The different duration and number of sessions between programs (6 months and 6 visits vs 3 months and 23 visits) as well as the engagement on physical activities based in daily routines seem to explain differences between studies and support the implementation of LiFE4D in clinical practice.

The neuromotor component (i.e., balance) is one of the most common risk factors for falls in community-dwelling people with dementia.(Allan, Ballard, Rowan, & Kenny, 2009) Balance declines over time as age progresses however, such decline is significantly faster in people with dementia than in their cognitively healthy peers.(Suttanon, Hill, Said, & Dodd, 2013) Thus, it is important to maintain or increase balance performance in people with dementia. Significant improvements in the neuromotor component have been previously observed in other physical activity programs.(Park & Cohen, 2019; Potter et al., 2011) Nevertheless, such programs were not personalized, had longer durations,(Almeida, Gomes da Silva, et al., 2019) were conducted in different settings or were structured, which might compromise adherence.(Hancox et al., 2019; van Alphen et al., 2016) The improvements observed in the cardiorespiratory and neuromotor components with a short-term intervention conducted at home, that is tailored to each participant and integrated in their daily routines, places LiFE4D as a clinical relevant intervention to stimulate autonomy and independence of people with dementia, whilst respecting their individuality and their wish of living at home.(Moise et al., 2004)

The effects of physical activity in body composition of people with dementia has been poorly studied. The lack of significant differences on body composition found in this study might be explained by the fact of BMI and FFM being associated with different factors (e.g., age, gender, medication, comorbidities, time on tv watching), not depending just on physical activity.(Zeinali, Habibi, Samadi, Azam, & Djafarian, 2016) Regarding to muscular strength and flexibility, controversy results have been reported with structured exercise programs, mostly conducted in groups of people with dementia.(Pitkälä, Savikko, Poysti, Strandberg, & Laakkonen, 2013; Potter et al., 2011) Improvements in muscular strength/endurance and flexibility seem challenged to be obtained as they decline significantly due to the ageing process, thus, longer and/or more structured interventions to address these components have been suggested.(Adams, O'Shea, & O'Shea, 1999) Nevertheless, compliance and adherence might be compromised in such interventions in people with dementia.(Di Lorito et al., 2020; Hancox et al., 2019; Pitkälä et al., 2013) It is also likely to have results being influenced by the choice of the outcome measures (handgrip, the 30-s STS and CSRT), which might not be sensitive enough to detect changes on muscular strength/endurance or flexibility after a physical activity program in this population.(Blankevoort, van Heuvelen, & Scherder, 2013; Hesseberg, Bentzen, & Bergland, 2015) Future research on the most sensitive to change measures and/or most suitable programs/structures to achieve clinical relevance in muscular strength, muscular endurance and flexibility should be conducted.

Other meaningful outcomes for people with dementia, such as cognitive function and health-related quality of life have been showing inconsistent effects after physical activity programs in this population.(Park & Cohen, 2019; Potter et al., 2011) Most physical activity interventions have been unable to show any significant changes on health-related quality of life.(Lamb et al., 2018; Padala et al., 2017; Suttanon et al., 2012) Although we found significant improvements on health-related quality of life, possibly explained by the improvements on cardiorespiratory and neuromotor components when performing functional daily routines,(Andersen et al., 2004) careful interpretation is needed as the available evidence of the effects of physical activity on this outcome is still scarce.(Forbes et al., 2015; Potter et al., 2011)

Finally, we would like to emphasize the excellent adherence obtained to LiFE4D with no adverse events being reported, which might be explained by the setting, the tailoring and the involvement in daily routines.(Hancox et al., 2019; Moise et al., 2004) Although 23.7% of the participants reported at least one fall during 3 months, this is not surprising since the prevalence of falls in dementia is 65.7% [47% to 90%, depending on dementia type] per year and the incidence is nearly eight times higher than in their healthy peers.(Allan et al., 2009) Furthermore, none of the falls occurred during the intervention sessions.

This person-centered intervention seems to have the potential to overcome identified barriers to physical activity in people with dementia, by having a face-to-face contact at home, which is a familiar and safe environment; avoiding the need of transportation; and including tailored strategies to how and when be more physically active in daily routines without the need of equipment.(Hancox et al., 2019; van Alphen et al., 2016) Thus, LiFE4D seems a novel and promising intervention to be further explored in clinical practice as it helps people with dementia to live well at home, respecting their wish and following the international recommendations.(Moise et al., 2004)

This study has some limitations that need to be acknowledged. Participants were not blinded due to the nature of the intervention; however, a randomized concealed allocation was used to minimize bias and the opportunity to receive the LiFE4D after their participation in the study was given to the CG. Another limitation of this study was the existence of some missing values (i.e., dropouts, refusal of the participants to perform some tests). The GEE analysis was conducted to overcome this difficulty since it is a robust method to deal with missing values. Lastly, a heterogeneous sample in terms of different types of dementia with a wide age range was included in this study, as commonly observed in real-world studies and therefore adjusted models were computed to reduce the heterogeneity. Lastly, this study did not assess adherence to self-directed physical activity. Future studies are now required to explore the: I) impacts of the LiFE4D program on caregiver's burden; II) impacts perceived by the participants; III) medium- and long-term effects of the LiFE4D program; and IV) cost-effectiveness of this intervention.

Conclusion

The LiFE4D is an efficacious and effective home-based intervention to improve health-related physical fitness (i.e., cardiorespiratory endurance and neuromotor components) and health-related quality of life of people with dementia, with excellent adherence. This study might be important to guide future interventions, and clinical and policy decisions on improving access to physical activity at home for people living with dementia.

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Supplementary material

Table S1. Baseline differences between people with dementia participating at 3 months and lost to follow-up (n=47).

Table S2. Unadjusted efficacy of the Lifestyle Integrated Functional Exercise for People with Dementia after 3 months of intervention (per protocol analysis, n=38).

Table S3. Unadjusted effectiveness of Lifestyle Integrated Functional Exercise for People with Dementia after 3 months of intervention (intention-to-treat analysis, n=47).

Table S1. Baseline differences between people with dementia participating at 3 months and lost to follow-up (n=47).

	All			Experimental Group			Control Group		
	Post assessed (n=38)	**Lost to post assessment (n=9)**	**p**	**Post assessed (n=19)**	**Lost to post assessment (n=4)**	**p**	**Post assessed (n=19)**	**Lost to post assessment (n=5)**	**p**
Age (years)	80 [74.8 to 84]	87 [80.5 to 90.5]	0.017*	82 [78 to 85]	90.5 [83 to 92.8]	0.046*	79 [73 to 82]	83 [79 to 87]	0.075
Gender (female) n, %	23 (60.5)	7 (77.8)	0.333	14 (73.7)	3 (75)	0.957	9 (47.4)	4 (80)	0.193
Formal education (years) n, %			0.492			0.747			0.427
0	6 (15.8)	4 (44.4)		4 (21.1)	2 (50)		2 (10.5)	2 (40)	
1-4	26 (68.4)	5 (55.6)		11 (57.9)	2 (50)		15 (78.9)	3 (60)	
5-6	1 (2.6)	-		1 (5.3)	-		-	-	
7-9	2 (5.3)	-		1 (5.3)	-		1 (5.3)	-	
10-12	2 (5.3)	-		2 (10.5)	-		-	-	
12+	1 (26.6)	-		-	-		1 (5.3)	-	
Marital status n, %			0.772			0.584			0.717
Single	2 (5.3)	-		-	1 (5.3)		-	1 (5.3)	
Married	19 (50)	5 (55.6)		3 (75)	9 (47.4)		2 (40)	10 (52.6)	
Widow	17 (44.7)	4 (44.4)		1 (25)	9 (47.4)		3 (60)	8 (42.1)	
Dementia type n, %			0.732			0.462			0.891
Alzheimer's Disease	11 (28.9)	5 (55.6)		2 (50)	2 (10.5)		3 (60)	9 (47.4)	
Vascular dementia	6 (15.8)	1 (11.1)		-	4 (21.1)		1 (20)	2 (10.5)	
Frontotemporal dementia	2 (5.3)	-		-	1 (5.3)		-	1 (5.3)	
Parkinson's Disease	4 (10.5)	1 (11.1)		1 (25)	3 (15.8)		-	1 (5.3)	
Creutzfeldt-Jakob	1 (2.6)	-		-	1 (5.3)		-	-	
Non specified	14 (36.8)	2 (22.2)		1 (25)	8 (42.1)		1 (20)	6 (31.6)	
Day care services n, %	17 (44.7)	1 (11.1)	0.062	1 (25)	9 (47.4)	0.412	-	8 (42.1)	0.076
Number comorbidities	2 [1 to 3]	2 [1 to 2]	0.383	2 [1 to 2]	2 [1.2 to 2]	0.963	2 [2 to 3]	2 [0.5 to 3]	0.300
Number of medications	8 [6 to 10]	8 [4 to 9.8]	0.765	8 [6 to 10]	5.5 [2.2 to 8.8]	0.220	8 [5.2 to 9.8]	9 [7.2 to 10]	0.417
Outcome and outcome measures									

Cardiorespiratory endurance	2MST (number of repetitions)	27.5 [10.2 to 50]	0 [0 to 37.5]	0.040*	19.5 [10 to 34]	0 [0 to 14]	0.131	31 [10.8 to 68.8]	0 [0 to 33]	0.159
Body composition	BMI (kg/m^2)	27 [25.4 to 29.5]	26.5 [22.8 to 30.5]	0.534	27.2 [25.3 to 30.4]	27.4 [24.2 to 30.7]	0.705	26.8 [25.5 to 28.7]	26.5 [24 to 28.4]	0.566
	FFM (%)	37.4 [30.9 to 41.8]	36.7 [34.8 to 38.6]	0.853	37.4 [31.2 to 42.2]	34.8	0.535	37.2 [30.4 to 41.5]	38.6	0.789
Muscular strength	Handgrip (kg)	18.5 [13.2 to 27]	15.5 [8.8 to 20]	0.280	15.5 [9.5 to 23.2]	16 [14 to 18]	0.850	20.5 [17 to 30]	13 [8.2 to 23.8]	0.096
Muscular endurance	30-s STS (number of repetitions)	7.5 [4 to 10]	2.5 [0 to 5.5]	0.026*	6 [4 to 9]	3 [0.5 to 5.5]	0.121	8 [4 to 12]	1.5 [0 to 9]	0.113
Flexibility	CSRT (cm)	-15 [-22.5 to -9.2]	-13 [-17.5 to -0.5]	0.448	-11.5 [-21.5 to -4.5]	-16 [-17.5 to -13.5]	0.513	-17 [-23 to -12.8]	-1.5 [-13 to 10]	0.114
Neuromotor	Brief-BESTest (points)	4.5 [1 to 11.2]	1.5 [0.2 to 8]	0.194	4 [0 to 8]	1.5 [0.2 to 8]	0.651	5 [3 to 14]	1.5 [.2 to 10.2]	0.154
Cognitive function	ACE-III Total (points)	49.5 [33 to 60.2]	39.5 [12 to 64]	0.607	48 [35 to 59]	46 [25.5 to 58]	0.962	53 [30 to 61]	33	0.435
	ACE-III Attention (points)	10 [7 to 13.2]	10 [6 to 15]	0.676	8 [7 to 13]	10 [6.5 to 12.5]	0.962	12 [6 to 14]	12 [9 to 15]	0.588
	ACE-III Memory (points)	7.5 [4.8 to 12]	3.5 [0.8 to 17.5]	0.273	7 [3 to 12]	4 [2 to 13]	0.666	8 [5 to 12]	3	0.192
	ACE-III Fluency (points)	2 [0.8 to 4.2]	2 [0.5 to 4.2]	0.794	2 [0 to 3]	2 [1 to 2]	0.427	2 [1 to 5]	5	0.381
	ACE-III Language (points)	17 [11.8 to 21]	15.5 [4.2 to 21.5]	0.780	17 [14 to 21]	20 [11 to 21]	0.848	21 [17 to 22]	11	0.487
	ACE-III Visuospatial (points)	8.5 [5.8 to 10]	6.5 [1.2 to 10.2]	0.400	8 [5 to 10]	8 [4 to 9.5]	0.773	9 [8 to 10]	5	0.334
Health-related quality of life	QoL-AD (points)	27 [21 to 32.5]	26 [24.5 to 30.5]	0.818	24 [21 to 27.5]	24.5 [23 to 26]	0.640	30.5 [27.2 to 37.8]	35	0.540

Values are presented as mean ± standard deviation or median [interquartile range].
Legend: Abbreviations: 2MST: 2-minute step test; 30-s STS: 30-second sit to stand test; ACE-III: Addenbrooke's cognitive examination-III; BMI: body mass index; Brief-BESTest: brief-balance evaluation systems test; CSRT: chair sit-and-reach test; FFM: fat-free mass; QoL-AD: quality of life in Alzheimer's disease scale. *p<0.05

Table S2. Unadjusted efficacy of the Lifestyle Integrated Functional Exercise for People with Dementia after 3 months of intervention (per protocol analysis, n=38).

