Perceived and measured health benefits of aqua-based exercise for older adults with osteoarthritis

Alison L. Fisken

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Signed

Dated 14 June 2013

Declaration of co-authored works

All co-authors of the papers below have approved these for inclusion in Alison Fisken's doctoral thesis.

Chapter Three. Fisken, A., Keogh, J., Waters, D., and Hing, W. (in press). Perceived benefits, motives and barriers to aqua-based exercise amongst older adults with and without osteoarthritis. *Journal of Applied Gerontology*. Permission from Sage Publications to include in thesis granted 6 June 2013.	AF = 85% JK = 5% DW = 5% WH = 5%
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Abstract

Ageing is associated with a number of physiological and psychological changes. These include declines in muscle mass, strength, functional ability, and balance, which are associated with increased risk of falling and reduced quality of life. In addition, many older adults have osteoarthritis and the associated symptoms of joint pain and stiffness may exacerbate the age-related changes in physical function. Regular exercise can help offset the age-related declines in muscle strength, functional ability and balance, however many older adults do not regularly exercise. In particular older adults with osteoarthritis tend to have lower levels of physical activity than older adults without osteoarthritis. Aqua-based exercise is recommended for older adults with osteoarthritis due to the properties of water, however relatively few studies have investigated this type of exercise among this population.

The first aim of this thesis was to investigate perceived benefits and barriers to participation in aqua-based exercise among older adults with and without osteoarthritis, who regularly engage in this form of exercise. The key perceived benefit for those with osteoarthritis was pain reduction, whilst those without osteoarthritis identified general health and fitness as the primary benefit. Both groups identified social interaction as an important benefit. Cold changing facilities, particularly during winter, was a key potential barrier for both groups. The second study examined perceived barriers and benefits of aqua-based exercise among older adults with osteoarthritis who had tried, but no longer participated in aqua-based exercise. Key barriers were a lack of suitable classes and insufficient instructor knowledge, as well as cold changing facilities and pool temperature. Benefits included the cushioning effect of the water and the ability to move around more freely.

The third study was undertaken to gain greater insight into the effect of different types of aqua-based exercise on pain and heart rate response of older adults with osteoarthritis. In addition, participants' opinions and attitudes towards each exercise mode were explored. Participants tried different types of aqua-based exercise including: hydrotherapy, which is a therapist-supervised programme which takes place in warm water; aqua-jogging, which simulates running in deep water whilst wearing a flotation device; resisted-aqua jogging, which is similar to aqua jogging but utilises resistance equipment to increase drag; aqua-fitness, which involves strength and cardiovascular exercises to music in the shallow end of the pool and resisted aqua-fitness, which is similar to aqua-fitness but resistance equipment is used to increase drag. Pain scores immediately post-exercise decreased for all modes of aqua-exercises. Heart-rate response and rating of perceived exertion was also similar for all aqua-exercise modes. Overall, participants enjoyed the hydrotherapy session most, however the aqua-fitness session (un-resisted) was also enjoyed and identified as an acceptable alternative to hydrotherapy.

The final study explored the potential health benefits of a 12-week aqua-fitness intervention for older adults with osteoarthritis. An active control group, who undertook a seated aqua-based exercise session once a week, was used help minimise any effects of social interaction on the outcome measures. Positive physiological outcomes were associated with the aqua-fitness group who improved scores in several functional measures, as well as significantly reducing their fear of falling compared to the control group.

The findings of this thesis are relevant for future design of aqua-based exercise interventions aimed at older adults with osteoarthritis. The research undertaken may help to identify and therefore address barriers to this mode of exercise for this population. Furthermore, the findings of this thesis offers some insight into the acute responses to different modes of aqua-based exercise, as well as long longer-term chronic adaptations to an aqua-based exercise programme similar to those which are readily available in the community.

Chapter 1 : Introduction

1.1 Background

Over the last fifty years, the 65-year plus age group have increased steadily and now comprise 12.3% of the population in New Zealand. This number is expected to rise with older adults to represent one quarter of New Zealand residents by 2051 (Statistics New Zealand, 2007; Wilcox et al., 2006). With advancing age, a number of physiological changes occur and the risk of disease increases, one of the most common being osteoarthritis, which affects more than one third of adults over 65 years old (Minor, 1996).

Physiological changes, which are associated with ageing and osteoarthritis, include a loss of muscular strength, endurance and power as well as reduced dynamic gait and balance. These changes are related to a diminished ability to perform activities of daily living, such as rising from a chair and walking up stairs. This can lead to an increased falls incidence as well as an increased fear of falling amongst older adults (Friedman, Munoz, West, Rubin, & Fried, 2002). However, regular physical activity can induce a number of favourable physiological and psychological responses, which may help minimise these changes and contribute to healthy ageing.

Falls and fear of falling, both of which increase with advancing age, have a strong association with avoidance of activity (Zijlstra et al., 2007). Similarly, osteoarthritis is associated with physical inactivity and has been cited as one of the primary causes for limitation of physical activity in older adults (Minor, 1996). This avoidance of activity further exacerbates declines in muscular strength, dynamic gait and balance, which can lead to deterioration in quality of life and increased social isolation (Yardley & Smith, 2002).

The high rate of osteoarthritis and its resulting reductions in strength, balance and function carry an economic cost as well as social implications, such as loss of independence. Whilst the evidence that land-based exercise positively effects strength, balance, functional capability, fear of falling and quality of life in older adults is irrefutable, relatively limited research has been conducted in an aqua-environment and many studies on older adults with osteoarthritis in an aqua-environment, have focused on hydrotherapy rather than more commonly available aqua exercise modes, such as aqua-fitness and aqua-jogging (Rahmann, 2010).

In order for any exercise programme to maximise its benefits and ensure that positive outcomes are ongoing, participants must adhere to the programme. One of the key components of exercise adherence is the perceived benefits of participation in that programme among participants (Kirkby, Kolt, Habel, & Adams, 1999). Limited research is currently available with regard to the perceived benefits of aqua-based exercise amongst older adults with osteoarthritis. Social interaction has been shown to be an important benefit and motivator to exercise among older adults (Waters & Hale, 2007), whereas adults with arthritis are more likely to cite pain relief (Wilcox et al., 2006) as a key benefit. However none of these studies investigated the perceived benefits of an aqua-based exercise programme and none examined the difference in perception between current and former participants of this exercise mode. Due to the high incidence of osteoarthritis amongst older adults and the popularity of community-based aqua exercise programmes among older adults, these classes are likely to include a large percentage of older adults with osteoarthritis. Consequently there is a need to examine the perceptions of older adults with osteoarthritis on the potential benefits of aqua-based exercise, particularly among those participating in programmes which are readily available in the community. Reasons for ‘dropping out’ of an aqua exercise programme are also important, as this form of exercise is widely advocated for people with osteoarthritis, but reasons for termination have not been examined.

Two popular forms of aqua exercise include aqua-fitness and aqua-jogging. Both forms of exercise can potentially offer benefits to older adults such as improved strength and balance and may be especially appealing to older adults with osteoarthritis or joint discomfort since the buoyancy of the water reduces the load on the joints (L. T. Brody, 2009). In order to make recommendations regarding these forms of exercise for older adults with osteoarthritis, a greater understanding of their effect on pain as well as physiological responses is needed.

1.2 Aims and Objectives of this doctoral research

1. To investigate the perceived benefits, motivators and potential barriers to aqua-based exercise among current participants and whether these perceptions differ between older adults with and without osteoarthritis.
2. To investigate the perceived barriers and benefits of aqua-based exercise among older adults with osteoarthritis who have tried but discontinued this form of exercise.
3. To investigate the affect of several forms of aqua-based exercise; hydrotherapy, aqua-fitness, resisted aqua-fitness, aqua-jogging and resisted aqua-jogging, have on acute pain, heart rate (HR) response and rating of perceived exertion (RPE) amongst older adults with osteoarthritis and to explore perceptions towards these exercise modes.
4. To investigate the effects of 12-weeks of twice-weekly aqua-based exercise on strength, functional ability, quality of life, balance and fear of falling, cardiovascular fitness, arthritis symptoms and quality of life in older adults with osteoarthritis compared to an active control group.

5. To investigate adherence to an aqua-based exercise programme three months post-intervention

1.3 Significance of this Doctoral Research

The findings of this research add to current knowledge relating to aqua-based exercise for older adults with osteoarthritis. This research provides a greater understanding of the perceived benefits and motivators to participate in a community-based aqua exercise programme among older adults with and without osteoarthritis. It also provides a greater understanding of reasons for dropping out of an aqua-based exercise programme among older adults with osteoarthritis. This helps provide insight into how best to develop programmes, which are suitable and appealing to this population. This research also provides information relating to acute responses to different forms of aqua-based exercise for older adults with osteoarthritis. In particular, comparison was made between aqua-fitness and aqua-jogging, which are both widely available in many community swimming pools, and hydrotherapy, which requires specialised equipment and supervision, in order to assess whether these types of exercise result in comparable responses. Finally, the effects of a 12-week aqua-based exercise intervention on strength, functional performance, balance, fear of falling and quality of life among older adults with osteoarthritis was analysed. Combined, these results will help to increase understanding relating to the potential benefits of a generic aqua-based exercise programme for older adults with osteoarthritis and what factors are likely to enhance adherence to such a programme.

1.4 Thesis Presentation

This thesis is presented in a paper-based style. A general literature review discusses the relevant background issues relating to ageing and osteoarthritis, followed by an overview of the benefits of exercise and especially aqua-based exercise as well as the barriers to exercise among this population. Thereafter, the thesis is comprised of the following papers:

1. Perceived benefits, motives and barriers to aqua-based exercise amongst older adults with and without osteoarthritis.
2. Perceived barriers and benefits of aqua-based exercise among older adults with osteoarthritis.
3. Perception and responses to different forms of aqua-based exercise among older adults with osteoarthritis.
4. Effects of an aqua-fitness exercise programme on function, balance and perceived quality of life in older adults with osteoarthritis.

Thereafter a summary of the overall thesis is provided, conclusions are drawn and areas for future research identified.

Chapter 2 : Literature Review

2.1 Ageing Population

Over the last fifty years, the 65-year plus age group have increased steadily and now comprise 12.3% of the population in New Zealand, with the percentage of adults over 80 years also increasing to 3.4% of the population (Statistics New Zealand, 2007). The number of people aged over 65 years is expected to continue to rise, so that by 2051 there will be an estimated 1.33 million older adults in New Zealand, making up one quarter of all residents. Similar trends have been predicted for North America where the percentage of adults aged 65 years or older is expected to rise to approximately 20% of the population by 2030 (Goulding, Rogers, & Smith, 2003).

Ageing is associated with an increased risk of a number of diseases, such as hypertension, arteriosclerosis, diabetes, osteoarthritis and osteoporosis, as well as reduced functional capacity and an increase in the risk of falls and falls-related fracture. Ageing is also associated with reduced levels of physical activity, which further increases the likelihood of developing such health outcomes. Reduced levels of physical activity are associated with a loss of muscular strength, endurance and balance, all of which contribute to an increase in falls risk and fear of falling, reduced function and reduced perceived quality of life (QoL) in older adults (T. R. Henwood & Bartlett, 2008). A pictorial representation of these relationships can be seen in Figure 1.

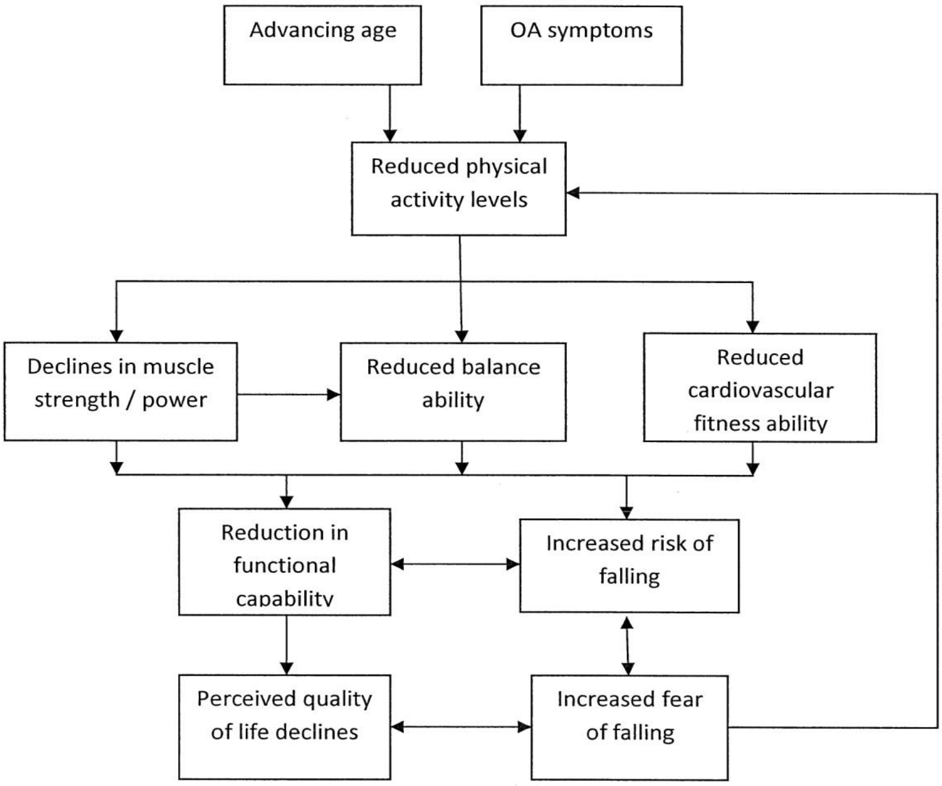

Figure 1. Simple model illustrating the effects of ageing

2.2 Osteoarthritis

One of the primary causes for limitation in physical activity in older adults is osteoarthritis (Minor, 2003). Osteoarthritis is the most common form of arthritis, the incidence of which increases with advancing age. Estimates suggest that 9.6% of men and 18% of women aged ≥ 60 years of age have symptomatic osteoarthritis (Woolf & Pfleger, 2003). Symptoms of osteoarthritis include joint pain, tenderness, limitation of movement and varying levels of inflammation without systemic effects. Osteoarthritis is characterised by; a loss of cartilage, thickening of subchondral bone, subchondral cysts, osteophytes and synovial inflammation at the affected site or sites (Flores &

Hochberg, 2003). Risk factors for the development of osteoarthritis include general factors such as; age, gender, menopause status, genetics and nutrition as well as mechanical factors such as; obesity, injury or surgery, muscle weakness, repetitive joint loading and joint deformity resulting in abnormal distribution of load (Arden & Nevitt, 2006). Areas of the body affected include the hip, knee, cervical spine, lumbosacral spine, first metatarsophalangeal joint and the distal interphalangeal, proximal interphalangeal and carpometacarpal joints in the hands (Jacobson, Girish, Jiang, & Sabb, 2008). Older adults with osteoarthritis are less physically active than older adults without osteoarthritis (Hootman, Macera, Ham, Helmick, & Sniezek, 2003), the majority of adults 65 years and older with osteoarthritis are not sufficiently active to gain health benefits (Fontaine, Heo, & Bathon, 2004). A study by Dunlop, Song, Semanik, Sharma, & Chang, (2011) found that only 12.9% of males and 7.75% of females aged between 48 and 84 years with knee osteoarthritis met the physical activity guidelines for cardiovascular exercise.

In order to understand some of the challenges associated with ageing and osteoarthritis, an overview of the key physiological changes associated with advancing age follows in the first section of this literature review. The second section provides a review on the benefits of exercise for offsetting these side-effects, focusing in particular on aqua-based exercise interventions in which participants were older adults with osteoarthritis. The third section examines the determinants of exercise, with a particular emphasis on perceptions of exercise among older adults with osteoarthritis.

The terms functional capacity, function capability, functional ability and functional performance are regularly used interchangeably within literature to describe the ability to carry out activities of daily living. In this review, functional ability will be used to describe the ability to carry out functional tasks such as walking, climbing stairs and rising from a chair.

2.3 Age-related Changes

2.3.1 Neuromuscular

The relationship between age-related changes in muscle function and joint degeneration in osteoarthritis has received considerable attention with several authors hypothesising that age-related muscle dysfunction may be involved in the progression of osteoarthritis in some people (Hurley, 2003; Slemenda et al., 1997a). It has been suggested that muscle dysfunction may be involved in the pathogenesis or progression of osteoarthritis in some cases and that the age-related decline in muscle function and concurrent increase in incidence of osteoarthritis is not coincidental (Hurley, 2003). Although there is insufficient scientific evidence to substantiate or refute this hypothesis, it is evident that reduced lower extremity strength is related to disability for those with hip and knee osteoarthritis (Van Baar, Dekker, Lemmens, Oostendorp, & Bijlsma, 1998) and large quadriceps strength deficits are common among those with knee osteoarthritis (T. E. McAlindon, Cooper, Kirwan, & Dieppe, 1993). Maintenance of muscular strength and function is important particularly for people with lower limb osteoarthritis as these muscles affect joint stability and absorb forces and loads generated during gait and other weight bearing activities (Hurley, 2003). Furthermore, it has been suggested that increased muscle strength may protect against further progression of knee osteoarthritis (Arden & Nevitt, 2006) and has been associated with reduced pain and increased function in people with knee osteoarthritis (Bennell, Wrigley, Hunt, Lim, & Hinman, 2013).

A geriatric condition known as sarcopenia is related to increasing age. Sarcopenia has been defined as a loss of muscle mass and strength that occurs with ageing (Roubenoff & Hughes, 2000). Recently, the European Working Group on Sarcopenia in Older People (EWGSOP) recommended additional inclusion of low muscle function and functional performance (e.g. walking speed) to define sarcopenia (Cruz-Jentoft et al., 2010). Muscle mass is estimated to decline by approximately 1-2% annually after the age of 50 years (Hughes, Frontera, Roubenoff, Evans, & Singh, 2002) with a more rapid decline (around 3% per annum) after the age of 60 years (Vandervoort, 2002). Although sarcopenia is considered by some to be a normal consequence of ageing, tendencies for older adults in the developed countries to reduce their levels of physical activity with increasing age, can further exacerbate this loss of muscle mass, strength and function. Similarly, osteoarthritis causes joint damage and pain, which are also linked to declines in activity levels and consequently, muscle strength and function (Slemenda et al., 1997a). It has been reported that muscle strength declines by about 15% per decade in the 6th and 7th decades and by about 30% thereafter (Mazzeo, 1998). Knee and hip osteoarthritis predicts even greater declines in lower extremity muscle strength in older women (Scott, Blizzard, Fell, & Jones, 2012). The declines in muscle strength contribute to the reduction in functional performance and ability to perform activities of daily living (ADL) often associated with increasing age (Baumgartner et al., 2012; Fiatarone Singh, 2002).

The loss of muscle mass experienced by those who live beyond 80 years, often results in frailty, mobility problems and further loss of independence (Roubenoff & Hughes, 2000; Vandervoort, 2002).

Alongside the age-related changes in muscle mass there is also a decline in the number of alpha motor neurons with increasing age (Doherty, Vandervoort, Taylor, &

Brown, 1993). Age-related loss of motor neurons affects type II, or fast-twitch motor neurons preferentially (Carmeli & Reznick, 1994) and reduced velocity of motor axon conduction also incurs with increasing age (Doherty et al., 1993; Wang, DePasqua, & Delwaide, 1999). Whilst muscle mass has an effect on the force which a muscle can generate, decreased activation of type II motor units and overall contraction velocity results in a diminished ability to produce muscular power, which has also been associated with reduced functional capacity and the ability to perform ADL (Tanimoto et al., 2012). The combination of reduced muscle mass and power result in a slower and less powerful muscle contraction for older adults, when compared to younger subjects of similar activity levels. This not only reduces maximum speed of movement but also the initiation of response to stimuli such as a loss of balance, thus increasing the likelihood of falling.

Reduced muscle mass contributes to a decline in resting metabolic rate, which combined with a reduction in physical activity, results in a decline in total daily energy expenditure. This contributes to an increase in total body fat and visceral fat (Greenlund & Nair, 2003). Accumulation of intra-abdominal fat is associated with an increased risk of hypertension, diabetes and heart disease (Zamboni et al., 2005). Furthermore, age-associated changes in body composition are related not only to health status but can also increase the risk for the onset, progression and symptoms of knee osteoarthritis (Teichtahl, Wang, Wluka, & Cicuttini, 2012). Those with a Body Mass Index (BMI) of 30 or more have a much higher rate of osteoarthritis (Felson, 1995).

2.3.2 Functional ability

Reduced muscle mass and a slower rate of muscle contraction contribute to age-related declines in functional ability (Baumgartner et al., 2012; Fiatarone Singh, 2002). Osteoarthritis in the hip or knee is associated with gait disturbance, decreased muscle strength and range of motion that increase the likelihood of functional problems (Minor, 2003). Declines in functional performance and the concurrent reduction in daily activities are often associated with a reduction in perceived quality of life due to loss of independence (Lomranz, Bergman, Eyal, & Shmotkin, 1988). Figure 2 gives an overview of the effects of advancing age and sarcopenia, osteoarthritis and decreasing physical activity levels.

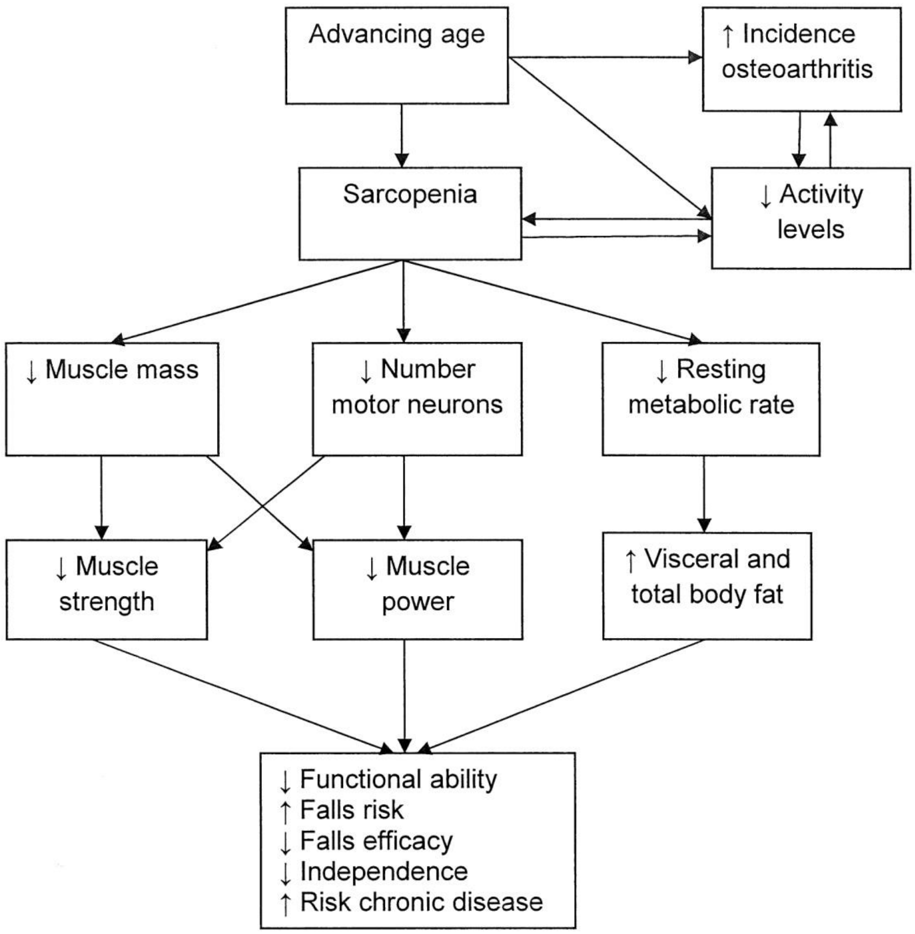

Figure 2. An overview of the effects of advancing age including sarcopenia, osteoarthritis and decreasing physical activity levels

2.3.3 Quality of life.

Perceived quality of life is comprised of a wide range of components and consequently there are a number of definitions and measures available to define this concept in older adults (Walker, 2005). Several key factors, which contribute to self-assessed quality of life amongst older adults include; good health and mobility, a sense of usefulness, on-going participation in hobbies and leisure activities, social interaction and support, access to local facilities and socio-economic status (Gabriel & Bowling, 2004). Netuveli & Blane (2008) noted that whilst the majority of older adults evaluate their quality of life based on social contacts, health, dependency, material circumstances and social comparison, ageing itself does not necessarily have a negative influence on perceived quality of life. Another study (Ozcan, Donat, Gelecek, Ozdirenc, & Karadibak, 2005) also observed that whilst quality of life was not automatically associated with ageing, an increase in falls risk factors, such as reduced balance, functional capability and muscle strength were associated with quality of life among older adults.

Studies focusing on older adults with osteoarthritis have associated pain and functional limitation with quality of life (Jakobsson & Hallberg, 2002). Social support has also been identified as a key factor among this population (Blixen & Kippes, 2007). If older adults have limited social interaction, due to reduced levels of function, this may lead to further declines in perceived quality of life. Reduced social interaction and cognitive function have also been associated with declines in muscle strength and function (Tanimoto et al., 2012). These factors can contribute to a loss of independence, which can lead to social isolation and intensify feelings of depression. Depression is especially prevalent amongst those with osteoarthritis, osteoarthritis patients are three times as likely to have a depressed mood than those who do not have osteoarthritis (Ang & Kroenke, 2003). The severity of joint pain has been strongly correlated with depression and anxiety (Salaffi, Cavalieri, Nolli, & Ferraccioli, 1996). Therefore, those with the most pain are more likely to avoid physical activity and have higher levels of anxiety and depression, thus further exacerbating declines in strength and functional ability. Figure 3 gives an overview of the effects of sarcopenia and osteoarthritis on quality of life.

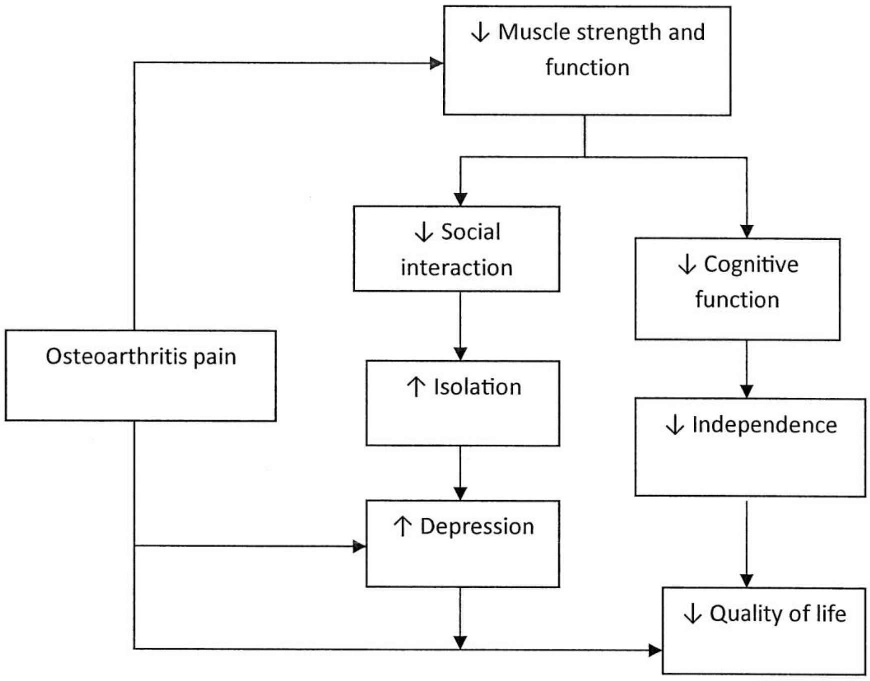

Figure 3. Model of impact of sarcopenia and osteoarthritis on quality of life

2.3.4 Balance and Fear of Falling

The risk of falling and severity of falls increases for those over the age of 65 years (Granacher, Zahner, & Gollhofer, 2008; Lord, Sherrington, Menz, & Close, 2007). Recent New Zealand data indicates that in a convenience sample of 130 older adults (under-active to active) who participated in a study examining a new falls risk assessment, 31% retrospectively reported a fall within the past year (Wagenaar, Keogh, & Taylor, 2012). Another study utilising a prospective design with older, frail adults suggested even higher rates of falls among this group (Shimada, Obuchi, Furuna, & Suzuki, 2004). Older adults with hip osteoarthritis are at a high risk of falling due to lower limb weakness, decreased mobility and pain (Arnold & Faulkner, 2010). Falls occur due to a loss of balance and failure of the body’s compensation mechanisms to quickly correct a loss of balance (Tideiksaar, 1994). Risk factors for falls encompass both intrinsic and extrinsic factors (Todd & Skelton, 2004). Intrinsic factors include advanced age (Robbins et al., 1989)}, muscle weakness (Skelton, 2001), reduced lower limb proprioception (Sturnieks et al., 2004), poor vision (Ivers, Cumming, Mitchell, & Attebo, 1998) and history of previous falls (Todd & Skelton, 2004). Extrinsic factors include obstacles or tripping hazards, slippery or uneven surfaces (Lord, Sherrington, & Menz, 2000) and some medications (Leipzig, Cumming, & Tinetti, 1999). Age-related declines in functional mobility, proprioception, muscle strength and flexibility and balance contribute to an increased risk of falling with advancing age. For example postural control is an important contributor to the preservation of postural stability (Lord et al., 2007). Postural control requires integration of a number of processes, muscle strength and reflex activity are responsible for a substantial proportion of postural stability, both of which decline with increasing age. Proprioceptive activity has been shown to be reduced in those with knee osteoarthritis compared to age and gender-matched controls (Smith, King, & Hing, 2012), however a review by Smith et al., (2012) concluded that proprioceptive exercises can improve functional ability of those with knee osteoarthritis. In addition, there is also considerable evidence to suggest that psychological factors, such as attentional limitations, cognitive impairment and depression are also associated with impaired stability and falling in older people (Lord et al., 2007).

Fear of falling further increases the likelihood of falls in older adults, as an individual with a fear of falling is more likely to actually fall. Similarly falling can induce a fear of falling (Friedman et al., 2002). Fear of falling is associated with avoidance of physical activity (Petrella, Payne, Myers, Overend, & Chesworth, 2000), reduced quality of life (Cumming, Salkeld, Thomas, & Szonyi, 2000) depression and social isolation (Howland et al., 1993). Fear of falling and subsequent avoidance of activity is often apparent among those with poor perceived general health (Zijlstra et al., 2007). Consequently those who would most benefit from regular physical activity, such as older adults with osteoarthritis, are most likely to avoid exercise due to fear of falling whilst taking part. This avoidance of activity further exacerbates declines in neuromuscular function, which in turn reduces balance and may contribute to further health declines.

2.4 **Pain**

Pain is one of the most common symptoms reported by people with osteoarthritis and pain reduction is considered one of the primary goals in the treatment of osteoarthritis (Rahmann, 2010). As stated previously, pain is often associated with avoidance of physical activity, which results in deconditioning of the cardiovascular and musculoskeletal systems, which in turn can have a negative impact on quality of life and functional ability (Westby, 2001). Older adults with osteoarthritis are less physically active than their non-affected age-matched peers (Shih, Hootman, Kruger, & Helmick, 2006) and consequently, may be more likely to suffer from age-related disease and loss of function. Treatment options for osteoarthritis pain reduction encompass anti-inflammatory medications, topical agents, intra-articular corticosteroid and hyaluronic acid injections as well as various forms of exercise (Blum & Kolasinski, 2007). Best practice guidelines developed by The American Geriatrics Society Panel of Exercise and Osteoarthritis conclude that regular moderate exercise does not exacerbate osteoarthritis pain, nor accelerate the progress of osteoarthritis, but can help to reduce pain and morbidity (Lundebjerg, 2001). While studies comparing aqua-based exercise and land-based exercise programmes for adults with osteoarthritis have demonstrated that both forms of exercise have the potential to improve function, aqua-based exercise has also been linked with greater improvements in pain (Fransen, Nairn, Winstanley, Lam, & Edmonds, 2007; Wyatt, Milam, Manske, & Deere, 2001) and fewer adverse effects (Lund et al., 2008).

2.5 Land-based exercise

According to the Ministry of Health (Ministry, of, & Health, 2013), regular physical activity is linked with improved health and general well-being, including a reduction in chronic disease and improvements in quality of life, self-esteem and improved social skills (Gabriel & Bowling, 2004). The American College of Sports Medicine (ACSM) recommend a combination of aerobic and resistance-based exercise in order to optimise results in minimising progression and development of chronic disease and disabling conditions among older adults (Chodzko-Zajko et al., 2009). Numerous studies have investigated different forms of land-based exercise for older adults. A systematic review demonstrated that progressive resistance-based exercise has a large, positive effect on strength among older adults (Latham, Bennett, Stretton, & Anderson, 2004). Progressive resistance training has also been linked to improved physical function (Brandon, Boyette, Gaasch, & Lloyd, 2000), reduced physical disability (Sayers et al., 2003) and improved coordination (Krebs, Scarborough, & McGibbon, 2007) in older adults. Land-based exercise has been associated with improved dynamic gait and balance (Bird, Hill, Ball, & Williams, 2009) and significant improvements in postural sway and coordinated stability measures have been observed following a low-intensity, land-based balance exercise programme among older adults at risk from falling (Barnett, Smith, Lord, Williams, & Baumand, 2003).

Tai Chi has become a popular exercise choice for older adults as it may improve their balance (Hakim, Kotroba, Cours, Teel, & Leininger, 2010), reduced fear of falling amongst previous fallers (Sattin, Easley, Wolf, Chen, & Kutner, 2005) and with improved functional ability (Wolf et al., 2006). A number of government agencies, such as Agewell New Zealand and the Accident Compensation Corporation (ACC) advocate Tai Chi as a exercise mode that can help prevent falls among older adults (ACC, 2012; Agewell, 2010).

