Rationale for Combined Exercise and Cognition-Focused Interventions to Improve Functional Independence in People with Dementia

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Abstract
Evidence suggests that exercise and some cognition-focused intervention approaches can be used to elicit functional improvements in older people and, to some degree, those diagnosed with dementia. Independently, the two intervention types have been found to improve functional performance in people with dementia. The mechanisms underpinning these improvements come from comparable and diverse pathways. This suggests that it may be beneficial for the two intervention types to be coupled as part of regular care in individuals with a range of cognitive impairments. The aims of this review are threefold. The first aim is to present evidence to support the use for combining exercise and cognition-focused interventions. This will be achieved by reviewing the mechanisms of both approaches in improving functional performance in older people and in people with dementia and summarising recent progress. The increased risk of depression, falls and cardiovascular disease risk in people with dementia will also be highlighted. The second aim is to discuss the parameters of the two approaches that should be considered when combining them in terms of possible efficient models, especially in relation to exercise protocols as this is where the current literature shows the most promising outcomes. Maximisation of the efficacy of preventative and treatment interventions which focus on both cognitive functioning and physical health should lead to improving and extending functional independence. Key aspects of any combined intervention would involve the inclusion of both cardiovascular and other types of exercises, including falls reduction, and exercises addressing memory and executive function via goal setting in the real-life context. The third aim is to explore some of the issues that may arise when attempting to incorporate interventions into the regular treatment of people with dementia. Consideration must also be given to caregivers and the education of health professionals as well as to the mode of intervention itself. Further research is necessary in order to discern the most effective types of both intervention models. Provision of combined interventions might enhance the improvements in functional independence in people with dementia over and above the interventions being used separately.
Introduction

Recent research has suggested that there are positive beneficial functional improvements for people diagnosed with dementia undertaking exercise and some cognition-focused interventions [1–6]. Much of this research has been focused on each of these intervention types independently [1, 2]. The two intervention models have been found to improve mobility and functional performance in healthy older people. However, as exercise and cognition-focused interventions are not mutually exclusive, there may be additional benefits for combining the two types of interventions, with each intervention augmenting the effects of the other. A key issue now is to determine whether the available positive findings are transferable to people with dementia. The current challenge for interdisciplinary health professionals and caregivers is to apply the most effective intervention models in practical settings to provide the best support for people with dementia. Additionally, the potential value of combining exercise and cognition-focused interventions in the most effective and practical way into regular care, although not fully elucidated, is becoming more apparent. This review will highlight the most important aspects of these types of intervention and how they have been shown to elicit functional improvements in older people with a range of cognitive impairments, and will highlight the possibilities of linking the two types of intervention together.

The aims of this review are threefold. The first aim is to present evidence to support the use of exercise and cognition-focused interventions, including a review of the mechanisms for evaluating the efficacy of these approaches in improving functional performance in people with dementia, and to discuss the possible additive benefits of combining the two approaches. Part of the rationale for using different types of exercise interventions comes from the increased risk of depression, falls and cardiovascular disease (CVD) in people with dementia, and this will also be discussed. The second aim is to discuss the parameters of the two approaches that should be considered when combining them in terms of possible efficient models, especially in relation to exercise protocols as this is where the current literature shows the most promising outcomes. The third aim is to consider some of the issues that may arise when attempting to incorporate these interventions into the overall treatment of people with dementia.

Dementia is broadly defined as ‘a clinical syndrome characterised by loss of function in multiple cognitive abilities in an individual with previously normal (or at least higher) intellectual abilities and occurring in clear consciousness’ [7]. This definition relates to a range of conditions, but the present review will focus on the most commonly diagnosed and investigated types of dementia occurring in later life: Alzheimer’s disease and vascular dementia. One of the fundamental motivations for research in dementia is to increase patients’ quality of life by enhancement or maintenance of their functioning.

Higher physical function and greater cognitive ability have been associated with better quality of life [8]. Functional decline is one of the main factors affecting quality of life for people with dementia [5]. Therefore, improving or maintaining functioning is important not only as a means of delaying or preventing dementia and consequently reducing public health costs, but also as a means of managing the disability resulting from dementia, as well as the associated risk factors such as risk of depression, falls or CVD. In addition, increasing functional performance and thus quality of life is imperative for people already diagnosed with dementia. If health professionals can combine approaches addressing physical and cognitive functioning, then it is likely that a higher quality of life would result for people with dementia.