Outcome	Outcome measure	Experimental Group (n=19)		Control Group (n=19)		Unadjusted model	Group*time
		Pre	Post	Pre	Post	β (95% CI)	p-value
Primary outcome							
Cardiorespiratory endurance	2-Minute step test (number of repetitions)	23.6±3.3 (17.8 to 31.1)	34.4±4.5* (26.7 to 44.5)	42.7±7.1 (30.8 to 59.2)	40.2±7 (28.6 to 56.4)	3.7• (3.4 to 4)	0.001Ŧ
Secondary outcomes							
Body composition	Body mass index (kg/m^2)	27.7±0.8 (26.1 to 29.4)	27.4±1.1 (25.4 to 29.6)	27.4±0.7 (26.2 to 28.7)	27.5±0.7 (26.1 to 29)	3.3 (3.3 to 3.4)	0.560
	Fat-free mass (%)	36.8±2.3 (32.5 to 41.6)	32.9±1.7 (29.7 to 36.4)	36.3±1.8 (32.9 to 40)	36.2±1.8 (32.7 to 40)	3.6 (3.5 to 3.7)	0.245
Muscular strength	Handgrip (kg)	18.1±2.4 (13.9 to 23.4)	17.7±2 (14.3 to 22)	23.4±1.9 (20 to 27.5)	22.4±2.3 (18.4 to 27.3)	3.1 (2.9 to 3.3)	0.708
Muscular endurance	30-s STS (no of repetitions)	7.4±0.9 (5.7 to 9.5)	8±0.9 (6.3 to 10)	9±1.1 (7.1 to 11.5)	9.2±1.2 (7.1 to 12)	2.2 (2 to 2.5)	0.656
Flexibility	CSRT (cm)	-13.1±2.7 (-18.4 to -7.7)	-10.8±2.6 (-15.8 to -5.7)	-15.8±2.2 (-20.2 to -11.4)	-17.8±2.7 (-23 to -12.6)	-17.8 (-23 to -12.6)	0.153
Neuromotor	Brief-BESTest (points)	5.7±1 (4 to 8.1)	9.2±1.1* (7.3 to 11.5)	8.8±1.3 (6.6 to 11.8)	8.7±1.3 (6.5 to 11.7)	2.2• (1.9 to 2.5)	0.001Ŧ
Exploratory outcomes							
Cognitive function	ACE-III Total (points)	44.8±4.4 (37 to 54.3)	46.7±4.8 (38.1 to 57.2)	46.6±5.1 (37.6 to 57.8)	45.1±5.3 (35.8 to 56.8)	3.8 (3.6 to 4)	0.090
	ACE-III Attention (points)	10.5±1 (8.8 to 12.6)	10.4±1 (8.7 to 12.4)	11±1 (9.1 to 13.2)	11±1.1 (9 to 13.4)	2.4 (2.2 to 2.6)	0.886
	ACE-III Memory (points)	9.4±1.3 (7.1 to 12.3)	10.7±1.6* (8 to 14.3)	10.5±1.5 (8 to 13.9)	10.3±1.4 (7.8 to 13.6)	2.3 (2.1 to 2.6)	0.082
	ACE-III Fluency (points)	3.7±0.6 (2.7 to 5.1)	3.6±0.6 (2.6 to 5)	4±0.7 (2.9 to 5.6)	3.5±0.6 (2.4 to 5)	1.2 (0.9 to 1.6)	0.423
	ACE-III Language (points)	16.8±1.5 (14.2 to 20)	17.2±1.5 (14.5 to 20.4)	15.5±1.7 (12.5 to 19.2)	15.3±1.8 (12.1 to 19.2)	2.7 (2.5 to 3)	0.456
	ACE-III Visuospatial (points)	8.4±0.8 (7 to 10.1)	8.8±0.9 (7.3 to 10.7)	9±1 (7.3 to 11.1)	9.1±1 (7.3 to 11.3)	2.2 (2 to 2.4)	0.660
Health-related quality of life	QoL-AD (points)	23.6±1.2 (21.3 to 26.1)	26.3±1.5* (23.6 to 29.4)	31.6±1.9 (28.2 to 35.5)	29.5±1.7* (26.3 to 33.1)	3.4Δ (3.3 to 3.5)	0.005Ŧ

Values of the pre- and post-assessments are presented as mean ± standard error of mean (95% CI). *p-value of post vs pre assessment ≤0.05. Δ p-value for group differences ≤0.05. • p-value for time differences ≤0.05. Ŧ p-value for interaction between group and time ≤0.05.

Abbreviations: 30-s STS: 30-second sit to stand test; ACE-III: Addenbrooke's cognitive examination-III; Brief-BESTest: brief-balance evaluation systems test; CI: confidence interval; CSRT: chair sit-and-reach test; QoL-AD: quality of life in Alzheimer's disease scale.

Table S3. Unadjusted effectiveness of Lifestyle Integrated Functional Exercise for People with Dementia after 3 months of intervention (intention-to-treat analysis, n=47).

Outcome	Outcome measure	Experimental Group (n=23)		Control Group (n=24)		Unadjusted model β (95% CI)	Group*time p-value
		Pre	Post	Pre	Post		
Primary outcome							
Cardiorespiratory endurance	2-Minute step test (number of repetitions)	21.7±3.2 (16.2 to 29)	34.4±4.5* (26.7 to 44.5)	39.9±6.8 (28.6 to 55.7)	40.2±6.9 (28.6 to 56.4)	3.7• (3.4 to 4)	0.006Ŧ
Secondary outcomes							
Body composition	Body mass index (kg/m²)	27.7±0.8 (26.2 to 29.3)	27.4±1.1 (25.4 to 29.6)	27.2±0.6 (26 to 28.5)	27.5±0.7 (26.1 to 29)	3.3 (3.3 to 3.4)	0.485
	Fat-free mass (%)	36.7±2.2 (32.7 to 41.2)	32.9±1.7 (29.7 to 36.4)	36.5±1.7 (33.3 to 39.9)	36.2±1.8 (32.7 to 40)	3.6 (3.5 to 3.7)	0.267
Muscular strength	Handgrip (Kg)	18±2.2 (14.2 to 22.7)	17.7±2 (14.3 to 22)	22.1±1.8 (18.8 to 25.9)	22.4±2.3 (18.4 to 27.3)	3.1 (2.9 to 3.3)	0.773
Muscular endurance	30-s STS (number of repetitions)	6.8±.8 (5.3 to 8.6)	8±.9 (6.3 to 10)	8.3±1.1 (6.4 to 10.6)	9.2±1.2 (7.1 to 12)	2.2 (2 to 2.5)	0.739
Flexibility	CSRT (cm)	-13.4±2.3 (-18 to -8.8)	-10.8±2.6 (-15.8 to -5.7)	-14.4±2.4 (-19 to -9.8)	-17.8±2.7 (-23 to -12.6)	-17.8 (-23 to -12.6)	0.055
Neuromotor	Brief-BESTest (points)	5.4±0.9 (3.9 to 7.6)	9.2±1.1* (7.3 to 11.5)	8.1±1.2 (6.1 to 10.9)	8.7±1.3 (6.5 to 11.7)	2.2• (1.9 to 2.5)	0.004Ŧ
Exploratory outcomes							
Cognitive function	ACE-III Total (points)	44.4±4.3 (36.6 to 53.7)	46.7±4.8 (38.1 to 57.2)	46±4.9 (37.3 to 56.6)	45.1±5.3 (35.8 to 56.8)	3.8 (3.6 to 4)	0.304
	ACE-III Attention (points)	10.5±.9 (8.8 to 12.5)	10.4±.9 (8.7 to 12.4)	11.1±1 (9.4 to 13.2)	11±1.1 (9 to 13.4)	2.4 (2.2 to 2.6)	0.900
	ACE-III Memory (points)	9.4±1.4 (7.1 to 12.5)	10.7±1.6 (8 to 14.3)	10.2±1.5 (7.7 to 13.5)	10.3±1.4 (7.8 to 13.6)	2.3 (2.1 to 2.6)	0.347
	ACE-III Fluency (points)	3.5±0.5 (2.6 to 4.7)	3.6±0.6 (2.6 to 5)	4.2±0.6 (3 to 5.6)	3.5±0.6 (2.4 to 5)	1.2 (0.9 to 1.6)	0.207
	ACE-III Language (points)	16.7±1.5 (14 to 19.8)	17.2±1.5 (14.5 to 20.4)	15.4±1.6 (12.5 to 18.9)	15.3±1.8 (12.1 to 19.2)	2.7 (2.5 to 3)	0.587
	ACE-III Visuospatial (points)	8.3±0.8 (6.9 to 10)	8.8±0.9 (7.3 to 10.7)	8.8±0.9 (7.2 to 10.9)	9.1±1 (7.3 to 11.3)	2.2 (2 to 2.4)	0.690
Health-related quality of life	QoL-AD (points)	23.7±1.1 (21.6 to 26)	26.3±1.5* (23.6 to 29.4)	31.8±1.8 (28.6 to 35.5)	29.5±1.7* (26.3 to 33.1)	3.4Δ (3.3 to 3.5)	0.003Ŧ

Values of the pre- and post-assessments are presented as mean ± standard error of mean (95% CI). *p-value of post vs pre assessment ≤0.05. Δ p-value for group differences ≤0.05. • p-value for time differences ≤0.05. Ŧ p-value for interaction between group and time ≤0.05.

Abbreviations: 30-s STS: 30-second sit to stand test; ACE-III: Addenbrooke's cognitive examination-III; Brief-BESTest: brief-balance evaluation systems test; CG: control group; CI: confidence interval; CSRT: chair sit-and-reach test; QoL-AD: quality of life in Alzheimer's disease scale.

Chapter 6. Impacts of LiFE4D on the participants' perspective

Original study III – qualitative study

A qualitative study to give voice to people with dementia and their caregivers about home-based physical activity

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Abstract

Objectives: To explore the perceived motivators/facilitators, barriers and impacts of the Lifestyle Integrated Functional Exercise for People with Dementia (LiFE4D) by people with dementia (PwD) and their caregivers.

Design: Exploratory, qualitative study.

Setting: Participants' home.

Participants: PwD and their caregivers.

Intervention: LiFE4D is a 3-month tailored home-based physical activity program, embed in daily routines, with a progressive decrease in face-to-face contacts with the health professional over time.

Measurements: A structured questionnaire and a cognitive function scale (Addenbrooke´s Cognitive Examination-III [ACE-III]) were used to characterize the sample. Short semi-structured interviews were conducted using a phenomenology theoretical framework, with PwD and their caregivers. Interviews were audio recorded, transcribed and analyzed by deductive thematic analysis using the Web Qualitative Data Analysis software.

Results: Fifteen PwD (60% female, 82 [75-84] years, ACE-III 50.4 [22-72] points) and 9 caregivers (77.8% female, 72 [60-76] years) were included. Most reported motivators/facilitators (PwD-professional support, easy exercises and emotional well-being; caregivers-professional support, setting, social contact and opportunities to learn), barriers (PwD-tiredness, memory problems and body pain; caregivers-tiredness and family conflicts) and; impacts (PwD-continued to practice physical activity, physical well-being and overcome limits; caregivers-physical benefits and emotional impacts on loved ones and positive impacts on family) were identified. Other subthemes (e.g., loneliness and burden) also emerged from the interviews.

Conclusions: More motivators/facilitators than barriers were found from participating in the LiFE4D. PwD and their caregivers demonstrated different perceptions, nevertheless, professional support, easy exercise, tiredness and lack of time, were commonly perceived. Only positive impacts on PwD and their caregivers emerged.

Key words: Major neurocognitive disorder, functionality, activities of daily living, thematic analysis, person-centred approach

Introduction

Dementia is a public health priority expected to affect around 152 million people, worldwide, by 2050 (OECD, 2017; World Health Organization, 2017). Most people with dementia live at home (Wimo, Gauthier, Prince, on behalf of ADI's Medical Scientific Advisory Panel, & the Alzheimer's Disease International publications team, 2018), and it is their wish to continue to live in their homes for as long as possible, which is also an international recommendation (OECD, 2017; World Health Organization, 2012).

Engaging in physical activity (PA) has the potential to help people with dementia living well at home since it improves their ability to perform activities of daily living (ADL), increases physical and cognitive function, and reduces caregiver's burden (Forbes, Thiessen, Blake, Forbes, & Forbes, 2015; Jia, Liang, Xu, & Wang, 2019; Park & Cohen, 2019). However, people with dementia present low levels of PA, spending most of their waking time in sedentary behavior or in very light activities (Hartman, Karssemeijer, van Diepen, Olde Rikkert, & Thijssen, 2018). In response, some PA programs have become available in community centers or institutions for people with dementia (Forbes et al., 2015). Nevertheless, high dropout rates and low adherence have been reported (Nyman, Adamczewska, & Howlett, 2018; van der Wardt et al., 2017; van der Wardt et al., 2019), which can be explained by the setting, dependence on transportation, strict timetables, dependence on third parties (e.g., caregiver) to accompany them during the intervention and the structured physical exercises, that rarely fit into the daily routines of this population (Forbes et al., 2015; van Alphen, Hortobágyi, & van Heuvelen, 2016).

Home-based PA programs might be the solution to increase motivation and adherence, as they have shown high adherence rates (Almeida, Gomes da Silva, & Marques, 2019) and have the potential to integrate tailored PAs in daily routines, involving caregivers support. PA programs have shown to be safe for people with dementia at home and to: i) improve the ability to perform ADL and health-related physical fitness, ii) positively change behavioral and psychological symptoms of dementia, iii) decrease caregiver's burden, and iv) slow cognitive function decline in this population (Almeida et al., 2019). Despite these promising results, the opinions of people with dementia and of those caring for them are often not heard. These are fundamental to improve the quality and relevance of the interventions and identify their motivations to become more physically active (Gove et al., 2018; van Alphen et al., 2016). Therefore, the aim of this study was to explore the perceived motivators/facilitators, barriers and impacts of participating in a home-based PA program, the Lifestyle Integrated Functional Exercise for People with Dementia (LiFE4D), in the perspective of people with dementia and their caregivers.