While various forms of land-based exercise can help offset a number of age-related diseases, and improve strength, balance and cardiovascular function, the American Geriatrics Society (AGS) suggest that the primary goals of an exercise programme for older adults with osteoarthritis pain should focus on pain control, increasing joint range of motion and improving muscle strength and endurance (Lundebjerg, 2001). Muscle mass and strength can only be maintained or increased in adults, including older adults, by means of overloading the muscle with resistance-based exercise (Klitgaard et al., 1990) and this form of exercise is particularly important for older adults with osteoarthritis, as they often have reduced muscle strength in the lower extremities. Slemenda et al., (1997b) noted that quadricep weakness was common in older adults with knee osteoarthritis. There have been a number of studies which have examined the effects of resistance-based exercise on older adults with osteoarthritis. A randomised, controlled trial by Hopman-Rock and Westhoff (2000) found that a 6-week exercise and education programme resulted in improved quadricep strength in older adults with hip or knee osteoarthritis and in addition, positive outcomes were observed for pain and perceived quality of life. Similar outcomes were noted following a four-month home-based strength training programme conducted among older adults with knee osteoarthritis (Baker et al., 2001). Strength is an important factor to help minimise falls among older adults and greater leg strength has been associated with better dynamic balance in older adults with knee osteoarthritis (Jadelis, Miller, Ettinger, & Messier, 2001). Lange and Vanwanseele, (2008) concluded that resistance training improved self-reported measures of pain amongst adults with knee osteoarthritis in 56% of the studies they reviewed.

Hall, Mockett, & Doherty (2006) observed that the presence of pain in adults with radiographic knee osteoarthritis resulted in increased postural sway, which is indicative of reduced balance ability. Postural sway reduced in older adults with knee osteoarthritis following an 18-month exercise intervention consisting of either walking or resistance-based exercise (Messier et al., 2000). Another form of exercise which has been investigated is proprioceptive-based exercise. A recent review of literature by Smith et al., (2012) examined proprioceptive-based exercise programmes for adults with knee osteoarthritis and found overall positive outcomes for functional performance, though the authors noted that these findings may not be applicable for older adults or for those with more advanced osteoarthritis.

Despite the many potential benefits of regular exercise for older adults with osteoarthritis, a large percentage do not regularly participate in any form of exercise (Lee et al., 2013). One of the key barriers to exercise cited is pain (Der Ananian, Wilcox, Watkins, Saunders, & Evans, 2008; Wilcox et al., 2006). Aqua-based exercise may offer a safe and appropriate setting for older adults with osteoarthritis, since the buoyancy of the water reduces the stress on joints (Gulick & Geigle, 2009). In addition water immersion has been associated with decreased pain symptoms, due to increased sensory input and decreased joint compression (Westby, 2001). Furthermore, provided participants are confident in the water, there is a reduced fear of falling and likelihood of falling during aqua-based exercise compared to land-based exercise (Kaneda, Sato, Wakabayashi, Hanai, & Nomura, 2008).

2.6 Aqua –based Exercise

2.6.1 Overview

Aqua-based exercise is recommended for older adults with osteoarthritis by The American College of Rheumatology (Westby, 2012). Different forms of aqua-based exercise include: hydrotherapy, aqua-fitness and aqua-jogging. Hydrotherapy is typically an individualised, therapist-supervised programme which focuses on strength and range of motion (ROM) exercises (Eversden, Maggs, Nightingale, & Jobanputra, 2007), usually in warm water between 33.5 and 35.5° Celsius (Becker, 2009). Aqua-fitness usually consists of partial weight-bearing aerobic and strengthening exercises performed while standing in the shallow end of a swimming pool, usually to music. Aqua-jogging consists of simulated running in deep water whilst wearing a flotation devise to keep the head above water (Reilly, Dowzer, & Cable, 2003). Aqua-fitness and aqua-jogging are generally performed in a group and are overseen by an aqua instructor, both are popular community modes of aqua-based exercise among older adults. Pool temperatures for aqua-fitness and aqua-jogging are variable, however, classes often take place in public or competitive swimming pools many of which operate in a temperature range of 27-29° Celsius (Becker, 2009).

These different forms of aqua-based exercise all utilise the combined effects of water viscosity, cohesion, adhesion and surface tension to provide a source of resistance to movement which can be utilised to provide gradual increases in resistance (Irion, 2009; Suomi & Collier, 2003). Sensory input, which is essential for maintenance of postural control and balance, is positively affected by hydrostatic pressure, viscosity, drag and turbulence of the water. Changes of body position against the resistance of the water increase the sensory input to the brain and the output to the musculature to stabilise postural alignment (Gulick & Geigle, 2009). A systematic review of literature concluded that aqua-based exercise can offer comparable health benefits to land-based exercise (Batterham, Heywood, & Keating, 2011). Furthermore, aqua-based exercise has been associated with pain reduction and it has been proposed that aqua-based exercise has greater adherence in older adults than land-based exercise (Tsourlou, Benik, Dipla, Zafeiridis, & Kellis, 2006). This is important as long-term participation in physical activity is an essential factor for ongoing health benefits and is linked to continued independent living and delayed disability among older adults (Spirduso & Cronin, 2001).

Many studies concerned with the potential benefits of aqua-based exercise for adults with osteoarthritis have utilised an exercise programme based around hydrotherapy. Several of these are outlined in Table 1.

Table 1: Hydrotherapy-based interventions

Authors	Sample	Design	Exercise intervention	Outcomes and measures	Results *
Hinman et al. 2007	71 adults, 50 years + OA of the hip +/or knee.	RCT	H: 6 wks, 2/wk. 45-60 min of therapist supervised balance and strengthening ex. C: normal activities Pool temp: 34°C.	Pain, self-assessed function, QoL, hip abduction, knee extension, Step test, TUG, 6-min walk test.	H: ↓ pain, ↑ self-assed function, hip abduction strength and QoL compared to C.
Wyatt et al. 2001	46 adults, 45-70 years with knee OA.	RCT	H v's L, 6 wks, 3/wk Both groups performed same resistance ex Pool temp: 32.2°C.	Passive ROM knee flexion and extension of affected knee, thigh girth measurement, pain and timed 1 mile walk test.	H & L improved all measures. Pain was ↓for H than L post-int.
Foley et al. 2003	105 adults aged 50 years + with hip +/or knee OA.	RCT	H v's L, 6 wks, 3/wk, 30 min. Both performed similar strengthening ex with individual progression C: normal activities Pool temp: not known.	Quadricep strength, 6-min walk test, Self-assessed pain, function and stiffness, arthritis satisfaction questionnaire.	↑ in quadricep strength and 6-min walking speed post intervention in H & L but not C. H ↓ pain post int. but not sig from L or C. Self-reported health improved for H post int. and was sig different from C. L sig improved arthritis satisfaction compared to C.
Fransen et al 2007	152 adults aged 59-85 years with hip or knee OA.	RCT	H v's Tai Chi (T), 12 wks, 2/wk H: strengthening and balance ex overseen by a physiotherapist with individualised progression T: practiced 24 forms from the Sun style, participants were able to purchase a video to practice at home C: normal activities Pool temp: 34° C.	Self assessed pain & function, general health/well-being, depression, anxiety & stress. Timed 50-FWT, stair climb, TUG.	Pain ↓ and function scores ↑ post int. in H & T, only H improved sig compared to C. H improved health/well-being, depression, anxiety & stress, Timed 50FWT, stair climb and TUG post int. compared to C. T improved stair climb time post int.
Silva et al 2008	64 adults, mean age 59 years with knee OA.	RCT	H v's L, 18 wks, 3/wk Both groups performed similar strengthening ex and gait training for approx 50 min per session supervised	Pain, pain in previous week, pain before and after 50-FWT, severity of osteoarthritis, 50-FWT time, no. of NSAIDs used.	H & L ↓pain in previous wk post int. but no sig difference between groups. H & L improved severity of osteoarthritis at 9 wks, H also improved

	by physical therapists, reps increased over 18 wks. Pool temp: 32°C.	Measured at baseline 9 & 18 wks	scores between wks 9 & 18 Both groups ↓pain scores between baseline and week 9, no sig difference between groups. Pain levels before and after 50FWT ↓ both groups. H had sig greater ↓ in pain compared to L at 18 weeks Both groups improved 50FWT, no sig difference between groups. NSAID use ↓ post intervention, no sig difference between groups.

OA: Osteoarthritis; RCT: Randomized Controlled Trial; H: Hydrotherapy; wks: weeks; wk: week; min: minutes; temp: temperature; QoL: Quality of life; C: Control; ex: exercises; TUG: Timed up-and-go Test; L: Land-based exercise; sig: statistical significant; ROM: Range-of-movement; int: Intervention; 50-FWT: 50-Foot Walk Test; NSAIDs: Non-steroidal Anti-inflammatory Drugs; no.: number; reps: repetitions

* means significantly different

While hydrotherapy-based programmes have been shown to improve physical function (Fransen et al., 2007) and reduce pain (Silva et al., 2008) among adults with osteoarthritis, hydrotherapy classes are often expensive and not always widely available due to the requirement of specialised therapists and facilities. Aqua-fitness and aqua-jogging classes are often more accessible and affordable than hydrotherapy classes. Although several studies have investigated the potential benefits of an aqua-fitness based exercise programmes, relatively few have focused on older adults with osteoarthritis, a summary of some of these studies is given in Table 2.

The following overview of research focuses on different forms of aqua-based exercise for older adults and in particular, those with osteoarthritis and discusses the age-related physiological changes outlined previously. This review of literature aims to highlight some of the key findings and current gaps in knowledge and understanding relating to aqua-based exercise.

Table 2: Aqua-based exercise interventions

Authors	Sample	Design	Exercise intervention	Outcomes and measures	Results *
Hale et al. 2012	39 adults, mean age 75, self-reported OA + at least one falls risk factor.	RCT	A v's C: 12 wks, 2/wk A: Balance and strength ex progressed up to 60min C: Computer skills training programme. Pool temp: Ave 28°C.	Falls risk assessment (PPA), Step test, TUG, self assessed pain/function/impact of osteoarthritis QoL and ABC.	No statistically sig. difference between A & C for any measures. Step test ↑ post int. for both A & C. Two components of PPA improved post int. C only.
Arnold and Faulkner, 2010	79 adults 65 years + with hip OA + at least one falls risk factor.	RCT	A v's AE v's C A & AE: aqua ex, 12 wks/ 2 wk. Strength, trunk-control and balance ex for 45 min. AE: additional 1/wk education session C: normal activities Pool temp: not known.	Balance: Berg Balance Scale, 6-min walk test, 30-sec STS, falls efficacy, TUG, Impact of arthritis.	AE improved falls efficacy and STS compared to A & C. No other sig. different outcomes.
Lund et al. 2008	79 adults, mean age 68, knee OA.	RCT	A v's L v's C, 8 wks, 2/wk A & L: Resistance, balance & stability ex for 50 min C: normal activities Pool temp: 33.5° C.	Pain, KOOS; Standing balance, knee muscle strength Measured baseline, 8 wks & 3-month F/U	No sig changes in pain at 8 wks. At 3 months L ↓ pain compared to C. L ↑ muscle strength compared to C. A ↓ muscle strength compared to C.

OA: Osteoarthritis; RCT: Randomized Controlled Trial; A: Aqua-based exercise; C: Control; wks: weeks; wk: week; ex: exercises; PPA: Physiological Profile Assessment; TUG: Timed up-and-go Test; QoL: Quality of Life; ABC: Activities-Specific Balance Confidence Scale; min: minutes; sig.: statistically significant; int.: intervention; AE: Aqua-based exercise and Education sessions; 30-sec STS: 30-second Sit-to-stand Test; L: Land-based exercise; KOOS: Knee Injury and Osteoarthritis Outcome Score Questionnaire; F/U: follow-up.

* means significant difference.

2.6.2 Aqua-based exercise and muscle strength

The effect of an aqua-based exercise programme on muscle strength in older adults has been investigated, although to a somewhat lesser extent than land-based exercise programmes. Significant improvements in strength of older adults was demonstrated by Tsourlou et al., (2006), Takeshima et al., (2002) and Katsura et al., (2010), whose participants took part in an aqua-based exercise programme, comprising of aerobic and resistance type exercises performed 3 times per week. In each study, intensity was gradually increased to moderate-strong by means of water-resistance products and velocity of movement to increase resistance. In contrast, some other aqua exercise studies have reported no significant increase in muscular strength. Lord et al., (2007) investigated the impact of once-weekly WAVES exercise programme on older adults. WAVES is a gentle warm water exercise class, which has specifically been designed for older adults. No statistical difference in quadricep strength was noted between the exercise and control group following a 20-week intervention. Due to the gentle nature of the WAVES exercise programme and the frequency of sessions (one per week), these results are not surprising due to the relatively low demands made on the neuromuscular system. However, the exercise group did significantly improve balance and stability post intervention. It is well documented that the volume and intensity of muscular work, as well as the actual exercises utilised, will affect the extent of any strength adaptation, regardless of whether exercises are conducted on land or in water. This highlights one of the key issues in trying to draw conclusions from literature relating to aqua-based exercise interventions. To date, there has been wide variation in the exercise methodologies used, with different exercises, volume, intensity and length of intervention, as well as differences in water depth and temperature.

Combined with the inherent difficulty in quantifying exercise intensity in the aqua-environment, these factors make it difficult to compare and contrast the relevant literature.

As previously stated, many studies investigating the effects of aqua-based exercise on older adults with osteoarthritis have employed an exercise programme based around a hydrotherapy session, which typically focuses on strengthening and Range of Motion (ROM) exercises. In a randomised, controlled trial by Hinman, Heywood and Day, (2007) the authors observed significant improvements in hip abductor strength following a hydrotherapy intervention among older adults with hip and knee osteoarthritis. However there was no significant difference in quadricep femoris strength following the six-week intervention. The increase in hip abductor but not quadriceps strength was a little surprising but may partially reflect the short timeframe of the intervention and the participants' reduced potential for quadriceps strengthening due to their greater familiarity with these exercises. Most land-based trials investigating the effect of resistance training on strength among older adults, have employed an exercise programme of at least eight weeks (Latham et al., 2004). A longer duration for the hydrotherapy programme may have resulted in more sizeable strength gains.

Two studies which used exercises from the Arthritis Foundation Aquatic Programme (AFAP) guidelines and procedures found significant strength increases following an 8-week intervention (Suomi & Collier, 2003) and a 12 week intervention (Wang et al., 1999). The AFAP consists of a range of strengthening and ROM exercises, in addition it includes several exercises, which are often used in aqua-fitness classes, such as the "Cossack Shuffle" and "Rocking Horse". Despite variations among these studies relating to length of intervention, pool temperature and exercise sessions, they all found favourable outcomes with regard to isometric strength following an aqua-based exercise intervention. However, an 8-week aqua-based exercise intervention among women with knee osteoarthritis resulted in unfavourable changes in muscle strength, despite improvements in a corresponding land-based exercise group who performed similar exercises (Lund et al., 2008). Although the exercises performed and the length of the study were comparable to the interventions outlined above, in which muscle strength improved, one key difference in the study by Lund et al., (2008) was that isokinetic strength was measured, rather than isometric strength. While isokinetic strength measures have been shown to provide useful information relating to torque production, some uncertainty has been expressed with regard to the ability of isokinetic measures to predict function, particularly lower intensity functional tasks (Salem, Wang, Young, Marion, & Greendale, 2000). Since Lund et al., (2008) did not measure any functional strength outcomes, it is not known whether the aqua-exercise group elicited any improvements in functional strength.

2.6.2.1 Measuring strength

Numerous methods of assessing strength are available, including measures of isometric, isoinertial and isokinetic strength. Hand grip dynamometry, a valid and reliable measure of muscle strength (Mijnarends et al., 2013). has been identified as a useful screening tool for health outcomes in older adults (Bohannon, 2008). Handgrip strength has been used to identify functional limitations and to predict disability in older men (Giampaoli et al., 1999). Although Giampaoli et al (1999) found no association between hand grip strength and presence of osteoarthritis it is generally acknowledged that declines in hand function occur as a result of ageing and age-related disorders, such as osteoarthritis (Carmeli, Patish, & Coleman, 2003) therefore measuring handgrip strength may be considered a valid assessment tool for older adults with osteoarthritis.

Although numerous strength measures are available for assessing lower limb strength, many studies interested in lower limb strength in older adults have chosen measures which assess functional strength. Measures of functional strength reflect the ability to carry out functional tasks which require lower limb strength. The 30-second sit-to-stand test (STS) is recommended by the Osteoarthritis Research Society International (OARSI) as a functional measure of lower body strength and balance for older adults with osteoarthritis (Dobson, Bennell, Hinman, Abbott, & Roos, 2012). The STS has been validated as a reliable measure of these modalities (Lord, Murray, Chapman, Munro, & Tiedemann, 2002). This measure requires the participant to stand and sit repeatedly and as often as possible over a 30-second time frame.

2.6.3 Aqua-based exercise and functional ability

As previously stated, maintaining muscle strength is an important factor in ensuring older adults are able to maintain function and the ability to perform ADL. A number of studies have examined the effect of an aqua-based exercise programme on functional ability of older adults and have demonstrated improvements in various measures such as gait speed (Arnold, Busch, Schachter, Harrison, & Olszynski, 2008), reaction time (Lord et al., 2006) and functional independence measures (Sato, Kaneda, Wakabayashi, & Nomura, 2007; Sato, Kaneda, Wakabayashi, & Nomura, 2009).

Similarly, several studies have examined the effects of aqua-based exercise on functional ability in older adults with osteoarthritis, as previously highlighted, many of these studies have utilised an exercise intervention based on a hydrotherapy programme. Whilst a randomised, controlled trial by Hinman, Heywood, & Day, (2007) observed only small improvements in function, which were not statistically significant, following a 6-week hydrotherapy intervention, other studies of longer duration have demonstrated more positive outcomes. In a randomised controlled trial by Fransen et al., (2007) 12-weeks of hydrotherapy and Tai Chi, both performed twice weekly, were compared with a control group. Only the hydrotherapy group showed significant improvements in TUG. Arnold & Faulkner (2010) also used the Timed up-and-go (TUG) test to measure functional performance, alongside the 30-second chair stand test (STS) among older adults with hip osteoarthritis. Three groups of participants were examined: an aqua-exercise group who undertook 11 weeks of strength and balance exercises twice weekly; an aqua-exercise plus education group, who undertook the same aqua-based exercise intervention, but also attended a weekly education programme during which a therapist encouraged them to transfer the skills learned in the pool to successfully perform tasks on land as well as providing education relating to fall-prevention strategies; and a control group, who continued with their normal activities. Only the aqua-exercise plus education group significantly improved STS compared to the aqua-exercise only and control groups. Similar trends were noted for the TUG and 6-minute walk test. It may be important to note that participants in the study by Arnold & Faulkner (2010) had at least 1 fall risk factor, such as previously falling, in addition to hip osteoarthritis. Fear of falling, which is often present in older adults who have previously fallen, is likely to have an effect on function with low falls efficacy related to self-limiting behaviour, which could affect performance of functional tasks (Delbaere, Close, Brodaty, Sachdev, & Lord, 2010). This may partially account for the reduced effectiveness of the aqua-exercise only group in the Arnold and Faulkner (2010) study, compared to those more positive outcomes in the study by Fransen et al., (2007). Another important factor in the study by Arnold and Faulkner (2010) was the large number of dropouts from the aqua-exercise group. The authors noted that participants who dropped out of the programme were older and less active, with lower levels of function. Since an intention-to-treat method of analysis was used, the large number of dropouts from the aqua-exercise group may have reduced the overall mean effect of the intervention. While the intention-to-treat analysis method is currently considered the criterion method of analysing randomised controlled trials, some researchers have questioned its use in all situations. Intention-to-treat analysis evaluates the effect of the treatment prescribed rather than the effect of the treatment received (Armijo-Olivo, Warren, & Magee, 2009). This may be less helpful in studies involving older adults, who often have several co-morbidities and who may discontinue for reasons not related to the intervention.

2.6.3.1 Measuring functional ability

As previously stated, the STS test is a measure of strength and function, which has been recommended by the OARSI. The Timed up-and-go test (TUG) also measures functional ability and has been widely used in previous studies investigating aqua-based exercise for older adults with OA (Arnold & Faulkner, 2010; Fransen et al., 2007; Hale, Waters, & Herbison, 2012). The TUG has been shown to be a valid measure of functional mobility among adults with OA (Hinman et al., 2007; Podsiadlo & Richardson, 1991) and has a high level of inter-rater reliability and test-rest reliability (Norén, Bogren, Bolin, & Stenstrom, 2001). The TUG has a high correlation with lower extremity strength (Gunter, White, Hayes, & Snow, 2000) and has also been identified as a useful tool for identifying older adults who are at risk for falls (Shumway-Cook, Brauer, & Woollacott, 2000).

2.6.4 Aqua-based exercise and quality of life

Quality of life is a complex concept and reflects physical and psychosocial aspects of life among older adults. Poor quality of life is linked with depression among older adults (Blixen & Kippes, 2007) and consequently, is an important factor when assessing the outcome of an intervention for older adults. A study by Sato et al., (2009), who compared the effects of once and twice weekly aqua-based exercise sessions in frail older adults, found improvements in quality of life assessed by The Medical Outcome Survey Short Form-36 Questionnaire (SF-36), alongside concurrent improvements in measures of functional independence. The authors observed that twice-weekly exercise was more effective than once-weekly exercise sessions.

Focusing specifically on quality of life following an aqua-based exercise intervention in older adults with hip and/or knee osteoarthritis, Cadmus et al., (2010) observed improvements in quality of life following 20 weeks of aqua-based exercise, based on the AFAP. The Perceived Quality of Life (PQOL) scale was used to measure quality of life and small but significant improvements were found. Hinman et al., (2007) also noted significant improvements in quality of life following 6-weeks of hydrotherapy, when compared to a control group, who continued their normal daily activities, when measured using the 15-item Assessment of Quality of Life scale. A number of other studies have used the SF-12 Health Survey questionnaire to assess physical and mental health, which contribute to quality of life, following a hydrotherapy intervention with Foley et al., (2003) and Fransen et al., (2007) indicating positive outcomes on quality of life among adults with osteoarthritis. Conversely, Cochrane, Davey and Matthes Edwards (2005) found no significant difference between an aqua-based exercise group and control group following a year-long intervention among older adults with osteoarthritis when measured with the SF-36. However, the authors did find improvements in pain and functional ability following the intervention. Although pain and functional ability do not represent direct measures of quality of life, they are important factors which contribute to self-rated quality of life.

2.6.4.1 Measuring Quality of Life

Since quality of life is a complex phenomenon and there are a wide range of measures available to assess quality of life, it may be difficult to make direct comparisons between studies utilising different measures to assess quality of life. For example, the SF12 is a shorter version of the SF36. The SF12 has been shown to be a comparable measure of quality of life, which is quicker to complete than the SF36 (Ware, Kosinski, & Keller, 1996). However an investigation among adults with rheumatoid arthritis concluded that whilst the SF12 has a close correlation with the SF36 for physical function, the correlation was not so strong for the mental health component. The authors went on to suggest that the SF12 may actually be a better measure of mental health (Hurst, Ruta, & Kind, 1998). While the authors could not fully explain why the SF12 seemed to give a more accurate measure of mental health, this example highlights the need for caution when interpreting results from studies which have utilised different outcome measures to assess quality of life.

The Arthritis Impact Measurement Scale 2-short form questionnaire, (AIMS2-SF) has been shown to be a valid and reliable tool to assess the quality of life and pain levels of patients with osteoarthritis (Klooster, Veehof, Taal, Van Riel, & Van de Laar, 2008; Rosemann, Joos, Koerner, Szecsenyi, & Laux, 2006). In addition, the AIMS has been shown to be sensitive to change in this population following an arthritis education programme (Taal, Rasker, & Riemsma, 2004). The questionnaire includes questions relating to a number of aspects including physical, social and emotional well-being. Although there are a wide range of measures available to assess quality of life, the AIMS2-SF is a useful tool for measuring quality of life among older adults with OA as it is disease specific questionnaire which is easily administered (American College of Rheumatism, 2013).

2.6.5 Aqua-based exercise, balance and fear of falling

Several studies have investigated the effect of aqua-based exercise on balance among older adults. A study by Takeshima et al., (2002) reported that a 12-week aqua-based exercise programme significantly improved dynamic balance and muscular strength in older women. Kaneda et al., (2008) compared the effects of two types of aqua-based exercise on balance among older adults. Participants performed exercises either in normal (chest-height) water or in deep-water whilst wearing a flotation device. The normal-water group significantly improved postural sway area post-intervention, while the deep-water group significantly improved postural sway distance post-intervention and tandem-walk time, indicating improvement in dynamic balance.

Whilst aqua-based exercise would appear to be linked with positive outcomes on balance among older adults, studies focusing on adults with osteoarthritis have been less conclusive. Arnold and Faulkner (2010) found that an aqua-based exercise programme did not improve falls risk amongst older adults with hip osteoarthritis and at least one fall risk factor. However, the same exercises combined with an educational programme, designed to help participants transfer skills learnt in the pool to land and provide falls education, did result in a significant improvement in fall risk factors. It may also be relevant to note that the aqua-exercise group in particular had a large number of dropouts, who overall had lower levels of function and were less active than those who continued in the programme. This may have had an impact on the difference between the aqua-exercise and aqua-exercise plus education groups. Hale et al., (2012) found significant improvements in dynamic balance, measured by the 15-second Step Test, following a 12-week aqua-based exercise intervention in older adults with osteoarthritis. However, the authors also found significant improvements in the same outcome measure for an active control group and there were no significant differences between the exercise and control group for any outcome measure. In the study by Hale et al., (2012) the control group attended a twice weekly computer skills training course. The authors suggested that the similar improvements observed in the exercise and control group post intervention may indicate that dynamic balance could be enhanced as a result of participants getting out of their home and into the community on a regular basis.

Suomi & Collier, (2003) found no significant improvement in balance and agility among older adults with osteoarthritis or rheumatoid arthritis who performed the Arthritis Foundation Aquatic Programme (AFAP) twice weekly for eight weeks. As previously stated, balance is multi-factorial and is affected by a number of physiological and other aspects. Furthermore, a wide range of methods are available to measure 'balance' or postural stability and the aforementioned studies used a variety of outcome measures to assess these features. Takeshima et al., (2002) used a side-stepping agility test, whereas Kaneda et al., (2008) measured postural sway distance and area alongside tandem walking time in order to assess balance. Arnold and Faulkner (2010) used the Berg Balance Scale as their measure, whilst Hale et al., (2012) employed the Step Test and Physiological Profile Assessment (PPA) to measure falls risk. Finally, Suomi & Collier (2003) measured dynamic balance and agility by a chair rise and walk test. Although these tests all measure slightly different aspects of balance, the results overall are disappointing and further research of the potential for aqua-based exercise to improve balance among older adults with osteoarthritis is warranted.

2.6.5.1 Measuring balance

The ability to maintain balance is affected by numerous intrinsic and extrinsic factors and as outlined previously, a range of measures are available to assess balance. The step test has been identified as a valid clinical test for dynamic balance with good test-retest reliability (Isles, Low Choy, Steer, & Nitz, 2004) and which can identify previous fallers from healthy older adults (Dite & Temple, 2002). The step test has been found to be a safe and reliable measure for older adults and patients with stroke (Hill, Bernhardt, McGann, Maltese, & Berkovits, 1996). Furthermore, the step test is easy to administer and requires little equipment (Hong, Goh, Chua, & Ng, 2012).

Few studies have examined the effect of an aqua-based exercise programme on fear of falling among older adults with osteoarthritis. This is surprising as fear of falling is an important predictor of falling as well as being linked to restriction of physical activity, reduced social interaction, loss of independence and physical frailty (Zijlstra et al., 2007). Arnold and Faulkner, (2010) noted that an aqua-based exercise intervention combined with a falls education programme resulted in improved falls efficacy, among older adults with osteoarthritis and at least one fall risk factor. Falls efficacy was measured by the Activity specific Balance Confidence (ABC) scale. Using the same measure, Hale et al., (2012) noted that an aqua-exercise intervention resulted in improved falls efficacy scores, which although not statistically significant, may have been large enough to be considered clinically meaningful. Furthermore, the authors observed that participants in the aqua-based exercise group also reduced their use of walking sticks. Although this was not measured, it may have indicated increased falls efficacy, in particular a reduced fear of falling when walking. The effect of aqua-based exercise combined with or without an education programme and the impact of active control groups on balance and fear of falling among older adults are important topics which deserve further investigation.

2.6.5.2 Measuring Fear of Falling

Several measures are available to assess fear of falling. Two of the most widely used among older adults are the Activities-specific Balance Confidence (ABC) scale and the Falls Efficacy Scale - International (FES-I). The ABC contains 16 questions relating to balance confidence when completing daily activities, the FES-I also contains 16 questions, which relate to balance confidence when completing mobility-related tasks (Hotchkiss et al., 2004). There is a high correlation between the ABC and FES-I (Hotchkiss et al., 2004). One of the key differences between them is the rating system: the ABC requires participants to give a rating of their confidence as a percentage out of 100, whereas the FES-I requires participants to tick one of four rating which range from 'not at all concerned' to 'very concerned' about falling. Consequently, the FES-I is considered a simpler, easier to administer questionnaire (Greenberg, 2011), which has been found to be a valid and reliable measure of fear of falling and is sensitive to change in older adults (Yardley et al., 2005).

2.6.6 Aqua-based exercise and cardiovascular function

Several researchers have focused on older women's cardiovascular responses to aqua-based exercise such as deep-water running (Broman et al., 2006) and aqua-aerobics (Benelli, Ditroilo, & De Vito, 2004), with both of these studies surmising that aqua-based exercise is a useful alternative to land-based exercise for older adults, offering an equally beneficial mode of exercise to improve cardiovascular function. Although immediate physiological responses to exercise in an aqua environment have been investigated, there have been fewer studies which have evaluated the long-term cardiovascular adaptations to this mode of exercise. Two studies, which did examine cardiovascular adaption found that VO_2 peak significantly improved following 12 weeks of aqua-based exercise in women aged 65-75 years (Taunton et al., 1996) and in women aged 60-75years (Takeshima et al., 2002). VO_2 maximum (max) is often considered the 'gold standard' measure of cardiovascular fitness, however VO_2 peak is often measured in older populations, as reaching a maximal rate of oxygen consumption (VO_2 max) may not be feasible.

There are several limitations when measuring VO_2 max or VO_2 peak to assess cardiovascular fitness. Firstly, specialist equipment is required and participant discomfort is often a result of having to wear a mask whilst exercising. Relatively few studies have examined the effect of an aqua-based exercise programme on cardiovascular outcomes among older adults with osteoarthritis, most of those which have included this parameter have chosen to use a walking test as the outcome measure. This type of test offers the advantage of also providing a useful measure of functional ability, walking being a key ADL. Significant improvement in one-mile walk test was demonstrated by Wyatt, Milam, Manske, and Deere, (2001) following 6-weeks of hydrotherapy-based exercise performed 3 times per week. Similarly Foley et al., (2003) found significant improvements in walking speed and distance, measured by the 6 minute-walk test, following a 6-week hydrotherapy intervention performed 3 times per week. Conversely, Hinman et al., (2007) found no significant difference in 6-minute walk time following a 6-week hydrotherapy programme. All of the studies employed strengthening exercises plus walking in warm water. Although participants in the studies by Wyatt et al., (2001) and Foley et al., (2003) exercised three times per week, compared to twice per week in the study by Hinman et al., (2007), the overall volume may have been similar since exercise sessions in the study by Hinman et al., (2007) were of longer duration. It is not clear whether participants in these studies had different severity of osteoarthritis and whether this could have affected their walking ability.

2.6.6.1 Measuring cardiovascular function

As previously stated, measuring VO_2 max, may not be the best or most feasible method of assessing cardiovascular function in older adults. The 400m walk test is considered a suitable measure to assess functional limitations (Chang et al., 2004), walking endurance and cardiorespiratory fitness (Simonsick, Montgomery, Newman, Bauer, & Harris, 2001) in older adults and has been shown to be a useful tool for identifying cardiovascular risk and mobility limitation among community-dwelling older adults (Newman et al., 2006) Although the OARSI recommend the 6-minute walk test as a performance outcome measure for aerobic capacity among older adults with OA (Dobson et al., 2012), the 400m walk test has been identified as a comparable test which may be easier to administer (Rolland et al., 2004). Simonsick et al.,(2001) suggest that a predetermined distance, as given in the 400m walk test, may be more motivating for older adults and that the 400m walk test may encourage older adults to work closer to their maximum than the 6-minute walk test.

2.6.7 Aqua-based exercise and pain

Pain management is considered a primary goal of any exercise intervention for older adults with osteoarthritis. The Osteoarthritis Research Society International (OARSI) provides evidence-based recommendations for management of hip and knee osteoarthritis and endorses both strengthening and aerobic exercise for pain relief in knee osteoarthritis and in some cases hip osteoarthritis, whilst acknowledging that aqua-based exercise has been associated with pain reduction and improved function in both the hip and knee (Zhang et al., 2010). Despite these recommendations, there have been some mixed results with regard to pain following an aqua-based exercise intervention for older adults with osteoarthritis. Hinman et al., (2007) noted significant reductions in pain among adults with hip or knee osteoarthritis following a 6-week hydrotherapy intervention, whereas Lund et al., (2008) did not find any change in pain following an 8-week aqua-based exercise intervention among participants with knee osteoarthritis. In both of these studies, pain was the primary outcome measure and was assessed using a visual analogue scale (VAS) and both sets of participants performed twice weekly aqua-based exercise classes. However, again there were differences in the exercises performed as well as the volume and intensity of the programmes. The exercise intervention by, Hinman et al., (2007) included strengthening exercises and walking in the pool, progression was individualised and overseen by a therapist. In the study by by Lund et al., (2008), progression was standardised for everyone and the programme also included strengthening exercises. However instead of walking in the pool, participants undertook periods of aqua-jogging, which is likely to have been more physically demanding than aqua walking. Furthermore, participants in the study by Hinman et al., (2007) had higher baseline pain scores which may have contributed towards the greater reduction in pain reported by participants.