This review will focus primarily on possible interventions for people with dementia. As people with dementia are generally older, research with healthy older people will also be incorporated, especially where there are still gaps in the literature involving people with dementia. However, some research has shown differences in outcomes from certain types of interventions, especially cognitive interventions, between healthy elderly and people with dementia [6, 9–11].

Summary of Studies Addressing Physical and Cognitive Functioning

Previous Studies Addressing the Physical or Cognitive Functioning of Healthy Older People

It has been known for some time that exercise interventions can increase muscle strength, power, balance, aerobic capacity and physical function [8, 12–15], even in people over 90 years old [16]. Most exercise programmes, whether low-intensity or high-intensity, and whether targeted or generalised, have been able to show increased physiological benefits. However, not all programmes have resulted in functional improvements [12]. For example, progressive resistance training alone, although eliciting gains in muscle mass and strength, does not routinely produce an increase in physical function or de-
crease risk of falls [17]. In order to achieve optimal functional performance improvements, physical exercise programmes should incorporate strength training of sufficient intensity, exercises aligned to functional tasks, aerobic activities and coordination/balance exercises [18].

Cognition-focused interventions that use multimodal approaches (i.e. incorporating complex interventions or lifestyle changes), or process training (training of specific cognitive processes without explicit strategy training), have shown greater transfer to improving functional performance than strategy-based training in healthy older adults [10, 19]. Although strategy-based training provides considerable improvements in the set tasks, it shows little to no transfer to functional performance of everyday tasks [10]. Multimodal interventions have shown the greatest chance of enhancing functional performance, perhaps due to their complex design that often incorporates social engagement, physical activity and enjoyable components that link to everyday life situations [10, 19, 20]. These multimodal programmes also increase the chance that the participants will continue to carry out the skills and activities even after the programme has concluded. Process training, especially when focused on speed of processing, has been observed to provide significant protection against extensive declines in health-related quality of life for up to 5 years after intervention [21]. In the healthy elderly population, cognitive interventions are promising and are still deserving of further research [22].

Of particular interest are the possible crossover effects between the two modalities of exercise-based and cognition-focused interventions; for instance, do exercise interventions increase cognitive function and/or do cognitive interventions assist with older people’s ability to undertake exercise? A growing number of studies have demonstrated this to be the case [10, 23–26]. Aerobic exercise programmes in healthy older adults have broadly improved cognitive function in many areas, especially executive function [26]. A recent Cochrane review relating to older people without cognitive impairment demonstrated that aerobic exercise aimed at increasing cardiorespiratory fitness improved motor function, cognitive speed, and auditory and visual attention [23]. However, a broad range of cognitive functions were assessed and most other comparisons between aerobic exercise and cognitive function yielded no significant effects [23]. The differences between studies may in part be due to the choices of cognitive tests, but also due to the exercise load, which may not have been sufficient in some instances. A summary of the literature concluded that there was mostly a significant, and at times a substantial, relationship between physical activity and later cognitive function and dementia, resulting in greater benefits for older adults who are, or had been, more physically fit [25]. Although aerobic training has been most extensively studied, larger positive cognitive effects have been observed when aerobic training was combined with strength and flexibility training [24].

Multimodal interventions that include cognition-focused factors and social participation and teach new activities (including physical) have positive effects on a range of cognitive functions, including speed of processing, in older people [10, 19]. These assist in facilitating complex movements, improving mood, increasing confidence and generating enhanced feelings of energy, thus further helping people to contemplate starting exercise programmes or to adhere to more physical activity [27]. Decreases in anxiety could also be achieved by specific cognitive and aerobic training in older people [28]. Interventions that enrich their environment by maintaining or increasing social and physical activities as well as cognitive activities may encourage continued practice and thus the maintenance of any improvements in functional performance [10]. Having a more engaged lifestyle has been demonstrated to mitigate age-related cognitive declines [20]. As well as this, the inclusion of interventions addressing self-efficacy into physical activity and exercise therapy programmes results in increased adherence to the programmes, but current cognitive-behavioural interventions show limited effectiveness [29].