Methods

Design and ethics

An exploratory, qualitative study was conducted. The theoretical framework used for data collection and analysis was phenomenology with a deductive approach, as it focuses on describing the meaning and significance of experiences (Creswell, 2007). The standards for reporting qualitative research (O'Brien, Harris, Beckman, Reed, & Cook, 2014) and the consolidated criteria for reporting qualitative research (COREQ) were followed (Tong, Sainsbury, & Craig, 2007).
The current study was performed nested to a randomized controlled trial (ClinicalTrials.gov ID: NCT03757806). Ethics approval was originally obtained to the LiFE4D program by the Ethics Committee of the Health Sciences Research Unit – Coimbra Nursing School, and an amendment was approved (AD-P437-06/2017) for this additional qualitative study. Written informed consent was obtained from all participants and caregivers and/or a proxy decision-maker (if applicable).

Participants

A convenience sample was recruited from the LiFE4D study (people with dementia and their informal caregivers/significant people [family member or friend], from now on referred to as caregivers). Participants who completed the home-based PA program, LiFE4D intervention, were contacted to participate in this study. The first contact was made by the researcher who usually contacted the participants during the LiFE4D to explain the program. A meeting was scheduled with participants who agreed to participate, to further explain the qualitative study, their voluntary participation and right to withdraw or not answer questions at any time. Interviews were arranged and conducted within six months of the LiFE4D completion.
Inclusion criteria were to have completed the participation in the LiFE4D program and voluntarily accept to participate. Exclusion criteria was being unable to respond to the interview (e.g., aphasia).

Data collection

Data collection were conducted at participants' homes (or in nursing home as two participants moved during the follow up period) by a researcher (i.e., psychologist) not involved in the LiFE4D intervention and who had no previous contact with the participants.

Sociodemographic (e.g., person with dementia and caregiver: age and gender; caregiver: relationship with the person with dementia and if living or not together), context of care (e.g., hours of basic/instrumental care, number of people involved in care and length of care) and clinical (e.g., person with dementia: number of comorbidities) data were collected to characterize the sample with a structured questionnaire. For the purpose of this study, basic care was defined as assistance on feeding, dressing, bathing and walking; and instrumental care was defined as assistance in cooking, cleaning, transportation, laundry and financial management (Katz, 1983).

The Addenbrooke´s Cognitive Examination III (ACE-III) was used to characterize the cognitive function of participants with dementia, as it is a sensitive measure of the early stages of dementia and has been shown to have high diagnostic accuracy compared to other widely used cognitive measures (Matias-Guiu et al., 2017). ACE-III distinguishes five cognitive domains with a total score of 100 points, with higher values indicating better cognitive performance (Matias-Guiu et al., 2017). ACE-III is a reliable measure (αCronbach=0.91) and a 74 points cut-off has been established to screen people with dementia (Peixoto et al., 2018).

Qualitative data were obtained through short semi-structured interviews to diminish disruption, intrusion and fatigue, due to the included population and to avoid burden of assessment (Lindlof & Taylor, 2001; Øksnebjerg et al., 2020). Open-ended one-to-one interviews were used to allow the exploration and understanding of participants' experiences, opinions, feelings and attitudes regarding their participation in LiFE4D (Braun & Clarke, 2006). This is an appropriate method for exploring areas of interest in people with poor collaboration skills (Digby, Lee, & Williams, 2016). The researcher talked through the script of the interview and re-worded, re-ordered or clarified the questions if needed. Although the presence of a third person in an interview might cause discomfort, distraction or inhibition to talk, in participants with dementia who might rely on their caregiver, the absence of the caregiver might also difficult their response, therefore, people with dementia and their caregivers were encouraged to participate in the interview individually but were offered the options of being interviewed together or individually. The interviews were recorded with 2 small portable audio recorders (Olympus digital voice recorder ws 750m; Olympus VN3100PC digital voice recorder). At the end of each interview, the researcher made notes about the interview environment and participants’ mood that could be useful for data interpretation (Hancox et al., 2019; Perfect et al., 2019).

Two short semi-structured interview guides with open-ended questions were developed, one for participants with dementia and another one for their caregivers’, both based on studies in people with dementia and cognitive decline (Fortin, 2006; van Alphen et al., 2016) (Table 1). The interviews were conducted between March and November 2019.

Table 1. Short semi-structured interview guides for people with dementia and their caregivers.

People with dementia	Caregivers
1. What are your thoughts about the program? 2. In your opinion, what were the barriers/difficulties of participating in the program? 3. In your opinion, what were the facilitators/aspects that helped your participation? 4. Are you still doing the activities? 4.1 If yes, what motivates you to continue? 4.2 If no, why did you stop doing it? 5. What were the impacts or effects of the program on you? 6. What were the impacts or effects of the program on the person who is closest to you? 7. What would you change about the program?	1. What are your thoughts about the program? 2. In your opinion, what were the barriers/difficulties of participating in the program? 3. In your opinion, what were the facilitators/aspects that helped your participation? 4. Does he/she continue to do physical activity alone/with help? 4.1 If yes, what motivates him/her to continue? 4.2 If not, why did he/she stop doing it? 5. What were the impacts or effects of the program on you? 6. What were the impacts or effects of the program on the person you care for? 7. What would you change about the program?

Intervention

LiFE4D is an individualized home-based PA program with face-to-face sessions complemented by phone calls for people with dementia, with a duration of 3 months. In the first month the health professional with training in PA and dementia, went to the participant's home 3 times a week. At the end of the first month, each participant received a book with the PAs that they could continue to perform by themselves or with the caregiver’s help during their daily living (Almeida, Gomes da Silva, & Marques, 2020). In the second month, the health professional reduced the visits for twice a week and made a call every two weeks. In the last month, the health professional went to the participant's home once a week, for the first three weeks, and called him once every two weeks with an extra call in the last week. The face-to-face sessions lasted approximately one hour, and telephone contacts lasted a maximum of 15 minutes. The face-to-face sessions aimed to adapt PA to everyday tasks, increase tasks frequency and intensity, monitor progress, clarify doubts, motivate and manage expectations (Almeida et al., 2020). Phone calls aimed to motivate participants and clarify doubts (Almeida et al., 2020). Each participant received an educational and psychosocial support component adapted to their needs. Caregivers were invited and encouraged to support and motivate their loved ones, however it was up to them to get or not involved. After the end of the program, follow-up assessments were performed at 3 and 6 months. Further details of the LiFE4D intervention can be found elsewhere (Almeida et al., 2020). For this study, interviews were conducted after the end of the program during the follow-up period.

Data analysis

Descriptive statistics were used for sociodemographic, context of care, clinical data and cognitive function data. The interviews were recorded in audio, transcribed in full and later analyzed by deductive thematic analysis (Braun & Clarke, 2006). Any information that could cause participants' identification was removed to preserve anonymity (Braun & Clarke, 2006). Thematic analysis is a method for identifying and reporting patterns in relation to a specific scientific question through the experiences, meanings and reality perceived by the participant (Braun & Clarke, 2006). Deductive thematic analysis was adopted as there were expectations to find preconceived themes based on existing knowledge (Karssemeijer, de Klijn, Bossers, Olde Rikkert, & van Heuvelen, 2020; van Alphen et al., 2016), but flexibility still existed to generate new themes if needed (Braun & Clarke, 2006). The transcripts were read and reread for familiarization with the data, before the subtheme coding process began (Braun & Clarke, 2006). Session annotations and audio recordings were analyzed using the six phases of the thematic analysis: familiarization with the data; generation of initial codes; search for themes/subthemes, review themes/subthemes; define and name themes/subthemes and producing the report (Braun & Clarke, 2006). Codes were organized in subthemes (e.g., combined with similar or related ideas from all participants data) and then the subthemes were grouped into themes of "motivators/facilitators", "barriers", "impacts of the program" and "other subthemes".

Two researchers were involved in the interpretation of data on the subthemes found (Green & Thorogood, 2004). The initial subthemes found from both researchers were compared and, in case of disagreement, consensus was reached by discussion and consultation with the other authors. The interviews were inserted into the Web Qualitative Data Analysis (WebQDA) software to facilitate the text analysis. The WebQDA was used to assist in the process of coding and data management for analysis (e.g., generate new codes, identify quotes for codes). Special attention was given to identify positive and negative subthemes (Braun & Clarke, 2006). The subthemes were then refined and clustered into the predefined themes: barriers, motivators/facilitators, impacts of the program, and other subthemes, separately for people with dementia and their caregivers. Verbatim quotations were included to support the interpretation of the identified themes and subthemes. Pseudonyms were assigned to each person with dementia and caregivers for confidentiality.

Results

Participants

From a total of 24 participants with dementia who engaged in the LiFE4D program, 2 did not accept to participate, 3 died, and 4 were excluded (due to aphasia). From those who were include, one was a couple, and their caregiver was the same, and 5 caregivers did not accept to participate. Thus, a total of 24 participants were included in this study: 15 people with dementia (60% female, 82 [75-84] years old, ACE-III 50.4 [22-72] points) and 9 caregivers (77.8% female, 72 [60-76] years old). The characteristics of participants are shown in Table 2.

Table 2. Characteristics of participants (n=24).

People with dementia (n=15)					**Caregivers (n=9)**				
	Age (years)	**Sex**	**ACE-III Total score points**	**No of Comorbidities[1]**		**Age (years)**	**Sex**	**Relationship**	**Living together**
John	82	Male	56	0	**Kelly**	76	Female	Sister-in-law	yes
Anne	73	Female	22	1	**Beth**	63	Female	Sister	yes
Emily	82	Female	33	1	**Suzy**	59	Female	Daughter	yes
Mariah	84	Female	31	4	**NA**	NA	NA	NA	NA
Anthony	75	Male	72	0	**Jessy**	72	Female	Wife	yes
Rose	81	Female	49	2	**NA**	NA	NA	NA	NA
Catherine	78	Female	38	1	**Patrick**	79	Male	Husband	yes
Jonathan	90	Male	69	3	**Wilson**	60	Male	Son	no
Wendy	89	Female	48	1					
Richard	75	Male	62	2	**Evelyn**	72	Female	Wife	yes
Caroline	84	Female	58	1	**NA**	NA	NA	NA	NA
Yolanda	85	Female	45	2	**Martha**	54	Female	Daughter	yes
Judith	91	Female	60	3	**NA**	NA	NA	NA	NA
Michael	81	Male	65	4	**NA**	NA	NA	NA	NA
Christian	79	Male	48	4	**Clare**	76	Female	Wife	yes
Total sample									
n=15 Median [IQR]	82 [75-84]	Female 9 (60%)	50.4 [22-72]	2 [1-3]	**n=9**	72 [60-76]	Female 7 (77.8%)	Wife 3 (33.3%)	Yes 8 (88.9%)

[1] Cardiac condition, hypertension, diabetes, arthritis, arthrosis, rheumatism, cholesterol and arteriosclerosis.

ACE-III: Addenbrooke´s Cognitive Examination III; IQR: interquartile range; NA: not available.

Most people with dementia were interviewed separately (n=10), the two participants who shared the same caregiver were interviewed separately and all caregivers were interviewed alone. Five people with dementia asked to be interviewed in the presence of a caregiver because they felt more comfortable. The duration of the short semi-structured interviews was approximately 15min for people with dementia and 25min for caregivers.

Six (66.7%) caregivers reported being 100% involved in basic and instrumental care of people with dementia. Five (55.6%) caregivers had no help from any person and 3 (33.3%) received help from only 1 person in the care provision. Caregivers performed a median of 4h/day of both basic (i.e., bathing, dressing) and instrumental (i.e., cleaning the house, shopping) care. Regarding the length of care provided by these caregivers, the median was 3 years (minimum 2 and maximum 5 years). Details of the care provided can be found in the supplementary material (Table S1).

Thematic analysis

A total of 44 subthemes were identified from the analysis of the interviews, from which 4 were common in people with dementia and their caregivers (e.g., motivators/facilitators - professional support and easy exercises from; barriers: tiredness and lack of time). People with dementia identified 25 subthemes - 10 (40%) motivators/facilitators, 9 (36%) barriers; 5 (20%) impacts of the program and 1 (4%) another subtheme. Caregivers identified 19 subthemes - 6 (31.6%) motivators/facilitators, 5 (26.3%) barriers; 4 (21%) impacts of the program and 4 (21%) other subthemes. More details on the themes and subthemes can be found in Figure 1, Table 3 and Table 4.