It is often reported that warm water is conducive to pain relief. Warm water immersion (balneotherapy) has been associated with a positive effect on the immune system and traditional spa treatments have been associated with immediate analgesic effects and potentially long-lasting effects following repeated application for those with rheumatic diseases (U. Lange, Müller-Ladner, & Schmidt, 2006). It could therefore be hypothesised that ongoing aqua-based exercise performed in warmer water temperatures would be likely to provide additional pain relief compared to those performed in cooler water temperatures. However, a year-long aqua-based exercise intervention by Cochrane et al., (2005) found that aqua-based exercise, conducted twice weekly in a water temperature of 29° Celsius, resulted in significant self-reported reductions in pain, as assessed in the pain dimension of the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) questionnaire. A water temperature of 29° Celsius is representative of a public swimming pool, where many aqua-based exercise classes take place and is considerably cooler than the water temperatures used for hydrotherapy sessions and in the studies by Hinman et al., (2007) and Lund et al., (2008) whose programmes took place in water temperatures of 34° and 33.5° Celsius, respectively.

2.6.7.1 Measuring pain

As pain is subjective, a wide range of factors are likely to influence perceived pain. However, despite the potential difficulties in quantifying pain, a range of simple tools are available for pain assessment such as the Numerical rating scale (NRS). The NRS is a widely used, self-reported measure of pain in which participants rate their pain levels on a scale ranging from 'no pain' (0) to 'worst pain imaginable' (10) (Younger, McCue, & Mackey, 2009). Although the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) has been widely used to assess pain and physical function among adults with hip and knee OA following an aqua-based exercise intervention, the WOMAC consists of 24 items and therefore takes several minutes to complete. The NRS is a valid measure of acute pain which can be administered quickly and easily (Bijur, Latimer, & Gallagher, 2003).

2.7 **Barriers and motivators to exercise**

Despite the numerous potential health benefits of aqua-based exercise for older adults with osteoarthritis, a large proportion of this population are not regularly physically active. In order to gain a greater understanding of why some older adults with osteoarthritis are active and others are not, it would be helpful to understand the potential motives and barriers to exercise among this population. Most of the studies presented earlier in this literature review, relating to aqua-based exercise for older adults with oseoarthritis, reported factors which contributed to attrition. The reasons given for dropping-out of an aqua-based exercise intervention included medical reasons (Arnold & Faulkner, 2010; Lund et al., 2008), pain (Foley et al., 2003; Lund et al., 2008), time issues (Hinman et al., 2007) and transportation issues (Arnold & Faulkner, 2010; Fransen et al., 2007). Whilst this information provides some insight into reasons for dropping out of an aqua-based exercise intervention, they do not explore perceptions or perceived benefits and barriers to this exercise mode among older adults with osteoarthritis.

2.7.1 Older adults

A number of studies have investigated barriers and motivators to exercise among older adults. Frequently cited barriers to exercise among older adults are poor health (Schutzer & Graves, 2004), painful joints (Newson & Kemps, 2007), fear of falling / injury (Lees, Clark, Nigg, & Newman, 2005) and environmental factors (Belza et al., 2004). Motivators to exercise, although varied, are commonly linked to improving or maintaining health and fitness (T. Henwood, Tuckett, Edelstein, & Bartlett, 2011; Newson & Kemps, 2007). However, relatively few studies have examined perceived benefits, motivators and barriers to exercise among older adults with osteoarthritis and even less have focused specifically on perceptions towards aqua-based exercise.

2.7.2 Adults with arthritis

Several studies have examined perceptions towards exercise among adults with different types of arthritis (see Table 3). Key barriers to exercise identified in these studies included pain, fatigue and mobility, lack of suitable programmes, lack of advice from health professionals and environmental factors. Key facilitators or benefits of exercise included symptom management, improved mobility and function, independence, feeling good and social interaction. As stated, these studies did not focus specifically on older adults (60 years plus) and only Petursdottir, Arnadottir, & Halldorsdottir (2010) included solely those with osteoarthritis in their analysis. Despite identifying a number of health benefits associated with exercise, middle-aged patients with osteoarthritis expressed doubts about the benefits or effectiveness of exercise for reducing osteoarthritis symptoms in a study by Thorstensson, Roos, Petersson & Arvidsson (2006). Participants indicated that appropriate supervision and continued encouragement were essential for ongoing exercise participation. This was substantiated by older adults with lower extremity osteoarthritis who identified the instructor as a key factor to ongoing participation in an aqua-based exercise programme (Moody, Hale, & Waters, 2012).

Table 3: Barriers and enablers of exercise, adults with arthritis

Author	Participants	Method	Barriers/enablers
Der Ananian et al. 2006	Adults with OA, RA, Fibro., Gout or other arthritis Mean age 55 years Classified as non-ex., insufficiently active or exerciser.	Focus groups	Barriers: Pain before/during/after ex., Mobility, Attitudes & beliefs, Insufficient advice from health advisor, Environment & weather, No specific ex. Programmes available Enables: Symptom management, improved mobility, independence, feel better, reducing stress social support, access to appropriate programmes
Wilcox et al, 2006	Adults aged 18+ with any type of diagnosed arthritis Classified as exercisers or non-exercisers	Focus groups	Barriers: Pain, fatigue, mobility, attitudes believes, perceived negative outcomes, lack of support, lack of programmes or facilities, environmental conditions, cost. Enablers: Symptom management, mobility and function, strength and flexibility, weight loss, improved self-confidence, feel good, social interaction
Gyurcsik et al, 2009	Women aged 18+ with any type of diagnosed arthritis	Online survey	Barriers: Pain, fatigue, fear of joint swelling/stiffness, lack of suitable programmes, doctors recommendation to avoid activity, other commitments, bad weather Coping strategies: Modify PA, take prescribed medication, thoughts about health benefits of p.a.
Pettursdottir et al 2010	Adults aged 50 + with diagnosed OA	Interviews	Barriers: Pain, stiffness/fatigue, support, availability of classes, weather, transportation Facilitators: motivation – enjoyment/results, health/fitness, disease knowledge
Thorstensson et al, 2006	Adults 39-46 years with knee OA defined as moderate or worse Mixed exercise experience/status	Interviews	Barriers: Doubts about benefits of ex., pain during ex., causing further harm Benefits: Health, well-being, improve function, symptom relief,

OA: Osteoarthritis; RA: Rheumatoid Arthritis; Fibro: Fibromyalgia; ex: exercise; PA: physical activity

2.7.3 Older adults with osteoarthritis

While relevant, the findings of the studies presented above, focused primarily on middle-aged adults with different forms of arthritis and may not be directly transferable to older adults with osteoarthritis. As progression of osteoarthritis is associated with age, it is likely these adults will have been living with osteoarthritis for more years and their symptoms may be worse than those who are middle-aged (Dougados et al., 1996). Combined with the potential differences in lifestyle and social priorities between middle-aged and older adults with osteoarthritis, these factors may result in a difference of perceived benefits, motives and barriers to aqua-based exercise. One study which focused on older adults with osteoarthritis or rheumatoid arthritis found that long term adherence to aqua-based exercise in Korean women was affected more by the social aspect of the programme than the exercise itself (Kang, Ferrans, Kim, Kim, & Lee, 2007). Although pain relief is most often cited as the key motivation to exercise by mixed-aged adults with different forms of arthritis, the emphasis on social interaction noted by Kang, et al (2007) may be due to the older age of the participants and their reduced circle of friends and acquaintances. Similarly, Moody et al., (2012) identified social camaraderie as an important benefit of aqua-based exercise among older adults with lower extremity osteoarthritis. Participants, who had recently completed a 12-week aqua based exercise intervention, also identified reduced pain and increased mobility as key benefits, similar to middle-aged adults with different forms of arthritis.

2.7.3.1 Methods of exploring perceptions

The studies outlined above used various methods to explore perceptions to exercise among adults with arthritis. Petursdottir et al., (2010) and Thorstensson et al., (2006) used individual interviews to explore perceived barriers and benefits relating to exercise, whereas Gyurcsik et al., (2009) used an online survey. Alternately, Der Ananian, Wilcox, Saunders, Watkins & Evans, (2006) and Wilcox et al., (2006) used focus groups to explore perceptions towards exercise. In contrast to interviews, focus groups are a socially orientated research method which allows group interaction and which may facilitate exchange of ideas (Kaplowitz & Hoehn, 2001). In addition, focus groups allow an everyday form of communication, which may increase the comfort level of participants (Kitzinger, 2005). The social aspect associated with the focus group method may make this type of research particularly appealing for older adults.

Focus groups and interview both allow exploration of views and attitudes therefore correct interpretation of the data derived from focus groups is extremely important (Kitzinger, 2005). The General Inductive Approach for analysis is a simple method of analysing focus groups which can provide reliable and valid findings (Thomas, 2006). This method derives themes relative to the research objectives whilst allowing findings to emerge from the raw data (Thomas, 2006). Themes are developed after repeated readings of the transcripts.

Krueger's framework analysis (Krueger, 1994) is an inductive approach which suggests five key stages of analysis: familiarisation of the data, identifying a thematic framework, indexing, charting, mapping and interpretation (Rabiee, 2004). However, this method also suggests that data analysis actually begins during the focus group, when clarification is sought and summaries provided to seek confirmation (Krueger, 1994). This approach allows themes to develop from the conversation as well as the research questions but also encourages the researcher to affirm key statements with participants.

2.7.4 Exercise status

Previous studies, such as those outlined in Table 3, which have examined barriers and perceived benefits of exercise among adults with different forms of arthritis, have differentiated between those who are currently physically active or inactive. However participants were classified according to their current exercise status and no clear distinction was made between those who had previously tried an exercise programme and those who had not. Neither was there any differentiation between modalities of exercise that participants engaged in. Aqua-based exercise is recommended for older adults with osteoarthritis by associations such as Arthritis New Zealand and the American College of Rheumatology. It would therefore be helpful to have a greater understanding of the barriers and motivators to participation specifically in this mode of exercise among older adults with osteoarthritis. In particular, understanding what the perceived benefits are among those who currently participate in this form of exercise, and the perceived barriers among those who have tried but no longer perform this mode of exercise, may be helpful in order to develop strategies to encourage greater levels of physical activity adherence in this population.

2.7.5 Transtheoretical Model of Change

The Transtheoretical Model of Change (TTM) was developed to help explain how people change their behaviour (Lach, Everard, Highstein, & Brownson, 2004), initially it was developed to explain changes in addictive behaviour (Burbank, Reibe, Padula, & Nigg, 2002). The TTM has since been modified to include adoption of health behaviour (Prochaska, Redding, & Evers, 2002), such as initiation of an exercise programme. Various stages of behaviour change are described in the model (see Figure 4).

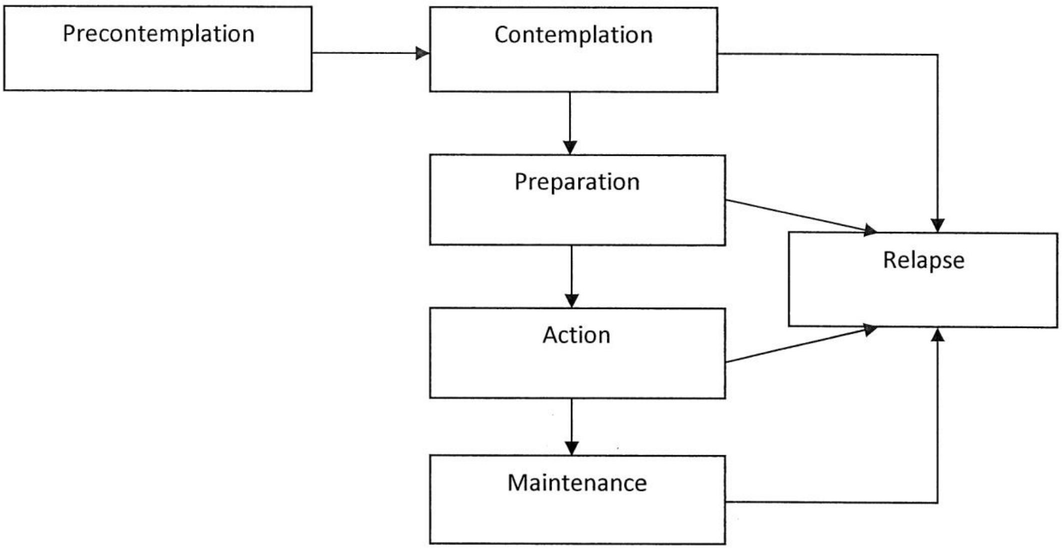

Figure 4: Stages of the Transtheoretical Model of Behaviour Change adapted from Di Clemete et al., (1991)

The *Precontemplation* stage describes the stage when the person has no intention of undertaking behaviour change, for example, does not intend to initiate an exercise programme. During this phase, the person is likely to consider that the barriers (cons) to exercise outweigh the benefits (pros) (Burbank et al., 2002). The *Contemplation* stage describes when the patient is seriously considering behaviour change, such as taking up an exercise programme, however is not quite ready to initiate this behaviour. During this phase, the cons are still likely to outweigh the pros (Marshall & Biddle, 2001). Following Contemplation is the *Preparation* stage, when preparation is made to initiate specific changes, such as joining a gym. During this stage, the pros start to outweigh the cons. The *Action* stage occurs when actual changes to behaviour are made. In the case of adopting an exercise programme, the action stage starts on the first day of exercise and lasts for six months, once regular exercise is consistent for at least six months, the *Maintenance* phase is reached (Burbank et al., 2002). Relapse can occur at any stage, when this occurs the person often reverts to the previous stage of the model (Kraft, Sutton, & Reynolds, 1999).

2.7.6 Behaviour Change

It is believed that behaviour change is influenced by several factors including self-efficacy, the process of change and decisional balance. These incorporate self-belief that behaviour change can be achieved as well as an evaluation of the pros and cons of engaging in a particular behaviour (Marshall & Biddle, 2001). Self- efficacy for exercise increases through the stages, from pre-contemplation to maintenance. Self-efficacy reflects ones perceived ability to succeed in a particular situation or setting (Bandura, 1997). Mastery is the most successful means of developing self-efficacy, therefore it is important that activities undertaken are achievable in order to further improve self-efficacy (Palmer, 2005). Failure to successfully complete the task or activity will further reduce self-efficacy relative to that activity. As previously stated, there is also a shift in emphasis from the cons to the pros with progression through the model (Burbank et al., 2002).

It has been proposed that the TTM can provide a useful tool to facilitate behaviour change in older adults (Lach et al., 2004). Barriers to exercise may vary between those in different stages of the model (Sit, Kerr, & Wong, 2008), therefore perceptions towards behaviour change are likely to differ for those who have maintained regular exercise compared to those who have relapsed. Understanding reasons specifically for relapsing, or ceasing participation in regular exercise, may be useful in helping to identify barriers relevant to those who have been sufficiently motivated to change but not maintain their new behaviour.

Wilder and Barrett (2005) investigated dropout status from an exercise study among older adults with osteoarthritis. They found that those with lower baseline health status were more likely to drop out of an exercise programme as were those taking higher levels of arthritis medication. However, while Wilder and Barrett (2005) identified some of the personal characteristics associated with relapse, the reasons and perceptions among those who dropped out of an exercise programme were not investigated.

The perceived benefits, motives and barriers specifically for aqua-based exercise amongst older adults with osteoarthritis have largely gone unexplored. This lack of research is surprising as aqua-based exercise may be a safe and cost-effective therapy for older adults with osteoarthritis (Cochrane et al., 2005). A study among adults with osteoarthritis, rheumatoid arthritis and other types of arthritis found participants wanted arthritis-specific programmes and many felt there was a lack of available aqua-based exercise programmes (Wilcox et al., 2006). Whilst arthritis-specific aqua-based exercise programmes may not be widely available (Cochrane et al., 2005), generic aqua-based exercise classes are available at many aqua facilities. Consequently it would be useful to have a greater understanding of perceptions towards this form of exercise among older adults with osteoarthritis. In particular, increased knowledge relating to the perceived benefits (pros) among older adults with osteoarthritis who are current aqua-exercisers and perceived barriers (cons) to aqua-based exercise among those who have tried but no longer participate in this form of exercise may help to facilitate development of suitable aqua-based exercise options for older adults with osteoarthritis.

2.8 Summary

Increasing age is associated with declines in muscle strength, functional capacity, quality of life, diminished balance reflexes as well as increased incidence of chronic diseases, such as osteoarthritis, likelihood of falls and avoidance of activity due to fear of falling. Regular physical activity can help reduce these age-related changes as well as reduce social isolation and help improve self-efficacy amongst older adults. As outlined above, a number of studies have examined the potential benefits of aqua-based exercise for older adults, focusing on a range of outcome measures. However a number of gaps in the literature are still apparent, especially in the application of this literature to older adults with osteoarthritis.

Limited research has focused on the perceived benefits of an aqua-based exercise intervention amongst older adults with osteoarthritis, despite the value of understanding motives for participation and adherence to an exercise programme. Similarly, barriers to, or reasons for dropping out of an aqua-based exercise programme amongst older adults with osteoarthritis have largely been unexplored. The benefits of a variety of aqua-based exercise programmes such as aqua-fitness and aqua-jogging, which are widely available in the community, have received relatively little attention.

To date, there has been a lack of consistency with regard to aqua-based exercise programmes, with interventions varying considerably in duration, as well as frequency, type, volume and intensity of exercise and water temperature. Although several hydrotherapy-based exercise interventions have produced some promising results for older adults with osteoarthritis, the availability and cost of such programmes may be a limiting factor.

The combined studies of this thesis offer some insight into several aspects of aquatic exercise. Firstly, perceived benefits, barriers and motives to aqua-based exercise will be explored. Perceptions will be sought from older adults with OA who are current, aqua-exercisers as well as those who have ceased participation in this form of exercise. A mixed-methods study will investigate acute pain and heart rate responses to different modes of aqua-based exercise, as well as perceptions towards the different types of aqua-based exercise undertaken. The triangulation of quantitative and qualitative data will be used to attempt to capture a more complete and holistic view of different forms of aqua-based exercise (Denzin, 1978). Finally, chronic adaptations to a generic aqua-based exercise for older adults with osteoarthritis will be explored in order to examine the potential benefits of this type of exercise for older adults with OA.

Chapter 3 : Perceived benefits, motives and barriers to aqua-based exercise amongst older adults with and without osteoarthritis

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3.1 Prelude

Ongoing participation in exercise is necessary if the health benefits associated with exercise are to be maintained. Adherence to an exercise programme is affected by a number of factors, including the perceived benefits and barriers to the programme. Although aqua-based exercise is recommended as a suitable exercise mode for older adults with osteoarthritis, relatively little is known regarding the perceptions of this population towards this type of exercise. Little if any comparison has been carried out between the perceptions of older adults with and without osteoarthritis, in addition, most of the literature has focused on attitudes towards exercise in general rather than one specific exercise form. Many older adults attend aqua-based exercise classes at their local community swimming pool. Given the high incidence of osteoarthritis among this population, it is likely that such classes are attended by many older adults who have osteoarthritis. The purpose of our first study was to explore opinions and attitudes among older adults with and without osteoarthritis who attend a generic aqua-based exercise class and compare how these two groups of older adults perceive the benefits and potential barriers related to this form of exercise.

3.2 Abstract

This study aimed to: identify factors that motivate older adults to participate in aqua-based exercise; identify potential barriers and compare perceptions between older adults with and without osteoarthritis. Fifteen adults over 60 years of age participated in one of three focus groups during which they discussed perceived benefits, motives and barriers to aqua-based exercise. Pain reduction was considered a major benefit amongst those with osteoarthritis, improved health and fitness was a principal benefit for those without osteoarthritis. All participants felt that the instructor could act as both a motivator and barrier, the most significant barrier was cold changing facilities in winter. With the exception of pain reduction, perceived benefits, motivators and barriers to aqua-based exercise are similar among older adults with and without osteoarthritis. A greater understanding of these factors may help us to facilitate older adults with osteoarthritis to initiate and adhere to aqua-based exercise.

3.3 Introduction

Ageing is associated with an increased risk of chronic diseases, one of the most common being osteoarthritis. Osteoarthritis is considered a degenerative joint disease, characterised by deterioration of cartilage and the underlying bone (Flores and Hochberg, 2003), which leads to joint pain and stiffness. Osteoarthritis is the most common form of arthritis among older adults, affecting 31% of females and 20% of males aged 65-74 years and 40% of females and 22% of males over 75 years of age (Borman et al., 2010). The large weight-bearing joints of the hips, knees and spine are most commonly affected.

Older adults tend to be less physically active than younger adults, which exacerbates the age-related losses in muscular mass and strength (sarcopenia), negatively impacting on functional ability, balance and quality of life (Henwood & Bartlett, 2008). Arthritis is cited as one of the primary causes for this age-related reduction in physical activity (Minor, 1996). Dunlop, Song et al. (2011) reported fewer than 1 in 7 men and 1 in 12 women with knee osteoarthritis accumulated sufficient physical activity for health benefits. This suggests that older adults with osteoarthritis are at even higher risk of deconditioning and consequent reduced functional ability, balance and quality of life.

Regular physical activity can help reduce the impact of sarcopenia and diminished balance in older adults and may help reduce the symptoms of osteoarthritis (Ettinger et al., 1997). Performing exercise in water (aqua-based exercise) offers an environment where the joints are supported and may allow individuals to perform exercises that they would not be able to perform on land, making this form of exercise ideal for many older adults, especially those with osteoarthritis. Types of aqua-based exercise include: hydrotherapy, defined as “supervised exercise in warm water” (Eversden et al., 2007); aqua-jogging, consisting of simulated deep water running and a flotation devise to keep the head above water (Reilly et al., 2003); and aqua-fitness, consisting of partial weight-bearing aerobic and strengthening exercises performed in the shallow end of a swimming pool.

A number of studies have demonstrated positive physiological adaptations to various forms of aqua-based exercise in older adults including improved dynamic gait and balance (Arnold & Faulkner, 2010; Katsura et al., 2010; Waters & Hale, 2007) and increased muscle strength (Katsura et al., 2010; Takeshima et al., 2002; Tsourlou et al., 2006). Furthermore, a recent review of the literature concluded that aqua and land-based exercise are comparable in terms of improving physical function and mobility in adults with osteoarthritis and rheumatoid arthritis, despite considerable variability between aqua-based exercise interventions (Batterham et al., 2011). In addition, there is some evidence that aqua-based exercise may result in greater adherence among older adults than land-based exercise (Fransen et al., 2007; Tsourlou et al., 2006).

While multiple factors affect physical activity levels in older adults, some of the most frequently cited barriers to exercise amongst this group are poor health (Schutzer & Graves, 2004) and the physical environment (Lees et al., 2005). Motivators to exercise, although varied, are commonly linked to improving or maintaining health and fitness (Newson & Kemps, 2007). However, relatively few studies have examined perceived benefits, motivators and barriers to exercise among osteoarthritis patients, with even less focus specifically on older adults' perceptions of aqua-based exercise.

A study by Der Ananian, Wilcox, Saunders, Watkins & Evans (2008) found that pain relief and improved mobility were perceived as benefits of exercise amongst mixed-aged adults with different forms of arthritis who were currently physically active. Conversely Thorstensson, Roos, Petersson & Arvidsson (2006) found that many middle aged patients with osteoarthritis had doubts about the benefits and effectiveness of exercise for reducing osteoarthritis symptoms.

While relevant, the findings of these two studies, which focused primarily on middle-aged adults with different forms of arthritis, may not be directly transferable to older adults with osteoarthritis. As progression of osteoarthritis is associated with age, it is likely these adults will have been living with osteoarthritis for more years and their symptoms may be worse than those who are middle-aged (Dougados et al., 1996). Combined with the potential differences in lifestyle and social priorities between middle-aged and older adults with osteoarthritis, these factors may result in a difference of perceived benefits, motives and barriers to aqua-based exercise. One study which focused on older adults with osteoarthritis or rheumatoid arthritis found that long term adherence to aqua-based exercise in Korean women was affected more by the social aspect of the programme than the exercise itself (Kang et al., 2007). Although pain relief is most often cited as the key motivation to exercise by mixed-aged adults with different forms of arthritis, the emphasis on social interaction (Kang, et al., 2007) may be due to the older age of the participants and their reduced circle of friends and acquaintances.

The perceived benefits, motives and barriers specifically for aqua-based exercise amongst older adults with osteoarthritis have largely gone unexplored. This lack of research is surprising as aqua-based exercise may be a safe and cost-effective therapy for older adults with osteoarthritis (Cochrane et al., 2005). Although aqua-based exercise is recommended by associations such as Arthritis New Zealand and the American College of Rheumatology, the number of regularly active older adults with osteoarthritis is low suggesting that a greater understanding of the barriers and motivators to participate in aqua-based exercise is needed to develop strategies encouraging more physical activity.

Long-term exercise adherence is important in order to help reduce the likelihood of osteoarthritis- related disability (R. Marks & Allegrante, 2005). A study among adults with osteoarthritis, rheumatoid and other types of arthritis found participants wanted arthritis-specific programmes and many felt there was a lack of available aqua-based exercise programmes (Wilcox et al., 2006). Whilst arthritis-specific aqua-based exercise programmes may not be widely available (Cochrane et al., 2005), aqua-fitness classes are available at many aqua facilities. Consequently it would be helpful to better understand what motivates older adults with osteoarthritis to participate in this form of exercise, particularly in the long-term**,** and the potential barriers and whether or not these differ greatly from older adults who do not have osteoarthritis.

3.4 **Method**

3.4.1 Research Design

Information related to the perceived benefits, motives and potential barriers of aqua-based exercise among older adults with and without osteoarthritis was obtained through a series of focus group sessions. A focus group design was used as it offered the possibility of analyzing how people make collective sense of their individual experiences and beliefs (D. F. Marks & Yardley, 2004). Focus groups allow an everyday form of communication, which may increase the comfort level of participants (Kitzinger, 2005). This social setting was considered appropriate since participants regularly took part in a social form of exercise.

3.4.2 Participants

Adults aged 60 years and older (mean age, 72.4, SD 5.5 years) who currently participate in aqua-based exercise and have regularly attended classes for at least the past 6 months, were invited to participate in a focus group. All participants attended aqua-based fitness classes two or three times per week. Classes were similarly structured, but conducted at different facilities with different instructors. Focus groups were conducted at or near the facility where participants normally exercise and consisted of participants who exercised together and who had the same experience with regard to the facility and instructor (Kitzinger, 2005). Three focus groups were held with a total of 15 participants (group 1 n=5, group 2 n=7, group 3 n=3), consisting of 1 male and 14 females. Sample size was determined by theoretical saturation (Curry, Nembhard, & Bradley, 2009). Nine of the fifteen participants who attended the focus groups self-reported a diagnosis of osteoarthritis as determined by their general practitioner. The average length of osteoarthritis symptoms was 11.6 years and sites affected were the hips, knees, ankles, spine and fingers. Other medical conditions were not recorded.

Potential participants were invited as a whole class to attend a focus group to discuss their views on aqua-based exercise. Classes had 20-30 participants, which were primarily female, of New Zealand European descent, with 70% of attendees over 60 years of age. Once eligibility of the interested individuals was determined, an information sheet was provided. Of those who were eligible to participate, 39% agreed and subsequently attended a focus group.

Focus group participants had been attending aqua-based fitness classes for an average of 6.7 years, ranging from 3 years to 17 years. Those who had osteoarthritis were not identified before or during the focus group sessions in order to ensure that the researcher guiding the sessions had no bias towards any participants or their comments. The research was conducted with the approval of the institutional research board and all participants gave informed, written consent.

3.4.3 Procedures

Focus group sessions were convened by two researchers, one who primarily guided the session and another took notes (Beyea & Nicoll, 2000; T. Henwood et al., 2011). Neither of the researchers were involved in the planning, management or delivery of the exercise programmes. None of the participants were previously known by the researchers, thereby minimizing the potential for social desirability bias. Each focus group session lasted approximately 60 minutes and was recorded using a digital voice recorder and later transcribed verbatim. Notes were made of any silent agreement, obvious body language or other factor(s) not captured on the audiotape recording. The note-taking researcher was experienced and highlighted any particularly emphatic agreement or disagreement of statements, which were utilized alongside the transcript to identify the most important themes (T. Henwood et al., 2011; Loeb, Penrod, & Hupcey, 2006). Name badges were provided and used to encourage participation of quieter group members.

All focus groups were guided by the same basic questions, focused on the benefits of exercise on land and in water and potential motives and barriers to aqua-based exercise. Questions were formulated using published guidelines (Krueger & Casey, 2000) and based around questions in a similar study investigating older adults' perceptions of resistance training (T. Henwood et al., 2011). Participants were encouraged to openly discuss their beliefs relative to the topic. The nature of the conversation was facilitated by the researchers relying on the following questions as a guide:

- What attracted you to taking part in an aqua-based exercise programme?
- Do you think the benefits of regular exercise in an aqua environment are better / different from land based exercise? If so, how?
- What specific benefits do you feel you have gained as a result of taking part in an aqua-based exercise programme?
- Which aspects of the programme do you enjoy most?
- Which aspects do you least enjoy?

3.4.4 Data Analysis

Data from all participants was analyzed using the General Inductive Approach, which encompasses meticulous analysis of raw data in order to derive themes (Thomas, 2006). This method allows identification of recurrent or significant themes without the constraint of structured methodologies such as deductive analyses and allows the investigator to describe what actually happened, rather than focus on testing a hypothesis (Scriven, 1991). Initially two of the research team members reviewed and coded one of the transcripts individually. The research team then met to review and discuss their coding, data was double checked to ensure the participants' statements logically reflected the themes identified and a consensus was reached on coding each transcript. Major themes emerged after reading and discussing the transcripts and these were checked, alongside the transcript by a third member of the research team, similar to the approach outlined by Thomas (2006). Analysis of simple frequency counts was not considered a good indicator of the importance of a theme (Wilcox et al., 2006), however statements had to be mentioned at least twice and by 2 or more participants, in order to be considered a theme (Galea, Bray, & Martin Ginis, 2008; Lees et al., 2005). This process generated seven core domains relating to the benefits, motivators and barriers to aqua-based exercise, Table 1 provides a summary of the results and an illustration of the hierarchy of the themes and sub-themes. At this point, the participants with osteoarthritis were identified and comparison was made between their comments and themes and those without osteoarthritis.

3.5 **Results**

Data analysis revealed that most of the benefits, motivators and barriers relating to aqua-based exercise were similar for older adults with and without osteoarthritis. Social interaction was a key theme for both groups and considered both a benefit and motivator to attend. Pain was considered a primary benefit and motivator by those with osteoarthritis, whereas this theme was weaker amongst those without osteoarthritis. The instructor was cited as a major theme by all participants and could be classified as a motivator or barrier; with the facility / environment also seen as both a potential motivator or barrier. General health and fitness improvements were considered a benefit and motivator to exercise amongst those with osteoarthritis, although these were not key themes. Conversely, participants who did not have osteoarthritis considered improved health and fitness to be key. Two other weaker themes identified by all participants were mobility and psychological benefits, which were both viewed as benefits of aqua-based exercise.

Table 4. Primary themes identified from focus groups

Theme	Sub-theme	Benefit/ motivator / barrier
Pain	Pain limiting land-based activities	Motivator
	Pain relief as a result of doing aqua-based exercise	Benefit
Social	Peer support and interaction during class	Benefit & motivator
	Social interaction following class	Benefit & motivator
Instructor	Well organised instructor	Motivator
	Poorly organised instructor	Barrier
Facility / Environment	Changing rooms	Barrier
	Pool temperature	Motivator & barrier
	Others: e.g. cost/ location	Potential barriers
Health and Fitness	Feeling better / able to do more	Benefit & motivator
Mobility	Improved mobility	Benefit
Psychological benefits	Improved confidence / keeping the mind active	Benefit

3.5.1 Pain

Pain was identified as both a motivator to participate in and a benefit of aqua-based exercise. For participants with osteoarthritis, pain was a primary theme. Several of these participants cited pain as a barrier to land based exercise, which motivated them to begin aqua-based exercise as an alternative form of exercise. One participant explained:

“I have been going to walking and keep fit classes but I was having trouble with my knees at that stage and so I decided that the water would be much better so I started the aqua.” Another participant also described pain as a primary motivator to participate in aqua-based exercise: “I have arthritic ankles so it’s really the only exercise I can get. I used to go to the gym years ago and hated it, I really enjoy aqua aerobics.”

Several participants with osteoarthritis also referred to aqua-based exercise as a means of pain relief, which they considered a benefit of this form of exercise:

> What I find with my knee that still gives me a bit of trouble but I was in a [dragon boat] regatta on Saturday and we had 5 hard races and I just get a bit of swelling, particularly in the back of the knee and I was feeling really tight this morning but after doing all those side-kicks it’s gone you know, the lymphatic drainage.. kind of works.

Similarly, another female participant felt that aqua-based exercise provided pain relief stating:

> Well I have a lot of problems but I have a hiatus hernia and have tried all other sorts of exercise. I have tried the bike and jogging but afterwards, am always in pain. But after aqua... the water is cushioning and I don’t have pain afterwards, it’s amazing.

One participant who did not have osteoarthritis agreed with this theme and stated: “you don’t feel pain afterwards”.

3.5.2 Social aspect

The social aspect was also a very dominant theme with all participants considering the social interaction as an important benefit and motivator to continue to participate in aqua-based exercise, regardless of whether or not they had osteoarthritis. There were two key social elements identified; the support from peers and interaction during the class and the coffee groups / social interaction after class. One participant reflected on the impact of the social interaction within the pool and how it had affected a person who previously participated in the aqua-based exercise class she attends:

> She did say prior to her death that the last 6 weeks in the pool with us girls was the happiest she’d ever been in her life. ‘Cause we just talked to her, had a laugh with her, encouraged her.