Previous Studies Addressing the Physical or Cognitive Functioning of People with Dementia

Several recent reviews have highlighted the way in which exercise interventions have demonstrated functional improvements in people with dementia [1, 3–5]. These studies mainly focus on the effects of aerobic training [1]. However, both aerobic and strength training have shown increases in physical functioning in cognitively impaired people [3, 5, 6]. Some of these exercise studies have shown substantial improvements in cognition, especially in executive functioning and memory [1, 4]. However, although a majority of exercise studies have shown no effect on cognition [6], of the studies involving people with cognitive decline, two thirds observed beneficial effects [6]. These few studies that did not show beneficial cognitive effects employed primarily strength-, balance- and/or flexibility-based exercises [6]. A recent Cochrane review concluded that there is insufficient evidence to
evaluate the effectiveness of physical activity programmes with regard to outcomes of cognition, function, behaviour, depression and mortality in people with dementia [30]. This was due in part to poor methodological quality in some studies, and to the use of a wide range of exercise protocols and durations as well as outcome measures. The Cochrane review could only analyse two studies, and only one of these included sufficient numbers of participants and involved sufficient intensity and duration of exercise [30]. This again highlights the need for more research on the effects of exercise in people with dementia. However, the use of exercise for maintaining or halting the decline in cognition in people with dementia does seem to be gaining support, with several recent reviews advocating its use [5, 31].

The application of cognition-focused intervention to assist in improving or maintaining functioning in people with dementia has been, overall, less positive than the results from healthy older people. Cognition-focused interventions can be classified into three groups: cognitive training, general cognitive stimulation and cognitive rehabilitation. Cognitive stimulation involves engagement in themed activities, usually in a group context, and this appears to provide some benefits in terms of scores on cognitive screening measures [32]. Positive results have also been reported for a combination of cognitive and motor stimulation [33]. Cognitive training involves repeated practice of standard tasks addressing particular cognitive skills. To date, there is no evidence to state that cognitive training delays or slows the progression to Alzheimer’s disease in healthy older people [11]. Nor is there clear evidence to say that cognitive training results in positive outcomes in relation to cognition, mood or well-being with people with Alzheimer’s disease or vascular dementia; the Cochrane review finds no positive effects [9]. Further studies are required as these conclusions may be at least partly due to a lack of high-quality randomised controlled trials and a range of methodological challenges/differences [9, 11], and it should be noted that some of the randomised controlled trials of cognitive training do report statistically significant positive effects on at least one measure of cognition [34]. It is well established, however, that people with early-stage dementia can demonstrate some new learning of verbal information, practical skills and routines, and retain the ability to associate a cue with a consequence and hence adapt their behaviour [35]. Non-randomised studies have found encouraging evidence with specific learning methods such as errorless learning [2], and these effects may in some cases be long lasting [36]. Thus, interventions tailored to the needs of people with dementia can produce beneficial effects on task performance. It has been argued [35] that a cognitive rehabilitation approach focusing on individualised, personally meaningful goals, with specific intervention methods selected in order to best address the desired practical outcomes, may result in more beneficial outcomes than a standardised cognitive training approach. Further to this, preliminary evidence from a short-term, goal-oriented cognitive rehabilitation programme in people with early-stage Alzheimer’s disease demonstrated significant improvements in ratings of goal performance and satisfaction with performance (supported by functional MRI data) [37].

**Mechanisms Underpinning These Functional Improvements**

Evidence for mechanisms that underlie the abovementioned functional improvements from exercise interventions stem mainly from research in animals and from healthy older adults. Aerobic exercise programmes in older people have been associated with increased neurogenesis, angiogenesis and synaptogenesis in the brain. Enhancing cognitive performance by exercise is thought to occur via several biological mechanisms. These include: enhancement of cerebral blood flow and oxygen delivery; induction of fibroblast growth in the hippocampus; decreased brain tissue loss; reduction in aberrant brain activity and stimulation of more efficient brain function; increasing mRNA and protein levels of brain-derived neurotrophin factor, perhaps leading to neurogenesis in the dentate gyrus of the brain; effects on neurotransmitter systems such as increasing serotonin and acetylcholine levels, and the exercise-related increase in insulin-like growth factor 1 which may also play a role in neurogenesis [4, 5, 10, 19, 25, 26, 31]. These central mechanisms affect the prefrontal cortex, which is linked to cognitive flexibility. This includes increased activation in the superior parietal regions of the brain related to attention and in portions of the middle frontal gyrus associated with cognitive control [25]. A recent study of aerobic exercise in people with mild cognitive impairment has demonstrated increased insulin sensitivity and reduced circulating levels of cortisol and brain-derived neurotrophic factor with better executive control, especially in women [1]. It is also possible that non-biological mechanisms are involved in improving function as a result of exercise, such as improved well-being [26] and environmental enrichment from greater physical activity [4]. Exercise itself is a stressor that reduces the harmful effects of other stressors when performed at moderate intensities.
Both cognitive and exercise interventions show activation in task-relevant regions of the brain and of brain plasticity in healthy older adults. Other brain areas show reduced activation, which possibly reflects more efficient processing and activity [10]. Less research to date has focused on functional brain activity patterns (e.g. as assessed by functional MRI) during interventions in people with dementia. Therefore, it is now important to further our understanding of the neural mechanisms underpinning possible functional improvements [38].