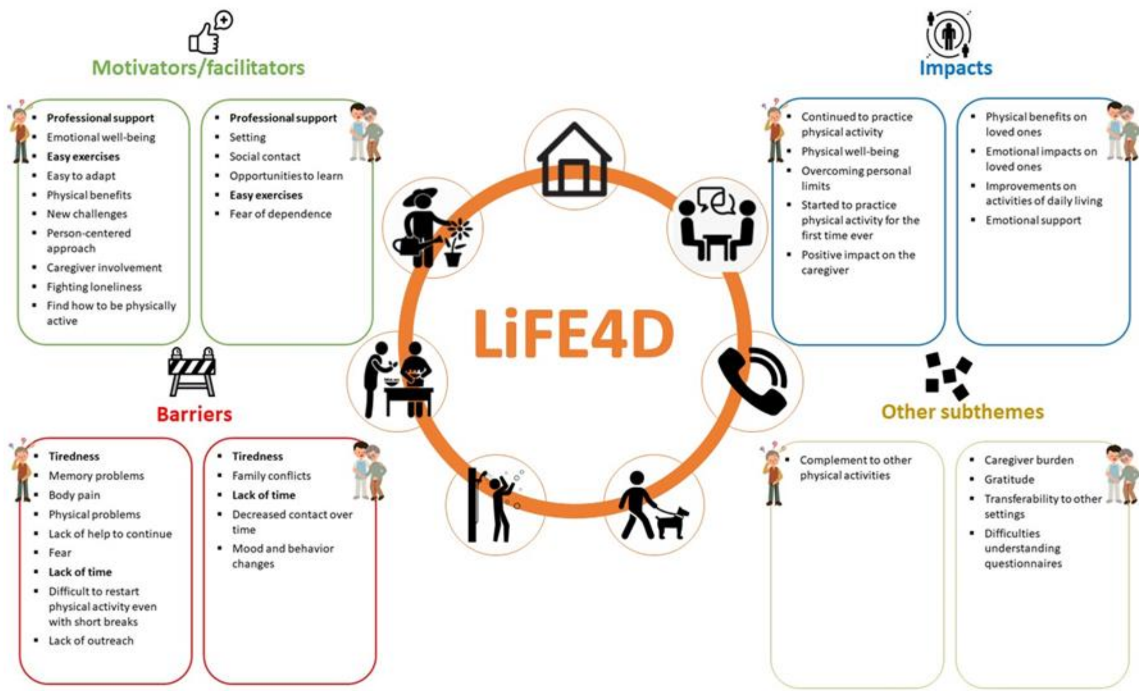

Figure 1. *Schematic representation of the themes and subthemes perceived from people with dementia and their caregivers.*

Perspectives of people with dementia

Motivators/facilitators

People with dementia identified more motivators/facilitators than barriers of being involved in the LiFE4D. Most reported motivators/facilitators were professional support, easy exercises and emotional well-being.

Generally, motivators/facilitators were related to the characteristics of the program, such as easiness to implement, professional support, person-centered, social contact, challenging and fun, and awareness of self-perceived benefits on physical and mental health. The professional support and empathy with the person “I like it a lot, just because of her face, very friendly” (Rose) and "She always helped me and was very patient with my difficulties" (Jonathan); together with acceptance of their limitations and identification of their capacities “I am here because I have an opportunity to better identify my difficulties and facilities (…) what I know is that some problems were identified and I overcame some of those problems, and we only notice that kind of things when things really happen" (Anthony), seem to facilitate and motivate the involvement of people with dementia in PA. Some participants also mentioned that the physical activities were easy to perform and the program was tailored to them "I don't have to adjust to the program, everything was simple without complications" (Anthony). Self-perceived physical and emotional well-being were also reported "It was the kind of thing that we needed to feel good" (Jonathan).

Barriers

The most reported barriers reported by people with dementia to participate in LiFE4D were tiredness, memory problems and body pain, and were mostly related to physical difficulties “Walking is very difficult; it hurts my knee. I also have a lot of pain in my arms and hands, they are always shaking" (Judith). Tiredness was also a barrier to continue a physically active lifestyle after LiFE4D as stated by Judith when she was asked if she continued to do the PAs: “a little, but I get tired and that’s it, I stay here [sitting on the couch]”.

Memory problems (i.e., difficulty in remembering the program and/or the instructor's name, or even their participation in the program) were directly expressed by participants or observed during the interviews. Some participants, like Yolanda, were unable to remember the program, saying “I don’t know (…) I don’t know what it is and what it is not, no one told me” when asked about her participation, and saying “I don’t know, with [name of the professional]? Who is [name of the professional]?” when asked about the health professional who accompanied the face-to-face sessions. Some other participants were unable to name/explain the activities, but they reproduced them with gestures, like standing up and showing to the interviewer the PAs that they enjoyed the most.

Impacts of the program

The most reported impacts of the program, perceived by people with dementia, were continued PA practice, physical well-being and overcoming personal limits. The motivation after realizing the improvements that PA brought to their independence and well-being, coupled with the facility to replicate the activities during their routines at home, lead to 10 participants to report to continue to perform PAs after the end of the program. For example, Richard stated that "I practically [practice] do it every day, I always walk and try to do what I can".

Some participants perceived a feeling of well-being by participating in LiFE4D, such as "I had the impression that I stretched my tendons, it left me relaxed, because they were all trapped" (Judith). The feeling of physical well-being and overcoming their own limits was also mentioned in contexts that referred to the maintenance of independence in ADL "Going up and down stairs, for example, I couldn't do it (...) now I can do it easily" (Anthony). People with dementia also reported that the program was an open window to new possibilities. They felt included and had the sense of belonging to the environment they were inserted in. Noteworthy, no negative impacts were identified.

Other subthemes

Complement to other activities emerged on the other subthemes, as one participant perceived LiFE4D as a good program to complement with other PAs.

Perspective of carers

Motivators/facilitators

The most reported motivators/facilitators were the professional support, the setting, the social contact, and the opportunities to learn. The professional support and the empathy established between the professional and the people with dementia and their caregivers were highly valued "the girl [health professional] arrived, and it was very different, it was like putting gasoline on fire, it burned quickly. She achieved with her in 15 days what others did not get in 2 years. There is no doubt about it. It also has a lot to do with people's ability to empathize. It has a lot to do with it, there is no doubt that the instructor was what she needed" (Patrick).

The fact that people with dementia did not have to go out of their home to have a professional who adapts the PAs, ended up meting both caregiver's and people with dementia needs: "I think the program at home is better than to go with her to other places (...) she [the wife], gets tired and does not like to leave home" (Patrick). Social contact is very important for people living with dementia and their caregivers. With this program, direct contact emerged through the contact with the professionals involved, and it seemed that there was also an indirect improvement in social contact that derived from the impacts of the program, on both physical and mental well-being of people with dementia, which allowed them to carry out their social contacts easier and with less constrains.

Other motivator/facilitator that emerged from the interviews was the opportunity to learn, as it "(…) can help the patient and their families" (Kelly) because "we know little or nothing about this kind of problem, they explained it to us, talked us through (…) and left written information too" (Beth).

Barriers

The most reported barriers by caregivers were tiredness and family conflicts, which might be explained by the reported overwhelming feeling with the care tasks provided.

Barriers reported were mostly related with the continuity of PA after the end of the program. In addition to burden (tiredness and lack of time), conflicts between the person with dementia and the caregiver were identified. To motivate her loved one to continue performing PAs, Clare had to deal with changes in mood and behavior as she explained: "He does not do activities with me, he is upset, he does not listen to me, he gets tired very quickly (...) when the instructor is here, he finds it funny and does not complain". On the other hand, lack of time and/or fatigue to continue doing PAs after the end of the program resulted in feelings of guilt and frustration for not being able to continue it "I can say that the program could have been more productive if there was really more availability on my part to continue the exercises" (Suzy). In line with this, some caregivers found that sessions should be less sparse, especially not decrease to only one session per week in the last month. Moreover, they also suggested that "the duration [of the program] should be longer" (Jessy). In contrast, others found that the structure of the program should be as it is, suggesting to "(…) don't change a thing to make it worse. If you change, be careful with the changes because as it is good, it will be hard to make changes and you can be at risk of spoiling it" (Patrick).

Impacts of the program

Physical benefits and emotional impacts on loved ones and positive impacts on family were the impacts most reported by caregivers.

Physical benefits via improvement of mobility and increased independence, especially when the sessions were held three times/week, were perceived: "I think that in the motor aspect while the exercise was practiced, with that weekly regularity, it improved" (Suzy). The impacts during the first month were also perceived to improve other important domains “At that time, three times a week, my mother clearly noticed big differences from one day to the next, and even in the reports the instructor did, even in terms of behavior and attitude, because my mother was very closed” (Wilson).

The emotional impact perceived due to the support given by the health professionals providing clarifications about dementia, care and attention were highly valued by caregivers (i.e., Beth: “These things motivate us a little bit”) and people with dementia (i.e., perceived by the caregiver Patrick: “I think she has become more active, more sober, has a different look, as she had before”), leading to positive impacts on family.

Other subthemes

The improvements on mobility and increased independence, especially in basic ADL, alleviated the burden of care “He [her husband] has changed a lot. (…) I was exhausted, imagine lifting a person with that weight (…) the program changed my husband a lot, he didn't walk, and he didn't eat alone, now he does all of these” (Clare).

Caregivers also expressed a feeling of gratitude to the program and professionals involved, and showed a desire to continue it, as they felt changes in themselves and in their loved ones. The replication of LiFE4D on other settings (i.e., nursing homes and day care centers) also emerged “in a space like this [nursing home] that [program] could happen once or twice a week, or also transmit the people who work in these entities the work that you are doing, which should be more publicized because it is very interesting (…) I think it was extremely interesting. I really liked it” (Wilson).

Table 3. Motivators/facilitators, barriers and impacts of participating in LiFE4D according to people with dementia (n=15).

Themes and subthemes identified by people with dementia	Number of participants	Representative quotes
Motivators/facilitators		
Professional support	6	“The instructor did a good job, and I can consider it very good” (Jonathan)
Emotional well-being	5	“Everywhere I do gymnastics it's always a joy, it was what I needed” (Jonathan)
Easy exercises	4	“I had no difficulties, nothing was complicated” (Jonathan)
Easy to adapt	3	“What I see, and highlight is that there is no difficulty, the program is easy to access and has quality” (Richard)
Physical benefits	2	“I liked it a lot, because I had the impression that I stretched my tendons, left me relaxed, because they were all trapped” (Judith)
New challenges	2	“The gym at the institution is very different from the [LiFE4D] program (...) LiFE4D is more challenging than the program at the institution” (Christian)
Person-centered approach	2	“(…) doctor's receptivity to hear my difficulties made me feel free to expose myself without fear” (Richard)

Caregiver involvement	2	"(...) my wife started doing it with us, she is always there watching the program's activities" (Christian)
Fighting loneliness	2	"Without a doubt I was [before LiFE4D] isolated" (Anthony)
Find how to be physically active	1	"I wouldn't change a thing, (…) because I like to be active, but sometimes I want to be active, but I don't know how [before the program]" (Rose)
Barriers		
Tiredness	6	"It's not like it used to be (...) now when I walk, I already feel breathless" (Rose)
Memory problems	6	"Everything can be good, but I don't remember anything, I don't remember any of that" (Yolanda)
Body pain	3	"I walk with a lot of difficulties, my kidney hurts, my hip hurts" (Rose)
Physical problems	2	"The vision and hearing problems disturbs me a lot" (Anthony)
Lack of help to continue	2	"(...) sometimes I want to move, but I don't know how, it is difficult alone" (Rose)
Fear	1	"I am also afraid of these things [physical activity]" (Emily)
Lack of time	1	"I have no time" (Judith)
Difficult to restart physical activity even with short breaks	1	"I notice this especially when I don't practice the exercises. At weekends, for example, when I decrease activities, I notice that something was missing" (Anthony)
Lack of outreach	1	"I think there was little visibility for the program, little publicity (…) some tv advertisement, or flyers on the road (…)" (Richard)
Impacts of the program		
Continued to practice physical activity	7	"I practically walk every day and almost every day I do the exercises with my hands and feet" (Richard)
Physical well-being	3	"(...) some things got better. Legs and arms and stuff, it got a little better" (Michael)
Overcoming personal limits	3	"Going up and down stairs, for example, I wasn't able to do it for a long time. Without a doubt, we improve and only after we perceive the real benefit" (Anthony)
Started to practice physical activity for the first time ever	1	"(...) I didn't do activities. I only started when she [the instructor] came here" (Michael)
Positive impact on the caregiver	1	"It [LiFE4D] had an impact for the better in both my life and my wife's" (Christian)
Other subthemes		
Complement to other physical activities	1	"It had an impact for the better, because in the institution where I participate, they don't do gymnastics like that. The ones we do here are more difficult and complements" (Christian)

Table 4. Motivators/facilitators, barriers and impacts of participating in LiFE4D according to caregivers' perspective (n=11).

Themes and subthemes identified by caregivers	Number of participants	Representative quotes
Motivators/facilitators		
Professional support	4	"The instructor has a sensitivity and empathy, she [instructor] did a fantastic job with great care and attention to my wife's needs" (Patrick)
Setting	2	"It is evident that the home program is better, for the patient it is better" (Patrick)

Social contact	2	"They [my parents] were always anxious for her [instructor] to arrive. My mother said that she liked to do that, she thought it was fun" (Wilson)
Opportunities to learn	2	"The instructors explained the difference between senility and Alzheimer's (...) and I already wanted to know a little more. For two or three times the instructor brought written information" (Kelly)
Easy exercises	1	"The exercises they did at home were very simple and easy to do" (Wilson)
Fear of dependence	1	"I stimulate him a lot because I am afraid. I am afraid. I know that when a person loses the ability to walk it is the beginning [of dependence]" (Kelly)
Barriers		
Tiredness	3	"He does little exercise, when the instructor came here, he did a bit with his legs and arms, but it is tiring for me to continue the exercises" (Evelyn)
Family conflicts	2	"If he goes with the instructor, he does the exercises. When he is with me, he says he is tired and does not do it" (Clare)
Lack of time	1	"I can say that the program could have been more productive if there was really more availability on my part to continue the exercises, but I am not with her [person with dementia] during the day" (Suzy)
Decreased contact over time	1	"They [my parents] did different things, they thought it was funny, they did a very big competition. It was funny (…) pity it started to be once a week and then it got more spaced" (Wilson)
Mood and behavior changes	1	"She is very lazy, she does not collaborate much, she is lazy and stubborn (...) she did not like physical exercises, and she was upset" (Beth)
Impacts of the program		
Physical benefits on loved ones	8	"(…) [he] already walks, has initiative to walk, and it feels like he doesn't lose his balance" (Kelly)
Emotional impacts on loved ones	5	"I used to say, Catherine was resurrected, emotionally resurrected. I think she became more active, more sober, has a different look then before, already answers a lot and also asks some questions" (Patrick)
Improvements on activities of daily living	2	"He didn't walk, didn't eat alone, he did nothing. It doesn't mean that now he does everything, he does some things, he already washes his teeth for example" (Clare)
Emotional support	1	"The instructors gave us a lot of strength and support when talking to us, any of the two who came here were good, spectacular (...) it was good because we were very discouraged" (Beth)
Other subthemes		
Caregiver burden	3	"I'm 76 years old, and taking care of someone with dementia, is difficult. I was exhausted" (Clare)
Gratitude	2	"That's why I say, stay as you are, don't change, keep doing it, it is very well, you helped us a lot" (Patrick)
Transferability to other settings	1	"This should be a program applied everywhere, like here [nursing homes], in the physical point of view, there are no exercises, like getting up from the chair" (Wilson)
Difficulties understanding questionnaires	1	"I didn't have difficulty, only in some questions when they came at the beginning with the questionnaires" (Evelyn)

Discussion

This study identified the perceived motivators/facilitators, barriers and impacts to LiFE4D by people with dementia and their caregivers. More motivators/facilitators than barriers; different perceptions, but some common ground (e.g., professional support, easy exercises, tiredness and lack of time) and only positive impacts were reported from participating in the LiFE4D.