A strong feeling of social support during the exercise class also came through: “I find exercising in a group is good. I slipped one day going into the pool at the steps and Jean was there right away, she helped me up.”

Whilst social interaction and support during the aqua-based fitness classes was deemed important, so too was the interaction after class. A female participant explained the significance of the post-class socialization for the group:

> Most of us come 3 times per week and the friendship part, we meet at the [name of cafe] and have a coffee and discuss everything, solve the politics of the world over a coffee. I think the exercise and the friendship has helped a lot of us get over a lot of things in life that... and a lot of us are on our own.

Most of the participants in the focus groups did meet for coffee after some or all of the aqua- fitness classes. For some this was a motivation to attend the exercise class, such as one who commented: "...I don't think I want to do that [aqua] class but then I meet for coffee afterwards... so that gets me there."

3.5.3 Instructor

The influence of the instructor generated a lot of discussion and revealed that the instructor had the potential to act as both a motivator and a barrier to aqua-based exercise. The only male participant referred to the instructor as an instrumental motivational factor:

> [instructor's name] really does have a big influence on us all because he brings everyone in and makes fun of things... where we've had other instructors coming in from outside and the thing would just go dead without him. He does the proper exercises and has the right personality.

Another agreed commenting on a particular aqua exercise teacher who used to work at the facility: "What attracted me in the first place was that [instructor's name] who used to do it very highly choreographed and I loved that because I like dance and I like the music and I like the challenge."

The instructor was also considered a potential barrier with one participant with osteoarthritis commenting: “Some instructors try to put too much in, changing exercises all the time, they need to slow it down.” Another participant who did not have osteoarthritis expressed concerns regarding the knowledge level of some instructors:

> Well, I like my classes to have structure and for the instructors to know about anatomy and know what they are doing... I often wonder what qualifications the instructors need and what training they have... They should know about anatomy and what exercise in the water does. Some instructors know more than others.

3.5.4 Facility / Environment

The facility/environment was seen as both a motivator and a potential barrier, encompassing a number of aspects including the changing rooms, pool temperature and location. Participants who attend classes in a relatively new facility predominantly felt that the facility was excellent, whereas participants at the older facilities were more negative about their facility and viewed it more as a potential barrier. There did not appear to be any discernible difference between participants who had osteoarthritis and those who do not have osteoarthritis with regard to the facility or environment.

3.5.4.1 Changing rooms.

References made to the changing rooms were generally negative particularly amongst those who went to older facilities: “...Especially in winter, those changing rooms, that area has been designed as a wind tunnel inadvertently.” Another said “Oh it’s freezing cold, the showers.”

3.5.4.2 Pool temperature.

There seemed to be little consensus on pool temperature, with some preferring a cooler environment: “The pool’s too hot though, I find it too hot, it was 34 degrees the other day, I checked. It’s too hot to exercise sometimes.”

Whilst other preferred a hotter pool: “... But I love it, [the heat] it’s personal.” Others commented that when classes took part in the warmer, therapy pool, they found it hard to exercise with one commenting: “It’s too hot for exercise, I just want to relax, it’s too hot.”

3.5.4.3 Location.

The proximity of the facility to where participants lived was an important aspect for many. One participant was attracted to the facility because she said “It’s close to where I live.” Another agreed: “Yes, it’s close for me too, I just live around the corner.”

3.5.4.4 Other.

There was some discussion around the cost of the classes, with several participants feeling that aqua-based exercise is too expensive, which may act as a barrier for some: “... At [name of facility] just a single class is something like $18 if you’re not a senior... and I thought, no wonder we don’t have any young people doing those classes.” The male participant considered parking a potential barrier when asked which aspects of the aqua-based exercise class they least enjoyed: “I think the parking... it’s hard to get a park.”

3.5.5 General Health and Fitness

Participants with osteoarthritis referred to a number of health and fitness benefits which they believed were associated with regular aqua-based exercise: “I had a big difference in my fitness, I used to only come once per week until I jarred my ankle walking downhill, so I stepped it up to 3 times per week and it's made a huge difference." Other participants mentioned noticing a difference if they take time off: "... through the holidays, when you come back you feel it."

Participants who did not have osteoarthritis described a wider variety of health-related benefits, one stated: "I think actually I can feel that I can breathe better" and another commented that aqua-based exercise: "...improves circulation".

Whether or not aqua-based exercise had any impact on the participants' body weight was highly contested, with some participants feeling strongly that it had helped them lose weight: "I just do it to keep fit. I've lost weight, a lot of weight actually, that's been 4 years now." Others felt that it has had no impact on their weight: "No, my weight is the same. I don't think I have lost any weight, I'm just the same."

3.5.6 Mobility

Other somewhat weaker themes which emerged included mobility and psychological benefits. Participants with and without osteoarthritis referred to mobility as a benefit of aqua-based exercise, with one stating: "But it's great for mobility you know, Hilary's scoliosis, my sore knee, that kind of thing." Another said "I know personally that with both of my knee replacements this just keeps me going you know, just keeps me mobile and I know if I didn't do it I wouldn't be able to do anything." One participant who did not have osteoarthritis stated: "it helps keep the arthritis at bay".

3.5.7 Psychological Benefits

Psychological benefits included keeping the mind active and improved confidence, again there was no discernible difference between participants with and without osteoarthritis: “Yes, it keeps you thinking, it’s good for Alzheimer’s”, another stated: “... keeps me mentally active”. Another participant explained how it had improved her confidence: “Well I think you get confident, it’s increased my confidence in the water, when I first started I couldn’t, well I don’t know if I could swim but it’s certainly given me a lot more confidence in the water.”

3.6 Discussion

The aim of this study was to investigate the perceived benefits, motives and barriers to aqua-based exercise amongst older adults who regularly performed aqua-fitness classes and to compare perceptions between older adults who have osteoarthritis with those who do not. Such a study would appear to have considerable merit as older adults with osteoarthritis are recommended to remain physically active (Roddy et al., 2005) but their age and arthritis-related symptoms, such as joint pain, make many forms of physical activity difficult to perform (Der Ananian et al., 2008). Consequently, aqua-based exercise might offer a more suitable exercise environment than land-based and a greater understanding of the perceived benefits and motivators to participate in this form of exercise, in particular amongst long-term exercisers, may assist in increasing adherence to this form of exercise for this population.

3.6.1 Benefits

Older adults have identified several important factors including improved health (T. Henwood et al., 2011) health and social interaction (Schutzer & Graves, 2004) as key to influencing exercise adherence. However, mixed-aged adults with arthritis are more likely to rate pain relief as a primary benefit / motivator to exercise, particularly amongst those currently active (Der Ananian et al., 2008; Petursdottir et al., 2010). Consistent with those previous studies involving mixed-aged adults with osteoarthritis, rheumatoid and other forms of arthritis, the current study established that pain was both a key benefit and motivator to participate in aqua-based exercise for older adults with osteoarthritis. A number of participants described the pain relief effects of exercising in an aqua environment and indicated that they felt that this form of exercise helped them to manage their symptoms. This is similar to a previous study in which mixed-aged adults with osteoarthritis reported less pain following hydrotherapy compared to a land-based Tai Chi programme (Fransen et al., 2007). Although results of the current study indicated pain was also a theme for older adults without osteoarthritis, the strength of this was weaker than for participants with osteoarthritis.

The current study also identified the social aspect of the aqua-fitness classes as a primary benefit, as well as a motivator for continued participation. This theme was equally important for those with and without osteoarthritis. Participants indicated that aqua-fitness classes offered a supportive environment where they felt secure and had the opportunity to interact with their peers. In addition, many enjoyed socialising with each other after the exercise class. Several participants lived alone and therefore felt that the opportunity for social interaction both during and after the class was invaluable. A recent study (Kang et al., 2007) which examined long term adherence to aqua-based exercise among older women with osteoarthritis and rheumatoid arthritis also highlighted the importance of social interaction, with the social aspect deemed to have a greater influence on adherence than the actual exercise performed. However, the study did not differentiate between social interaction which took place during or after the exercise class. Studies examining land-based exercise also report the social aspect as a moderate motivator to exercise for older adults although again no differentiation was made between social interaction during or after exercise classes (T. Henwood et al., 2011; Newson & Kemps, 2007).

Previous studies which have focused on older adults have identified improved health and fitness as key factors which promote exercise engagement and adherence (Kutner, Barnhart, Wolf, McNeely, & Xu, 1997; Newson & Kemps, 2007; Schutzer & Graves, 2004) and this was true of participants in the current study who did not have osteoarthritis. However, participants who did have osteoarthritis placed more emphasis on pain relief as a primary benefit and motivator to perform aqua-based exercise, with improved health and fitness considered a less influential factor. Although the prominence of this theme was different for those with osteoarthritis and those who did not have osteoarthritis, participants from both groups acknowledged they noticed a difference if they stopped exercising for any reason and that the exercise made them feel better as a whole.

Improved mobility was also referred to as a benefit of aqua-based exercise by some participants in the current study but it was not a primary theme regardless of whether or not they had osteoarthritis. This was in contrast to previous studies in which mixed-aged adults with osteoarthritis, rheumatoid and other forms of arthritis indicated that improved mobility was one of the key perceived benefits of exercise (Der Ananian et al., 2008; Wilcox et al., 2006). It is not known whether the greater age of the participants in the current study would have resulted in reduced expectations regarding the ability of aqua-based exercise to improve their mobility.

3.6.2 Motivators

In the present study, pain was regarded as a motivator to participate in aqua-based exercise. In particular, several participants indicated that pain had become a major barrier to land-based exercise, prompting them to try exercising in the aquatic environment, where joints are subjected to less stress. Similarly, the social aspect was indicated not only as a benefit but also a major motivator to participation. As well as the social interaction during the class, the majority of participants regularly met for coffee following the class, which provided further social interaction and support amongst the group. Participants with osteoarthritis, rheumatoid and other forms of arthritis have indicated that social interaction during class is important, regardless of the mode of exercise (Der Ananian et al., 2008). Older adults participating in a land-based exercise intervention emphasised the preference for interaction with individuals of similar age (T. Henwood et al., 2011). This suggest that social interaction during any group exercise and regardless of health status is an important factor for older adults. However little is known with regard to the level of post-exercise social interaction following exercise classes.

Previous studies, which have predominantly focused on land-based exercise for older adults or mixed-aged adults with a variety of forms of arthritis, have generally not identified the instructor as a major theme, most probably because participants were not all involved in a group exercise programme. However Der Ananian, et al. (2008), who investigated factors that influence exercise participation amongst primarily middle-aged adults with osteoarthritis, rheumatoid and other forms of arthritis, noted that participants had concerns regarding the lack of aqua-based exercise programmes in the community and they emphasised the need for aqua instructors to have a good understanding of arthritis. In this current study, the instructor was considered a key factor in attendance and adherence to aqua-based exercise. This was true for participants whether or not they had osteoarthritis. There was concern amongst some participants regarding the knowledge base of some instructors, in particular their understanding regarding the properties of the water. Other participants felt that their instructor was a key motivator to attend and their knowledge and personality vital to a supportive environment. This emphasis on support and in particular the knowledge of the instructor may be a more significant theme amongst adults who have chronic disease (s). A study by Dodd, Taylor, Denisenko & Prasad (2006) investigating perceptions of multiple sclerosis patients' about resistance training, also found that participants focused on the importance of an exercise leader with sufficient knowledge, viewing this as an essential element underlying the success of an exercise programme.

In common with previous studies investigating benefits of exercise for older adults (T. Henwood et al., 2011; Newson & Kemps, 2007) improvements in health and fitness were considered motivators to participate in regular exercise in the current study. However as stated previously, while improved health and fitness was a very important theme for those older adults without osteoarthritis, this was not considered to be a primary benefit or motivator amongst participants with osteoarthritis.

3.6.3 Barriers

The participants who took part in the current study all regularly attended aqua-based exercise classes and have done so for several years. Consequently, the perceived barriers to aqua-based exercise identified among this group would be likely to have less consequence and may differ from the barriers identified by non-exercisers. Previous studies with older adults have identified poor health, physical environment and lack of knowledge (Newson & Kemps, 2007; Schutzer & Graves, 2004), as well as a fear of falling (Lees et al., 2005) as key barriers to exercise. Pain, whilst often cited as a benefit of exercise amongst mixed-aged adults with different forms of arthritis, has also been identified as a barrier to exercise, most often amongst those who do not exercise (Der Ananian et al., 2008). Petursdottir, et al., (2010) found that the weather acted as a barrier to exercise amongst adults aged 50-years and older with osteoarthritis, a result similar to the current study whereby the weather was a potential barrier to exercise, particularly the cold changing rooms in facilities during winter. The current study did not identify any detectable difference in the perceptions of those with and without osteoarthritis with regard to cold changing facilities. However, the facility where participants exercised did have an effect on their attitude, with those who exercised in older facilities being more likely to feel that the cold changing facilities were potentially a barrier. Whilst some studies have found that fluctuations in barometric pressure and temperature influences pain severity of patients with osteoarthritis (Brennan et al., 2012; T. McAlindon, Formica, Schmid, & Fletcher, 2007), others such as Wilder (2003) found no evidence to support this, despite a large amount of anecdotal evidence to the contrary. It is unclear whether the age of the participants in the aforementioned studies examining the relationship between temperature and arthritis symptoms would have influenced the findings, or if differences in the methodology may account for some of the equivalence of results. In the current study, pool temperature was identified as a possible barrier, with seemingly little consensus on pool temperature preference amongst participants regardless of whether or not they have osteoarthritis. Furthermore, there did not appear to be any link between pool temperature preference and participant's age, history of osteoarthritis symptoms or joints affected by osteoarthritis. Poorly structured classes with ill-informed instruction were also identified as potential barriers in the current study.

This study focused on understanding the primary benefits, motives and potential barriers to aqua-based exercise in a group of older adults both with and without osteoarthritis, who were regular participants in an aqua-fitness exercise class. Having a mixture of adults who did and did not have osteoarthritis in the focus groups could be considered a limitation. However, the discussion between and among those with and without osteoarthritis was considered a valid perspective given that those with and without osteoarthritis exercised together. The participants who had osteoarthritis were not identified before or during the focus groups. Therefore discussions were not guided in relation to osteoarthritis symptoms or preferences and any differences between those with and without osteoarthritis was analysed following the focus group. However, osteoarthritis was established through one self-report question and pain levels due to osteoarthritis or any other medical condition were not established. Therefore when pain was discussed among participants, it is not known whether this was a result of osteoarthritis, another form of arthritis or other condition. It was considered most appropriate to group participants together who exercised together in order to ensure that they discussed the same exercise experience. Pre-existing groups utilises the networks in which people might normally discuss issues likely to be raised, and this is an important factor when deciding on the members of a focus group (Loeb et al., 2006).

One question used during the focus group sessions; "Do you think the benefits of regular exercise in an aqua environment are better / different from land based exercise?" might be considered a leading question. However, the participants had been performing aqua-based exercise an average of 6 years and in most cases, preferred it to land-based exercise options. This suggests that these individuals believed greater benefits were gained from aqua- rather than land-based exercise. The small sample size could also be a limitation, although it is comparable to other qualitative physical activity studies of older adults (Galea et al., 2008; Melillo et al., 2001). In addition it is believed that data-saturation was achieved, meaning little additional detail would be gained with additional participants (Curry et al., 2009; Guest, Bunce, & Johnson, 2006).

3.7 Conclusion

In this study of older adults who regularly perform aqua-based exercise, the key perceived benefits of this activity, among those with osteoarthritis, were pain relief and the social contact with their peers. In contrast, for participants who did not have osteoarthritis, the social aspect and improved health and fitness were key benefits. The primary motivators to exercise also included the social aspect of attending classes and for many participants, regardless of whether or not they had osteoarthritis, the instructor. Potential barriers to aqua-based exercise for both groups of older adults included poor facilities, which were negatively affected by the weather and poor instruction. However these participants were long-term exercisers and potential barriers identified by them had not prevented them from attending classes. The findings of this study may help develop more suitable aqua-based exercise programmes and environments to encourage long-term adherence. Future research focusing on those who have discontinued exercise programmes would be helpful in identifying further barriers to aqua-based exercise for older adults with osteoarthritis.

Chapter 4 : Perceived barriers and benefits of aqua-based exercise among older adults with osteoarthritis

4.1 Prelude

Previous literature, which has investigated perceived benefits, barriers and motives to exercise among older adults with and without osteoarthritis, have generally classified participants as either ‘active’ or ‘not active’. To date, no known studies have focused specifically on reasons for dropping out of an exercise programme among older adults with osteoarthritis. The purpose of this study was primarily to explore reasons for dropping out of an aqua-based exercise programme among this population. Given that this form of exercise is considered suitable for older adults with osteoarthritis, it would be helpful to gain insight into the perceptions of those who have tried, but did not continue to participate in aqua-based exercise. Gaining insight into the reasons for discontinuing aqua-based exercise may help to increase knowledge relating to barriers specific to this mode of exercise, among participants who were sufficiently motivated to try it. Furthermore, focusing on older adults with osteoarthritis will help to understand and hopefully develop strategies to address some of the primary barriers to aqua-based exercise for this group, who potentially can benefit highly from regular exercise.

4.2 Abstract

Osteoarthritis is a common disease amongst older adults often associated with symptoms of joint pain and stiffness. Regular exercise may help combat these symptoms nevertheless, many older adults with osteoarthritis do not meet physical activity guidelines. Pain has been cited as a key barrier to exercise among adults with

arthritis however few investigations have focused on aqua-based exercise, despite this modality being recommended for older adults with osteoarthritis.

The present study investigated reasons for cessation of aqua-based exercise (barriers) among older adults with osteoarthritis, who had previously participated in this form of exercise. Perceived benefits were also explored.

Focus groups were conducted, they were audiotaped and transcribed then analysed using the General Inductive Thematic approach. A consensus was reached on all coding categories and themes were identified.

This process created eight core themes relating to the barriers and perceived benefits of aqua-based exercise. Key theme barriers included; Classes: lack of suitable classes and insufficient instructor knowledge, leading to increased pain. Facilities: cold water, poor facilities and cost. Themes for perceived benefit included Water: increased physical ability and cushioning and Social interaction: increased social contact.

4.3 Introduction

Osteoarthritis is the most common form of arthritis amongst older adults. Over 31% of females and 20% of males aged 65-74 years and more than 40% of females and 22% of males over 75 years of age have osteoarthritis (Borman et al., 2010). Osteoarthritis is often described as a degenerative disease, which involves the loss of hyaline cartilage and deterioration of its underlying bone. Symptoms include joint pain and stiffness accompanied by local inflammation (Tak, Staats, Van Hespen, & Hopman-Rock, 2005). Although the large weight-bearing joints, such as the hips and knees are the most commonly affected sites, the spine and hands can also be affected (Borman et al., 2010).

Regular exercise is beneficial for older adults, helping to prevent disease and maintain physical function and balance. However older adults with osteoarthritis have lower levels of physical activity than older adults without osteoarthritis (Hootman et al., 2003). Pain has been cited as a barrier to exercise for adults with osteoarthritis, rheumatoid arthritis and other forms of arthritis who do not regularly exercise (Der Ananian et al., 2008; Wilcox et al., 2006). Conversely, adults with osteoarthritis and other forms of arthritis who do exercise regularly often cite pain relief as a benefit and motivator to exercise (Der Ananian et al., 2008; Fisken, Keogh, Waters, & Hing, in press; Petursdottir et al., 2010). Despite the potential for pain relief and the role of regular exercise in reducing the likelihood of osteoarthritis-related pain and disability (R. Marks & Allegrante, 2005), the majority of adults with arthritis do not meet the public health recommendations for physical activity (Fontaine et al., 2004).

Aqua-based exercise may offer a safe and appropriate setting for older adults with osteoarthritis. Different forms of aqua-based exercise include: hydrotherapy, usually supervised exercise in warm water (Eversden et al., 2007); deep water running, performed whilst wearing a flotation device (Reilly et al., 2003) and aqua-fitness which generally consists of partial-weight bearing aerobic and strengthening exercises in waist-chest level water. All of these forms of aqua-based exercise provide varying degrees of buoyancy, which reduces the stress on joints and may lessen pain for those with osteoarthritis (Gulick & Geigle, 2009). Since aqua-based exercise has been shown to elicit significant improvements in strength of older adults (Katsura et al., 2010; Tsourlou et al., 2006) and improved functional independence and balance (Sato et al., 2009; Waters & Hale, 2007), it may present an excellent exercise option for older adults with osteoarthritis. Despite the potential health benefits of aqua-based exercise for older adults with osteoarthritis, few studies have investigated their perception of this form of exercise and what the barriers are to ongoing adherence.

Previous studies, which have examined barriers and perceived benefits of different forms of exercise among older adults (Lees et al., 2005; Newson & Kemps, 2007) or mixed-aged adults with osteoarthritis, rheumatoid arthritis and other forms of arthritis (Der Ananian, Wilcox, Abbott, et al., 2006; Wilcox et al., 2006), have differentiated between those who are currently active or inactive. However these studies classified participants according to their current exercise status and no clear distinction was made between those who had previously tried an exercise programme and those who had not. Neither was there any differentiation between modalities of exercise that participants may have engaged in. A recent study specifically investigated perceived benefits and barriers of aqua-based exercise among older adults with and without osteoarthritis who currently perform this exercise mode on a regular basis (Fisken et al., in press). Key perceived benefits included pain relief and social interaction. When questioned about potential barriers, participants identified cold changing facilities and poor class instruction.

The Transtheoretical Model of Change (TTM) was developed as a model of intentional behaviour change, originally for addictive behaviour (Burbank et al., 2002). Since its initial development, the TTM has been modified to include the adoption of health behaviour (Prochaska et al., 2002), such as exercise adoption. The model describes various stages of behaviour change including; precontemplation, contemplation, preparation, action and maintenance. During the precontemplation stage, patients do not even consider changing their behaviour, for example, adopting a new exercise programme. During the contemplation stage, behaviour change is considered and patients contemplate both the advantages (pros) and disadvantages (cons) of change (Marshall & Biddle, 2001). During the preparation stage, preparation is made to initiate specific changes, such as joining a gym. The action stage occurs when actual changes to behaviour are made. In the case of adopting an exercise programme, the action stage starts on the first day of exercise and lasts for six months, once regular exercise is consistent for at least six months, the maintenance phase is reached (Burbank et al., 2002). Relapse can occur at any stage and when this occurs the patient often reverts to the previous stage of the model (Kraft et al., 1999). Barriers to exercise may vary between those in different stages of the model (Sit et al., 2008), therefore participants who have previously tried, but no longer participate in an exercise mode, may have different perceptions than those who have never tried or who currently participate in exercise.

It is believed that behaviour change is influenced by several factors including self-efficacy, the process of change and decisional balance. These incorporate self-belief that behaviour change can be achieved as well as an evaluation of the pros and cons of engaging in a particular behaviour (Marshall & Biddle, 2001). Self-efficacy for exercise increases through the stages, from pre-contemplation to maintenance. In addition, with progression through the model towards action and maintenance, the perception of the "pros" tends to increase while the "cons" decrease (Burbank et al., 2002). As a result, it has been suggested that the Transtheoretical model can help promote behaviour change by utilising different methods to encourage those at different stages of the model (Zimmerman, Olsen, & Bosworth, 2000). .

Understanding reasons specifically for relapsing, or ceasing participation in regular exercise, may be useful in helping to identify barriers relevant to those who have been sufficiently motivated to change but did not maintain their new behaviour. Wilder and Barrett (2005) investigated dropout status from an exercise study among older adults with osteoarthritis. They found that those with lower baseline health status were more likely to drop out of an exercise programme as were those taking higher levels of arthritis medication. However, while Wilder and Barrett (2005) identified some of the personal characteristics associated with relapse, the reasons and perceptions among those who dropped out of an exercise programme were not investigated.

The current study aimed to provide insight into the factors contributing to older adults with osteoarthritis who had tried aqua-based exercise but who no longer participate in this type of exercise. Since aqua-based exercise is recommended by a number of arthritis associations, such as Arthritis New Zealand, it would be useful to have a greater understanding of perceptions towards this form of exercise among older adults with osteoarthritis. In particular, increased knowledge relating to perceived barriers (cons) and benefits (pros) of aqua-based exercise among this population who have tried but no longer participate in this type of behaviour may help to facilitate development of suitable exercise options for older adults with osteoarthritis.

4.4 Methods

Focus groups were utilised to gather qualitative information relating to the perceived barriers and benefits of aqua-based exercise among older adults with osteoarthritis who have tried, but no longer participate in this form of exercise. Focus groups were chosen since they enable an exploration of peoples beliefs, opinions and experiences and allow examination of different perceptions and priorities within a group or social environment (Kitzinger, 2005). Furthermore, in older adults, focus groups may increase the comfort level of individuals to freely discuss their opinions (Loeb et al., 2006).

4.4.1 Participants

Adults aged 60 years and older who had been diagnosed with osteoarthritis by their General Practitioner and who had previously tried, but no longer participate in aqua-based exercise were invited to take part in a focus group. Participants who had previously attended aqua-fitness or aqua-jogging classes were eligible to take part in the study. A total of 11 female participants were randomly allocated to one of two focus group sessions (n = 6 and n = 5, respectively). Demographic details were collected at the time of the focus group meetings (see Table 5). Osteoarthritis was self-reported to the researcher and other medical conditions disclosed included hypertension, fibromyalgia, asthma and type-II diabetes. Participants had all tried either aqua-fitness or aqua-jogging classes at different pool facilities within the same region.

Table 5. Participant Demographics

Characteristic	Value
Age, year (SD)	69.3 (4.0)
Duration of arthritis symptoms, year (SD)	13.1 (9.3)
Sites affected by osteoarthritis (n=11)	
Hip(s)	5
Knee(s)	5
Spine	3
Hand(s)/finger(s)	3
Ethnicity	
NZ European	6
Maori	2
Other	3

4.4.2 Procedure

Advertisements were placed in medical centres and health clinics as well as in a local newspaper and on the Arthritis New Zealand website. Individuals who volunteered for the study were contacted by telephone and their eligibility determined.

Participants were mailed and asked to read an information sheet before attending a focus group at a community centre where they signed a consent form before the focus group began. The research was conducted with the approval of the institutional research ethics board.

The focus group sessions were overseen by two researchers, one who primarily led the conversation and one who took notes. None of the participants were previously known to the researchers and as such, the potential for social desirability bias was limited. Each focus group was approximately 60 minutes and recorded using a digital voice recorder and later transcribed verbatim. Notes were made of any silent agreement or obvious body language not captured on the audiotape recording. Ardent agreement or disagreement among the group of any statements made were utilised alongside the transcript to identify the most important themes (T. Henwood et al., 2011; Loeb et al., 2006). Both focus groups were asked the same questions, which aimed to explore participant's experiences and opinions regarding aqua-based exercise. Questions were specifically chosen to gain insight into the perceived barriers and potential benefits of this form of exercise among older adults with osteoarthritis who have tried but no longer participate in aqua-based exercise. The intent was to explore self-efficacy, process of change and decisional balance components of the Transtheoretical model using open ended questions.

The questions outlined in Table 6 were used to guide the conversation, questions were formulated using guidelines for question development (Krueger & Casey, 2000; D. F. Marks & Yardley, 2004). In addition, questions were similar to those used by Fisken et al., (in press) who explored perceptions of older adults with and without osteoarthritis who are current aqua-exercisers.

Table 6. Questions used to guide focus groups

Topic	Specific questions
General attitudes towards exercise	What do you think are the benefits of regular exercise?
	What do you think are the key differences between aqua-based exercise and land-based exercise?
Benefits of aqua-based exercise	Why did you decide to take up aqua-based exercise?
	Where did you participate in aqua-based exercise? What type of aqua class did you attend?
	Which aspects of the aqua-based exercise programme that you attended did you most like?
Barriers to aqua-based exercise	Which aspects of the aqua-based exercise programme that you attended did you least like?
	What were the primary reasons for stopping aqua-based exercise?
Current status	Do you currently participate in any other form of regular exercise?
	Would you consider re-starting an aqua-based exercise programme?
Additional factors	We wanted you to help us to evaluate your reasons for taking part in and stopping an aqua-based exercise programme. Is there anything that you came wanting to say that you haven't had a chance to say?

4.4.3 Data Analysis

Data from all participants was analysed using the General Inductive Approach, which involves multiple readings and analysis of the raw data in order to derive themes (Thomas, 2006). This method has been recommended for health research as it allows significant themes to be established without the restriction associated with structured methodologies such as deductive analysis, permitting the researcher to focus on what is revealed by the raw data, rather than concentrating on testing a hypothesis (Scriven, 1991; Thomas, 2006) and is similar to the approach used in an earlier study (Fisken et al., in press).

In the first instance, two members of the research team individually reviewed and coded one of the transcripts. The other members of the research team then reviewed each transcript and the coding was double checked to ensure that they reflected participants' views (Melillo et al., 2001). Themes were developed after reading the transcripts repeatedly, until no new themes emerged, similar to the approach outlined by Thomas (2006). On this basis, simple frequency counts were not considered a good indicator of the importance of a theme (Wilcox et al., 2006) however, whilst it is generally considered inappropriate to utilise percentages when reporting focus group data (Kitzinger, 2005), a concept did have to be mentioned at least twice and by more than one participant in order to be considered a theme (Galea et al., 2008; Lees et al., 2005). This process created eight core themes relating to the barriers and perceived benefits of aqua-based exercise.

4.5 **Results**

A number of themes relating to barriers and benefits of aqua-based exercise were identified. Barriers included a lack of suitable classes and knowledgeable instructors as well as cold water and / or changing facilities and cost. In addition, two participants suffered from a skin reaction to the pool water. Key benefits included being able to do more in the water, the cushioning effect of the aqua environment and social interaction. General health and fitness also considered a potential benefit however this was not the strongest theme.

4.5.1 Barriers

4.5.1.1 Inappropriate classes

All participants felt that there was insufficient availability of aqua-based exercise classes suitable for their level of functional ability. A number of participants had had negative experiences at a generic aqua-based exercise class where they felt the exercises or pace of the class was inappropriate for their ability but had often felt pressurised to keep up with the group, which for some, resulted in excessive pain the following day. One participant commented:

> "I found it was going too fast for me and I didn't like that, I couldn't keep up, couldn't hold some of the equipment.. and the day after I just couldn't cope, I was in so much pain."

Others agreed that the class they attended was too difficult:

> "I didn't enjoy the classes because they were too strenuous."

> "Somebody took over and I couldn't keep up with the class and I just gave it away, not able to keep up."

> "I found it very stressful to be honest because I felt like I had to do the same as the others and keep up... they were all young, athletic ones. Too competitive, that's what I found."

4.5.1.2 Instructor

Instructor knowledge contributed to the lack of suitable classes, several participants expressed concerns relating to the lack of appropriate aqua-exercise instructors:

> "The instructor was not geared up for my particular disability [osteoarthritis]... and I found it very stressful."

> "Perhaps it could be recommended within this study that aqua-aerobics instructors be more attuned to older people and their needs as opposed to younger people, or specific ones that will help people with arthritis."

> I think knowing that aqua is for people possibly who have arthritis or conditions like that, that I think they ought to have, perhaps do an extra training course or something to fit, to accommodate that. It's not the same as going to a gym, if you've got arthritis you're not necessarily going to work out at the gym are you but if you're going to aqua aerobics you're going possibly because you've got arthritis..the water's beneficial so.

Participants also felt that there was a need for classes specifically for older adults, most expressed a preference for age-specific classes to be available:

> "But I would love to see something for the elderly people, to be active and keep reasonably fit. There's very little around for the older people. They don't want to know the older people."
>
> "It's got to be paced at our age range."
>
> "They need to have something for the older people, keep the younger ones different."

> Well I think it's important that you go, even if it's on land, that you go with people relative to your own age and that you're all at the same level 'cause I mean if you go with a 30-year old... we can't keep up with that, as much as we'd like to. Whereas if you go and you're all this age, you encourage each other.

4.5.1.3 Cold water or facilities

` Conversation relating to facilities mainly focused around the temperature of the pool or facility as a whole. Although warm pool water was considered a benefit for two participants, most felt that cold water and / or facilities were a key barrier:

> "I suppose one of the reasons why I did stop is because it's coming up to winter and it's outside... and it's cold.. I would like to go to a class in a hotter pool."

> "Very cold, I found that a real downside."

> "Well I didn't like the cold water."

> "At [the pool I attended] that was the worst... coming out you were freezing cold and you have to get changed back again."

As well as the cold water/changing facilities one participant had additional concerns about her safety:

> The water wasn't warm enough for me, this was a class at about 5 o'clock, the other thing was where I went you parked your car and you had to take quite a big walk to the actual pool and then after a few weeks when it was getting towards winter it would be dark when you came out and I didn't feel it was very safe. I'm not sure about the security round there.

4.5.1.4 Cost

Several participants felt that cost was a major barrier to aqua-based exercise, regardless of whether they attended a public or private swimming pool and for some, this was a contributing factor to ceasing to attend classes:

> "Then I ran out of money basically... it's very expensive, to belong to a gym club."

> I mean some of them charge an awful lot to get in. When you go up to the pool it's $2 and then you get charged $5 to go into the aerobics, well that's really, sort of, you know, pay for the guys time, that person's time but when you're on a pension you haven't got that.

> "The cost, when you're on a limited budget."

4.5.1.5 Reaction to water

Two participants described having a skin reaction to the pool water, which caused them to cease attending:

> "When I was in [name of pool] I stopped going because I got chlorine burns on my skin, from here (indicated chest level) right up."

> That's right, it was like weeping eczema and the arthritis society was so worried because I was going to one of their classes at the beginning and they said that they wanted to take it further and of course I became allergic to a lot of the minerals that are added to the [name of pool].