Rationale for Combining Exercise and Cognition-Focused Interventions in People with Dementia

The strongest arguments in favour of combined interventions come from research that has only been conducted in the last few years [22, 28]. If both exercise and to some extent cognitive interventions have produced positive outcomes in functional performance including brain plasticity, more efficient processing and physical function in healthy older people, what is the outcome if both methods are combined? To date, this question remains largely unanswered. Combined aerobic training and cognitive training in healthy older adults resulted in equal or greater effects when combining the training types than when undertaking them separately [28]. In addition, combining memory and psychomotor training for people without dementia shows greater beneficial effects on a cognitive composite score over single-intervention application [22]. It is not clear whether these training modes are additive or interactive. More importantly, the outcome of combining these methods in people with dementia is yet to be determined, and the appropriate parameters for interventions of this kind need to be established in order to ensure that they are pitched at a suitable level and that a combination of activities does not overtax the abilities and resources of the person with dementia.

A key question is how these interventions can be combined to counteract the decline in functional independence and quality of life, thus overcoming those risk factors that occur in people with dementia, such as the increased risk of depression, falls and CVD. These will be discussed below.

Link between Depression and Dementia

One of the risk factors for dementia is increased anxiety and depression [39, 40]. Depression in people with dementia is common, although actual data on cooccurrence is unclear [39]. Due to the complex interrelationships between dementia and depression, it is still unclear whether depression is an early symptom of, a risk factor for, or a reaction to having dementia, or some combination of these [39, 40]. Physical exercise is known to improve mood and feelings of energy [41], and exercise training studies in people with dementia show promise. For example, dementia patients with initially high levels of depression maintained significant improvements in depression 24 months after a 12-week exercise programme [42]. However, no change in mood and well-being was observed in people with low cognitive impairment following a 24-week exercise training [4]. There is no evidence to suggest that improvements in mood should be expected as an outcome of cognition-focused intervention; however, early suggestions that such interventions tended to worsen mood have not been supported by more recent studies.

Link between Falls Risk and Dementia

Older people with dementia are 2–8 times more likely to experience falls than those without dementia [43, 44]. Thus people with dementia, including people with mild cognitive impairment, are at greater risk of falling, and this cognitive impairment is integral to the causes of falls in many older people [5, 44, 45]. Falls risk has been demonstrated to result from a myriad of interconnecting factors [5, 17, 44, 46]. These factors include those specific to people with dementia or cognitive impairments, such as the type and severity of dementia, behavioural disturbances, functional disturbances and neuroleptics [44]. However, most falls risk factors in people with dementia are also risk factors for older people in general: muscle weakness; impaired motor function (including impaired gait), vision, balance, cognition and mood; functional impairment; diseases causing fainting; use of 4 or more prescription medications; depression; being over 80 years of age; a history of falls; low bone mineral density, and environmental hazards [17, 44, 46]. Investigations of people with a higher level of physical activity have demonstrated a protective effect on falls [43]. Falls risk can also be decreased in older people via exercise interventions that improve muscular strength (particularly of the lower body), power and balance ability [17]. Interventions that incorporate one or more of these, especially if they perturb balance, have shown significant reductions in falls risk [46]. However, the use of just one type of exercise programme, for example progressive resistance training only, has yet to provide conclusive evidence that falls risk is reduced [17].
Recurrent falls have been associated with a generalised cognitive decline resulting from advanced brain ageing; people who have had a single fall were only demonstrated to differ from non-fallers in terms of accuracy and inhibition (due to changes in the prefrontal cortex leading to failures of executive control) [45]. The neurobiological mechanisms for the link between subtle cognitive impairments and increased falls risk still needs to be elucidated [44, 47]. Impairments in executive function, judgement, memory or attention could be involved [44]. Several of these cognitive domains (attention, executive function and working memory) are associated with gait. Impairments linked to slower gait velocity or greater variability in gait velocity whilst under dual-task conditions are linked to higher falls risk [44, 47]. Increasing confidence, decreasing anxiety and behavioural disturbances in older people could lead to them partaking in activities that would further encourage them to improve their strength and gait and thus their functional ability, thereby providing a positive feedback effect. Further trials to address falls prevention in people with dementia are required to fully determine possible management strategies, including orthostatic hypotension, cognitive enhancers, targeted surveillance, depression and physical activity [43, 44, 47]. It is also possible that cognitive training focused on dual-task capability might help to reduce the risk of falls. Thus, decreasing falls risk, thereby enhancing functional performance, is of major importance with respect to increasing the independence and quality of life of all older people.