Motivators/facilitators and barriers to LiFE4D (e.g., professional support, easy exercises, setting, well-being, tiredness, memory problems and body pain) are in line with the literature for PA in people with dementia (Farina et al., 2020; Gonçalves, Demain, Samuel, & Marques, 2020; Hobson, Dupuis, Giangregorio, & Middleton, 2020; Karssemeijer et al., 2020; Malthouse & Fox, 2014; Stubbs et al., 2014; van Alphen et al., 2016). Some of the motivators/facilitators to LiFE4D have the potential to overcome barriers to PA in this population (e.g., home-based vs. need of transportation; person-centered with easy PAs during daily routines vs. structured exercises and difficulties to find ways to be physically active) (Hancox et al., 2019; Hobson et al., 2020; Karssemeijer et al., 2020; van Alphen et al., 2016).

The professional support and a trust relationship between the professional and participants, seem to influence adherence to PA in people with dementia (Hancox et al., 2019; Karssemeijer et al., 2020). Additionally, the support of a caregiver, to encourage or facilitate PA, is also important (Stubbs et al., 2014), as people with dementia might have symptoms of apathy that lead to loss of initiation and motivation to PA (David et al., 2012; Farina et al., 2020; van Alphen et al., 2016). However, caregivers' involvement was challenging in LiFE4D, which might be explained by the burden (e.g., tiredness and lack of time) that caregivers experience (Farina et al., 2020; Karg, Graessel, Randzio, & Pendergrass, 2018). In fact, it has been reported that adding a PA promotion role to caregivers might result in family conflicts (Gonçalves et al., 2020). PA in people with dementia might be influenced by caregivers' psychosocial factors (Kim, Ullrich-French, Bolkan, & Hill, 2017), thus offer interventions to support caregivers (e.g., coping strategies, reduce BPSD) might help to achieve positive impacts (Pearlin, Mullan, Semple, & Skaff, 1990; Zarit & Leitsch, 2001). Future PA interventions should consider focusing on caregivers perceptions (Gonçalves et al., 2020; Kim et al., 2017) and providing them support and information (Hancox et al., 2019). Specifically, future studies on LiFE4D intervention might consider professional support on a regular basis, to motivate PA, to maintain the benefits and to manage possible conflicts between people with dementia and their caregivers (e.g., monthly face-to-face follow-up and periodic assessments of 3 times/year). Nonetheless, some caregivers also perceived a reduction in caregiver burden due to improvements on ADL performance by people with dementia, which has been previously valued by caregivers and professionals (Gonçalves et al., 2020). Carers' burden might have not increased in this intervention since the involvement of carers was optional and the intervention occurred at home (i.e., participants were not dependent on carers' transport). The direct contact with the professional and the indirect increase of the social contacts due to physical and mental benefits during the LiFE4D seem to have helped to overcome the low social interaction experienced by people with dementia (Hackett, Steptoe, Cadar, & Fancourt, 2019) and the social isolation experienced by their caregivers (Victor et al., 2020).

Some barriers were perceived by people with dementia and their caregivers' in this study. Although LiFE4D was individually tailored and time to rest was given, for some participants this was not enough to overcome barriers as tiredness, body pain and physical problems. This might be explained by the perceived lack of help to continue the program with the recommended adaptations. Memory problems were also a barrier as people with dementia frequently forget the actions to perform activities (Farina et al., 2020). Future studies, and LiFE4D, might consider to use prompts and cues to overcome the memory problems barrier (van der Wardt et al., 2019).

Subthemes in common. Perceptions of people with dementia and their caregivers were generally different, highlighting the need to consider both needs and preferences. The different perceptions might be explained by their distinct experiences during the path of dementia (e.g., cognitive impairment and behavior changes vs. psychological burden and anxiety) (Zarit & Leitsch, 2001). Still, common perceptions emerged, emphasizing the importance to include professional support and easy exercises and to explore strategies to overcome tiredness and lack of time in home-based PA programs.

Impacts of participating in LiFE4D. All impacts perceived by both groups were positive, which might be explained by the relationship between the well-being and functionality of people with dementia and the well-being of their caregivers (e.g., intervening on one impacts the well-being of the other one) (Zarit & Leitsch, 2001). These positive impacts (e.g., physical and mental well-being) led to a considerable number of participants to report to continue to practice PA after their participation in the LiFE4D. Although a long-term adherence remains unknown, a strong intention to continue with the PA is a facilitator to influence adherence in this population (Hancox et al., 2019).

This study has some limitations that need to be acknowledged. First, people who were not included (e.g., participants who did not complete the program and did not want to be part of the qualitative study, and people with aphasia) might have had different perceptions, namely regarding barriers to complete the LiFE4D. Nevertheless, all participants that dropped out during the LiFE4D were invited to be part of this study. Secondly, in five interviews, the caregiver accompanied the person with dementia, which might have inhibited their perceptions. Nevertheless, without the caregivers we would not be respecting the person with dementia willingness. Lastly, only positive impacts were reported, possible influenced by social desirability (Lavrakas, 2008). Nevertheless, the interviewer was a psychologist that had not been involved in the LiFE4D intervention to minimize bias.

Conclusion

In conclusion, this study adds insights on motivators/facilitators to reduce barriers to PA in people with dementia, namely through the LiFE4D program that showed positive impacts. This study stresses the need to implement home-based PA programs in daily routines, with easy activities, adapted to each participant, that guarantees professional support and that also focuses on caregivers.

Conflict of interest declaration

None.

Description of authors' roles

Sara Almeida, gerontologist (PhD student) led the LiFE4D programme, contacted the participants for this study, and was involved in the conceptualisation, methodology, formal analysis, writing – original draft, review & editing.

Ana Oliveira, psychologist (MSc student) led the qualitative interviews, transcribe them, and was involved in the methodology, formal analysis, writing – original draft, review & editing.

Madalena Gomes da Silva, physiotherapist (senior researcher) reviewed the themes and coding and discussed them with the other authors, and was involved in the conceptualisation, writing – review & editing, supervision.

Alda Marques, physiotherapist (senior researcher) reviewed the themes and coding and discussed them with the other authors, and was involved in the conceptualisation, writing – review & editing, supervision, project administration.

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Supplementary material

Table S1. Information on the context of care provided by caregivers (n=9).

	Basic care (hours/day)	Instrumental care (hours/day)	People involved in care (no)	Involvement in care (%)	Length of care (years)
Kelly	5	12	0	100	2
Beth	8	8	1	100	2
Suzy	4	4	0	100	3
Jessy	4	0	0	100	5
Patrick	3	1	1	80	5
Wilson	0	0	5	40	3
Evelyn	24	24	1	100	3
Martha	4	2	0	80	-
Clare	2:30	4	0	100	2
Total sample					
n=9 Median [IQR]	4 [2.8-6.5]	4 [0.5-10]	0.5 [0-1]	100 [80-100]	3 [2-4.5]

Abbreviations: IQR: interquartile range.

Chapter 7. Discussion

General discussion

The main aim of this thesis was to develop/adapt, implement and evaluate an individualised home-based physical activity programme embedded in daily routines of people with dementia, the Lifestyle Integrated Functional Exercise for People with Dementia (LiFE4D). This research was presented in a series of papers, a physical activity manual and a book chapter. The first study was a **systematic review** that showed that home-based physical activity programmes for people with dementia are effective on delaying cognitive function decline, improving activities of daily living (ADL) and health-related physical fitness (HRPF) and reducing behavioural and psychological symptoms of dementia (BPSD) and carer's burden. The second study (**protocol study**), along with the LiFE4D manual and a book chapter guided the implementation of LiFE4D. The original studies showed that promoting a tailored physical activity intervention at home of people with dementia through LiFE4D: i) is feasible (e.g., safe and excellent adherence) (**original study I**); ii) is efficacious (i.e., good results under ideal/controlled conditions) and effective (i.e., good results under usual or "real world" conditions) (Revicki & Frank, 1999) in improving the cardiorespiratory endurance and balance components of the HRPF and health-related quality of life (**original study II**); and iii) presents more motivators/facilitators than barriers, and positive impacts on both people with dementia and their carers (**original study III**).

Although discussion of findings has been previously provided in each study, an overall discussion integrating the results of the five studies, which have supported this thesis, is provided in this chapter. This section was developed in light of the most recent literature and discusses the main contributions of this thesis to the fields of: i) home-based physical activity for people with dementia and, ii) promotion of independence and functioning at home in people with dementia. A description of the general limitations and recommendations for future work and practice is also provided.

Home-based physical activity for people with dementia

Research on the field of physical activity in people with dementia is recent. Most studies have been published in the last three decades but build a strong evidence (Blankevoort et al., 2010; Burton et al., 2015; Forbes et al., 2015; Heyn et al., 2004; Pitkälä et al., 2013; Potter et al., 2011; Rao et al., 2014). If we focus on physical activity at home, most evidence reports just to the last decade, as shown in our **systematic review** in **chapter 3** (Almeida et al., 2019), demonstrating that this is an exciting new area of research.

Our systematic review has shown that home-based physical activity programmes for people with dementia seem to be effective on delaying cognitive function and reducing BPSD. These findings were not in accordance with some previous studies, which reported controversial results regarding cognitive function and BPSD (Barreto Pde et al., 2015; Forbes et al., 2015; Heyn et al., 2004; Potter et al., 2011; Rao et al., 2014). Differences might be explained by the inclusion of only home-based interventions in our systematic review, contrarily to those studies, which included physical activity interventions conducted in different settings (Barreto Pde et al., 2015; Forbes et al., 2015; Heyn et al., 2004; Potter et al., 2011; Rao et al., 2014). It is likely that physical activity conducted in different settings, where the environment might not be as well controlled and familiar as at home, lead to different results in cognitive function and BPSD. A reduced number of studies was included in the meta-analysis but the confidence on our results is supported by pooled data from only measurement tools regularly used in people with dementia (i.e., Mini-Mental Status Examination and Neuropsychiatric Inventory) (Gonçalves et al., 2018).

Our systematic review also showed improvements on ADL, HRPF and decreased burden in carers, similarly to other studies on physical activity for people with dementia in different settings (Forbes et al., 2015; Heyn et al., 2004; Potter et al., 2011; Rao et al., 2014; Ribeiro et al., 2019; Zeng et al., 2016). Showing similar (e.g., ADL, HRPF, carers' burden), or even better (e.g., cognitive function, BPSD) results than physical activity interventions conducted in institutions or community centres, either individualised or in group, it is important to place home-based physical activity as a promising intervention to increase functional independence, that should be further explored, and hopefully implemented in clinical practice.

Nevertheless, a high heterogeneity in the design of home-based physical activity programmes and in the outcomes and outcome measures assessed was found, hampering the recommendation of the most effective intervention. Moreover, none of the included interventions was simultaneously tailored to each participant and their daily routines, and these seem to be key factors to improve adherence in people with dementia (van der Wardt et al., 2017; van der Wardt et al., 2020). The Alzheimer's Disease International also emphasizes the need for innovative interventions and research in home settings (Alzheimer's Disease International, 2019). To acknowledge these gaps, we focused our research on developing/adapting and evaluating a tailored home-based physical activity programme embed in daily routines of people with dementia.

Chapter 4 of this thesis provided a description of the design/adaptation of LiFE4D. It included the **LiFE4D manual**, a **book chapter** and the **protocol study**. The LiFE4D manual transfers the scientific knowledge produced during this thesis directly into clinical practice, being an instrument that can be used by different stakeholders (e.g., people with dementia, carers and healthcare professionals) to extend and maximise the LiFE4D results in the long run. The LiFE4D manual and the book chapter contributed to guide the implementation of LiFE4D project and to increase the literacy on physical activity in daily routines, aligned with the global action plan on physical activity 2018-2030 (WHO, 2018). Providing enough information to support replication by others is essential (Hoffmann et al., 2014), thus the LiFE4D **protocol study** (**chapter 4**) was published (Almeida et al., 2020). This study also provided the foundation for **original studies I** and **II** (**chapter 5**).