4.5.2 Benefits

4.5.2.1 Able to do more

Participants felt that the water allowed them to move more freely and enabled them to do more than they could on land:

> "My knees were getting really bad and I, so I thought, well the only thing I can do really is to do aqua, which I did and I love it."

> "I started doing it because I can't walk very far and I needed some form of exercise and that's what prompted it."

> "I could walk solidly in that pool for an hour but I'm lucky if I can walk down the end of my drive."

> "I'm able to do a lot more in the water than when I was going to the gym."

Similarly, participants acknowledged that the buoyancy of the water was a key benefit of aqua-based exercise, which allowed them to move and exercise with reduced impact on the joints:

> "I love the water because it doesn't impact so much, it's a lot easier on your joints and the water keeps you balanced."

> The buoyancy... I like deep water, I don't like the shallow water aerobics 'cause I feel easier in the deep water. It takes the impact off your joints... it

gives you freedom... if you've been used to sitting down, being sedentary and not being able to move around... the water makes you feel wonderful.

"Yes I can go into the water because the weight of the water takes it off the body."

"In particular you know the aqua aerobics, you don't put your weight on your legs, that's the main thing."

4.5.2.2 Social

For most participants, the social aspect was very significant and the opportunity to get out of the house and reduce feelings of isolation was particularly important:

"You know, you're not stuck at home all the time, it's a way of getting out.
It's nice to be out in a group and not feel so isolated so it was a good, psychological it was, really good."

"I think it's important to be with other people, how other people cope and that you're not alone and there are other people you know, in similar situations."

4.5.2.3 Health and fitness

General health and fitness was identified as a benefit of aqua-based exercise by some participants although this was not a key theme. A variety of benefits were described by two participants:

"Strengthening your muscles... keeping your weight down... keeps you in shape."

"Keeps the body moving, takes your mind off it, it's good to be outside. Yea, keeping active, or else if you've got osteo, it can get you right down, if you stay inside you just mope about it."

4.6 Discussion

The primary objective of this study was to examine decisional balance (perceived pros and cons) to aqua-based exercise amongst older adults with osteoarthritis who have previously but no longer engage in this form of exercise. Key themes relating to the discontinuation of aqua-based exercise emerged. These included: a lack of suitable classes and trained instructors to deliver classes matched to their limitations and environment factors such as cold water or changing facilities and excessive costs. Two participants described having a skin reaction to the water. Despite these barriers, participants believed that aqua-based exercise offered a number of benefits including the ability to do more in the aqua environment and its cushioning effect, as well as the opportunity for social interaction. General health and fitness was also identified as a slightly less significant theme.

One of the primary reasons given for ceasing an aqua-based exercise programme was that participants felt the class they had attended was not suitable for their age or ability. In particular, exercising at a higher intensity than they perceived was suitable for their age or ability, sometimes resulting in pain the following day, was a strong barrier to exercise adherence. Pain has been widely reported as a barrier to exercise among adults with various forms of arthritis (Petursdottir et al., 2010; Wilcox et al., 2006). Participants in the current study felt strongly that they should be attending classes suitable for their age and functional ability but that there were no such classes available. Previous literature has revealed similar findings, a randomised, controlled trial by Cochrane et al., (2005) into the cost effectiveness of aqua-based therapy for lower limb osteoarthritis also highlighted the importance of exercise classes suitable for participant's ability but concluded that there was an overall lack of availability of this type of class. Training with others of a comparable age has also been identified as important among older adults who performed land-based resistance training (T. Henwood et al., 2011). Self-efficacy has been strongly associated with exercise adherence (Cheung et al., 2006) and progression through the TTM (Litt, Kleppinger, & Judge, 2002). Participants in the current study demonstrated low self-efficacy for aqua-based exercise based on the class they had attended. Attending age and/or ability appropriate classes may have increased self-efficacy for aqua-based exercise, which could have had a positive effect on adherence. In a review of literature, Marks & Allegrante, (2005) also identified self-efficacy as key factor for promotion of exercise adherence among adults with chronic osteoarthritis. Mastery is one of the most successful means of improving self-efficacy (Bandura, 1997). However exposure to an aqua-based exercise class in which participants felt they could not keep up, particularly if they had minimum prior experience of this exercise type, would likely have had a negative impact on self-efficacy towards that exercise mode (Flavell & Ross, 1981). This may have contributed to the participants' reluctance to continue attending the exercise class.

The instructor was also considered a potential, environment barrier, participants deemed it important for the instructor to understand their age and condition and several participants expressed concerns regarding the lack of education of their instructor and lacked confidence in the instructor's knowledge. This theme has been identified in other studies with Wilcox, Der Ananian et al. (2006) finding that participants with arthritis considered the lack of qualified aqua instructors who understood their physical limitations a major barrier. A previous study by Fisken et al., (in press) found that older adults with osteoarthritis who currently participate in aqua-based exercise considered the instructor an important element of the class, with the potential to be either a motivator or a barrier. In the current study, a combination of poor instructor knowledge and a lack of suitable classes for this population created sufficient reason to cease participation for several participants.

Environmental factors including cold water or changing facilities, particularly during winter, were identified as potential barriers and a key theme. A number of previous studies investigating perceived barriers to exercise amongst older adults have also established that poor weather is often considered a barrier to exercise (Lees et al., 2005; Newson & Kemps, 2007). Fisken et al., (in press) who focused specifically on perceptions of aqua-based exercise among older adults with osteoarthritis, also noted that cold pool or changing room temperature was considered a potential barrier. There is considerable anecdotal evidence to suggest that pain severity of patients with osteoarthritis increases when temperatures decline and a number of studies have indicated that pain due to osteoarthritis is negatively influenced by rises in barometric pressure (Brennan et al., 2012; T. McAlindon et al., 2007). This has important implications since pain itself is also considered a barrier to exercise amongst adults with a form of arthritis (Der Ananian, Wilcox, Saunders, et al., 2006; Petursdottir et al., 2010; Wilcox et al., 2006). A report by Bunning and Materson (1991) stated that compliance to an aqua-based exercise programme decreases amongst people with osteoarthritis when the water temperature drops below 29 degrees Celsius. This was consistent with the current study in which participants indicated a preference for pools with temperatures of 30 degrees Celsius and above.

Another environmental theme identified was the cost of aqua-based exercise. Several participants in the current study felt that cost was a barrier to continued participation in aqua-based exercise and this applied whether they had attended a private or public facility. Although cost was identified as a barrier to exercise amongst some adults with arthritis in a study by Wilcox et al., (2006), it was not identified as a major theme in other studies examining barriers among older adults (Lees et al., 2005; Newson & Kemps, 2007). Not surprisingly, socioeconomic status would appear to be a major factor in whether or not cost is perceived as a barrier to activities like aqua-based exercise.

Previous studies indicate that decisional balance of pros and cons changes with progression through the TTM (Lach et al., 2004). The identification of similar barriers to aqua-based exercise between ex-exercisers in the current study and current aqua-exercisers in a previous study (Fisken et al., in press) may support this. Both these groups of older adults with osteoarthritis cited similar potential barriers to aqua-based exercise, such as cold facilities. However despite similar barriers, these groups differed in their exercise behaviour. Further investigation is warranted to explore the effect of decisional balance and self-efficacy on exercisers who have dropped out of an exercise programme.

Two participants in the current study described having a skin reaction to the pool water, one whilst exercising in a chlorine-based swimming pool and the other at a public hot pool. One of these participants described using an emollient cream to help reduce the severity of her reaction. Ageing is associated with changes in the epidermis which becomes thinner thus reducing the effectiveness of the skin as a barrier which may result in the skin becoming more sensitive to potential irritants (Benbow, 2010; Watkins, 2011). Emollient therapy is considered useful for reducing skin sensitivity (Benbow, 2010), however, it is not known whether this could offer a cost-effective tool to prevent or minimise skin reactions for susceptible older adults allowing them to participate in aqua-based exercise.

Although participants in this study had not maintained regular, ongoing participation in aqua-based exercise, it was important to gain insight into why they were motivated to try this mode of exercise. One of the key benefits was feeling able to do more in the water, in particular, finding it easier to exercise in the pool than on land. Previous studies have identified reduced pain and stiffness as well as improved mobility and function as key benefits of exercise among current exercisers (Der Ananian, Wilcox, Saunders, et al., 2006; Petursdottir et al., 2010; Wilcox et al., 2006). Participants in the study by Wilcox, Der Ananian et al. (2006) expressed a desire to have access to aqua-based exercise, stating that this type of programme would make it easier for them to exercise. Decreased pain symptoms have been associated with water immersion due to increased sensory input and decreased joint compression (Westby, 2001), which may contribute to the feeling of being able to do more in water. Participants in the current study also indicated that the reduction of weight on the joints, due to the buoyancy of the water, aided movement and was a benefit of this form of exercise. Again, the potential benefits of aqua-based exercise identified by older adults with osteoarthritis who no longer participate in this form of exercise were similar to those identified by current aqua-exercisers in a previous study (Fisken et al., in press).

The social aspect of group exercise has been cited as a key facilitator of long-term adherence to aqua-based exercise (Kang et al., 2007) and land-based exercise (Der Ananian et al., 2008) in adults with osteoarthritis or rheumatoid arthritis. A review of literature identified social support as a key predictor of exercise adherence among adults with chronic osteoarthritis (R. Marks & Allegrante, 2005). Similarly, social stimulation was identified as at potential benefit by all but one participant in the current study. Participants referred to aqua-based exercise classes as having provided an opportunity to get out of the house, with many feeling that socialising with others of a similar age or who also had osteoarthritis was valuable in helping to reduce the feeling of isolation. Social isolation is believed to have a significant effect on depressive symptoms in older adults (Alpass & Neville, 2003). In addition, depression is considerably more prevalent amongst people with osteoarthritis relative to people who do not have osteoarthritis (Lin, 2008). Participation in social and leisure activities by individuals with conditions such as osteoarthritis is often restricted due to a combination of depressive symptoms and physical activity limitations (Machado, Gignac, & Badley, 2008). However, regular participation in activities such as aqua-based exercise may help reduce feelings of isolation among older adults with osteoarthritis and consequently lessen depressive symptoms. A study by Litt et al., (2002) observed that older women are far more likely to adhere to an exercise programme, after they have started, if there is social support for their behaviour. Bandura, (1997) hypothesised that social support may strengthen self-efficacy, and as previously stated, self-efficacy is strongly associated with exercise adherence. Social support provided by the exercise instructor and peers in an appropriate exercise class could have increased levels of self efficacy for exercise among these ex aqua-exercisers and this may have had a positive influence on adherence.

Older adults most often cite health and fitness as key motivators to exercise, however this did not emerge as a primary theme in our focus groups. This coincides with previous research which has identified differences in the primary perceived benefits of exercise identified by apparently healthy older adults, who are most likely to cite health (Newson & Kemps, 2007) and adults with osteoarthritis, rheumatoid and other forms of arthritis who are more likely to identify pain reduction or symptom relief (Petursdottir et al., 2010; Wilcox et al., 2006).

As previously stated, different stages of the TTM are associated with a different emphasis on the associated pros or cons of behaviour change. It has been reported that pros are significantly higher for those in the action and maintenance stages of the TTM, compared to those who have relapsed (Plotnikoff, Hotz, Birkett, & Courneya, 2001). Similarly, those in the action or maintenance phases of the TTM demonstrate less emphasis on the cons (Plotnikoff et al., 2001; Prochaska et al., 2002). In addition, self efficacy for exercise increases with progression through the TTM (Plotnikoff et al., 2001). The current study identified similar perceived barriers and benefits to aqua-based exercise among older adults with osteoarthritis who no longer participate in this form of exercise to those identified by current aqua-exercisers in a previous study (Fisken et al., in press). This would suggest a difference in the emphasis placed on the barriers (cons) versus benefits (pros) between current and ex aqua-exercisers. It is hypothesised that this shift in importance is affected to some extent by self-efficacy for exercise, which may have been negatively affected by the type and level of class attended by participants. The relationship between self efficacy and decisional balance warrants further investigation.

To the best of our knowledge this is the first study to investigate the perceived barriers and benefits of aqua-based exercise amongst older adults with osteoarthritis who have tried but not maintained ongoing participation in this form of exercise. Since aqua-based exercise is widely recommended for adults with osteoarthritis, it is important to gain a greater understanding of the perceptions and potential barriers regarding this form of exercise. Whilst this study has provided some new evidence about the perceptions of aqua-based exercise among older adults with osteoarthritis, there are several study limitations. Firstly, the objective of a focus group methodology was to explore decisional balance by opinions and perceptions obtaining in-depth data rather than a large quantity of less detailed information, which we believe was achieved in this study. However it is important to acknowledge the potential for selection bias which is inherent when participants voluntarily take part in this type of investigation. Potential participants who declined, or did not have the opportunity to take part in the study may have been less willing to discuss their experiences or may have held different opinions regarding the potential barriers and benefits of participating in aqua-based exercise. There is a possibility that focus group discussions may result in a group response, however this was not believed to be a factor in the current study, participants appeared to talk freely about their experiences and opinions. It should also be noted that due to the age of the participants, many had co-morbidities, which may have contributed to their experiences and opinions relating to aqua-based exercise. Finally, although participants had relapsed from aqua-based exercise, current participation in any other form of exercise was not utilised for the analysis. However, it is interesting to note that around half of the participants were regularly taking part in some other form of organised physical activity specific to older adults.

4.7 Conclusion

Older adults with osteoarthritis are particularly susceptible to functional impairment and reduced balance, which can have a negative effect on independence and quality of life. Aqua-based exercise is widely recommended as a suitable form of exercise for older adults with osteoarthritis. This study helps supplement current knowledge with regard to perceived barriers and benefits of participation in aqua-based exercise among older adults with osteoarthritis, in particular, among those who have not continued with this form of behaviour. The primary barrier identified in the study was the lack of suitable age or ability appropriate classes available, which may have resulted in low self-efficacy for aqua-based exercise. In addition, an environment of cold water and facilities were also considered a significant barrier to long-term adherence. Despite these barriers, participants did acknowledge that aqua-based exercise provided them the opportunity to move more freely and interact socially, and all expressed a willingness to undertake this form of exercise in the future, provided the class addressed these barriers. Providers should be educated with regard to preferences and barriers among older adults with osteoarthritis with a view to increasing provision of suitable classes and facilities in order to encourage long-term adherence to aqua-based exercise. Further research is warranted to gain greater understanding of the processes of shifting emphasis of the decisional balance of the pros and cons, as well as self-efficacy, which are associated with progression through the TTM and long-term exercise adherence.

Chapter 5 : Perception and responses to different forms of aqua-based exercise among older adults with osteoarthritis

5.1 Prelude

Several forms of aqua-based exercise exist including; hydrotherapy, aqua-fitness and aqua-jogging. Hydrotherapy is widely recommended for older adults with osteoarthritis, however this mode of exercise requires specialized staff and a warm therapy pool. Consequently, hydrotherapy is not always an affordable or available aqua-based exercise mode. Although several studies have established a number of positive outcomes following a hydrotherapy intervention for older adults with osteoarthritis, little investigation has been made to establish whether this mode of exercise offers greater potential benefits than other aqua-based exercise programmes. Aqua-fitness and aqua-jogging are attended by many older adults, with and without osteoarthritis, however these forms of exercise have not been widely investigated among this population. The purpose of this study was to compare these different types of aqua-based exercise and the acute heart rate and pain responses to these exercise modes. In addition, it was hoped that exploration of opinions towards these exercise types could help further understand which, if any, mode of aqua-based exercise was preferred among older adults with osteoarthritis.

5.2 Abstract

Osteoarthritis (OA) is prevalent among older adults. Aqua-based exercise is often recommended as a therapeutic intervention. However, relatively limited evidence exists on the effectiveness of this form of exercise intervention. Perceptions of pain, mean and maximum heart rate (HR) responses, ratings of perceived exertion (SRPE), and subjective enjoyment to different forms of aqua-based exercise were investigated. Thirteen older adults with documented OA completed five aquatic exercise sessions: body-weight aqua-fitness (AF), body-weight aqua-jogging (AJ), resisted aqua-fitness (RAF), resisted aqua-jogging (RAJ), and hydrotherapy (HYD). HYD was rated most enjoyable compared to AJ, AF and RAF ($p = 0.001$). Pain scores immediately post-exercise were significantly lower than 24-hour post-exercise for all exercises ($p = 0.02$). Mean HR was significantly higher during AJ than during HYD ($p=0.008$), maximum HR was not significantly different during any sessions. SRPE was significantly higher for RAJ than for HYD ($p = 0.005$) although similar for all other sessions. These data suggest similar pain and maximum HR responses to different modes of aqua-based exercise. AF may be considered an acceptable alternative to HYD as a water-based exercise for older adults with OA.

5.3 **Introduction**

The global population is aging at a rapid pace (Lopez, Mathers, Ezzati, Jamison, & Murray, 2006). Over the last fifty years, the population of 65 years and older age group has increased steadily. In New Zealand it is expected that older adults will make up one quarter of the population by 2051 (Statistics New Zealand, 2007). Similar trends have been predicted for North America where the percentage of adults aged 65 years or older is expected to rise to approximately 20% of the population by as early as 2030 (Goulding et al., 2003).

Advancing age is associated with an increased risk and incidence of a number of degenerative conditions, the most common being osteoarthritis (OA). According to the World Health Organisation (WHO), 45% of women over the age of 65 years have OA, with the primary complaint being joint pain and stiffness (Flores & Hochberg, 2003).

Not surprisingly, the majority of adults 65 years and older with OA typically have not met the public health recommendations for type, quantity and quality of physical activity (Fontaine et al., 2004). These lower levels of physical activity are associated with a loss of muscular strength, endurance, and balance, which together contributes to an increased risk of falls and lower perceived quality of life (T. R. Henwood & Bartlett, 2008). Consequently, older adults with OA are particularly susceptible to greater than age-related reductions in muscle strength, functional ability, balance, increased rates of co-morbidities and associated declines in independence and perceived quality of life.

The American College of Rheumatology recommends aqua-based exercise for older adults with OA (Westby, 2012). Water immersion has been associated with decreased pain symptoms, due to increased sensory input and decreased joint compression (Westby, 2001). Since pain is often cited as a primary barrier to exercise among adults with different forms of arthritis (Der Ananian et al., 2008; Wilcox et al., 2006), aqua-based exercise may offer an ideal environment in which to exercise for this group. Aqua-based exercise is associated with reduced loading on the joints and a decrease in HR response compared to land-based exercise (Graef & Kruel, 2006). A review of literature related to OA and aqua-based exercise concluded that aqua-based exercise can result in comparable outcomes to land-based exercise for adults with knee or hip OA and rheumatoid arthritis (RA), despite a wide variability in characteristics among the reviewed aqua-based exercise programs (Batterham et al., 2011).

Despite these recommendations and the potential benefits of aqua-based exercise for older adults with OA, there is limited evidence-based knowledge relating to the effects of this form of exercise among this population. Many studies of aqua-based exercise for adults with OA have used exercise programmes based around hydrotherapy (Fransen et al., 2007; Lund et al., 2008; Silva et al., 2008). Hydrotherapy typically is defined as any individualised, therapist-supervised programme which focuses on strength and range of motion (ROM) exercises (Eversden et al., 2007), usually conducted in warm water between 33.5° and 35.5° Celsius (or 92.3-95.9 ° F) (Becker, 2009). While hydrotherapy-based programmes have been shown to improve physical function (Fransen et al., 2007) and reduce pain (Silva et al., 2008) among adults with OA, hydrotherapy classes are often expensive and not always widely available due to the requirement of specialised therapists and facilities with warm water temperatures.

Aqua-fitness and aqua-jogging classes are popular community modes of aqua-based exercise among older adults and are often more accessible and affordable than hydrotherapy classes. Aqua-fitness usually consists of partial weight-bearing aerobic and strengthening exercises performed while standing in the shallow end of a swimming pool, usually to music. Aqua-jogging consists of simulated running in deep water while wearing a flotation devise to keep the head above water (Reilly et al., 2003). Both these types of aqua-based exercise are generally performed in a group and are overseen by an aquatic instructor. Pool temperatures are variable; however, classes often take place in public or competitive swimming pools many of which operate in a temperature range of 27-29° Celsius (80.6°-84.2°) (Becker, 2009).

Despite the popularity of aqua-fitness and aqua-jogging classes, few studies have compared these forms of aqua-based exercise to hydrotherapy. A study by Kaneda, Sato, Wakabayashi, Hanai, & Nomura (2008) did compare adaptations to walking exercises in waist-chest depth water with aqua-jogging among healthy older adults. Both exercise groups significantly improved reaction time following 12-weeks of twice-weekly classes ($p< 0.05$). In addition, the aqua-jogging group also significantly improved dynamic balance ($p< 0.05$). The study did not analyze the participants' perceptions of these different exercise modes or whether they would be likely to adhere to such a program following cessation of the study.

In order to maintain the benefits of any exercise programme, ongoing participation and long-term adherence is required. A study by Kang, Ferrans, Kim, Kim & Lee (2007) found that long-term adherence to aqua-based exercise among older Korean women with OA or RA is affected by social cohesion and self-efficacy, as well as attraction to the task. It is therefore important to increase our understanding of perceptions among older adults with OA towards different modes of aqua-based exercise in order to ensure that appropriate programmes are made available and encourage ongoing participation.

The purpose of this mixed-methods study was to utilise a combination of quantitative and qualitative analysis to explore responses and preferences to different types of aqua-based exercise. A mixed methods approach allows examination of different, complementary components of one phenomenon (Greene, Caracelli, & Graham, 1989). In this study, it was considered appropriate not only to gauge physiological data, such as HR response, relative to different forms of aqua-based exercise but to also explore perceptions regarding these exercise modes, since preferences play an important role in exercise adherence (Findorff, Wyman, & Gross, 2009). Self-reported pain, heart rate responses, ratings of perceived exertion and the participants' perceptions relating to enjoyment of five different aqua-based exercise sessions were examined among older adults who were diagnosed with OA. These data may allow us to develop more suitable and accessible forms of aqua-based exercise for older adults with OA, and ultimately the information may contribute to improved functional independence, healthfulness, and quality of life for older adults who suffer from OA.

5.4 Method

5.4.1 Design

The study was a cross-sectional comparison of five forms of aqua-based exercise. Participants each took part in five different aqua-based exercise sessions that included a session of body-weight aqua-fitness (AF), body-weight aqua-jogging (AJ), hydrotherapy (HYD), resisted aqua-fitness (RAF) and resisted aqua-jogging (RAJ). Four groups of participants attended classes, which took place in partially randomised order as outlined in Table 7. Partial randomisation was selected to ensure that participants were not exposed to the resistance exercise options during either of the first two sessions. This was in order to give participants the opportunity to practice the basic movements before adding any resistance to the moves. Each class was separated by 48-72 hours.

Table 7. Order of Exercise Sessions

	Group 1	**Group 2**	**Group 3**	**Group 4**
Session 1	AF	AJ	HYD	AJ
Session 2	AJ	HYD	AJ	AF
Session 3	RAF	AF	AF	RAJ
Session 4	HYD	RAF	RAJ	RAF
Session 5	RAJ	RAJ	RAF	HYD

AF = aqua-fitness, AJ = aqua-jogging, HYD = hydrotherapy, RAF = resisted aqua-fitness, RAJ = resisted aqua-jogging

AF, AJ, RAF and RAJ were chosen to reflect aqua-fitness and aqua-jogging classes similar to those available in community pools and attended by older adults with and without OA. The aqua instructor was experienced in all these different exercise modes as well as working with older adults. The hydrotherapy session was overseen by a physiotherapist who was experienced in delivering hydrotherapy sessions. This class consisted of a range of strengthening and ROM exercises similar to those previously reported in the literature (Fransen et al., 2007; Hinman et al., 2007). Although hydrotherapy classes traditionally consist of a one-on-one session with a therapist, the hydrotherapy sessions in this study were conducted in small groups. Consequently, exercises were not individualised for each participant, however there were a maximum of five participants in each exercise group. This protocol is similar to other studies which have investigated hydrotherapy-based exercise programs (Fransen et al., 2007; Silva et al., 2008). The exercise protocol for each session is outlined in Appendix 1: Exercise protocols.

5.4.2 Participants

Thirteen community-dwelling older adults were recruited in response to advertising in community newspapers, medical centres, and the Arthritis New Zealand webpage. To be eligible for the study, participants had to be over 60 years of age and have been diagnosed by radiography as having OA. Participants had to be able to walk unaided and could not be currently participating in any aqua-based exercise programme. In addition, it was required that participants were not taking part in any land-based organised exercise programme more than twice per week. Twelve females and one male took part in the study, with a mean age of 69.8 years ± 6.6. Mean length of time of OA symptoms was 12.1 years ± 7.9. Participants with any level of circulatory disease or other relevant medical condition obtained their physician's permission to participate in the study. The research was conducted with approval of the institutional research board and all participants gave their written informed consent.

5.4.3 Outcome measures

5.4.3.1 Pain

Participants were asked to rate pain using the numerical rating of pain scale (NRS), which ranks pain severity from 0 (no pain) to 10 (worst possible pain) (Salaffi, Stancati, Silvestri, Ciapetti, & Grassi, 2004). Pain intensity is frequently measured using this method (Farrar, Young Jr, LaMoreaux, Werth, & Poole, 2001) and it has been reported as a valid and reliable measure of acute pain (Bijur et al., 2003). Participants were shown the NRS scale immediately before entering the pool and immediately after each aqua-based exercise session and asked to rank their pain accordingly. Participants were then contacted 24 hours after each session by telephone and again asked to rank their NRS pain level according to the scale they had taken home for the follow-up contact.

5.4.3.2 Heart Rate

Heart rate (HR) was measured and recorded with a Polar heart-rate monitor (Polar RS 400, Kempele, Finland) and T31 coded transmitter every 5 seconds throughout each exercise session. A member of the research team allocated participants with a HR watch at the start of each session which they wore throughout. The researcher initiated each device immediately before participants entered the pool. On leaving the pool, participants removed their watch and handed it to the researcher who stopped each watch immediately. HR data were transferred via infrared device onto Polar WebLink software; mean and maximum HR for each of the five exercise condition classes were calculated for each participant and used in the analysis.

5.4.3.3 Ratings of Perceived Exertion

The Rating of Perceived Exertion (RPE) Scale is a valid, reliable and widely accepted method of quantifying exercise intensity (Faulkner & Eston, 2008). A modified version of the original Borg RPE scale (6-20) was used. The modified version of the original RPE was used: a scale of 0-10, where zero represented no effort (rest) and 10 is maximal effort. It has been suggested that this scale offers enhanced individual interpretation of exertion compared to the original scale of 6-20 (Borg & Kaijser, 2006). Participants were asked to rate each exercise session (SRPE) at the completion of each session, this was done as they were leaving the pool and at the same time as they were asked to rate their pain level.. This procedure, where participants give an overall rating for the session at the end of the session, has been shown to be equally effective as the traditional method whereby participants rate the session throughout and during different phases of the exercise session (Egan, Winchester, Foster, & McGuigan, 2006).

5.4.3.4 Enjoyment

Participants were asked to rank a series of questions relating to enjoyment on a scale of 1 (least enjoyable) to 5 (most enjoyable) for each of the exercise sessions. These questions related to the exercises themselves, the social aspect, pool temperature, and the instructor. They were similar to and adapted from the relevant section of the exit questionnaire used by Cochrane, Davey, & Matthes Edwards (2005) for individuals with OA after an aqua-based exercise intervention. The questionnaire (Appendix 2: Enjoyment questionnaire) was given to participants to complete at the end of each exercise session once they had dried and dressed.

5.4.3.5 Focus Group

All participants were invited to attend a focus group upon completion of the five exercise sessions. The purpose of the focus group was to explore the participants' views of the exercise classes they experienced and to estimate whether they would be likely to attend any of those types of exercise classes on a regular basis. A focus group was chosen to allow exploration of participant's opinions, perceptions, and priorities while in a small group social environment (Kitzinger, 2005) because the investigators felt that a focus group would reflect the group social aspect of the aqua exercise classes more adequately than a one-on-one interview. Eight participants agreed to attend a focus group, the session was recorded using a digital voice recorder and later transcribed verbatim. Two researchers were present during the focus group, one who took notes of any silent agreement, disagreement, or obvious body language not captured on the audiotape recording, while the other researcher guided the conversation using semi-structured probe questions (Appendix 3: Focus group questions) to steer the discussion. Questions were developed using published guidelines (Krueger & Casey, 2000).

5.4.4 Data Analysis

As a number of the assumptions for the parametric tests in each variable were not satisfied, it was decided that five separate parametric and non-parametric tests would be applied. To minimise the chances of a Type 1 error, the significance level was adjusted to be 0.05/5 = 0.01. Repeated measures analysis of variance (ANOVA) with Bonferroni post hoc tests were calculated out for the quantitative parametric data that included HR mean, HR maximum, SRPE, and pain ratings. For the non-parametric data derived from the enjoyment questionnaire, Friedman's ANOVA was used to analyze each question. Wilcoxon signed ranks tests with a Bonferroni correction were used for subsequent post hoc analyses of the non-parametric measures.

Focus group data were analysed using Krueger's framework analysis (Krueger, 1994) as a general guide for interpretation. This thematic approach suggests five key stages of analysis: familiarisation of the data, identifying a thematic framework, indexing, charting, mapping and interpretation (Rabiee, 2004). This approach was considered appropriate since it allows themes to develop from the conversation as well as the research questions but also encourages the researcher to affirm key statements with participants.

5.5 Results

Eighteen participants initially volunteered to participate in the study. Two were not eligible as they did not have diagnosed OA, one participant was unable to complete all five exercise sessions in the allocated timeframe.   Fifteen participants enrolled to take part in the study. Only 13 completed the study by participating in all five exercise sessions, these participants data were used for the analyses. Attrition was due to cold pool temperature during AF (n=1) and finding the first session (AF) too hard (n=1).

5.5.1 Enjoyment

Participants ranked 6 questions each on a scale of 1-5 relating to their enjoyment of different aspects of each exercise session. The HYD session scored significantly higher overall on enjoyment than the AF, AJ, and RAF sessions. A breakdown of questions revealed that the HYD session also scored significantly higher than several other sessions for the relaxation aspect of the session, and pool temperature (see Table

8). The open-ended questions were poorly answered by participants, therefore a focus group was considered an appropriate alternative method of gaining qualitative feedback.

Table 8. Mean Enjoyment Rating for Each Exercise Session

	AF (A)	**AJ (B)**	**HYD (C)**	**RAF (D)**	**RAJ (E)**	**Chi -Square**	**Sig**
Overall Enjoyment (out of 30)	24.85±3.36 A-C**	24.46±3.07 B-C**	28.21±2.23 C-D**	25.77±2.72	26.07±3.27	19.3	.001*
Exercises with equipment	4.1 ± .68	3.77 ± .83	4.5 ± .65	4.2 ± .699	3.93 ± .917	7.07	0.13
Strength/range-of-movement exercises.	4.25 ± .64	3.79 ± .80	4.43 ± .76	4.14 ± .66	4.07 ± .73	9.39	0.05
Relaxation	4.46 ± .52	3.99 ± .62 B-C**	4.71 ± .47	4.57± .51	4.43 ± .65	17.92	0.001*
Social	4.29 ± .91	4.43 ± .65	4.93 ± .27	4.57 ± .51	4.71 ± .61	11.24	0.024*
Pool temp.	3.07±1.59 A-C**	4.07± 1.0 B-C**	4.71± .61 C-D**	3.57±1.16	4.21±1.12	20.99	0.000*
Instructor	4.64 ± .84	4.71 ± .47	4.93 ± .27	4.71 ± .61	4.71 ± .61	5.54	0.236

AF: Aqua-fitness; AJ: Aqua-jogging; HYD: Hydrotherapy; RAF: Resisted aqua-fitness; RAJ: Resisted aqua-jogging

.* Friedman's ANOVA, ($p<.05$); **Wilcoxon signed-rank test, ($p<.005$)

5.5.2 Pain

None of the aqua-based exercise sessions resulted in any significant difference in pain ratings pre, post or 24-hours post-exercise. However, when AF, AJ, RAF, RAJ and HYD scores were pooled, there was a trend for pain to be lower immediately post exercise than 24-hours post exercise (p=.02) (see Figure 5).

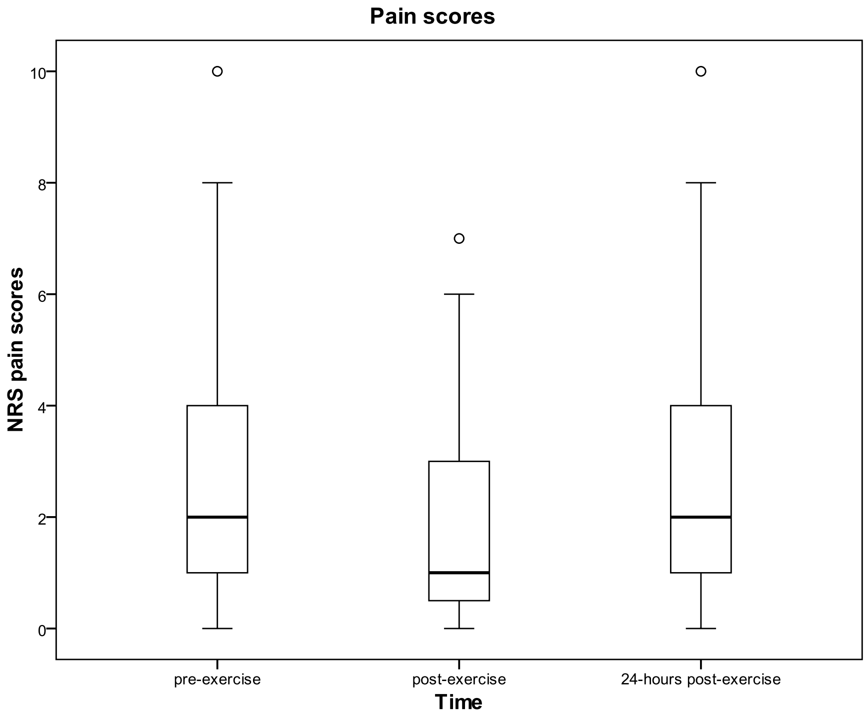

Figure 5. NRS pain ratings immediately before exercise, immediately post-exercise and 24 hours post-exercise.