**Link between Cardiovascular Risk and Dementia**

One of the most compelling reasons for combining exercise with cognitive interventions for people at risk of and with dementia is the accumulating evidence that suggests CVD risk factors may be important in the development of dementia [48–50]. Although this link was traditionally thought to be specific to vascular dementia, recent evidence also links CVD risk factors with Alzheimer’s disease [48–50]. Many of the CVD risk factors have recently been shown to serve as risk factors for developing both Alzheimer’s disease and vascular dementia, with the risk of developing dementia being increased in the presence of multiple CVD risk factors [49]. These factors may also predict the progression of cognitive decline [51]. The main CVD risk factors for dementia include hypertension, dyslipidaemia and type II diabetes mellitus. The review by Fillit et al. [49] has collated evidence to show that the relative risk of dementia may be more than 4 times higher in patients with a systolic blood pressure of >160 mmHg compared to those with a systolic blood pressure of 110–139 mmHg [49]; having diabetes almost doubles the risk of dementia [49]. Hypertension was found to occur in a third of Alzheimer disease patients (34%), with hypercholesterolaemia occurring in 18% and diabetes in 14% in a recent Italian study of Alzheimer disease patients [51]. Being overweight or obese was found to increase the risk of dementia/Alzheimer’s disease by 35–90%; smoking increases the risk by 8–203%, whilst exercise or high levels of physical activity decreased the risk by 37–62% in several longitudinal studies [49].

The likely reasons why CVD risk factors are linked with dementia are related to the fact that many of the risk factors result in cerebrovascular disease, hypoperfusion and ischaemia, which may lead to damage in areas of the brain responsible for cognition [49]. The mechanisms underlying these factors are still to be fully elucidated and may be multifactorial. They include: vascular brain injury; changes in the white matter of the brain; cerebral atrophy, and silent cerebral microbleeds [49, 50]. Some of the mechanisms correlate with cognitive impairments, especially in poststroke dementia. This lends support to the link between CVD risk and dementia. However, it has been suggested that the various vascular factors have different roles in the progression of cognitive decline [50]. Type II diabetes may also assist in slowing further decline in cognition in people who already have dementia [51]. Although the mechanisms for this are unclear, the treatment of diabetes may be behind this observation [51].

The CVD risk factor medications given to patients could assist in protecting them from dementia or from further cognitive decline [48, 49]. These include antihypertensive therapy, lipid-lowering therapy (including statins), insulin, antiinflammatory drugs and homocysteine-lowering therapies (folate and vitamin B12). However, some of the results to date have been conflicting [48, 52]. For example, the initial evidence for the use of statins to lower cholesterol and thus assist in the prevention of dementia was promising. However, no effects of statins were observed in randomised controlled trials in healthy older adults aimed at preventing dementia [52].

Management of lifestyle CVD risk factors is also key in reducing the risk of developing dementia. Many studies have assessed the relationships between cognitive decline and these risk factors such as obesity, lack of physical exercise, smoking, excessive alcohol intake and psychosocial factors including living alone, lack of close social ties, limited participation in social or leisure activities and depressive episodes [48, 49]. However, intervention trials to control vascular factors in order to re-
duce the risk of dementia are still required [53]. Physical activity may have a protective role via reducing vascular risk and obesity, lowering the levels of inflammatory markers, and increasing neuronal health, fitness, physical function and positive behaviour [48]. At present, these studies have focused on the relationships between the lifestyle risk factors and dementia. Future studies are required to investigate making lifestyle changes (e.g. increasing exercise, better nutrition and gaining greater social involvement) as part of CVD risk management to address further the links between CVD risk and developing dementia as well as minimising further decline in people with dementia. This is vital as a lack of physical activity has been highlighted to be a major risk factor for the epidemic of chronic disease and disability, especially CVD, facing our ageing population [27]. In summary, there is a strong association between CVD risk factors and developing dementia. Therefore, rigorous treatment of CVD risk factors in dementia patients is highly important in order to reduce not only the CVD risk factors and their associated complications, but also the progression of cognitive decline in people with dementia and those at risk of developing dementia [27, 49].