Non-pharmacological interventions must be evidence-based and feasible in the care setting (Fazio et al., 2018; Scales et al., 2018; WHO, 2017). **Original study I** (**chapter 5**) showed that LiFE4D is a feasible intervention and provided valuable information on recruitment process, design of the intervention and adequate sample size for **original study II**. This pilot study (**original study I**) highlighted the need to improve recruitment strategies to identify people with dementia in the community (e.g., contact all organisations in the region that work with/for people with dementia), reduce the number of phone calls during the intervention and raised awareness for the importance of including people with dementia in research (Boada et al., 2018; Grill & Galvin, 2014). The acceptability of the data collection protocol (i.e., quick and easy assessable measures previously used in this population) (Gonçalves et al., 2018), excellent adherence, safety and clinically significant results on cardiorespiratory endurance and balance found on **original study I**, supported the conduction of a RCT (**original study II**). **Original study III** (**chapter 6**), complemented the findings from original study II and was conducted to give voice to people with dementia and their carers, and to explore their perceptions about LiFE4D in order to achieve a more person-centred research (Brooks et al., 2017; Kontos et al., 2018).

The excellent adherence to LiFE4D found on **original studies I** and **II** and the results of **original study III** might be explained by the strategies used to support physical activity in people with dementia: individualised tailored approach, support (e.g., face-to-face and phone calls), educational and psychosocial component (i.e., worksheets and information) and offer of a manual (van der Wardt et al., 2017). Although long-term adherence was not explored in this research, the willingness to continue to practice physical activity after their participation in LiFE4D emerged as a perceived positive impact of this programme (**original study III**), which has been pointed out as a facilitator to long-term adherence in people with dementia (Hancox et al., 2019).

From the results found on **original studies I**, **II** and **III** we can infer that home-based physical activity, through LiFE4D, has a positive impact on functional independence of those living with dementia, which ultimately increased their health-related quality of life and social interaction, and reduced their carers' burden.

Promotion of independence and functioning at home in people with dementia

Physical activity is a non-pharmacological intervention able to promote functional independence by improving HRPF (e.g., cardiorespiratory endurance, muscular strength, balance), which can improve the ability to perform ADL in people with dementia (Almeida et al., 2019; Forbes et al., 2015; Hesseberg et al., 2016; Heyn et al., 2004; Oppewal et al., 2015; Potter et al., 2011; President's Council on Physical Fitness and Sports, 1971). Although the path of dementia symptoms is heterogeneous, the ability to perform ADL significantly declines over time, making these people with dementia gradually more reliant on their carers (Oppewal et al., 2015). Thus, functional independence is a key element on dementia care, and to improve, maintain or delay the decline of ADL performance is a priority for people living with dementia and their carers (Fried et al., 2008; Kelly et al., 2015).

The ICF defines functioning as an umbrella term for body functions and structures, activities and participation, which implies the interaction between the individual and his/her context (e.g., environmental and personal factors) (WHO, 2001). LiFE4D used the ICF framework and aimed to promote functional independence of people with dementia by motivating physical activities (i.e., tasks or actions executed by the individual) and participation (i.e., involvement in life situations), whilst considering the environmental factors (e.g., setting and support) (WHO, 2001).

Cardiorespiratory endurance is a widely used objective measurement of functional capacity (Forman et al., 2017), and it is a predictor of mortality and decline in performance of ADL in people with dementia (Liu et al., 2012; Oppewal et al., 2015). Moreover, balance is one of the most important risk factors for falls and it is also a significant predictor of ADL decline in this population (Allan et al., 2009; Oppewal et al., 2015). Our study seems to increase function of people with dementia by increasing their cardiorespiratory endurance and balance (**original study II**), leading to perceived improvements on ADL performance and social interaction, and decreasing carer's burden (**original study III**). The improvements on cardiorespiratory endurance and balance found on **original study II** are in line with other physical activity programmes (Heyn et al., 2004; Park & Cohen, 2019; Potter et al., 2011). Nevertheless, those interventions were highly structured, conducted in different settings (e.g., day care centres, nursing homes, community centres), were not personalised and had longer durations than LiFE4D (up to 12 months) (Almeida et al., 2019; Potter et al., 2011), factors that might compromise adherence (Hancox et al., 2019; van Alphen et al., 2016).

Additionally, our study adds new and highly relevant knowledge by showing significant improvements on health-related quality of life in people with dementia, which has been a gap in the literature (Forbes et al., 2015; Lamb et al., 2018; Padala et al., 2017; Potter et al., 2011; Suttanon et al., 2013). The ability to perform ADL has been established as the main health-related quality of life determinant in this population (Andersen et al., 2004). Thus, by leading to improvements in the performance of ADL, perceived by both people with dementia and their carers (**original study III**), LiFE4D also contributed to improve their health-related quality of life (**original study II**).

Improvements on ADL performance in people with dementia have been valued in the literature by carers and professionals (Gonçalves et al., 2020). In our study, these improvements contributed to reduce carers' burden in some carers. This is particularly important because informal care is the cornerstone of dementia care and represents the larger percentage of costs spent with dementia in almost all world regions (WHO, 2015). Furthermore, carers of people with dementia experience high burden (Karg et al., 2018; Schulz & Martire, 2004). Thus, interventions to support carers and to reduce their burden are indispensable.

A perceived increase on social contacts was also found, placing LiFE4D on a favourable position to help facing the low social interaction of people with dementia (Hackett et al., 2019) and the social isolation experienced by carers (Victor et al., 2020). A recent systematic review found that group physical exercise had higher adherence rates than home-based exercise interventions (i.e., structured and planned), in part due to opportunities for socialisation (Di Lorito, Bosco, Booth, et al., 2020). Although, LiFE4D is an individualised home-based physical activity intervention, it seems to help to indirectly increase the social contacts of people living with dementia and their carers. The perceived higher social interaction after LiFE4D might be explained by the contact held with the professional and by the benefits achieved on physical and mental well-being, allowing people with dementia to make their social contacts easier and with less constraints.

The professional support, as well as the carers' support, seem to influence the success of the home-based physical activity programmes (Di Lorito, Bosco, Pollock, et al., 2020). In LiFE4D, the professional support was ensured during the face-to-face sessions and with phone calls. The carers support occurred (whenever possible and if carers accepted to be part of the study) when the professionals decreased their presence and on a long run.

The professional support and the relationship of trust established between the professional and the participants was highly valued in LiFE4D, being both a facilitator to physical activity and a motivator for physically active behaviour change (Di Lorito, Bosco, Pollock, et al., 2020; van Alphen et al., 2016). In fact, professional support was one of the motivators/facilitators perceived in common by both people with dementia and their carers on **original study III**. The professional support also generated perceived positive impacts in carers' emotional level (e.g., through the educational and psychosocial component), who have an undeniable vital role in the adherence to physical activity interventions in people with dementia (van Alphen et al., 2016).

Carers' role is important to support, encourage and/or facilitate physical activity (Stubbs et al., 2014) as people with dementia often present symptoms of apathy that lead to loss of initiation and motivation to be physically active (David et al., 2012; Farina et al., 2020; van Alphen et al., 2016). However, some carers are not willing and/or able to be involved in a physical activity intervention, due to feelings of tiredness and lack of time, which are directly related to their caring role (Farina et al., 2020; Karg et al., 2018; Peach et al., 2017). The involvement of carers in LiFE4D also proved to be challenging as they seemed to experience high levels of burden (e.g., perceived barriers of tiredness and lack of time, and other subtheme burden, reported on **original study III**). It is known that the success of carers' involvement might be influenced by their psychosocial factors (e.g., expectations, self-efficacy for dementia management and for physical activity, and willingness to encourage physical activity and to introduce new interventions to improve their loved ones' quality of life) (Kim et al., 2017). Addressing the needs of both people with dementia and their carers is of great importance to minimise carers burden and to increase their well-being (Zarit & Leitsch, 2001). However, further research in this topic is still needed to better understand how to engage carers of people with dementia in supporting physical activity interventions without increasing their burden (Gonçalves et al., 2020).

Carers play an important role not just as activity enablers but also in protecting their loved ones from hazards, and if they fear that their loved one's safety is compromised it can act as a barrier to physical activity (Di Lorito, Bosco, Pollock, et al., 2020; Peach et al., 2017). In fact, health and safety concerns are a big challenge when trying to maintain people with dementia living alone at home (Evans et al., 2016). Carers seem to prioritise avoidance of harm (i.e., felling of holding the risk) whilst people with dementia and different professionals seem to prioritise autonomy (i.e., promotion of positive risk-taking and facilitate independence), which might create a tension between autonomy and dependence (Rapaport et al., 2020). Thus, in the perspective of people with dementia, their carers and different professionals, to achieve and maintain independence at home (i.e., the capacity to do an activity without or with little help from others (WHO Centre for Health Development, 2004)) it is crucial to be in a safe and familiar environment, get proper support and maintain relationships and connection with the community (Rapaport et al., 2020). Since LiFE4D was conducted in a safe environment (i.e., home), with easy exercises (perceived by both as a motivator/facilitator to physical activity on **original study III**) that can be safely included in daily routines and had professional support (e.g., health professionals with experience on physical activity and dementia), it has the potential to contour act the possible existing tensions between people with dementia, carers and health professionals and maximize independence at home.

In fact, conducting LiFE4D at home was appreciated by carers. Staying at home gives a sense of belonging and comfort to people with dementia, and it is a familiar place, where their identity can be preserved (Zingmark et al., 2002). The concept of ageing in place is a policy and a person goal for many governments and people, and can be defined as having the desire and the capacity to continue living relatively independently in his/her home or other appropriate house (e.g., relative's home), through the provision of appropriate services and assistance (Forsyth & Molinsky, 2020; WHO Centre for Health Development, 2004). Increasing the access to home-based physical activity programmes for people with dementia (e.g., through LiFE4D) can be a strategy to promote ageing in place and follows the WHO agenda for 2018-2030 recommendations, i.e., "physical activity should be integrated in the setting where people live, work and play" (WHO, 2018).

People with dementia and their carers had different perceptions of their participation on LiFE4D, possible explained by their unique experiences (Zarit & Leitsch, 2001). This emphasizes the need to consider both needs and preferences, but also their shared opinions, either to include the motivators/facilitators (e.g., professional support and easy exercises) or to counter the barriers (e.g., tiredness and lack of time) perceived in common. **Original study III** was the first study exploring the perceptions of people with dementia and their carers about the impacts of a home-based physical activity programme, and only positive impacts emerged. It is worth noting that some motivators/facilitators identified on **original study III** (e.g., setting, person-centred approach, easy exercises, provide information material and professional support) have the potential to overcome some of the previously identified barriers to physical activity in this population (e.g., need of transport, structured exercises, highly demanding activities, difficulty to find a way to be physically active) (Hancox et al., 2019; van Alphen et al., 2016; van der Wardt et al., 2017).

In sum, we believe that the positive results of LiFE4D found on **original studies I, II** and **III** might be explained by: i) being a person-centred and tailored intervention (van der Wardt et al., 2017); ii) being a home-based programme, that occurred in a familiar environment, without the need of transport (Boada et al., 2018; van Alphen et al., 2016); iii) having easy and adapted tasks that safely fit into daily routines (Hancox et al., 2019); iv) having an educational and psychosocial component that provided meaningful information to participants (Boada et al., 2018; van der Wardt et al., 2017); v) providing professional on-site and telephone support (Karssemeijer et al., 2020; van der Wardt et al., 2017) and; vi) giving the opportunity to carers to get involved (van Alphen et al., 2016). LiFE4D seems to promote the functional independence of people with dementia on a daily basis, while respecting their individuality, as recommended by the Alzheimer's Association (Fazio et al., 2018) and INTERDEM network (Vernooij-Dassen et al., 2019) to empower this population to live well at home for as long as possible (Moise et al., 2004; WHO, 2012).

This research offers important insights for professionals by boosting their confidence to encourage physical activity at home in people with dementia. Moreover, this thesis adds important knowledge to guide future interventions, clinical practice, guideline developers and policymakers in their decisions on improving access to physical activity at home for people living with dementia.

Limitations

This thesis has some limitations that need to be acknowledged when interpreting our results.

Firstly, in the **systematic review** only articles published in English, Spanish, French or Portuguese were included, thus studies in other languages might have been missed. However, careful searches in different databases were conducted to minimise the missing of potential eligible studies. This **systematic review** also included only RCT, so data of other peer-reviewed work, unpublished work or grey literature were excluded. RCT is, however, the most appropriate design to reduce bias when studying interventions. The **systematic review** conducted in this research work included studies with heterogeneity of designs, outcomes, outcome measures and control groups. Weighting this limitation and the scarce research in the field we decided to include one poor-quality study in the quantitative analysis, which might have affected meta-analysis quality. Nevertheless, most of the included studies were of high quality, reinforcing our trust in the presented results.

Completion of the whole sessions of the LiFE4D was quite demanding for some people with dementia, as anticipated in the **protocol study**, and confirmed in the **original study III**.

Involvement of carers was truly challenging due to lack of time to accomplish their care role, lack of time for themselves and the burden that they were already experienced. To minimise these challenges, LiFE4D was adapted to each participant and, every time the person was not able to follow the session, that session was rescheduled. Moreover, LiFE4D is not an "one size fits all" intervention, therefore, some heterogeneity across interventions might have occurred and some bias introduced. However, this was somewhat expected since LiFE4D aimed at being a real-world person-centred intervention. Notwithstanding, all participants received the same amount and duration of face-to-face sessions to minimise bias.

Original studies I, II and **III** included a heterogeneous sample in terms of types of dementia (e.g., Alzheimer's disease or vascular dementia). Since symptoms and progression vary among types of dementia, some bias might have been introduced. Nevertheless, this is a common issue observed in real-world studies and efforts were made to overcome this limitation in the **original study II** by computing adjusted models.