NRS: Numerical rating of pain scale

5.5.3 Heart Rate

Mean HR during AJ was significantly higher than during HYD (p=0.008). There were no significant differences among maximum HR achieved during any of the sessions. Mean and maximum HR values for each exercise mode are presented in Figures 6 and 7, respectively.

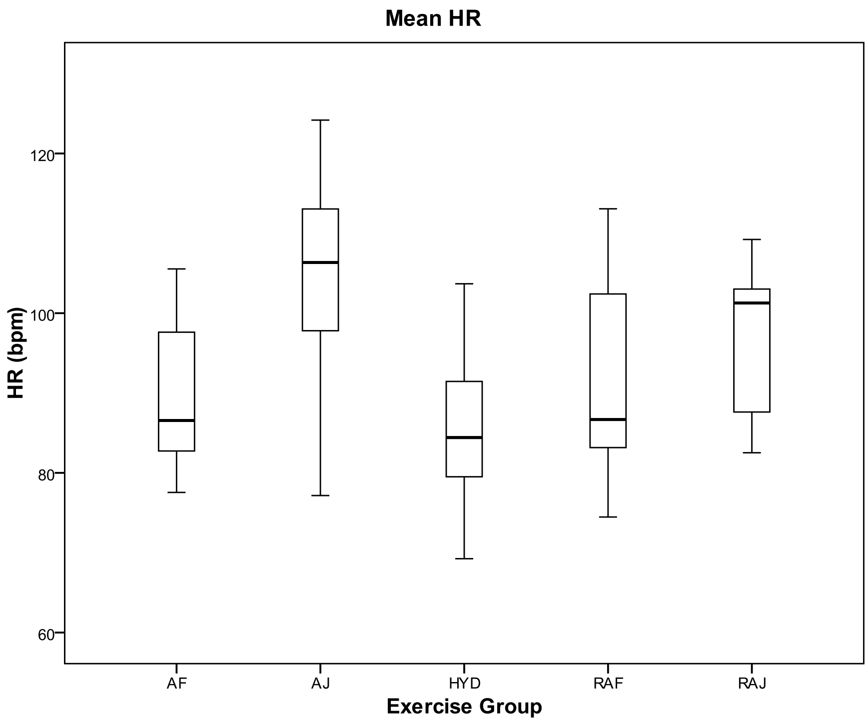

Figure 6. Mean HR for each exercise mode
HR: Heart rate; bpm: beats per minute; AF: Aqua-fitness; AJ: Aqua-jogging; HYD: Hydrotherapy; RAF: Resisted aqua-fitness; RAJ: Resisted aqua-jogging

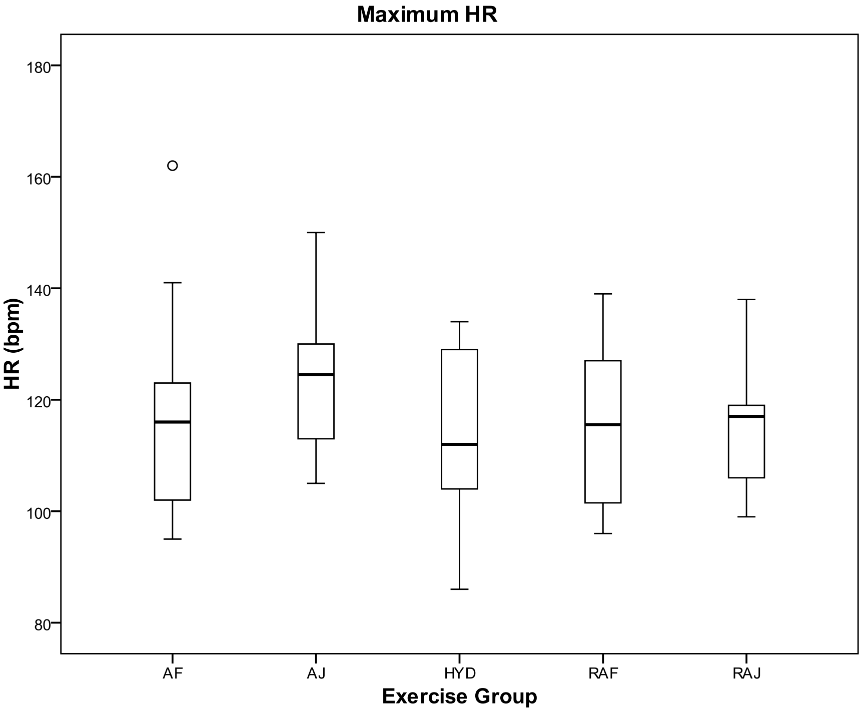

Figure 7. Maximum HR for each exercise mode

HR: Heart rate; bpm: beats per minute; AF: Aqua-fitness; AJ: Aqua-jogging; HYD: Hydrotherapy; RAF: Resisted aqua-fitness; RAJ: Resisted aqua-jogging

5.5.4 Session Rating of Perceived Exertion

SRPE values were similar across all five exercise conditions. The only exception was the significantly greater SPRE for RAJ than for HYD (p=0.005). SRPE mean values are displayed in Figure 8.

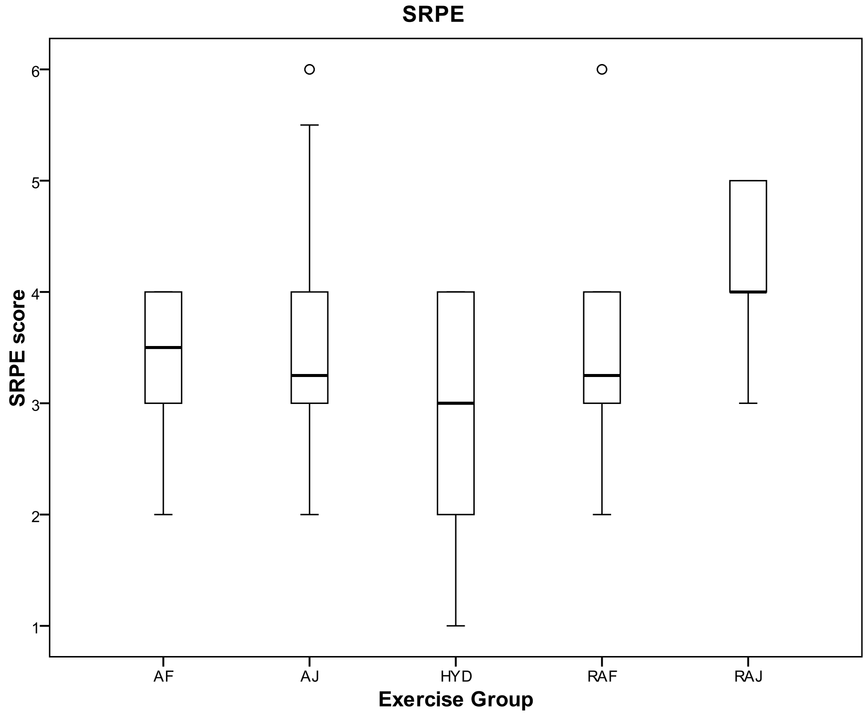

Figure 8. SRPE scores for each exercise mode

SRPE: Session rating of perceived exertion; AF: Aqua-fitness; AJ: Aqua-jogging; HYD: Hydrotherapy; RAF: Resisted aqua-fitness; RAJ: Resisted aqua-jogging

5.5.5 Focus Group

Eight of the thirteen participants, attended the focus group session that sought to further explore perceptions and preferences among participants relating to the different modes of exercise. The mean age of those who attended the focus group was 71.6 years ± 7.6. Participants had OA symptoms for an average of 16.4 years ± 6.8. All of those who attended the focus group were female.

Participants did not directly differentiate between the resisted and non-resisted exercise sessions. However when prompted, the equipment used during the resisted exercise sessions, which included flotation noodles and barbells, was discussed. Participants enjoyed using the noodles in the water but found the dumbbells too difficult, with many finding them too hard to hold on to as indicated by the following focus group responses:

"the noodles were kinder, the barbells were very hard"

"for hands, for people who have arthritis in their hands, holding onto them [barbells], that was quite hard"

During the aqua-jogging sessions, participants wore a flotation belt. Several participants stated that they found the belts uncomfortable:

"oh, I didn't like the belts at all"

"you felt like you were being cut in half cause they were really tight"

The social aspect was identified as an enjoyable feature of the classes. Although there was little differentiation between the different exercise modes, the focus group discussed the importance of social support and highlighted the importance of being with others who have OA:

"yes, and you all had the same goals, symptoms, do you know what I mean? and you were all there for the same reason"

"yeah and everybody was helping each other, yeah support... I think, there was good support"

Two participants indicated that they felt the aqua-jogging sessions were less social than the other classes:

"[during aqua-jogging] we became isolated"

"I found it [aqua jogging] quite competitive"

Water temperature and the facility both were considered important. The hydrotherapy pool had a ramp and handrail, which made access into and out of the pool easier. Most participants commented on the handrail and ramp and expressed a preference for the hydrotherapy pool, although one participant acknowledged that the warmer hydrotherapy pool may not be suitable for the aqua-fitness or aqua-jogging sessions:

> "the water was warmer, the actual pool was nice and I liked the ramp"
>
> "it was easier... the [pool name] ones were easier to get into because of the ramp"
>
> "the aqua-aerobics... in the [hydrotherapy] pool I think you'd get too hot... I mean the water wasn't that hot over here but once you moved it was good"

Most participants rated both instructors highly although two participants had more confidence in the physiotherapist who took the hydrotherapy session and felt that she was more aware of their needs and the limitations of OA:

> the only thing you can really say, and it's not a criticism, but that it depends on the leader and who was taking the class. Now when we went with the physiotherapist who obviously understood arthritis and the effect of arthritis on certain parts of the body then obviously her exercises were totally different to the ones who are just the...either sports or PE specialists who wanted you to go as fast as you could with a piece of equipment that quite honestly was not correct especially for people with arthritis.

Participants were asked to discuss the exercise sessions and how these affected their arthritis symptoms. Most participants felt that in general the sessions were beneficial; however, some did feel that the intensity was too high and that having sessions so close together would be difficult to maintain:

> "my whole body felt alive and everything felt.. happy, so what is it.. endorphins or something"
>
> "it was sore to start off with and after sort of about 48 hours it did calm down.. and then you work to your limit"
>
> "I think as far as the arthritis went, if you kept at that pace for any length you'd probably do more harm than good, personally, I think if you really went full on like that all the time, you probably need more gentle exercise with arthritis... depending where it is of course"
>
> "I think you could maintain it better if it was probably a little bit more gentle"

Participants were asked to discuss anything they particularly disliked about the sessions. Cold water and music that was too loud were the main themes:

> "I didn't like the cold water"
>
> "the music, it was awfully loud"
>
> "I just couldn't stand the music...I felt it particularly over here [facility] extremely loud"

In general participants enjoyed the feeling of being able to move more freely in the aquatic environments:

> "I loved that feeling of being free to move"
>
> "Well I haven't done that for years because I can't you know walk without pain, but you get in the water, and you could really move"

When asked if they would prefer to continue with aqua-fitness or aqua-jogging, almost all indicated that they preferred the aqua-fitness:

"It would be aqua aerobics (fitness)"

"I thought the aerobics – no to jogging"

"I didn't like the jogging"

"I don't really like it [aqua jogging] but I think it would do me good!"

5.6 Discussion

The key aims of this study were to compare five different forms of aqua-based exercise and establish which, if any, older adults with OA most enjoyed and might be likely to attend on a regular, ongoing basis. The study also aimed to address whether a hydrotherapy-based session, led by a therapist, was considered comparable to other modes of aqua-based exercise, since hydrotherapy classes, while frequently recommended, are often less accessible and more expensive than other types of aqua-based exercise. To achieve these aims, we performed a mixed-method study involving the collection of psycho-physiological data as well as the participants' views on many aspects of the aqua exercise classes. This mixed-methods approach included integration of quantitative and qualitative data in order to give a greater insight into the similarities and disparities felt by the participants regarding the different modes of aqua-based exercise they performed. By comparing the data for the five aqua exercise conditions in the current study to the literature for our outcome measures described below, we hoped that aqua instructors and facilities managers may better accommodate the needs of older adults with OA.

The questionnaires revealed that the HYD session scored highest overall for enjoyment and significantly higher than both the AF and AJ sessions. A breakdown of the questions revealed that the HYD session scored highest for every question and significantly more for pool temperature and the relaxation aspect of the session. Pool temperature during the HYD sessions was between 32 and 33° Celsius (89.6-91.4°F), whereas it ranged from 26 to 30° Celsius (78.8° to 86° F) for the other sessions.

Sessions during which the pool temperature was below 29° Celsius (84.2° F) scored lowest. In fact, for one participant the pool temperature of 26° Celsius (78.8° F) was sufficient reason to pull out of this study. The importance of water temperature in our study agrees with Bunning & Materson (1991) who reported that compliance to an aqua-based exercise program decreases among people with OA when the water temperature drops below 29° Celsius (84.2° F). It is likely that the warmer pool temperature during the HYD sessions contributed to participants scoring this session highest for relaxation.

During the focus group, participants noted that there was no loud music during the HYD session, which may have also have added to the sense of a more relaxed session. Music is widely used during aqua-fitness and aqua-jogging classes to motivate and aid synchronization of participants as well as pace the velocity of movements (Barbosa et al., 2010). While some participants in the current study stated that they enjoyed the music, several indicated that they had found it too loud. One participant wore earplugs because she found the sessions too noisy and several others agreed that they preferred the music to be more subdued.

Previous studies have identified that the social aspect of aqua-based exercise is extremely important, especially among older adults with OA (Fisken et al., in press; Kang et al., 2007). While there was a trend for the HYD session to be scored higher for the social aspect than the AF and AJ sessions, post-hoc analysis found no significant differences among these exercise sessions. Further, there were no significant differences in the rating of the social aspect due to session order. Discussion during the focus group revealed that several participants felt the AJ and RAJ sessions were less social than the AF, RAF and HYD sessions and that the AJ and RAJ sessions were too competitive. Participants stated that they liked exercising with others who were similar in age and had the same symptoms, as this increased the feeling of support among them. Previous literature intimated that this was characteristic of physically active older adults (T. Henwood et al., 2011) and adults with OA (Cochrane et al., 2005). This would support the likely appeal of aqua-based exercise classes specifically for older adults with OA.

Previous studies have indicated that many adults with arthritis consider that a lack of qualified instructors who understand their physical limitations is a major barrier to aqua-based exercise (Wilcox et al., 2006), whereas other studies have identified the instructor as a potential motivator to participate in this form of exercise (Fisken et al., in press). Although the questionnaire in the current study did not identify any significant differences between instructors during any of the exercise sessions, two participants who took part in the focus group expressed a greater degree of confidence in the knowledge of the qualified physiotherapist who took the HYD session than the fitness instructors who led the other classes. A greater understanding of the symptoms and limitations of OA among aqua-exercise instructors may help to increase confidence and possibly adherence to instructor-led aqua-based exercise classes among participants with OA.

There were no significant differences in the pre, post and 24-hours post-exercise pain levels for each of the five different exercise sessions. However, when data were pooled across the exercise sessions, a trend for pain scores immediately post-exercise to be lower than pain scores 24-hours post-exercise was identified. Cochrane et al., (2005) found a reduction in self-reported pain following a one-year aqua-based intervention among older adults with OA. Collectively, these results suggest that ongoing participation in different forms of aqua-based exercise may offer some degree of pain relief for those with OA.

The role of the aqua instructor in observing and listening to how their older clients, especially those with conditions like OA respond to these activities should not be ignored. This was highlighted by the results of the focus group whereby some participants in the current study expressed reservations regarding the pace and intensity of the programme undertaken, the use of equipment such as hard-to-grasp barbells, and, in particular, the relative proximity of classes to each other (e.g., that 2 days was insufficient for these adults with OA to recuperate from a novel session. Several participants felt that the resisted exercise classes were too demanding, despite the similar HR response and SRPE rating among sessions. Such concerns suggested that aquatic exercise instructors and therapists need to be able to provide multiple options for their clients in regards to movements performed, use of resistance equipment, and speed of movements so that the newer, less well-conditioned, and older clients do not perceive the classes to be too hard or painful and stop attending.

Implications from Physiological Variables

Mean HR achieved during AJ was significantly higher than HYD. SRPE scores indicated that participants also rated the HYD session as requiring the lowest exertion, with RAJ requiring the highest level of exertion. These complementary results provide support for the validity of both HR and SRPE measures. Previous research with young, healthy participants found that adding dumbbells to aqua-based exercise activities increased maximum HR and SRPE (Costa, Afonso, Bragada, Reis, & Barbosa, 2008).

It may have been expected that the resisted exercise sessions would have resulted in the highest values for mean and maximum HR and scored highest for SRPE.

In the current study, there may be a number of possible reasons for why the data did not support such a hypothesis. One possible explanation could reflect comparable energy expenditure in both forms of exercise due to similarities in the work performed in a given period of time (i.e. power) via the work-energy relationship. The resisted exercise classes included the use of equipment to increase drag, such as dumbbells and noodles. While the increased drag force during the resisted exercise sessions would have required a greater muscular force output, the velocity of movement was reduced based on the force-velocity relationship from the greater density of the water medium. As power is the product of force and velocity, the increased force but reduced velocity of movement found in the resistance aqua conditions would have likely resulted in similar muscular power outputs in the resisted and bodyweight versions (L. T. Brody & Geigle, 2009). Based on the work (power)-energy relationship, this could therefore have contributed to the similar HR responses during the resisted and unresisted exercise sessions.

The disparity in HR response and SRPE between the current study and that found by Costa et al., (2008) may be due to the different populations measured and the difference in methodologies. The study by Costa et al., (2008) measured responses to 6-minute exercise bursts, with or without dumbbells, rather than an exercise class as a whole. Furthermore a number of factors influence HR response during aqua-based exercise such as depth of immersion and water temperature. Therefore HR responses across these studies should be interpreted with some caution due to possible inter-study differences in these factors (L. T. Brody & Geigle, 2009). Despite this limitation, they do provide some insight into the exercise intensity of the different modes of aqua-based exercise used in this study. The similar HR responses measured across the exercise types in the current study would tend to indicate that these different modes of aqua-based exercise may offer comparable cardiovascular/physiological adaptations and associated long-term health benefits.

Limitations to our findings included the relatively small sample and potential variability of baseline fitness parameters among participants. Pool temperatures between the aqua-fitness and aqua-jogging sessions were not always consistent and could be relevant because pool temperature is considered an important determinant of adherence to aqua-based exercise among older adults, with and without OA (Fisken et al., in press). The order of exercise sessions was not completely randomised, with the resisted conditions performed after the unresisted conditions. Statistical analysis revealed no order effect on the outcome measures. Finally, participants who volunteered to participate in the focus group may have had different perceptions or opinions from those who did not take part.

5.7 Conclusion

In a review of literature (Rahmann, 2010), it was reported that aqua-based exercise is often recommended for people with OA but that there is no evidence to establish whether a physiotherapist-supervised hydrotherapy program is more effective than a generic aqua-based exercise program at improving strength and function. Although the current study did not examine the long-term physiological effects of hydrotherapy or other modes of aqua-based exercise, it did give some insight into pain response, heart rate response, ratings of perceived exertion, and preference between different types of aqua-based exercise among older adults with OA. Our results indicate that while hydrotherapy uniformly was considered the most enjoyable and beneficial form of aqua-based exercise, aqua-fitness was also deemed an acceptable and enjoyable form of aqua-based exercise for older adults with OA. Similar pain, HR responses, and SRPE ratings across the different modes of aqua-based exercise suggest that potential long-term benefits from these forms of aquatic exercise may be comparable, which is promising given the relative popularity of aqua-fitness and aqua-jogging classes. Our results and those of other studies indicate that long-term adherence to aqua-based exercise is likely to be affected by variables such as pool temperature, instructor knowledge, exercising with a similar-age population, music which is not too loud, and the provision of a programme which is not too physically demanding and uses equipment such as noodles appropriate for the population. The potential long-term benefits of different modes of aqua-based exercise for older adults with OA warrant further investigation.

Chapter 6 : Comparative effects of two aqua-fitness exercise programmes on physical function, balance and perceived quality-of-life in older adults with osteoarthritis

6.1 Prelude

Encouraging older adults to engage in regular exercise is important in order to minimise age-related declines in functional ability and balance. In particular, older adults with osteoarthritis are especially susceptible to these negative outcomes, as pain is a key barrier to exercise among this population resulting in low levels of physical activity in this group. Aqua-based exercise offers an environment which is often appealing to older adults with osteoarthritis due to the properties of water. However, whilst a number of studies have investigated the effects of a hydrotherapy-based exercise intervention among older adults with osteoarthritis, little attention has been given to aqua-based exercise programmes, which are available at many community swimming pools, such as aqua-fitness.

The purpose of this study was to determine the potential health benefits of a 12-week, twice weekly aqua-fitness programme for older adults with osteoarthritis. This type of aqua-based exercise was selected since aqua-fitness classes are generally well-tolerated among this population and participants have identified some degree of pain relief immediately following an aqua-fitness session. In addition, older adults with osteoarthritis indicated that they considered aqua-fitness to be an enjoyable and acceptable alternative to hydrotherapy.

6.2 Abstract

Osteoarthritis is a degenerative joint disease, which affects a large number of older adults. Symptoms include joint pain and stiffness; consequently many older adults with osteoarthritis are not regularly physically active. Low levels of physical activity have been associated with limitations in functional ability, increased risk of falls and fear of falling, social isolation and reduced quality of life. While a form of aqua-based exercise known as hydrotherapy is often recommended for older adults with osteoarthritis, less is known about the potential benefits of aqua-fitness, a widely available form of aqua-based exercise.

This study examined the effect of an aqua-fitness programme on muscle strength, balance, function, perceived quality-of-life, fear of falling and physical activity levels among older adults with osteoarthritis.

Thirty-five older adults with osteoarthritis were randomly allocated to either an aqua-fitness group (AF) or an active control group who performed seated exercises in warm water (C). An active control group was chosen in order to give control group participants the opportunity for social interaction with their peers, similar to the AF group. This was felt vital to control for the potential positive effect of being a part of social group on the quality of life outcomes. Participants were measured at baseline, post-intervention (12 weeks) and then followed-up at 24 weeks. Outcome measures were: Timed Up-and-go (TUG) test; Step Test; Sit-to-stand (STS) test; Handgrip Strength test; 400m walk test; Arthritis Impact Measurement Scale 2 Short Form (AIMS2-SF) and Falls Efficacy Scale International (FES-I). The Rapid Assessment of Physical Activity (RAPA) questionnaire was also used to assess physical activity levels.

Although intention-to treat analysis was initially carried out, results presented are based on participant scores at baseline and post-intervention only for participants

who completed the 12-week intervention, due to a large number of dropouts from the study. FES-I scores improved significantly in the AF group compared to C at 12 weeks (p = .04). Within-group analysis indicated both groups significantly improved their 400m walk time (p = .036) and that the AF group significantly improved their Step Test Right (p = .017) and Left (p = .002) and AIMS2-SF total score (p = .02). Cohen's effect size calculations for AF indicated a moderate clinically important improvement in Step test (right and left legs), STS and 400m walk time and trivial practical improvements in TUG and AIMS2-SF for AF. No significant change in handgrip strength was observed for either group, with the effect size trivial.

Aqua-fitness may offer a number of positive functional and psychosocial benefits for older adults with osteoarthritis, such as a reduced fear of falling. Furthermore, a seated hydrotherapy-based programme may offer a suitable introduction to aqua-based exercise for those with low levels of function and self-efficacy for aqua-based exercise.

6.3 Introduction

Osteoarthritis is a degenerative joint disease which affects many older adults. According to the World Health Organization (WHO), approximately 45% of women over the age of 65 years (Symmons, Mathers, Pfleger, & Organization) and 20% of males aged 65-74 years have osteoarthritis (Borman et al., 2010). Symptoms include joint pain and stiffness; the large weight-bearing joints of the hips, knees and spine are most often affected although joints in the hands are also a common site (Flores & Hochberg, 2003). Older adults with osteoarthritis are less physically active than older adults without osteoarthritis (Hootman et al., 2003) and the majority of adults with all forms of arthritis are not sufficiently active to meet the public health guidelines relative to physical activity levels (Fontaine et al., 2004). Low levels of physical activity exacerbate age-related physiological changes such as loss of muscular strength and endurance as well as reduced balance ability, all of which contribute to an increase in falls risk and a reduced ability to perform activities of daily living (ADL) (Dunlop, Song, Semanik, Chang, et al., 2011; Hughes et al., 2001). Consequently, older adults with osteoarthritis are particularly vulnerable to age-related reductions in muscle strength, functional ability and balance and related declines in independence and perceived quality of life.

Aqua-based exercise is recommended for adults with osteoarthritis by numerous organisations such as the American College of Rheumatology (Westby, 2012). Performing exercise in an aqua environment reduces joint loading and water immersion has been associated with decreased pain symptoms, due to increased sensory input and decreased joint compression (Westby, 2001). A number of studies investigating the potential health benefits of aqua-based exercise for older adults with osteoarthritis have focused on hydrotherapy-based exercise programmes (Foley et al., 2003; Hinman et al., 2007; Lund et al., 2008) rather than AF exercise classes, which are more commonly available in community-based swimming pools. Hydrotherapy is typically an individualised, therapist-supervised programme which focuses on strength and range of motion (ROM) exercises (Eversden et al., 2007), usually in water temperatures between 33.5-35.5 degrees Celsius (Becker, 2009). While hydrotherapy-based programmes have been shown to improve physical function (Fransen et al., 2007) and reduce pain (Hinman et al., 2007; Silva et al., 2008) among adults with osteoarthritis, hydrotherapy classes may be expensive and in some areas, are not widely available due to the requirement of specialised staff and facilities.

In a review of literature by Rahmann, (2010), it was noted that aqua-based exercise is often recommended for people with osteoarthritis but that there is no evidence to establish whether a physiotherapist-supervised hydrotherapy programme is more effective than a generic aqua-exercise programme, such as AF, at improving strength and function. The purpose of this randomised controlled trial was to investigate the effects of an aqua-fitness programme, compared to an active control group, on strength, function, balance, fear of falling and perceived quality of life among older adults with osteoarthritis. The active control group, who undertook a seated aqua-based exercise programme, performed a range of exercises from the Arthritis Foundation Arthritis Water Exercise programme.

6.4 Methods

6.4.1 Participants

Volunteers aged 60 years and older with osteoarthritis were recruited by advertisements on the Arthritis New Zealand website, in local community groups, general practitioners' rooms, at the orthopaedic ward at the local public Hospital and in the local newspaper. Participants with osteoarthritis were included if they; had radiological diagnosis of osteoarthritis in the hip, knees, spine and / or hand; had current and chronic (>1 yr) pain and were able to obtain medical clearance to participate in the study. Exclusion criteria included joint replacement surgery in the past 12-weeks; received physical therapy intervention in the preceding 12-weeks; current participation in an organised exercise programme twice a week or more; inability to safely enter and exit pool; and cognitively incapable of providing informed consent.

The study consisted of a 12-week intervention. Participants were randomly allocated, using computer software, to either the AF exercise group or the C group.

Participants were assessed in the week preceding the first exercise classes and within a week of completing the 12-week exercise programme. Follow-up assessments were also carried out at 24-weeks (i.e. 12-weeks after the intervention was completed) to determine whether any benefits were maintained in the short term and to assess adherence to an independent AF exercise programme. .

6.4.2 Aqua-Fitness Intervention

The AF programme consisted of aerobic and strength-based exercises performed twice weekly for 12- weeks (see Appendix 4). Each session lasted for approximately 45-60-mintues, intensity and length of sessions increased progressively over the 12-week period. Music was used to motivate and aid synchronization of participants as well as pace the velocity of movements (Barbosa et al., 2010). The beats per minute (bpm) of the music tracks were used to help quantify the velocity and therefore intensity of the movements during each class. The instructor encouraged increased movement range as the programme progressed. An experienced aqua instructor supervised each session, with a maximum of 10 participants per group. Average water temperature was 30.5° Celsius, exercises were performed at a depth of 1.2-1.5m depending on participant's height, so that water level was at chest height.

6.4.3 Control group

The rationale for having an active control group was in order to provide participants with a structured, low-intensity exercise class which would allow some social interaction in order to minimise any effect that social interaction among the AF group could have on the outcome measures (Li et al., 2005). Social isolation, including infrequent participation in social activities can have a negative effect on health among older adults (Cornwell & Waite, 2009), therefore it was considered important to facilitate some degree of social interaction for those in the control group Exercises were randomly selected from the Arthritis Foundation Arthritis Water Exercise programme (see Appendix 5) and performed in warm water, since warm water immersion and gentle movements may improve acute osteoarthritis symptoms (Becker, 2009). The inclusion of water-based exercises for the control group was considered to be an appropriate motivator to attend these classes and minimise drop-outs from this group. Exercises were all performed in the seated position in order to minimise any physiological adaptation relative to lower body strength or balance, there was no progression of exercises. The control group attended once-weekly sessions for 12-weeks, each session lasted for approximately 35-40 minutes. The emphasis was on range of motion and relaxation and an experienced aqua instructor oversaw each session with a maximum of 10 participants per group. Average water temperature was 36.5° Celsius.

6.4.4 Outcome Measures

The follow outcome measures were assessed:

The Timed Up and Go (TUG) test was the primary outcome measure. The TUG has been shown to be a valid measure of functional mobility among adults with OA (Hinman et al., 2007; Podsiadlo & Richardson, 1991). The TUG has a high correlation with lower extremity strength (Gunter et al., 2000) and has also been identified as a useful tool for identifying older adults who are at risk for falls (Shumway-Cook et al., 2000). Participants were allowed one practice trial, thereafter the best time from two timed trials was used for analysis.

The 15-second step test was used as a measure of dynamic balance. The step test has been found to be a safe and reliable measure for older adults and patients with stroke (Hill et al., 1996) and is easy to administer (Hong et al., 2012). Participants were instructed to stand unsupported with feet parallel and 5cm in front of a 7.5cm block. Participants were advised which leg to step with and instructed to place the whole foot onto the block and then return it fully down to the floor. This was repeated as many times as possible in 15 seconds. Following a short break, participants changed legs and repeated the test with the opposite foot stepping.

The 30-second sit-to-stand test (STS) was used to measure lower extremity strength and function. This measure is recommended by the Osteoarthritis Research Society International (OARSI) as a functional measure of lower body strength and balance for older adults with OA (Dobson et al., 2012). The STS has been validated as a reliable measure of these modalities (Lord et al., 2002). The test was performed on a straight-backed, armless chair 43cm in height. Participants were instructed to sit in the chair with their arms crossed across the chest. On the word 'go' participants stood up and sat down as many times as possible in 30 seconds.

Hand grip dynamometry has been identified as a useful screening tool for health outcomes in older adults (Bohannon, 2008) and is a valid and reliable measure of muscle strength (Mijnarends et al., 2013). A Jamar dynamometer (0-200lb, Sammons Preston Inc., Bolingbrook, IL) was used to measure grip strength using the methodology employed by Ranganathan, Siemionow, Sahgal, & Yue, (2001). Participants were seated and were instructed to grip the device with their maximal effort. Grip strength in each hand was assessed three times, the highest value from each hand was used for statistical analysis.

The 400m walk test was chosen to assess functional limitations (Chang et al., 2004) walking endurance and cardiorespiratory fitness (Simonsick et al., 2001). Participants were instructed to walk as quickly as possible over 400m, walking back and forth between two cones set 25m apart. Participants were informed that they may slow down, stop and rest as necessary but should resume walking as soon as they were able. Time taken to complete 400m was recorded and used for analysis.

The Arthritis Impact Measurement Scale 2-short form questionnaire, (AIMS2-SF) was chosen to assess perceived quality of life and pain levels of the participants. This questionnaire has been shown to be a valid and reliable tool to assess the quality of life and pain levels of patients with osteoarthritis (Klooster et al., 2008); Rosemann et al., 2006) which is sensitive to change (Taal et al., 2004). The questionnaire contains four domains: Physical, Symptoms, Affects and Social. The total health score was calculated by adding scores from all domains together. Lower scores indicate a better health state.

Fear of falling was assessed using the Falls Efficacy Scale-International (FES-I), which has been found to be a valid and reliable measure of fear of falling and sensitive to change in older adults (Yardley et al., 2005). Scores were added together to give a total score between 16 (no concern about falling) and 64 (severe concern about falling).

Physical activity levels were assessed by the Rapid Assessment of Physical Activity questionnaire (RAPA). The RAPA is considered an easy-to-use, valid measure of physical activity for use in clinical practice with older adults that is sensitive to change and allows categorisation of physical activity levels (Topolski et al., 2006). The questionnaire consists of questions relating to activity levels in two separate domains; aerobic exercise and strength and flexibility exercise, a higher score indicates a higher level of physical activity. Individual's physical activity levels were categorised as:

"sedentary", "insufficiently active" or "active", similar to previous research (Keogh et al., 2010). In addition, participants who attended the follow-up session at 24-weeks were asked by the assessor to determine whether or not they had continued participation in aqua-based exercise on completion of the intervention.

The same assessor conducted measurements across all assessment points. The assessor was not blinded to group allocation but was blinded to measurement data from prior assessments

Participants were not excluded from the study if they changed their medication. However, they were asked to keep a log of arthritis-related medication taken throughout the study.