**Parameters to Consider for Combined Interventions**

It is important that healthcare professionals are able to advocate the most efficient and beneficial treatment options for their clients with regard to exercise and cognition-focused interventions. In order to do this, we have attempted to collate recent evidence that would work in a variety of settings, from institutional care to home-based programmes, and could be implemented in a variety of formats, whether group-based or individualised programmes.

Recent reviews relating to people with dementia and healthy older people have still not been able to reach a consensus on the types of exercise – or the amount, duration or intensity of exercise – that are most effective and efficient for these demographics [19, 23, 25, 26, 41]. The primary reason for this confusion stems from researchers using a wide variety of outcome measures (whether they are physical function tests or tests of cognition) and a wide variety of interventions, as well as including a range of age groups, frailty and cognitive impairment in the participant samples. This has resulted in insufficient evidence to provide a detailed meta-analysis of the data, as highlighted by several recent reviews [6, 23, 30, 54]. Most meta-analyses and reviews have concluded that further research, especially longitudinal randomised controlled trials, is of vital importance [10, 12, 19, 22, 23, 41, 54]. There is also a need for more research to be conducted with people with more severe cognitive impairments and to consider possible variations in guidelines for varying degrees of cognitive impairment [3]. However, some general themes have emerged from the literature and these will be explored below.

Previously it was considered that dementia was regarded as a contraindication for participating in exercise programmes. However, recent evidence has demonstrated that similar attendance, adherence and aerobic and strength outcomes are achieved by the use of exercise for rehabilitation in people with and without cognitive impairments, including high-intensity resistance exercises [3]. Exercise prescription specifically for people with dementia, or at risk of developing dementia, should firstly target reducing cardiovascular risk and risk of falls. Thus there is a strong rationale for a multifaceted exercise programme for increasing functional performance in people with dementia, rather than a wholly aerobic-based programme. One striking finding that has emerged from the literature has been that aerobic exercise appears to be more effective in increasing cognitive function in older people than other exercise types. Advocating aerobic exercise for more effective treatment of dementia is in part due to increasing cerebral blood flow and reducing CVD risk, but has also perhaps been due to the focus that has been placed on aerobic exercise in the literature. However, it is still unknown whether it is the aerobic exercise per se that can improve cognitive function, or whether any type of physical activity can do the same [23]. Apart from progressive resistance and balance training being more effective in improving physical function and decreasing falls risk in older people than aerobic training alone [12, 46, 55], combined exercise programmes have been shown to be as effective, or more effective, in improving cognitive function in older people [3, 24, 25]. As well as this, exercise that specifically improves motor fitness may differentially improve cognitive functioning and involve different brain regions and processes [56]. Resistance training also increases concentrations of insulin-like growth factor 1, which is a possible mechanism for improving cognitive performance [57]. To reduce falls risk in people with dementia, multifaceted interventions that therefore target their motor strength and function, especially gait and balance ability, reduce behavioural disturbances, and medications are required [44, 46]. Interventions aimed at improving cognitive function could also decrease falls risk [44], including medication to en-
hance cognition [47]. Further studies are required to fully elucidate the effectiveness of exercise interventions that involve progressive resistance training, flexibility, training targeted to minimise falls risk and/or anaerobic exercises in people with dementia, and how these interventions interrelate with each other for the most efficient functional improvements [3, 12, 13, 57].

Exercise and physical activity interventions have been shown to increase functional performance in older people [8, 12, 15] and have been used successfully in people with a range of cognitive impairments [3]. Although there is no consensus on a specific type of programme, there is general agreement on several key issues. These include: (1) performing combinations of moderate-intensity and vigorous-intensity aerobic physical activity (e.g. moderate-intensity activity for a minimum of 30 min on at least 5 days each week) over and above light-intensity activities of daily living; (2) including exercises to maintain or increase balance, and (3) recommending flexibility and moderate-to-high intensity strength training at least 2 days per week [5, 13, 27, 55, 58]. Varied training that leads to a greater capacity to undertake everyday tasks (e.g. multimodal cognitive approaches) as well as different types of physical activities are also more likely to elicit positive benefits in functional performance in people with dementia [10, 22].