The small sample size of the **original study I** reduced the power to identify significant effects in most variables being studied. Nevertheless, this was a feasibility study, and a more robust methodology, with a larger sample and a power calculation for the primary outcome (e.g., cardiorespiratory endurance) was conducted in **original study II**.

Participants were not blinded due to the nature of the intervention on **original studies I** and **II**; however, a randomised concealed allocation was used to minimise bias and the opportunity to receive LiFE4D after their participation in the study was given to the control group. Another limitation of the **original study II** was the existence of some missing values (i.e., dropouts, refusal of the participants to perform some tests), generalised estimating equations analysis were therefore conducted, which has been considered a robust method to deal with missing values. Results from **original studies I** and **II (chapter 5)** might also have been influenced by the geographical culture because of the convenience geographic sample. However, an attempt was made to identify people in urban and rural areas.

On **original study III,** the people who were not included (e.g., people with dementia and carers who did not complete the programme and did not want to be part of the qualitative study, and people with aphasia) might have had different perceptions about the LiFE4D compared to those included. Nevertheless, it is important to notice that all participants that dropped out during the LiFE4D programme were invited to be part of the qualitative study. Also, in **original study III**, five people with dementia were accompanied by their carers during the interview, which might have caused some inhibition to openly talk and express their opinions. Even so, it was the participants' choice to be accompanied because they felt more comfortable, thus, without the presence of their carers their perceptions could also have been compromised and we would not respect their will. Finally, only positive impacts were reported in this study, which might be partially explained by the social desirability factor (Lavrakas, 2008). However, this possible bias was minimised by including an interviewer (e.g., psychologist) that had not been involved in the LiFE4D intervention.

Nonetheless, this thesis builds on and contributes to the body of knowledge in promoting functional independence through a home-based physical activity programme for people with dementia. This research includes studies with different methodologies that strongly support a new intervention conducted at home for people living with dementia. Still, some future research is needed to continue improving this work and to corroborate our promising results.

Chapter 8. Recommendations for future research and clinical practice and conclusions

Recommendations for future research and clinical practice

This section provides recommendations for future research and implications for clinical practice.

Findings from **chapter 3** (**systematic review**) showed that heterogeneity of interventions and measures used in the home-based physical activity programmes exist. Therefore, more research conducted with robust methodologies and reporting similar outcome measures is needed to further update this systematic review and meta-analysis, and possibly allow to explore the most effective design for the intervention. This would enable stronger recommendations of home-based physical activity programmes for people with dementia. To explore the influence of having, or not, the support of a carer on the adherence and impacts of home-based physical activity programmes, and how to manage carer's burden in their role of motivators and supporters for active behaviours would also enrich our understanding on how to provide the best care to people with dementia.

A multicentre randomised controlled trial (RCT) is warranted to strengthen the findings of this work. Future research would be of great interest to consolidate our work, namely, to: i) determine medium- and long-term adherence to Lifestyle Integrated Functional Exercise for People with Dementia (LiFE4D), to explore the impacts of LiFE4D on additional measures (e.g., objective measures of physical activity and sedentary behaviour, ADL questionnaires, BPSD and sleep); ii) determine the cost-effectiveness of LiFE4D; and iii) explore the impact of LiFE4D on the extension of time living at home. Additionally, the determinants for home-based physical activity participation and adherence in this population should be further explored to foster the development and implementation of effective interventions that ensure the adoption of active lifestyles at home in the long run. The implementation of LiFE4D was possible with participants without carers, but the medium- and long-term adherence to physical activity in people with dementia with and without carers needs to be further explored.

The World Health Organization (WHO) defined one action for 2018-2030 that focus on enhancing the access to tailored programmes to increase physical activity and reduce sedentary behaviour in older adults, in key settings (e.g., home) (WHO, 2018). To enhance the access to LiFE4D in clinical practice, without increasing the burden on care systems (i.e., social and health), we present two options to be considered.

The first option is to integrate LiFE4D in a community-based integrated support system, through a team that works with people with dementia and their carers. Innovative models have recommended to point a single contact person (i.e., case manager) to people with dementia and their carers to enhance access to support and services (Lord et al., 2020; Røsvik et al., 2020). After the 3-months of LiFE4D intervention, long-term adherence could be supported by one carer (daily, if possible) and a weekly face-to-face accompaniment by the contact person (e.g., to motivate physically active behaviours, to maintain the benefits and to manage possible conflicts between people with dementia and their carers).

The second option is to use new technologies. The WHO stresses the opportunity to promote and support people of all ages to be more physically active through digital innovations (e.g., mobile health) (WHO, 2018). Applications for dementia healthcare have been becoming popular (e.g., cognitive training, monitoring of health and safety, leisure and socialisation) and have the potential to engage people with dementia in activities of daily living (Yousaf et al., 2019). Thus, showing potential to promote independence of people with dementia and also to support their carers (Yousaf et al., 2019). The concept is to integrate LiFE4D on a physical activity mobile application, with a user-centred design, that provides support to the participants during the 3-months of the programme (i.e., replace the face-to-face support by feedback in real time on the mobile application). This would include support to people with dementia but also to their carers (i.e., educational and psychosocial component inclusive). The accompaniment would then continue through weekly follow-ups and by sending participants reminders and challenges to promote physical activity during their daily living.

Conclusions

This thesis contributed to enrich the body of knowledge on home-based physical activity programmes for people with dementia, and on novel interventions to promote functional independence in this population. Specifically, this thesis provided an overview of the existing home-based physical activity programmes for people with dementia (**systematic review: chapter 3**) and presented a new intervention (**chapter 4**), that showed to be feasible, efficacious and effective to improve health-related physical fitness (HRPF) and health-related quality of life in this population (**chapter 5**). Lastly, it also provided the unique perspectives of people with dementia and their carers about their participation on LiFE4D (**chapter 6**).

Chapter 3 (**systematic review**) identified the available designs and synthesised the effects of home-based physical activity programmes for people with dementia. This **systematic review** showed that home-based physical activity is effective to delay cognitive function decline and to improve behavioural and psychological symptoms of dementia (BPSD), activities of daily living (ADL), HRPF and carer's burden in people with dementia living at home. Additionally, home-based physical activity interventions seemed to be safe and presented high adherence.

This thesis presented a novel approach (LiFE4D) to promote independence in people with dementia through a home-based physical activity programme, described on **chapter 4** (**manual LiFE4D, book chapter and protocol study**). The LiFE4D programme showed, to be feasible and safe, and presented promising clinical results on improving cardiorespiratory endurance and balance of people with dementia, with an excellent adherence (**original study I, chapter 5**). Moreover, further research work on this intervention showed that LiFE4D is an efficacious and effective home-based programme to improve HRPF (i.e., cardiorespiratory endurance and neuromotor components) and health-related quality of life of people with dementia (**original study II, chapter 5**).

This research culminated with the involvement of people with dementia and their carers by giving them voice about their participation on LiFE4D (**original study III, chapter 6**). In this study, more motivators/facilitators than barriers have emerged, and only positive impacts of the programme were reported. Differences on perspectives of people with dementia and their carers have emerged, but still they agreed on some motivators/facilitators (e.g., professional support and easy exercises) and barriers (e.g., tiredness, lack of time).

In conclusion, this thesis adds new important insights and strongly supports the implementation of individualised home-based physical activity programmes, embed in the daily routines of people with dementia, with professional support and providing opportunities to carers to get involved. These interventions have great potential to enhance independence/minimise dependence and functionality of people with dementia, and thus help them to live at home for as long as possible, respecting their will and following the international recommendations.

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Appendix

Appendix 1. List of publications within the scope of the Thesis

List of publications	
Publications in peer-reviewed journals	
Citations: 7 [Impact factor: 3.286] GERONTOLOGY: Q1	Almeida Sara, Gomes da Silva Madalena, Marques Alda (2019) “Home-based physical activity programmes for people with dementia: a systematic review and meta-analysis” *The Gerontologist* 60(8): e600-e608. doi: 10.1093/geront/gnz176
Citations: 0 [Impact factor: 0.15] REHABILITATION: Q4	Almeida Sara, Gomes da Silva Madalena, Marques Alda (2019) “Lifestyle Integrated Functional Exercise for People with Dementia: study protocol for a home-based randomised controlled trial” *International Journal of Therapy and Rehabilitation*. 27(5): 1-14. doi: https://doi.org/10.12968/ijtr.2019.0066
Accepted [Impact factor: 1.763] GERIATRICS & GERONTOLOGY: Q3	Almeida Sara, Paixão Cátia, Gomes da Silva Madalena, Marques Alda (2019) “Lifestyle Integrated Functional Exercise for People with Dementia: Pilot Study” *Journal of Aging and Physical Activity*. (accepted)
Submitted	Almeida Sara, Gomes da Silva Madalena, Marques Alda (2020) “Efficacy and effectiveness of the Lifestyle Integrated Functional Exercise for People with Dementia: LiFE4D a home-based randomised controlled trial” (submitted: Journal of Geriatric Physical Therapy)
Submitted	Almeida Sara, Gomes da Silva Madalena, Marques Alda (2020) “A qualitative study to give voice to people with dementia and their carers about home-based physical activity” (submitted: Journal of Geriatric Physical Therapy)
Abstracts in conference proceedings	
23rd-25th October 2019 Poster presentation	Paixão Cátia, Almeida Sara, Marques Alda (2019) “Respiratory function and upper limb functional ability in people with dementia: a shout for attention” 29th Alzheimer Europe Conference, 23rd to 25th October 2019, Hague, Netherlands
23rd-25th October 2019 Poster presentation	Paixão Cátia, Almeida Sara, Marques Alda (2019) “Relationship between upper limb functional ability and respiratory function in people with dementia” 29th Alzheimer Europe Conference, 23rd to 25th October 2019, Hague, Netherlands
23rd-25th October 2019 Poster presentation	Almeida Sara, Gomes da Silva Madalena, Marques Alda (2019) “Lifestyle Integrated Functional Exercise for people with dementia - LiFE4D: pilot study” 29th Alzheimer Europe Conference, 23rd to 25th October 2019, Hague, Netherlands
23rd-25th October 2019 Poster presentation	Almeida Sara, Gomes da Silva Madalena, Marques Alda (2019) “Home-based physical activity for people with dementia: a systematic review and meta-analysis” 29th Alzheimer Europe Conference, 23rd to 25th October 2019, Hague, Netherlands
26-31st March 2018 Poster presentation	Almeida Sara, Silva Madalena, Marques Alda (2019) “Exercise capacity and function impact after a home-based lifestyle integrated functional exercise for people with dementia” The 14th International Conference on Alzheimer's & Parkinson's Diseases, 26-31st March 2018, Lisbon, Portugal

26-31st March 2018 Poster presentation	Almeida Sara, Silva Madalena, Marques Alda (2019) "Impacts of a home-based lifestyle integrated functional exercise for people with dementia on balance" The 14th International Conference on Alzheimer's & Parkinson's Diseases, 26-31st March 2018, Lisbon, Portugal
26-31st March 2018 Poster presentation	Paixão Cátia, Almeida Sara, Marques Alda (2019) "Cognitive function and lung function, respiratory muscle strength and upper limb functionality in people with dementia" The 14th International Conference on Alzheimer's & Parkinson's Diseases, 26-31st March 2018, Lisbon, Portugal
13-15th December 2018 Poster presentation	Paixão Cátia, Almeida Sara, Marques Alda (2018) "Feasibility and effectiveness of LiFE4D on the respiratory function and upper limb functionality of people with dementia – an exploratory study", III Seminário Internacional – Alzheimer e outras demências: conhecer, compreender, intervir, 13-15th December, Viseu, Portugal
13-15th December 2018 Poster presentation	Almeida Sara, Silva Madalena, Marques Alda (2018) "LiFE4D: A home-based physical activity programme for people with dementia – exploratory study", III Seminário Internacional – Alzheimer e outras demências: conhecer, compreender, intervir, 13-15th December, Viseu, Portugal
25th June 2020 Pitch	Almeida Sara, Gomes-da-Silva Madalena, Marques Alda (2020) "Effectiveness of the Lifestyle Integrated Functional Exercise for People with Dementia" 3rd Research Summit p. 121-122, 24-26th June 2020, University of Aveiro, Aveiro, Portugal URL: https://www.ua.pt/file/61863
13th October 2020 Oral communication	Almeida Sara, Gomes da Silva Madalena, Marques Alda (2020) "Untangling the relationship between physical activity and physical capacity in people with dementia" 14th International Conference on Alzheimers Disease & Dementia, 12-13th October, Zurich, Switzerland
Communications by invitation	
4th June 2018	Almeida Sara, Paixão Cátia (2018) "LiFE4D – projeto de promoção da atividade física em pessoas com demência a viver na comunidade" 4th June 2018, Escola Superior de Saúde de Leiria, Leiria, Portugal (3 hours)
October 25th 2018	Almeida Sara et al. (2018) "Potential of a multisensory and motor-based group activity in moderate to advanced dementia" IX Congresso Nacional de Cuidados Paliativos/8º Congresso de Cuidados Paliativos do IPO-PORTO 25-27th October 2018, Fundação Dr. António Cupertino de Miranda, Porto, Portugal
November 29th 2018	Marques Alda, Miranda Sara, Almeida Sara (2018) "Prevenção de Quedas em Pessoas Idosas: Exemplos Reais Implementados na Comunidade" Health Talks: enVELHecer ativamente 29th November 2018, Escola Superior de Saúde da Universidade de Aveiro, Aveiro, Portugal
1st October 2019	Almeida Sara, Gomes da Silva Madalena, Marques Alda (2019) "LiFE4D: programa de atividade física no domicílio de pessoas com demência" CEPD by CEPD I Congresso Envelhecimento e

	Práticas na Demência 1st October 2019 Hotel Vale do Rio, Oliveira de Azeméis, Portugal
27th February 2020	Almeida Sara, Gomes da Silva Madalena, Marques Alda (2020) "LiFE4D Programa de atividade física no domicílio" Congresso Nacional Gestão da Qualidade dos Cuidados à Pessoa Idosa. 27th February 2020 Porto Hotel Dom Henrique, Porto, Portugal
29th July 2020	Almeida Sara, Gomes da Silva Madalena, Marques Alda (2020) "A importância da atividade física no período de distanciamento social", XXI Congresso Nacional Online Gerontologia Estratégias nos Cuidados em Tempo de Pandemia, 29th July 2020 Virtual meeting during the COVID-19 pandemic (Zoom)
Book	
2019	Almeida Sara, Marques Alda, Gomes da Silva Madalena (2019). "LiFE4D: Manual de Apoio para a Atividade Física em Pessoas com Défice Cognitivo Ligeiro ou com Demência" Aveiro: UA Editora, ISBN: 978-972-789-608-0
Book chapter	
Submitted	Marques Alda, Gomes da Silva Madalena, Almeida Sara. (2020) "A importância da atividade física no período de distanciamento social" In "Pensar e compreender o envelhecimento em emergência de pandemia"

Appendix 2. Ethical approval letters

COMISSÃO DE ÉTICA

da **Unidade Investigação em Ciências da Saúde - Enfermagem** (UICISA: E)

da **Escola Superior de Enfermagem de Coimbra** (ESEnfC)

Parecer Nº P437-06/2017

Título do Projecto: LIFE4D: Programa de Atividade Física no Domicílio de Pessoas com Demência.