6.4.5 Data Analysis

As each section of the AIMS2-SF questionnaire contains a Guttman Scale, items were scored separately then the score for each section was standardised to a 0-10 scale using standardized formula (American College of Rheumatism, 2013). After scoring for each dimension of the questionnaire, a total score was calculated by summing the scores from each section of the questionnaire. Raw scores from the FES-I were added together to give a total score. Total scores from the first part of the RAPA were added to give a score between 1 and 7. This data was used to classify participants as 'sedentary', insufficiently-active' or 'active' as previously described.

6.4.6 Statistical analysis

A power analysis was conducted using the TUG as the primary outcome measure. This power analyses, based on previous literature by Katsura et al.,(2010) and Bird et al.,(2009) indicated that a total sample size of 30 would give 80% power with a

5% chance of Type I error to detect significant differences between aqua exercise groups.

Statistical analysis was initially performed on an intention-to-treat basis, using the last observation carried forward methodology (C. C. Wright & Sim, 2003). Outcome measures were applied as dependent variables (TUG; Step test; STS; Handgrip strength; 400m Walk ; AIM2-SF; FES-I and RAPA) for each individual at a particular time point (Lund et al., 2008). Data was checked for normality and homogeneity of variance prior to analyses, baseline data was compared between groups with independent t-tests. Repeated-measures ANOVA with group (AF versus C) as the between-subject variable and time (0-weeks, 12-weeks and 24-weeks) as the within-subjects variable.

Due to high rates of drop-out from baseline to completion of the intervention among the exercise intervention group (31.6%) and further dropouts between completion of the intervention and 3-month follow-up (20%), further analysis was carried out solely for participants who completed the 12-week intervention, using baseline and post intervention scores. Repeated-measures ANOVA were performed with group (AF versus C) as the between-subject variable and time (0-weeks and 12-weeks) as the within–subjects variable. All statistical analyses were performed on SPSS, version 19.0 with significance set at $P \leq .05$.

In order to calculate effect size, Cohen’s *d* was calculated for each outcome measure. Standardised changes of <0.2, <0.6, <1.2 and <2.0 were interpreted as trivial, small, moderate and large effects respectively based on a modification (Snowling & Hopkins, 2006), of Cohen’s thresholds of 0.2, 0.5 and 0.8 (Cohen, 1988).

6.5 Results

Of the 73 individuals initially screened by telephone, 35 participants were enrolled in the study and randomly allocated to the AF group (n=19) or the control (C) group (n=16). Twenty-five of those enrolled in the study completed the 12-week intervention. Six participants withdrew from the AF group and four from the HT group. Seven participants from the AF group and 11 from the control group attended the 24-week follow up. Figure 9 shows the flow of participants. One participant in the AF group reported exacerbation of hip pain during the intervention, no other adverse results were reported. Baseline characteristics are shown in Table 9, independent t-test revealed there were no significant differences between the groups at baseline for any of the outcome measures.

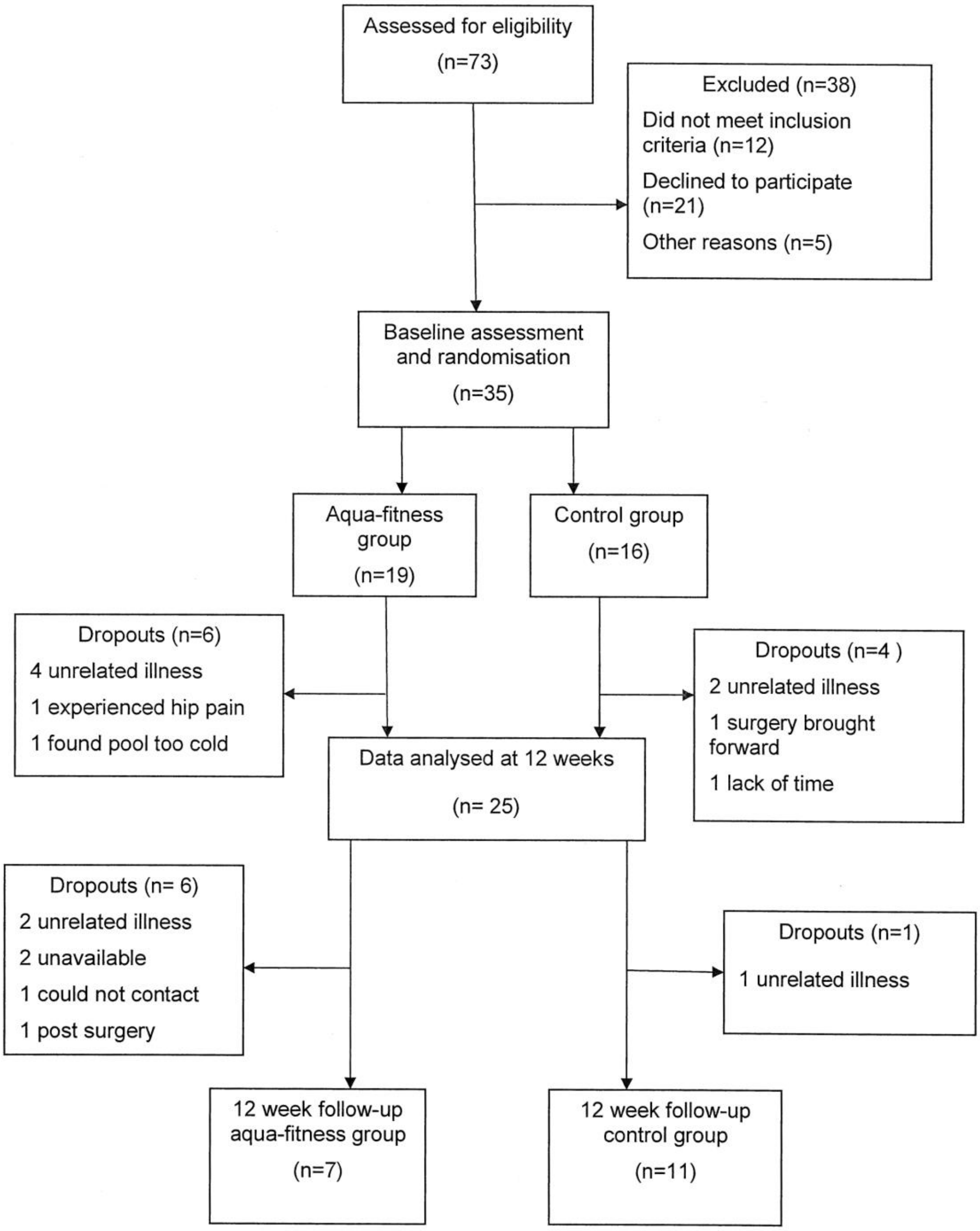

Figure 9. Flow of participants

Table 9. Baseline characteristics

	Aqua-fitness (n = 19)	**Control (C) (n = 16)**
Sex, no. participants	18 females, 1 male	15 females, 1 male
Age, years	71.9 ± 7.3	70.4 ± 6.5
Duration of symptoms, years	13.1 ± 9.3	17.6 ± 10.9
Joints affected by OA (no. participants)		
Hips	6	9
Knees	11	9
Spine	7	7
Hands/fingers	9	8
Ethnicity (no. participants)		
NZ European	15	13
Maori	1	0
Other	3	3
Medications taken (no. participants)		
Analgesics	9	8
NSAIDs	3	4
TUG (s)	7.86 ± 1.8	7.18 ± 1.6
Step Test: right leg (number of steps)	14.1 ± 4.2	12.2 ± 2.9
Step Test : left leg (number of steps)	13.3 ± 4.0	12.3 ± 3.5
STS (number of stands in 30 s)	12.2 ± 4.1	11.2 ± 3.2
Handgrip strength: right hand (kg)	33.8 ± 16.4	32.6 ± 13.3
Handgrip strength : left hand (kg)	31.3 ± 13.4	29.5 ± 11.0
400m walk (s)	314.71 ± 43.29	327.65 ± 42.63
AIMS2-SF total (range 0 – 40)	13.9 ± 5.5	13.0 ± 4.7
FES-I (range 16 – 64)	29 ± 9.5	27.68 ± 9.84
RAPA (1) (range 1 – 7)	4.4 ± 1.9	5.1 ± 1.5
RAPA (2) (range 0 – 3)	1.5 ± 1.3	0.6 ± 1.2

Values are the mean ± SD unless otherwise stated.

OA: Osteoarthritis; NZ: New Zealand; NSAIDs: Non-steroidal anti-inflammatory drugs; TUG: Timed up-and-go test; STS: Sit-to-stand test; AIMS2-SF: Arthritis Impact Measurement Scales 2 – Short form; FES-I: Falls efficacy scale international; RAPA: Rapid assessment of Physical Activity

AIMS2-SF and FES-I: lower score = better health state

No statistically significant between-group differences were found for any of the outcome measures after the 12-week intervention, or at the 3-month follow up using the intention to treat analysis, as outlined in Table 10.

Table 10. Data at baseline, post intervention and 12-week follow up

	Aqua-fitness (n = 19)			Control (C) n = 16			Group x time interaction effects	
	Pre-int. mean	**Post-int. mean**	**12-week follow up**	**Pre-int. mean**	**Post-int. mean**	**12-week follow up**	***F***	***P*-value**
TUG (s)	7.18 ± 1.6	6.72 ± 2.2	6.72 ± 2.3	7.86 ± 1.8	7.60 ± 1.6	7.29 ± 1.7	0.256	0.64
Step Test: right leg (no. of steps)	12.2 ± 2.9	13.8 ± 4.9	13.5 ± 4.9	14.1 ± 4.2	14.5 ± 3.2	14.5 ± 3.2	0.514	0.50
Step Test: left leg (no. of steps)	12.3 ± 3.5	13.9 ± 5.1	13.5 ± 5.3	13.2 ± 4.0	14.3 ± 4.0	14.3 ± 3.8	0.195	0.69
STS (no. stands in 30 s)	11.2 ± 3.2	12.1 ± 4.5	11.8 ± 4.3	12.16 ± 4.1	11.8 ± 3.6	11.6 ±2.9	0.596	0.46
Handgrip strength: right hand (kg)	32.6 ± 13.3	27.1 ± 13.3	28.2 ± 13.8	33.8 ± 16.4	28.8 ± 12.0	38.8 ± 16.0	3.358	0.59
Handgrip strength: left hand (kg)	29.5± 11.0	24.2 ± 12.4	24.7 ± 12.5	31.3 ± 13.4	26.9 ± 11.4	31.3 ± 12.5	0.967	0.36
400m Walk test (s)	328.87 ±43.72	301.38 ± 36.28	302.56 ± 42.36	314.7 ± 43.29	298.07 ± 46.81	285.71 ± 34.27	0.701	0.41
AIMS2- SF Total	13.1 ± 4.7	11.1 ± 5.0	11.7 ± 5.5	13.9 ± 5.5	12.9 ± 4.7	13.3 ± 4.0	0.772	0.39
FES-I	27.7 ± 9.8	23.8 ± 6.3	26.2 ± 10.1	29.0 ± 9.5	28.9 ± 9.1	28.0 ± 8.9	0.885	0.36

TUG: Timed up-and-go test: STS: Sit-to-stand test; AIMS2-SF: Arthritis impact measurement scales 2 – short form; FES: Falls efficacy scale – International; int.: intervention

When data was re-analysed to include only baseline and post-intervention values for participants who completed the 12-week intervention, the AF group demonstrated a significant improvement in falls efficacy ($p = .04$) compared to the C group. There were no other statistically significant between-group differences. All results including within-group analysis are summarised in Table 11.

Table 11. Data for those who completed intervention only (n= 25)

Variables	Aqua-fitness (n = 13)		Control (C) (n=12)		Group x time interaction effects		Within group (time) effects		Cohen's *d* Aqua-fitness
	Baseline mean ± SD	Post-int. mean ± SD	Baseline Mean ± SD	Post-int. mean (SD)	*F*	*P*-value	F	P-value	
TUG (s)	7.41 ± 1.62	7.17 ± 1.61	7.41± 1.30	7.08 ± 0.68	0.53	0.821	1.76	0.198	0.15
Step Test: right leg (no. of steps)	12.2 ± 3.2	15.2 ± 3.9	15.0 ± 4.1	15.6 ±2.5	3.23	0.85	6.58	0.017*	0.87#
Step Test: left leg (no. of steps)	11.9 ± 3.6)	15.3 ± 3.9	14.2 ± 3.5	15.7 ± 2.8	1.75	0.198	12.87	0.002*	0.89#
STS (no. stands in 30 s)	10.9 ± 3.2	13.4 ± 3.6	12.5 ± 4.1	12.0 ± 3.5	3.28	0.83	1.44	0.243	0.73#
Handgrip strength: right hand (kg)	33.1 ± 12.3	28.9 ± 12.4	30.4 ± 18.8	28.8 ±13.3	0.09	0.771	3.43	0.077	0.34^
Handgrip strength: left hand (kg)	29.6 ± 11.1	25.3 ± 13.1	32.9 ± 15.0	27.5 ± 12.9	0.06	0.811	3.86	0.062	0.35^
400m Walk test (s)	330.36 ± 45.4	265.13 ± 92.3	313.82 ± 47.6	292.64 ± 50.1	1.32	0.265	5.06	0.036*	0.90#
AIMS2-SF Total	13.5 ± 5.4	11.53 ± 5.2	12.3 ± 6.6	11.22 ± 5.6	0.16	0.692	6.26	0.02 *	0.36^
AIMS2-SF Physical domain	1.9 ± 1.8	1.5 ± 1.5	2.0 ± 1.5	1.9 ± 1.4	0.13	0.722	0.91	0.349	0.22^
AIMS2-SF Symptoms domain	4.6 ± 2.4	3.9 ± 2.5	4.7 ± 2.0	3.9 ± 2.1	0.01	0.939	4.36	0.048*	0.27^
AIMS2-SF Affects domain	2.4 ± 1.8	1.4 ± 1.3	2.4 ± 2.0	2.6 ± 1.6	1.18	0.288	1.59	0.219	0.64#
AIMS2-SF Social domain	4.0 ± 1.8	4.3 ± 2.3	4.5 ± 1.8	3.7 ± 1.7	0.19	0.893	0.34	0.565	0.13
FES-I	28 ± 9.4	24.5 ± 7.5	24.5 ± 10.1	24.36 ± 9.6	4.57	0.043*	5.38	0.029*	0.41^

TUG: Timed up-and-go test: STS: Sit-to-stand test; AIMS2-SF: Arthritis impact measurement scales 2 – short form; FES: Falls efficacy scale – International; int.: intervention; int.: intervention.

* $p < .05$; ^ small effect; # moderate effect

Cohen's effect size calculations demonstrated moderate, positive changes in Step Test (right and left legs), Sit-to-stand test and 400m walk time for the AF group. There were small positive changes in FES-I score and trivial, positive changes in TUG and AIMS2-SF total score for the AF group. Trivial declines in handgrip strength were demonstrated for both hands at 12 weeks for both the AF and C group. Self-reported physical activity levels showed no change in activity status (classified as "Sedentary", "Insufficiently active" or "Active") post intervention for either group (see Table 12).

Table 12. RAPA scores pre and post intervention

RAPA categories	**Aqua-fitness group**		**Control group**		**group x time interaction effects**	
	Pre-int.	**Post-int.**	**Pre-int.**	**Post-int.**	***F***	***P-value***
RAPA (out of 7)	5.3 ± 1.7	5.5 ± 1.3	4.5 ± 1.8	5.0 ± 1.3	0.039	0.846
Sedentary	0	0	0	0		
Insufficiently Active	5	5	5	5		
Active	8	8	7	7		

RAPA: Rapid assessment of physical activity; int.: intervention

Of the participants who were randomly assigned to and started the aqua-fitness class (n = 19), 2 (10.5%) attended 100% of offered sessions, 3 (16%) attended > 90%, 1 (5%) attended > 80% of offered sessions, 5 (26%) attended > 70% and 2 (10.5%) attended > 50% of offered sessions. Six participants attended less than 40% of offered sessions. In the control group (n= 16), no participants attended 100% of offered classes. Five participants (31%) attended > 80% of offered sessions, 4 (25%) attended > 70% of offered session and 3 (19%) attended > 50% of sessions. Four participants attended less than 50% of offered sessions.

Of those participants who completed the 12-week intervention, 42% of those in the C group and 38% of those in the AF group were continuing to participate in an aqua-based exercise programme 12-weeks later.

Only 28% of participants returned their medication diary at the end of the intervention, returned diaries indicated no change in osteoarthritis medication during the study.

6.6 Discussion

The aims of this study were to investigate the potential physiological and psychological benefits of AF as an exercise mode for older adults with osteoarthritis and to compare these outcomes with an active control group who performed seated exercises in water. There were no statistically significant differences between the groups for any outcome measure when analysed on an intention-to-treat basis. However, when data from only those who completed the programme were analysed, those in the AF group, significantly reduced their fear of falling, determined by improved scores in the FES-I, compared with the control group. Although other outcome measures did not demonstrate statistical significance between groups, several outcomes did demonstrate a significant within-group improvement. Furthermore, effect size calculations revealed that the AF group demonstrated a moderate practical improvement in several outcome measures, and clinically important improvements were observed for the step test and 30 second sit-to-stand test.

Participants in the AF group significantly improved the number of steps performed during the step test from baseline, in right and left legs by 3.1 and 3.3 steps, respectively post-intervention. Effect size calculations suggested a moderate practical effect (d = 0.87 & 0.89). Furthermore, previous research has indicated that an improvement of 3 steps may be considered clinically meaningful (Hill et al., 1996). The step test is a measure of dynamic balance, when these improvements in stepping ability are considered alongside the significant improvement in falls efficacy demonstrated post-intervention, the combined results are promising.

The likelihood of falling and sustaining injury increases with age (Lord et al., 2007). Previous fallers are more likely to have a fear of falling, similarly older adults with hip osteoarthritis tend to have low falls efficacy (Arnold & Faulkner, 2009). Fear of falling is often associated with avoidance of physical activity (Petrella et al., 2000). Furthermore, low falls efficacy has been related to reduced quality of life (Cumming et al., 2000; Yardley & Smith, 2002), depression and social isolation (Howland et al., 1993). Improving falls efficacy and balance ability among older adults with osteoarthritis may help to improve functional ability and reduce avoidance of activity, helping to minimise the associated negative impact on physiological and psychosocial outcomes.

Although there was no significant improvement in the number of chair stands performed during the sit-to-stand test, the AF group did increase stands completed by a mean of 2.5 post-intervention. This indicates an effect size of moderate practical effect (d = 0.73). In addition, previous data has intimated that an increase of two repetitions could be considered clinically important for the 30 second sit-to-stand test (A. A. Wright, Cook, Baxter, Dockerty, & Abbott, 2011). A study by Arnold & Faulkner (2010) found that sit-to-stand scores improved following an aqua-based exercise intervention when combined with a weekly educational session but not when the exercises were performed without the educational session. The authors postulated that the educational session gave participants the opportunity to practice the movements performed in water whilst on land, since carryover from an aqua-environment to land may be difficult. The authors also suggested that the improvements in sit-to-stand scores may be linked to improved falls-efficacy. In the current study, falls efficacy improved significantly post-intervention for the AF group. Although the relationship between these measures was not calculated, previous research noted that adults with a balance disorder performed sit-to-stand more slowly than those without a balance disorder (Whitney et al., 2005), it is therefore probable that improved balance ability and falls efficacy may have been related to the improvement observed in functional capacity, as seen in the sit-to-stand test.

Timed up-and-go test results did not improve in either group post intervention, there was no difference between the groups and Cohen's effect size was trivial. Previous studies have reported mixed results for older adults with osteoarthritis; Hale, Waters & Herbison (2012) found no improvement in TUG following an aqua-based exercise intervention whereas Fransen et al., (2007) noted a significant improvement in TUG following a 12 week hydrotherapy intervention. Based on reference values for the TUG (Bohannon, 2006), the baseline scores in the current study' participants were better than the normative data derived from older adults without musculoskeletal disease. Therefore, improvements for this measure may not have been possible for this group due to a ceiling effect for this test.

Participants in the AF group demonstrated a mean reduction in 400m walk time of 65 seconds, which indicated a significant improvement from baseline. Furthermore, Cohen's effect size value (d = .90) suggested a moderate practical improvement. A study by Kwon et al. (2009) investigated meaningful change in physical performance among older, sedentary adults aged 70-89 years. The authors found that minimally clinically important changes in 400m walk time were 20-30 seconds, with improvements of 50-60 seconds classified as substantial. The C group also significantly improved 400m walk time from baseline, however based on the classifications by Kwon et al (2009), this improvement of 21 seconds would be considered only minimally significant. A number of factors affect sustained walk performance in older adults including leg strength (Buchner, Larson, Wagner, Koepsell, & De Lateur, 1996), aerobic fitness (Pettee et al., 2010) and self efficacy towards the task (Maly, Costigan, & Olney, 2007). Falls efficacy has also been linked to self-reported walking performance (Tinetti, De Leon, Doucette, & Baker, 1994). Again, no analysis was made in the current study of any link between falls efficacy and 400m walk time and it can only be hypothesised that a reduced fear of falling may have had a positive effect on this measure of functional performance.

The AIMS2-SF is a self-administered questionnaire designed to assess perceived quality of life, pain and the impact of arthritis on their lives. Participants answered questions relating to four domains: Physical, Symptoms, Affect and Social aspect. Analysis revealed there was no between groups difference in the total questionnaire score post-intervention, however individual scores improved significantly in both the intervention and control group compared to baseline (p = .02). When broken down by domain, the questionnaire revealed some differences between the groups. Both groups demonstrated small improvements in the Physical and Symptoms domains. However the AF group improved their Affect scores, whilst the C group's score in this domain declined. Cohen's effect size value (d = .64) suggested a moderate practical improvement for the AF group for Affect. Interestingly, the C group demonstrated an improvement in their Social domain score, with the Cohen's effect size value (d = .40) suggesting a small practical effect, whereas the AF group's scores for this domain were trivial. This was initially unexpected as the AF group met twice per week while the C group only met once per week. However, the C group exercised in a seated-circle, there was no music and movements were gentle, this may have resulted in a more relaxing experience with greater opportunity to communicate with others in the group, thus potentially enhancing the social experience.

Handgrip strength test post-intervention had a tendency to decline slightly from baseline, Cohen's effect size values (*d* = -.34 to -.35 for the two hands) suggesting a trivial practical effect. Although trivial, these results are surprising as previous studies have reported small-moderate improvements in handgrip strength following a specific hand-exercise intervention (Rogers & Wilder, 2009; Stamm et al., 2002) for older adults with hand osteoarthritis. In this current study, handgrip strength declined in the AF group by 13% and in the C group by 17%, which far exceeds the estimated 2% per annum decline reported in adults aged 65 years and older (Bassey & Harries, 1993). Some hand exercises were performed by both groups, therefore it was anticipated that participants would increase or at least maintain their handgrip strength throughout the intervention. It should be noted that not all participants in this study had osteoarthritis in their hands, but for those who did, the joint(s) affected were not recorded. Distal and Proximal interphalangeal joints are commonly affected, as is the carpometacarpal thumb joint (CMCJ). Pain and disability is significantly higher for those with CMCJ symptoms (Bijsterbosch et al., 2010) however little is known about the impact this may have on handgrip strength and whether or not this affected the results of the current study. Further investigation into the effects of aqua-based exercise on handgrip strength among older adults with hand osteoarthritis is warranted.

Interesting trends in relation to exercise participation before and after the intervention were revealed. Of particular interest was the number of participants who continued an aqua-based exercise programme on completion of the study. Follow up analysis conducted at 24 weeks revealed 42% of those in the C group had joined an AF class following completion of the study and 38% of those in the AF group continued this form of exercise after the study finished. Previous research has identified pain (Der Ananian, Wilcox, Saunders, et al., 2006), as well as cold pool water and facilities (Fisken et al., in press) as barriers to aqua-based exercise among adults with osteoarthritis and two participants who dropped out of the current intervention cited these reasons. The venue was believed to have been an important contributing factor both to the number of dropouts from the study and the number who went on to participate in an AF programme on completion of the study. Two groups undertook the AF programme, each at a different venue. One venue had a greater number of dropouts and fewer participants in this group went on to join an aqua-fitness programme on completion of the study. During the school holidays, the pool in this venue was extremely busy and staff failed to separate the lanes for the AF group from the rest of the public. Although no participants specifically cited this as a reason for dropping out of the study, many reported feeling uncomfortable during these sessions and this may have contributed to an overall less positive association with aqua-based exercise.

Although participants were asked to keep a diary of arthritis medication taken throughout the study, only 28% of those who completed the intervention returned their medicine diary at the end of the study. Participants who did keep a medication diary for the duration of the intervention demonstrated no change in the number or type of arthritis medication taken from baseline to post-intervention. Regular telephone contact with participants has been reported to improve completion rates of health diaries (Burman, 1995) and this may have helped compliance in the current study. Future studies should consider weekly telephone follow-up to encourage participants to complete their diary.

Despite a relatively small sample size, the current study demonstrated promising results with regards to functional status and reduced fear of falling among older adults with osteoarthritis, following an AF exercise programme. However, there are several limitations of the present study. There were a large number of dropouts, in particular from the AF group. As stated previously, this was believed to have reflected some of the environmental features of one of the venues. Furthermore, data relating to affected hand joint(s) or limb was not used in analysis of the handgrip strength test or step test data. Further analysis relating to affected joint(s) could have provided useful insight into the effects of aqua-based exercise specifically on joints which are affected by osteoarthritis.

6.7 Conclusions

The current study demonstrated that an AF exercise programme has the potential to produce clinically important improvements in physical function and a reduced fear of falling among older adults with osteoarthritis. AF has not been widely investigated as an exercise mode for older adults with osteoarthritis, this study indicates that this type of aqua-based exercise may offer several potential health benefits for this group and further research of long-term participation is warranted. However the large number of dropouts may indicate that this type of aqua-based exercise is not suitable for all older adults with osteoarthritis and the suitability of the venue should be carefully considered. Seated exercise sessions conducted in warm water may provide an appealing introduction to aqua-based exercise for some older adults with osteoarthritis. In particular, it may provide a useful starting point for those who are less active and have low falls efficacy allowing a transitional period of adaptation before undertaking a more intense aqua-based exercise programme such as AF. The relatively large percentage of participants, in particular from the control group, who joined an AF programme after the study is encouraging and may reflect an increase in self-efficacy towards aqua-based exercise.

Chapter 7 Discussion

7.1 Overview

The overall aim of this research was to gain greater insight into the perceived and measured health benefits of aqua-based exercise for older adults with osteoarthritis. As previously outlined, a number of physiological changes occur with increasing age that when combined with a diagnosis of osteoarthritis, may result in declines in functional ability and quality of life as well as an increased risk of falls and subsequent injury. Regular physical activity helps to minimise the effect of these changes, however, many older adults avoid physical activity due to the symptoms of osteoarthritis. Although aqua-based exercise is generally considered a suitable exercise form for older adults with osteoarthritis, evidence-based literature relating to this exercise mode is relatively limited. The first two studies in this thesis set out to gain insight into perceptions, such as barriers and motivators, to aqua-based exercise among older adults with osteoarthritis, in order to better understand reasons for participation and cessation of such a programme. The next study compared acute pain and heart rate responses to different types of aqua-based exercise as well as opinions relating to these different exercise modes. The key purpose of this study was to compare hydrotherapy, which literature has widely recommended for older adults with osteoarthritis, to aqua-fitness and aqua-jogging which are commonly performed modes of aquatic exercise available at many community-based swimming pools. Based on the results of this study, the final study sought to examine the effects of a 12-week aqua-fitness exercise intervention compared to a seated aqua-based exercise programme on strength, functional ability, balance, fear of falling and quality of life, among older adults with osteoarthritis. The following discussion outlines key findings relating to each study and then summarises the combined findings of these studies.

7.2 Perceived benefits of aqua-based exercise

The initial aim of the thesis was to investigate perceptions of older adults, with and without osteoarthritis, who are current participants in aqua-based exercise, of particular interest were the motivators to attend and benefits that they believed resulted from regular participation in this form of exercise. Previous research has indicated that one of the primary perceived benefits of exercise among older adults is general health and fitness (T. Henwood et al., 2011; Newson & Kemps, 2007), whereas adults with arthritis are most likely to cite pain relief as a primary benefit and motivator to exercise (Petursdottir et al., 2010). The findings of this first study corroborate these findings, older adults without osteoarthritis cited general health and fitness as key benefits of aqua-based exercise, whereas those with osteoarthritis alluded specifically to pain relief. Social interaction was also identified as a key motivator to attend, whether or not participants had osteoarthritis, again this coincides with previous research (Moody et al., 2012; Schutzer & Graves, 2004). In addition to social support during the actual exercise sessions, a number of participants in our focus groups referred to social interaction after classes being important, with a large number of participants regularly meeting for coffee after class. Although a number of studies have identified social support and interaction as important motivators to exercise for older adults (Kang et al., 2007; Moody et al., 2012), few have differentiated between social interaction during exercise and post-exercise contact with peers. Enhancing the opportunity for post-exercise interaction, by provision of affordable facilities, may provide another incentive to encourage older adults, with and without osteoarthritis, to participate in regular exercise.

Psychological benefits were identified as a theme among some participants, primarily those who were current aqua-exercisers, however this was not one of the key topics discussed. Previous literature examining benefits of exercise among adults with arthritis has identified several psychological themes including increased independence and reducing stress (Der Ananian, Wilcox, Saunders, et al., 2006; Wilcox et al., 2006). Since participants who took part in our focus groups were older adults, it may have been expected that increased independence would have been identified as a key motivator to participate in aqua-based exercise. However, this theme was not brought up by any of our ex-aqua exercisers and only a few current aqua-exercisers. This may be a result of the health status of those who volunteered to participate in our focus groups. All were capable of making their own way to the focus group meeting place, which indicated a reasonable level of independence, therefore this may not have been considered an issue among participants in our studies. The level and degree of osteoarthritis symptoms are likely to impact on independence and this may also contribute to differing attitudes towards the benefits of exercise relating to independence and the relative importance given to this issue.

7.3 Perceived barriers to aqua-based exercise

The second focus of this thesis was to explore reasons for ‘dropping out’ of aqua-based exercise among older adults with osteoarthritis. Many previous studies investigating the perceived barriers and benefits of exercise among adults with arthritis, have divided participants into categories according to their current exercise status (Der Ananian, Wilcox, Saunders, et al., 2006; Wilcox et al., 2006), however none to our knowledge have focused specifically on those who have tried but no longer participate in regular exercise. Consequently it was deemed relevant to explore reasons for ceasing participation in an aqua-based exercise programme, especially given that current aqua-exercisers have consistently identified pain relief as a key benefit of this exercise mode. In order to commence and adhere to any exercise programme, participants must have self-efficacy for that exercise (Cheung et al., 2006). However, most participants in our study, who no longer participated in aqua-based exercise, described negative experiences with regard to aqua-based exercise classes they had attended, stating that they were too vigorous or advanced for them. According to Bandura's Social Cognitive Theory, mastery and past experiences are the most important sources of self-efficacy and if an individual has a negative experience, self-efficacy is likely to be reduced (Bandura, 1997). As a result, many participants in our study may have had low self-efficacy for aqua-based exercise which would have affected their desire to continue participating in an aqua-based exercise programme. The most important barrier identified by ex-aqua exercisers was the lack of suitable classes combined with a lack of instructor knowledge relating to arthritis. Training with others of a similar age has also been identified as important among older adults who performed land-based exercise (T. Henwood et al., 2011). The participants in our study also expressed a preference to exercise with others of a similar age, which helped facilitate social support and interaction.

Previous studies have identified the environment and facilities as a potential barrier to exercise among adults with arthritis (Der Ananian, Wilcox, Saunders, et al., 2006; Wilcox et al., 2006). Cold water and /or changing facilities were considered a key barrier by our participants, regardless of current exercise status. Cost was also identified as a potential barrier for several participants. Ensuring sufficiently warm facilities is likely to have a positive effect on the appeal of aqua-based exercise for older adults with osteoarthritis. Although a year-long aqua-based exercise intervention resulted in pain reduction and was considered a potentially cost-effective treatment for older adults with lower limb osteoarthritis (Cochrane et al., 2005), not all facilities are able to maintain suitable pool and ambient temperatures at a reasonable cost. Given the potential benefits of this exercise mode for older adults with osteoarthritis, and the likely increase in this population, consideration is warranted into the provision of suitable facilities, which can provide affordable and appealing aqua-based exercise options.

The instructor was identified as a potential motivator or barrier and was important regardless of whether participants were current or ex-aqua exercisers and regardless of whether or not they had osteoarthritis. Several participants with osteoarthritis were concerned with the underlying knowledge of some instructors. This theme has previously been identified among older adults with lower extremity osteoarthritis who also stressed the importance of an appropriate instructor, and considered this an essential component for ongoing participation in an aqua-based exercise programme (Moody et al., 2012) . Having confidence in the exercise leader is likely to increase participant's self-efficacy towards that exercise class, which again, is likely to affect adherence to the programme.

7.4 Summary key benefits/barriers

One of the key findings of our research into perceived benefits, motivators and barriers to aqua-based exercise among older adults with osteoarthritis, was that the themes identified were similar, whether participants were current or ex-aqua exercisers and older adults without osteoarthritis demonstrated many shared views and beliefs to those with osteoarthritis. An important finding was that almost all participants who had tried, but no longer undertook aqua-based exercise, expressed a desire to try this form of exercise again, provided it was suitable for their ability and the ambient and pool temperatures were warm enough.

In summary, these studies have highlighted the importance of provision of aqua-based exercise classes specific to older adults and in particular, having an instructor who has a sound understanding of the symptoms and limitations associated with osteoarthritis. Appropriate ambient and pool temperatures are necessary to encourage adherence and highlighting the potential social aspect of this type of exercise may encourage participation among older adults. However, it should be noted that participants in our studies were primarily female, whether the social aspect is a major motivator for older males may require further investigation.