Exercise training parameters may vary with frailty, deconditioning and/or health status of the participants [12, 54, 55]. However, previous studies eliciting positive outcomes have highlighted the following key points. In general, for positive functional improvements, exercise sessions, mainly group based [54], should be conducted more than once per week [59]; generally, 3 times a week is suggested [58], if not most days [55]. However, some of these sessions could be home based rather than led by an exercise instructor [4, 12]. The use of exercise professionals to deliver the programmes may achieve more beneficial results, with some reviews stating that this should be a requirement to ensure the exercise intensity is optimal for possible beneficial effects [12, 58]. Studies in people with dementia have shown a dose-response relationship; the more frequently people exercise, the better their cognitive improvements [26]. High-intensity resistance exercise has been demonstrated to be as safe as low-intensity exercise, and is also considerably more effective in terms of increasing physiological and functional measures [55, 58], and increasing the intensity is also possibly more beneficial for cognitive function [23]. Intense exercise interventions should last for 3 months or more. However, these programme parameters could be decreased for more frail populations [12, 54], who may also derive greater benefits from individualised interventions [54]. Participants have also been shown to regress to baseline levels after completion of exercise programmes in terms of physical function [15, 27, 54] if they do not continue to exercise. However, cognitive outcomes may still be maintained, especially if booster sessions are provided [4, 20], as may muscle strength [15], although further investigation is still required.

Interventions involving cognitive rehabilitation rather than specific cognitive training are more likely to increase or maintain functional performance in people with early-stage dementia. Cognitive rehabilitation aims to maintain or enhance specific daily activities and has demonstrated significant improvements in some outcomes [37]. The inclusion of personally meaningful goals and provision of cognitive strategies, for example methods for learning new information and techniques for stress management involving caregivers, have produced improvements in ratings of goal performance and satisfaction [37]. Although promising, cognitive rehabilitation has yet to be combined with physical performance measurements or exercise interventions to fully elucidate the most effective intervention type for people with dementia. Regular exercise (as a pleasant activity), combined with teaching people with dementia and their caregivers behavioural and problem-solving strategies to establish and maintain realistic exercise goals, has started to become more recognised, for example via the Seattle protocols [42]. These protocols have demonstrated that in people with dementia, exercise training with caregiver education and problem solving can reverse physical disability, increase mood and decrease sleep and behavioural disturbances [42].

In summary, the rationale for combining physical activity that increases functional performance with cognition-focused interventions in people with dementia can be viewed from different perspectives. Increasing function and mobility via increasing physical performance leads to people gaining the ability to be more involved in social interactions, to carry out more activities (be they physical and or cognitive), to live more independently, to improve their mood, to decrease their falls and CVD risk and to gain confidence. In summary, the exercise component of a combined intervention needs to target reducing cardiovascular risk and risk of falls by incorporating a multifaceted exercise programme of sufficient intensity based on exercise guidelines for older people [5, 13, 27, 55, 58]. The exercise component needs to address individual variability and frailty, gait and the benefits of social in-
teractions of group settings where possible, and needs to link the programme to everyday activities. Although at present cognition-focused interventions in people with dementia have thus far shown limited positive outcomes for improving functional performance, the cognition-focused component of a combined intervention would need to address individual meaningful goals and the provision of behavioural and problem-solving cognitive strategies. Cognitive rehabilitation and the use of some of the cognitive techniques with exercise still need to be further explored to fully enhance patient care.

**Issues in Incorporating Combined Exercise and Cognition-Focused Interventions into Regular Care**

In order to successfully incorporate exercise and cognition-focused interventions into regular care, there needs to be a coordinated approach by the multidisciplinary health team and by the caregivers of older people. Prescribing the correct and most appropriate advice should be a priority for any health professional. It has yet to be determined how this can be done in the most efficient and effective way. There are already calls for changes to geriatric healthcare practice so that physical exercise/rehabilitation aimed at increasing quality of life is provided to people with dementia as standard care [3]. There are several key issues that need to be addressed in order for this to be achieved. These include understanding the complex factors regarding translating recent research demonstrating the efficacy of these programmes to the healthcare practitioners in the clinical and community setting. For much of the research mentioned above we are still perhaps within the time lag between the research being conducted and implementation. There is also a need for more robust evidence showing the efficacy of these programmes, especially cognition-focused interventions, in people with dementia. There is also a need to advocate the greater use and acceptance of interdisciplinary research (e.g. the inclusion of exercise science/rehabilitation into dementia care). Greater exercise-specific knowledge is perhaps also required in healthcare practitioners at the user interface as a lack of detailed exercise knowledge may be one of the impediments to achieving positive benefits within the community.