Identificação do Proponente

Nome(s): Sara Isabel Lebre de Almeida

Filiação Institucional: Instituto de Biomedicina (iBiMED) e na Escola Superior de Saúde (ESSUA) da Universidade de Aveiro

Investigador Responsável/Orientador: Alda Sofia Pires de Dias Marques e Madalena Ramos Lopes Gomes da Silva

Relator: Maria Filomena Botelho

Parecer

O projecto tem como objectivo principal avaliar os efeitos do LiFE4D na promoção da atividade física das pessoas com demência. Como objetivos secundários o estudo considera: a) estabelecer a viabilidade do LiFE4D e a adesão à intervenção; b) explorar os efeitos do LIFE4D na componente da função respiratória, aptidão física/funcionalidade (dados antropométricos, equilíbrio, força de preensão, força dos membros inferiores, funcionalidade dos membros superiores, flexibilidade, tolerância ao exercício), nível cognitivo, qualidade de vida e auto percepção do desempenho ocupacional; c) avaliar o custo-efetividade do LiFE4D na duração de internamento hospitalar, idas às urgências, número de quedas, número de crises respiratórias, tempo despendido no cuidado informal e sobrecarga do cuidador. Para atingir estes objetivos, segundo os autores, será conduzido um estudo piloto e um estudo randomizado controlado com avaliações aos 3, 6, 9 e 12 meses.

Segundo os autores trata-se de um estudo randomizado e controlado, em que a amostra será constituída por pessoas com demência que vivam no domicílio, mas identificados através de serviços de apoio domiciliário, residências assistidas, café memória, Alzheimer Portugal, grupos de suporte, juntas de freguesia, consulta geriátrica do Centro Hospitalar e Universitário de Coimbra e do Serviço de Psicogeriatria do Hospital de Magalhães Lemos.

Os critérios de inclusão estão claramente definidos. Existe garantia de confidencialidade. São apresentados o consentimento informado e os instrumentos de colheita de dados.

Atendendo ao formato da investigação, a Comissão de Ética dá o seu parecer favorável. Contudo o presente parecer não dispensa a autorização formal das entidades onde vai decorrer o estudo.

O relator: Maria Filomena Botelho

Data: 19/7/2017 O Presidente da Comissão de Ética: Maria Filomena Botelho

UNIDADE DE INVESTIGAÇÃO EM CIÊNCIAS DA SAÚDE ENFERMAGEM

escola superior de enfermagem de coimbra

FCT Fundação para a Ciência e a Tecnologia

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COMISSÃO DE ÉTICA

da **Unidade Investigação em Ciências da Saúde - Enfermagem** (UICISA: E)

da **Escola Superior de Enfermagem de Coimbra** (ESEnfC)

Aditamento Parecer Nº AD-P437-06/2017

Título do Projecto: LIFE4D: Programa de Atividade Física no Domicílio de Pessoas com Demência.

Identificação do Proponente

Nome(s): Sara Isabel Lebre de Almeida

Filiação Institucional: Instituto de Biomedicina (iBiMED) e na Escola Superior de Saúde (ESSUA) da Universidade de Aveiro

Investigador Responsável/Orientador: Alda Sofia Pires de Dias Marques e Madalena Ramos Lopes Gomes da Silva

Relator: Maria Filomena Botelho

Parecer

Solicita a Investigadora Responsável a introdução no projecto de um complemento qualitativo para a recolha e análise de dados qualitativos, em forma de entrevistas individualizadas, semi-estruturadas ao cuidador informal/pessoa significativa de pessoas com demência.

São apresentados o consentimento informado e os instrumentos de colheita de dados.

Considerando a natureza do inquérito a Comissão de Ética dá o seu parecer favoável.

Contudo não se pode deixar de chamar a atenção para a necessidade de garantir a confidencialidade dos dados recolhidos, assim como a anonimização dos inquéritos.

O presente parecer não dispensa a autorização formal das entidades onde vai decorrer o estudo.

O relator: Maria Filomena Botelho

Data: 23/4/2019 O Presidente da Comissão de Ética: Maria Filomena Botelho

UNIDADE DE INVESTIGAÇÃO EM CIÊNCIAS DA SAÚDE ENFERMAGEM

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Appendix 3. National Data Protection Committee letter of approval

Autorização n.º 7897/ 2017

Instituto de Biomedicina da Universidade de Aveiro (iBiMED) , NIPC 501461108, notificou à Comissão Nacional de Protecção de Dados (CNPD) um tratamento de dados pessoais com a finalidade de realizar um Estudo Clínico com Intervenção, denominado LiFE4D: Programa de Atividade Física no Domicílio de Pessoas com Demência .

Existe justificação específica, validada pela Comissão de Ética Competente (CEC), para o tratamento do dado pessoal raça/etnia.

Existe justificação específica para o tratamento de dados comportamentais, psicológicos ou volitivos, os quais estão diretamente relacionados com a investigação.

O participante é identificado por um código especificamente criado para este estudo, constituído de modo a não permitir a imediata identificação do titular dos dados; designadamente, não são utilizados códigos que coincidam com os números de identificação, iniciais do nome, data de nascimento, número de telefone, ou resultem de uma composição simples desse tipo de dados. A chave da codificação só é conhecida do(s) investigador(es).

É recolhido o consentimento expresso do participante ou do seu representante legal.

A informação é recolhida diretamente do titular.

As eventuais transmissões de informação são efetuadas por referência ao código do participante, sendo, nessa medida, anónimas para o destinatário.

A CNPD já se pronunciou na Deliberação n.º 1704/2015 sobre o enquadramento legal, os fundamentos de legitimidade, os princípios aplicáveis para o correto cumprimento da Lei n.º 67/98, de 26 de outubro, alterada pela Lei n.º 103/2015, de 24 de agosto, doravante LPD, bem como sobre as condições e limites aplicáveis ao tratamento de dados efetuados para a finalidade de investigação clínica.

No caso em apreço, o tratamento objeto da notificação enquadra-se no âmbito daquela deliberação e o responsável declara expressamente que cumpre os limites e condições aplicáveis por força da LPD e da Lei n.º 21/2014, de 16 de abril, alterada pela Lei n.º 73/2015, de 27 de junho – Lei da Investigação Clínica –, explicitados na Deliberação n.º 1704/2015.

O fundamento de legitimidade é o consentimento do titular.

A informação tratada é recolhida de forma lícita, para finalidade determinada, explícita e legitima e não é excessiva – cf. alíneas a), b) e c) do n.º 1 do artigo 5.º da LPD.

Assim, nos termos das disposições conjugadas do n.º 2 do artigo 7.º, da alínea a) do n.º 1 do artigo 28.º e do artigo 30.º da LPD, bem como do n.º 3 do artigo 1.º e do n.º 9 do artigo 16.º ambos da Lei de Investigação Clínica, com as condições e limites explicitados na Deliberação da CNPD n.º 1704/2015, que aqui se dão por reproduzidos, autoriza-se o presente tratamento de dados pessoais nos seguintes termos:

Responsável – Instituto de Biomedicina da Universidade de Aveiro (iBiMED)

Finalidade – Estudo Clínico com Intervenção, denominado LiFE4D: Programa de Atividade Física no Domicílio de Pessoas com Demência

Categoria de dados pessoais tratados – Código do participante; idade/data de nascimento; género; raça/etnia; dados antropométricos; sinais vitais; composição do agregado familiar sem identificação dos membros; dados da história clínica; dados dados de exame físico; medicação prévia concomitante; dados de cuidadores/acompanhantes (apenas os relacionados com as necessidades do participante); dados de qualidade de vida/efeitos psicológicos; relativos à atividade profissional com conexão com a Investigação; comportamentais, psicológicos ou volitivos com conexão com a Investigação

Exercício do direito de acesso – Através dos investigadores, presencialmente/ por escrito

Comunicações, interconexões e fluxos transfronteiriços de dados pessoais identificáveis no destinatário – Não existem

Prazo máximo de conservação dos dados – A chave que produziu o código que permite a identificação indireta do titular dos dados deve ser eliminada 5 anos após o fim do estudo.

Da LPD e da Lei de Investigação Clínica, nos termos e condições fixados na presente Autorização e desenvolvidos na Deliberação da CNPD n.º 1704/2015, resultam obrigações que o responsável tem de cumprir. Destas deve dar conhecimento a todos os que intervenham no tratamento de dados pessoais.

Lisboa, 23-10-2017

A Presidente

Filipa Calvão

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Appendix 5. Informed consents forms

Consent for people with dementia

Código________

Termo de Consentimento Livre e Esclarecido do Participante

Título do Projeto: LiFE4D: programa de atividade física no domicílio de pessoas com demência

Nome da orientadora e co-orientadora: Alda Marques e Madalena Gomes da Silva

Nome da estudante de Doutoramento: Sara Almeida

Por favor leia e assinale com uma cruz (X) os quadrados seguintes.

1. Eu confirmo que percebi a informação que me foi dada e tive a oportunidade de questionar e de me esclarecer. ☐

2. Eu percebo que a minha participação no programa de atividade física no domicílio é voluntária e que sou livre de desistir, em qualquer altura, sem dar nenhuma explicação, sem que isso me afete de alguma forma. ☐

3. Eu concordo que as sessões presenciais do programa de atividade física sejam realizadas no domicílio onde habito. ☐

4. Eu concordo que possam ser tiradas fotografias às atividades que vou realizar. ☐

5. Eu compreendo que os dados recolhidos durante o programa são confidenciais e anónimos e que só os investigadores do projeto da Universidade de Aveiro terão acesso a eles. Portanto, dou autorização para que os mesmos tenham acesso a esses dados. ☐

6. Eu compreendo que os dados recolhidos durante o programa podem ser utilizados para publicação em Revistas Científicas e usados noutras investigações, sem que a minha identidade (p.e., nome e morada) seja revelada. Portanto, dou autorização para que a utilização dos dados para esses fins. ☐

7. Eu concordo então em participar no estudo. ☐

______________________	__________	______________________
Nome do Participante	Data	Assinatura
______________________	__________	______________________
Nome do Investigador(a)	Data	Assinatura

Consent for carers

Código________

Termo de Consentimento Livre e Esclarecido do Cuidador/Pessoa Significativa

Título do Projeto: LiFE4D: programa de atividade física no domicílio de pessoas com demência

Nome da orientadora e co-orientadora: Alda Marques e Madalena Gomes da Silva

Nome da estudante de Doutoramento: Sara Almeida

Por favor leia e assinale com uma cruz (X) os quadrados seguintes.

1. Eu confirmo que percebi a informação que me foi dada e tive a oportunidade de questionar e de me esclarecer. ☐

2. Eu percebo que a nossa participação é voluntária e que somos livres de desistir, em qualquer altura, sem dar nenhuma explicação, sem que isso nos afete de alguma forma. ☐

3. Eu concordo que as sessões presenciais do programa de atividade física no domicílio sejam realizadas no domicílio onde o meu familiar/significativo habita. ☐

4. Eu concordo que possam ser tiradas fotografias às atividades em que o meu familiar/significativo vai participar. ☐

5. Eu compreendo que os dados recolhidos durante o programa são confidenciais e anónimos e que só os investigadores do projeto da Universidade de Aveiro terão acesso a eles. Portanto, dou autorização para que os mesmos tenham acesso a esses dados. ☐

6. Eu compreendo que os dados recolhidos durante o programa podem ser utilizados para publicação em Revistas Científicas e usados noutras investigações, sem que as nossas identidades (p.e., nome e morada) sejam reveladas. Portanto, dou autorização para a utilização dos dados para esses fins. ☐

7. Eu concordo então em participar no estudo. ☐

______________________	________	______________________
Nome do Participante	Data	Assinatura
______________________	________	______________________
Nome do Investigador(a)	Data	Assinatura