Caregivers play a vital role in the lives of people with dementia, influencing the activities they undertake, their nutrition and the level of environmental stimulation. Most caregivers require support and advice on possible interventions that would improve the quality of life for the person with dementia and for themselves. Interventions that have involved caregivers, where present, have produced added benefits for both the people with dementia and the caregivers [35, 37, 60]. It is also important to work with and through carers to achieve better outcomes for people with dementia. An example of this is the availability of nurses to advise families on possible interventions to prevent falls [44]. Linking the interventions discussed above with the needs and wishes of caregivers is also an important aspect to consider [60].

For all older adults, whether cognitively impaired or not, it is imperative that physical activity and exercise programmes be maintained or increased. Evidence for incorporating exercise into the lives of older people, and thus also of people with dementia, is compelling, from decreasing disease and falls risk to increasing physical and cognitive functional performance. These exercises should be initiated early in life for continued health and functional improvements. As a result, healthy older adults may delay the onset of dementia and reduce the disease burden [40, 57]. By initiating exercise programmes early for people diagnosed with dementia, it now appears possible to slow down the rate of cognitive decline, and this will also positively address other health issues due to more sedentary behaviours.

Unfortunately, exercise interventions do not usually have lasting effects unless they are accompanied by lasting change in behaviour. Thus, the exercise should be maintained throughout life. For improvements in fitness, the intensity – and to some extent the duration – of exercise has to be at an appropriate level as, in the past, the exercise prescribed may not have been optimal [12]. However, for maintenance of fitness, this level, or the duration, can be lowered. It should also be noted that it is never too late to begin an exercise programme for people with dementia as long as there are appropriately qualified trainers present and hazards are reduced [44]. Cognition-focused intervention studies are ongoing to determine which of these are the most effective. As with exercise, starting cognitive interventions whilst older adults are still cognitively healthy may contribute to delaying or reduce the incidence of dementia. However, once dementia is present there is no evidence to suggest that cognition-focused interventions in combination with physical exercise will be to the detriment of the individual. In fact, it is possible that there may be additive benefits from combining the two. One of the striking aspects of exercise and/or cognition-focused interventions is the observation that the positive cognitive benefits that have been observed are long lasting [4, 36]. Perhaps these interven-
tions can be brief (≤3 months), with ‘booster sessions’ to maintain the cognitive benefits at regular intervals and for as long as possible in a person’s life.

In conclusion, although there currently is sparse evidence regarding combined exercise and cognition-focused interventions in people with dementia, the rationale for combining the two types to improve function is gaining support from recent research, especially from exercise interventions. There seem to be additive benefits in terms of functional ability in combining the two types of intervention, for example by increasing physical health, becoming more socially engaged and addressing individual goals. Part of the rationale for using different types of exercise interventions comes from improving the higher risk of depression, falls and CVD that occur in people with dementia. Exercise prescription specifically for people with dementia, or at risk of developing dementia, should firstly target reducing cardiovascular risk and risk of falls via a multifaceted exercise intervention. Having dementia does not appear to be a contraindicator for exercise, rather a compelling reason to undertake an exercise programme. Although cognition-focused interventions have so far resulted in less positive effects, the results from recent studies have been encouraging, especially using a cognitive rehabilitation approach focusing on individualised, personally meaningful goals. There is still a range of issues that needs to be addressed, and further research has to be conducted in order to discern the most effective types of both intervention models. However, the provision of combined interventions might enhance improvements in functional independence in people with dementia over and above the interventions being used separately.

References


2. van Uffelen JG, Chin APMJ, Hopman-Rock J, van Bockxmeer FM, Xiao J, Greenop PA: The effects of exercise interventions comes from improving the higher range of issues that needs to be addressed, and further research has to be conducted in order to discern the most effective types of both intervention models. However, the provision of combined interventions might enhance improvements in functional independence in people with dementia over and above the interventions being used separately.

References


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¹ A more extensive reference list may be obtained directly from the authors.