7.5 **Acute responses to aqua-based exercise**

The purpose of the third study in this thesis was to examine pain and heart rate responses to different modes of aqua-based exercise and to explore participant's attitudes towards these types of exercise. To our knowledge, no previous study has directly compared the acute physiological demands and participants' perceptions to different forms of aqua-based exercise among older adults with osteoarthritis. Participants in our study attended five aqua-based exercise sessions; body-weight aqua-fitness, resisted aqua-fitness, body-weight aqua-jogging, resisted aqua-jogging and hydrotherapy. Our results revealed that while there was no significant difference in pain response to any exercise type, there was a difference between pre-exercise pain scores and pain scores immediately post-exercise, this reduction in pain approached statistical significance. It was also found that pain scores immediately post-exercise were significantly lower than pain scores 24 hours post-exercise. Several studies have indicated long-term pain reductions following an aqua-based exercise intervention (Fransen et al., 2007; Hinman et al., 2007; Silva et al., 2008). Our study suggests that there may be important pain relief implications immediately post-exercise for different types of aqua-based exercise and further exploration of this is warranted, particularly as many older adults with osteoarthritis cite pain as a key barrier to exercise and consequently limit their activities.

Comparison between the different modes of aqua-based exercise revealed there were no significant differences in mean or maximum heart rate between the sessions and SRPE scores did not vary greatly. This would suggest that these different forms of aqua-based exercise have the potential to elicit similar adaptations over time. However participants revealed that the hydrotherapy session was the most enjoyed mode of aqua-based exercise and aqua-jogging was the least enjoyed. The hydrotherapy session was performed in a warm therapy pool, warm water immersion has been associated with pain relief due to a variety of mechanisms such as enhanced blood flow, which may help disperse algogenic chemicals and aid muscle relaxation (Kamioka et al., 2010) as well as reducing peripheral edema (Gabrielsen et al., 2000). The effects of the warm water could have contributed to participants reporting that the hydrotherapy session was the most enjoyable and relaxing form of aqua-based exercise.

Aqua-jogging is a popular mode of aqua-based exercise, however limited research has focused on this exercise mode. In a randomised controlled trial, deep water running was cited to reduce pain among women with fibromyalgia (Assis et al., 2006). Although our study demonstrated that pain was reduced immediately post-exercise for all exercise types, some participants identified the aqua-jogging sessions as too stressful and several participants found the belt uncomfortable. Consequently this was deemed the least favourable form of aqua-based exercise among older adults with osteoarthritis.

As well as providing insight into the efficacy of different forms of aqua-based exercise for older adults with osteoarthritis, this mixed-methods study afforded triangulation of quantitative and qualitative data in order to help guide the type of aqua-based exercise programme employed in our final intervention study. An aqua-fitness exercise programme was chosen for our final study since this was identified by participants as an enjoyable and acceptable alternative to hydrotherapy.

7.6 **Adaptations to 12-weeks of aqua-based exercise**

Although aqua-based exercise has been widely recommended for older adults with osteoarthritis, there are a number of problems when attempting to draw conclusions and recommendations from the literature.

Firstly, a number of studies have examined a hydrotherapy-based session supervised by a qualified therapist (Foley et al., 2003; Fransen et al., 2007; Hinman et al., 2007; Lund et al., 2008). This type of programme is not necessarily available or affordable in many communities. Studies that have examined more ‘traditional’ aqua-exercise classes, such as aqua-fitness, have used a variety of methodologies. Factors such as exercises modality, number of sessions per week, length of the intervention, overall volume, water depth and temperature vary greatly. Combined with the inherent difficulty in quantifying the intensity of aqua-based exercise, it is difficult to make evidence-based recommendations relating to exercise guidelines specific to older adults with osteoarthritis.

In addition, previous research has not always considered the likelihood of participants wanting or being able to continue with a similar exercise programme on completion of the intervention. Intention to treat analysis has been used to examine the potential for a treatment intervention (Sainani, 2010) but it does not lend itself to understanding or addressing attrition rates. Many of the studies reported did not have a follow-up period to examine whether participants wanted to, or actually did, continue with an aqua-based exercise programme after completion of the study. Consequently, any assessment of the programme as a potential treatment is restricted to short-term analysis without any evaluation of the potential as a long-term treatment.

The purpose of our third study was therefore to investigate the effects of a 12-week aqua-based exercise programme on muscle strength, functional ability, cardiovascular fitness, quality of life and fear of falling among older adults with osteoarthritis. The effect on pain was measured indirectly by means of an arthritis-medication diary which participants were asked to keep for the duration of the intervention. The study included a 12-week follow up in order to assess how many participants continued an aqua-based exercise programme following completion of the study. In addition, our study attempted to use a straightforward method of quantifying the velocity of movements in the aqua-fitness programme. A systematic review of literature concluded that aqua-based exercise trials rarely provided sufficient details allowing the exercise protocol for them to be reproduced reliably (Batterham et al., 2011). However a study by Raffaelli, Lanza, Zanolla & Zamparo, (2010) demonstrated that several common aqua-fitness exercises could be standardised by changing the speed of the music track. Our study specifically used music tracks to determine the velocity and therefore the intensity of the programme, increasing the number of tracks with faster beats-per-minute in each session as the study progressed.

There was a fairly large number of drop-outs from our 12-week intervention, particularly from the aqua-fitness group. Participants primarily cited unrelated health problems for failing to complete the programme. It was noted that most of those who dropped out attended one particular venue, the facility is often cited as an important factor relating to aqua-based exercise participation, with issues such as cold changing facilities and water being considered key barriers to this form of exercise. This may have been an influence on the number of dropouts from this group. Due to the attrition rates, our analysis and discussion focused primarily on those who completed the intervention.

Despite the rates of adherence, participants who did complete the aqua-fitness intervention gained a number of health benefits. Fear of falling was reduced significantly and dynamic balance improved in both legs. Falls are the leading cause of injury hospitalisation and one of the primary causes of injury-related death in older New Zealanders. Consequently strategies to improve balance ability and reduce falls risk are crucial, particularly as the number of older adults continues to rise.

Previous research has found mixed results relating to balance outcomes following an aqua-based exercise programme among older adults with osteoarthritis. Whilst Arnold & Faulkner (2010) only found positive balance outcomes when an aqua-based exercise programme was combined with an education programme, Hale et. al, (2012) observed significant improvements among those who participated in an aqua-based exercise intervention and those in a control group who attended twice weekly computer sessions. These authors suggested that the increase in habitual physical activity may have influenced the control group's improvement in balance. Conversely, our study did not observe any change in dynamic balance in the control group, despite participation in a weekly seated aqua-based exercise class. Differences in these results may partially be accounted for by potential variations in the baseline balance status of participants, with those recruited by Hale et al., (2012) were classified as at risk for falling, in addition to having lower extremity osteoarthritis.

Fear of falling may result in avoidance of activity which can increase social isolation among older adults (Howland et al., 1993). Despite this, few studies have investigated the effect of an aqua-based exercise intervention on fear of falling. Arnold and Faulkner (2010) previously reported reduced fear of falling among participants following an aqua-based exercise intervention when combined with an education programme. Conversely, our study did find a significant reduction in fear of falling post-intervention in the aqua-fitness group. Again, differences in the baseline status of participants may have affected the results with those in the study by Arnold and Faulkner (2010) having all had a fall within the past 12-months. Those who have had a fall are more likely to have a fear of falling, consequently, those in the study by Arnold and Faulkner (2010) may have had much lower falls efficacy than participants in our study. It is possible that they therefore required additional support, such as falls education, to increase their falls efficacy and confidence to carry out activities of daily living.

Several studies which have demonstrated improved leg strength following an aqua-based exercise intervention in adults with osteoarthritis have measured isometric strength (Foley et al., 2003; Hinman et al., 2007), however, functional movements, such as standing from a chair and walking are examples of tasks requiring the development of eccentric and concentric isoinertial strength. Therefore, our study considered it appropriate to measure this form of muscle strength. Participants in the aqua-fitness group improved the number of chair stands performed in 30-seconds by a mean value of 2.46. Although this was not a statistically significant improvement, previous literature has indicated that an increase of 2 repetitions could be considered clinically significant

(A. A. Wright et al., 2011). Maintaining leg strength is important in order to minimise the effects of sarcopenia on function. Furthermore, older adults with lower limb osteoarthritis can help increase joint stability and absorb forces during weight bearing activities by increasing muscular strength (Hurley, 2003). Therefore, increasing isoinertial leg strength is an important outcome of this aqua-fitness exercise programme and is a key element in maintaining functional ability.

Although our participants did not improve their speed for the timed up-and-go test, which was our primary outcome measure of functional ability, participants in both the aqua-fitness and control groups did improve in the 400m walk. Whilst the 400m walk test was included as a measure of cardiovascular fitness, it does also provide a measure of function, with walking being an important activity of daily living. Previous literature identified improvements in dynamic balance among an active control group, who attended computer classes twice weekly (Hale et al., 2012). Similarly, participants in our active control group improved 400m walk time, despite performing all exercises whilst seated in order to minimise any adaptations in lower limb muscle strength or proprioception. A review of literature conducted by Jacobs et al., (2008) concluded that going out daily results in reduced declines in functional ability and improved health among older adults. Although participants in our control group only attended exercise sessions once weekly, the observed improvements in walk time, when considered alongside the improvements in balance observed by Hale et al., (2012) are interesting and merit further consideration.

Quality of life, as assessed by the AIMS2-SF, improved significantly following a 12-week aqua-based exercise intervention. Notably, the aqua-fitness group improved their rating of questions related to feeling like a burden, being in low spirits and how often participants enjoyed the things they do, factors that affect quality of life. Quality of life is also affected by pain and functional ability among older adults with osteoarthritis (Jakobsson & Hallberg, 2002). Participants in our focus groups who were regular aqua-exercisers identified pain and symptom control as key benefits of this form of exercise. It is therefore likely that reduced pain and improved function could have contributed to the improved outlook and positive frame of mind observed in the aqua-fitness group, although pain was not directly measured as an outcome. However, there were some concerns with regard to this questionnaire, several participants found some of the questions confusing and had to seek clarification for their meaning. It may be appropriate to provide continued supervision for completion of the AIMS2-SF in order to ensure participants have read and fully understood each question.

A number of studies have measured the effect of an aqua-based exercise programme on pain, among adults with osteoarthritis, with positive outcomes (Fransen et al., 2007; Hinman et al., 2007; Silva et al., 2008). Although pain was not a primary outcome measure in our intervention study, participants were asked to keep a diary of all arthritis medication taken throughout the study in order to indirectly assess the impact the programme had on pain. However, participants did not adhere well to this method of data collection, therefore results were inconclusive. In order to improve completion rates Burman (1995) suggested regular phone contact with participants may increase compliance to completion of health diaries. However, it may have been more appropriate for a direct measure of pain to be included in the outcome measures, such as having participants score their pain levels on a numerical rating of pain scale regularly throughout the study.

This thesis aimed to establish whether or not participants would continue participating in an aqua-based exercise programme on cessation of the supervised intervention, by means of follow-up assessment 12-weeks after the study was completed. Although the aqua-fitness programme was well tolerated by participants, the number who attended the follow-up assessment was disappointing. Despite the potential for selection bias, an encouraging number of those who came to the follow up indicated that they had continued to participate in aqua-based exercise after completion of the study. Of note, many who had participated in the control group went on to join an aqua-fitness group after the intervention had finished. This may indicate an increase in self efficacy towards aqua-based exercise among the control group, which could suggest that a gentle, seated aqua-based programme may be a useful tool in encouraging older adults with osteoarthritis to undertake this form of exercise and essentially, progress onto a more demanding aqua-based exercise programme.

7.6.1 Seated aqua-based exercise

Our intervention study compared the effects of a twelve-week aqua-fitness intervention performed twice weekly with an active control group, who performed seated exercises in a hot mineral pool once per week. Balneotherapy is a popular form of alternative therapy and bathing combined with light exercises were considered appropriate for our control group as it allowed participants to engage in some social interaction and was considered appropriate for recruitment, retention and adherence purposes. Furthermore, this allowed greater insight into the effects of warm-water immersion, since the exercises performed were gentle and unlikely to have any significant effect on physical function. Participants in both groups informally gave feedback to the assessor relating to their opinions of the programme. In general, feedback was positive and a number of participants from the control group stated that they had experienced increased pain relief following each session. In addition, 42% of participants from the control group joined an aqua-fitness group on completion of the study. It is hypothesised that these participants increased their self-efficacy for aqua-based exercise as a result of the gentle introduction and perceived benefits to aqua-based exercise gained from the therapy class. Again, directly measuring pain would have provided further insight into the potential benefits of a seated aqua-based programme.

7.6.2 Aqua-fitness

To provide detail relating to the intensity of the aqua-fitness exercise programme, the velocity of movements was determined by various music tracks, which were specifically chosen and arranged according to the number of beats per minute. As previously stated, the programme was well tolerated by the participants. Although the aim was to examine the potential health benefits of a 12-week aqua-fitness programme similar to those widely available in many community pools, the programme was specifically designed to be suitable for older adults with osteoarthritis. Since participants also started together, progression was easier than what may be possible in a community setting with a wider mix of people in the exercise class. Furthermore, participants in our study were aware that the programme had been approved by a University Ethics Committee and was being overseen by a PhD candidate. This may have improved self-efficacy towards the exercise programme and increased their conviction and trust in the suitability of the exercise sessions.

7.7 Study Limitations

There are several limitations associated with the studies in this thesis. All studies relied on volunteers which incurs the potential for selection bias The focus group studies (studies 1 and 2, chapters 3 and 4) which investigated perceived benefits and barriers of aqua-based exercise among older adults with osteoarthritis, would have benefited from greater detail relating to any co-morbities that participants may have had and whether or not these contributed to pain levels discussed. For those participants who had dropped out of an aqua-based exercise programme (study 2, chapter 4), more information relating to any other exercise forms undertaken would have added to the depth of understanding. When comparing the different forms of aqua-based exercise (study 3, chapter 5), pool temperature variability was likely to have influenced preferences among participants. In addition, greater detail relating to the severity of osteoarthritis and any medication taken would also have increased insight and further complemented the triangulation of data. The key limitation in the final, randomized controlled trial (study 4, chapter 6) was the attrition rates. It was postulated that the facility had a large impact on the number of drop-outs from the aqua-fitness programme. This would appear to be consistent with themes drawn from the focus groups which identified the facility as an important factor in sustaining attendance to an aqua-based exercise programme. The study would also have benefited from inclusion of a pain measure, rather than relying on medication diaries to provide information relating to osteoarthritis pain. The small number of participants who completed the medication diaries may have been improved had a follow-up system been in place.

7.8 Summary of combined studies

Despite the limitations outlined, the combined studies in this thesis help contribute to existing knowledge relating to aqua-based exercise for older adults with osteoarthritis. Firstly, greater insight into perceived benefits, motivators and barriers to aqua-based exercise was gained. Older adults enjoy the social aspect of aqua-based exercise, those with osteoarthritis also cite pain reduction as a primary benefit of this form of exercise. The instructor has the capacity to be a key motivator for ongoing participation in group-based aqua-exercise classes. However the instructor may also be considered a barrier, in particular when they demonstrate insufficient knowledge of the limitations associated with older age and osteoarthritis. Lack of instructor knowledge combined with a lack of provision of age-specific classes may result in low self-efficacy towards this type of exercise. In addition, cold water and facilities are considered a primary barrier to aqua-based exercise. Provision of facilities which maintain a suitable temperature, combined with knowledgeable instructors and age-specific classes may attract a greater number of older adults to adhere to this form of exercise. Furthermore facilities that provide amenities suitable for post-exercise socialising may also present further motivation to attend these classes on a regular basis.

Hydrotherapy was considered the most enjoyable form of aqua-based exercise, however aqua-fitness elicited similar heart-rate and pain responses among older adults with osteoarthritis. Aqua-jogging was considered the least enjoyable form of aqua-based exercise and use of equipment during both aqua-jogging and aqua-fitness was considered too difficult. All types of aqua-based exercise resulted in some pain relief immediately post-exercise.

Finally, twelve weeks of twice-weekly aqua-fitness classes resulted in several positive outcomes including improved balance and a reduced fear of falling, improved leg strength and walking endurance among older adults with osteoarthritis. The results of these studies combined suggest that an aqua-fitness programme can provide a number of health-related benefits for older adults with osteoarthritis and may offer a cost-effective alternative to traditional hydrotherapy. Furthermore, a seated aqua-based exercise programme was well tolerated among older adults with osteoarthritis and may present a suitable ‘entry’ level form of aqua-based exercise for this population. Suitable instructors, classes and facilities can help to encourage the appeal and potentially ongoing participation in this form of exercise among older adults with osteoarthritis.

7.9 Recommendations for further research

Future research is warranted to investigate perceived barriers and benefits of aqua-based exercise among older men with osteoarthritis. Most aqua-based exercise classes and research studies to date have consisted primarily of older women, whether or not the social aspect of group exercise is perceived as an equally important factor for older males has not been widely investigated.

Future studies should focus on methods of quantifying aqua-based exercise and the conditions in which classes take place in order that studies can be properly compared and evidence-based recommendations with regard to frequency, volume, pool depth and temperature for older adults with osteoarthritis can be made.

Studies that have employed an active control group are relatively limited in number. Further investigation into the effects of an active control group, particularly among older adults who may participate in restricted activities and have limited social interaction is justified.

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Appendix 1: Exercise protocols study 3

AF: Body-weight aqua-fitness All exercises performed in time to music Session approximately 50-60 minutes Pool temperature varied between 26 - 30° Celsius Water level at or near chest level	Warm up (5-10 mins) Marching on the spot, walking forwards and backwards, side-stepping, chest presses and arm raises Body of programme Each music track was used to vary exercises and emphasis on aerobic or strengthening exercises. Aerobic exercises were performed alternatively with strength exercises for approximately30-35 minutes Aerobic exercises: Heel jacks Rocking horse Cross country ski Running in place Jumping Jacks Strengthening exercises: Squats Standing flex hip Lunges Chest Press Tricep pushdowns Bicep curls Cool down (5 mins) Exercises as warm up, reducing pace Stretches (5mins) Upper and lower body static stretches
RAF: Resisted aqua-fitness All exercises performed in time to music Session approximately 50 mins	Structure and exercise as AF: Faster music tracks used for the aerobic exercises Strengthening exercises utilised noodles, barbells and dumbbells to increase resistance

Pool temperature varied between 28.5 - 30° Celsius Water level at or near chest level	
AJ: Aqua-jogging Session approximately 50-60 mins Pool temperature ranged from 29 - 30° Celsius All exercises performed wearing a flotation belt to prevent feet from touching the bottom of the pool	Warm up (10 mins) Simulated walking up and down length of pool using arm to assist movement, gradually increasing pace to running Body of programme: Each of the following intercepted with 2-3 lengths of aqua jogging at a moderate pace Aqua jogging focusing on cupping hands and pushing down with feet : 3 lengths Aqua jogging focusing on running with high knees : 4 lengths Cross country ski, scissor straight arms and legs: 2 lengths Cycle: sitting as if in a recliner cycle and use arms to assist movement through the water: 3 lengths Rock climb: 3 lengths Aqua jogging with breast-stroke arms : 4 lengths Aqua jogging moderate-fast paced length alternated with recovery length, 3 x sets Cool down: Simulated walking up and down length of pool reducing pace: 3 lengths
RAJ: Resisted aqua-jogging Session approximately 50 mins Pool temperature ranged from 29 - 30° Celsius All exercises performed wearing a flotation belt to prevent feet from touching	Structure and exercises as AJ Following the warm-up, noodles and dumbbells were added to increase resistance and drag

the bottom of the pool	
HYD: Hydrotherapy Session 45 mins Pool temperature 32-33° Celsius. Water approximately waist height.	Warm-up Walking forwards, backwards and sideways gradually increase pace and arm movements. Walk round the pool on heels then on toes. Exercises 1 set of 10 repetitions per exercise: (may be performed holding onto side of pool for balance) Hip flexion Hip extension Push ups against side of pool Hip adduction Hip abduction Shoulder abduction Knee cycling, 30 secs each leg Chest press, shoulders/arms submerged Double leg squat Trunk rotation Trunk control in standing position. : lift alternate legs for balance practice, then reach across to touch knee with opposite hand. Cool down Circle ankles, knees and hip and shoulders slowly Upper and lower body static stretches Relax in supine position with flotation devices.

Appendix 2: Enjoyment questionnaire study 3

EXERCISE EVALUATION

We would like to obtain your feedback on this exercise session and give you the opportunity to comment on various aspects of the session

Please answer the following questions on today's exercise session

1. Which aspects of the exercise class did you enjoy the most?

Try to indicate your level of enjoyment using numbers 1,2,3,4 or 5 where the 1 = least enjoyable, and the number 5 = most enjoyable.(please put a circle around the appropriate number)

	Least enjoyable		**Most enjoyable**		
i. The exercises using floats/other equipment	**1**	**2**	**3**	**4**	**5**
ii. The strength and range of movement exercises	**1**	**2**	**3**	**4**	**5**
iii. The relaxation/recovery parts of the session	**1**	**2**	**3**	**4**	**5**
iv. The social aspect	**1**	**2**	**3**	**4**	**5**
v. The water temperature	**1**	**2**	**3**	**4**	**5**
vi. The instructor	**1**	**2**	**3**	**4**	**5**

2.Would you be likely to regularly attend an aqua class similar to the one today if it was available?

3. Was there any aspect of today's exercise session that you particularly liked?

4. Was there any aspect of today's exercise session that you particularly disliked?

5. Is there anything else about today's session that you would like to comment on?

Appendix 3: Focus Group Questions study 3

- Has anyone in the group not previously tried aqua-exercise before taking part in this study?
- In general, what did you think of the aqua exercise sessions you took part in?
- What did you think of the facilities where the exercise sessions took place?
- What did you think of the aqua instructor / hydrotherapist?
- Do you think you would attend any of these sessions on a regular basis if available?
    - Which one(s) would you be most likely to attend?
    - What did you specifically like about that/those classes?
    - Which one(s) did you least like?
    - What did you specifically dislike about that/those classes?

- Did you feel that taking part in any of the aqua exercise sessions helped your arthritis symptoms?
- Did you feel that taking part in any of the aqua exercises sessions benefited you in any other way?
- Did you feel that there were any negative aspects to taking part in the aqua exercise sessions?

- We wanted you to help us to evaluate the aqua exercise classes you took part in. Is there anything that you came wanting to say but didn’t get the chance to say?

Appendix 4: Exercises to music study 4

Table A1. The exercises and music track used for the Aqua-fitness programme. Beats per minute (bpm) of each music track was used to pace the velocity and pace of movements.

Track no.	Music bpm	Exercises
1	134	March; Heel Taps; Walk forwards/ back; Squats; Shoulder raises; Calf raises
2	125.5	Walk round/whirlpool; Chest press; Knee lift & press down; Arms raises forward and back
3	118	Wooden Soldier; Side Steps; Side chops
4	144	Side twists; X-country ski; Jumping jacks; Shoulder press down
5 5.i	122 140	Hamstring curls; Bicep Curls; Elbow to knee Same exercises as 5 at increased pace
6	162	Side step with claps; Step behind and push arms forward; Jumps: side, middle, side
7 7.1	134 149	Shoulder pinch; Fishtail; Lunges; Arm roll in front Same exercises as 7 at increased pace
8 8.1	131 200	Side bends; Back kick; Cossack shuffle; Jumps with arms in air Same exercises as 8 at increased pace
9	125	March / wide march; Rocking horse; Leg Raises; Hugs
10	128	Lateral leg raises; Leg raise behind; Tricep push down; Side steps – small
11	112	Shoulder shrugs; Play piano; Toe point/flex; Achilles stretch: toes/heels; Neck side to side & back; Cheerios; Pelvic circles; Arms forward/back hands pronate/supinate; Slow walk
12	128	Heel of hand strike; Punch to front; Kick to front; Side step & roundhouse punch; Upper cut; Back kick
13	220	Foot taps to front, side, back; Jump and kick forward; March forward back; Lateral shoulder raises
14	106	Marching on spot; Wide knees marching on spot; Running on spot
15	174	Lateral raises; Ankle twists; Tuck jumps; Arms freestyle
16	92	Stretches upper and lower body

no.:number; bpm: beats per minute

Table A2. Exercises and tracks used for each session over the 12-week intervention. From weeks 9-12 the aqua-instructor encouraged participants to increase the range of movement for each exercise in order to increase the velocity and intensity.

Weeks	Tracks/exercises used each session
1 & 2	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 16
3 & 4	1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 10, 11, 16
5 & 6	1, 2, 3, 4, 5.i, 6, 7.i, 8, 12, 13, 10, 11, 16
7 & 8	1, 2, 3, 4, 5.i, 6, 7.i, 8, 12, 13, 14, 10, 11, 16
9 – 12	1, 2, 3, 4, 5.i, 6, 7.i, 8.i, 12, 13, 14, 15, 10, 11, 16

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Appendix 5 : Seated aqua-based exercises study 4

Table B1. Seated aqua-based exercise programme. A random selection of exercises from the following list were performed during each session. Where required, exercises were adapted in order that they could be performed whilst seated. Exercises taken from Arthritis Foundation Arthritis Water Exercise Programme.

Neck Stretches	• Chin retractions: slowly pull back and back to start • Turn to look over shoulder towards back • Side neck bends (ear to shoulder)
Trunk Stretches	• Side bends (hands on hips or slide hand down side) • Trunk rotation – hands together then turn to left then right
Shoulder Stretches (pick 4 or 5 per workout)	• Shoulder blade pinch: shoulders forward then back • Shoulder shrugs: single or double • Should circles: forward and back – single or double • Overhead reach: raise arms as high as possible (without pain) • Finger tips to shoulders: fingers to shoulder then lift elbows keeping fingers on shoulders • Arm waves: raise arms overhead, move side to side stopping in centre (12 o'clock) go to 10 o'clock and 2 o'clock • Raise & lower arms: lateral arm raises to surface of water • Raise/lower arms to overhead: clap, lateral raises then when reach surface, turn palms over and continue arms up to overhead clap. • Scissors: keep arms close to front/back of body – alternate top arm each top as arms scissor • Stand at attention: arms at side, bend elbow, put hand on buttocks then slide arm up back as high as you can (like reaching for bra) • Pat neck, back: one arm at a time, place hand behind buttock, raise arm to water surface, rotate wrist and continue on to pat the back of your neck, rotate wrist opposite way when going back down towards buttock • Front and back clap: clap just under surface of water at front, close to buttocks at back • Front arm circles: small circles below water, palms down, progress to bigger circles, clockwise and anti-clockwise. For a change do it palms upwards too • Arm circles at side: palms up or down, arms out to side • The hug: arms by side then bring in to hug yourself – fingers to shoulders • Breast stroke: shoulders under water • Front crawl stroke • The Slide: raise arms, palms down, bend elbows, slide arms back and shoulders together, keep forearms parallel to floor • Straight arm sweeps: raise arms in front palms up, then move arms to side of body and turn palms down

Elbow exercises	• Thumbs to shoulders: arms close to body, thump to shoulders, single or double arms • Fingers to shoulders: arms at side – turn palms upwards, on way down rotate wrist so palms down • The chop: hands together bend elbow, hands towards left shoulder then lower towards opposite thigh
Wrist & finger exercises	• Supinate / Pronate • Hand and wrist wave: bend wrist up (like you're going to wave) then down • Prayer position – moving: raise both arms to water surface, put hand together bend elbows and bring arms towards body. Then rotate wrist to move fingers up into prayer position, return to start • Wrists left / right: keep elbows close to body, hands together, move hands to left and right by bending wrists • Finger curl: open and close into fists under water • Cats claw: bend and straighten fingers like a cats claw. Also do one finger at a time • Play the piano: one finger at a time • Cheery O's: make an 'o' by bringing each finger to the thumb • Thumb circles • Thumb touch: touch thumb to base of each finger move back to start position each time
Hip & knee exercises	• Forward kick: kick forward straight leg • Hamstring curls • Kick out: lift and bend knee, kick out keep ankles / toes relaxed • Leg lift: as above but on way down keep leg straight • Toes in toes out: balance on one leg, turn toes in and out from hips, keep feet parallel with floor • Leg circles: lift leg few inches from floor, make small circles clockwise and anti – gradually increase the size of the circles

Appendix 6 : Information sheet study 1

Participant Information Sheet

Date Information Sheet Produced:

11 March 2011

Project Title

Perceived and measured health benefits of aqua exercise for older adults with osteoarthritis: Study 1

An Invitation

You are invited to participate in a study which aims to examine the perceived and real benefits of aqua exercise amongst older adults. Your participation in this study is completely voluntary and you may withdraw at any time without giving a reason or being disadvantaged in any manner. You may also withdraw any information you have provided at any time up until data collection is completed.

What is the purpose of this research?

The purpose of this research is to examine perceived benefits of aqua exercise amongst older adults with and without osteoarthritis. The purpose of this research is to examine perceived benefits of aqua exercise amongst older adults with osteoarthritis. This information will help develop further research in which the potential health benefits of aqua exercise for older adults with osteoarthritis will be measured. .

How was I identified and why am I being invited to participate in this research?

As an older adult in the Tauranga region who regularly participates in an aqua-exercise programme, you are eligible to participate in this study.

What will happen in this research?

You will be invited to attend a focus group along with other regular aqua-exercisers. During the focus group, perceived benefits of aqua exercise will be discussed. The session will be audio-taped and will be transcribed in order to identify the key themes discussed by the group.

What are the discomforts and risks?

Such discussion may result in psychological distress or bring up potentially painful memories.

How will these discomforts and risks be alleviated?

AUT University can provide online counselling free of charge if required.

What are the benefits?

The results of this study will be used to help increase our knowledge of perceptions of people with osteoarthritis regarding aqua exercise and will be used to help develop suitable aqua-based exercise programmes for older adults. The combined results may help exercise instructors to develop and implement effective aqua-based exercise programmes which can help improve strength, balance, functional ability and quality of life and reduce pain and fear of falling in older adults with osteoarthritis..

What compensation is available for injury or negligence?

In the unlikely event of a physical injury as a result of your participation in this study, rehabilitation and compensation for injury by accident may be available from the Accident Compensation Corporation, providing the incident details satisfy the requirements of the law and the Corporation's regulations.

How will my privacy be protected?

On completion of data collection, your name will be replaced on the data sheets with an identification code and stored on the primary investigators' computer. The primary investigators will be the only people to have access to the coded data, with this data to be stored on a password-protected computer and in a locked cabinet, respectively. When presenting the results, your name will not be identified.

What are the costs of participating in this research?

There are no costs involved in the participation in this study, except your time commitment. The focus group will also take place straight after your normal aqua class and will take approximately 60-90 minutes. Tea/Coffee will be provided.

What opportunity do I have to consider this invitation?

You will have two weeks to consider your participation in this study.

How do I agree to participate in this research?

You will need to complete a Consent Form if you wish to participate in this study.

Will I receive feedback on the results of this research?

If you wish, at the completion of the study you will be sent a short summary of the results as a whole. No individuals' names will be identified in the summary results.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, *Dr Justin Keogh,* justin.keogh@aut.ac.nz, 09 921 9999 x7617 .

Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEC, Madeline Banda, *madeline.banda@aut.ac.nz* , 921 9999 ext 8044.

Whom do I contact for further information about this research?

Researcher Contact Details:

Alison Fisken

Division of Sport and Recreation

Auckland University of Technology

Private bag 92006

Auckland 1020

Email: alison.fisken@yahoo.co.nz

Project Supervisor Contact Details:

Assoc Professor Justin Keogh

Division of Sport and Recreation

Auckland University of Technology

Private bag 92006

Auckland 1020

Phone: 09 921 9999 ext 7617

Email: justin.keogh@aut.ac.nz

Approved by the Auckland University of Technology Ethics Committee on, 28 September 2010

AUTEC Reference number *10/153*

Appendix 7 : Consent form study 1

Consent Form

Project title: Study 1: Perceived and measured health benefits of aqua exercise for older adults with osteoarthritis

Project Supervisor: Associate Professor Justin Keogh & Dr Debra Waters

Researcher: Alison Fisken

○ I have read and understood the information provided about this research project in the Information Sheet provided

○ I have had an opportunity to ask questions and to have them answered.

○ I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.

○ I agree to take part in this research.

○ I am aged 60 years of age or older.

○ I wish to receive a copy of the report from the research

(please tick one): Yes○ No○

Participant's signature : ....

Participant's name : ....

Do you have osteoarthritis ? (please tick one) : Yes○ No○

Participant's Contact Details (if appropriate):

……………………………………………………………………………………………..

……………………………………………………………………………………………..

……………………………………………………………………………………………..

Approved by the Auckland University of Technology Ethics Committee on

28 September 2010

AUTEC Reference number 10/153

Note: The Participant should retain a copy of this form.

Appendix 8 : Information sheet study 2

Participant Information Sheet

Date Information Sheet Produced:

11 March 2011

Project Title

Perceived and measured health benefits of aqua exercise for older adults with osteoarthritis: Study 2.

An Invitation

You are invited to participate in a study which aims to examine the perceived and real benefits of aqua exercise amongst older adults. Your participation in this study is completely voluntary and you may withdraw at any time without giving a reason or being disadvantaged in any manner. You may also withdraw any information you have provided at any time up until data collection is completed.

What is the purpose of this research?

The purpose of this research is to examine perceived benefits and barriers of aqua exercise amongst older adults with osteoarthritis. This information will help develop further research in which the potential health benefits of aqua exercise for older adults with osteoarthritis will be measured.

How was I identified and why am I being invited to participate in this research?

As an older adult in the Tauranga region who has previously participated in an aqua-exercise programme, you are eligible to participate in this study.

What will happen in this research?

You will be invited to attend a focus group along with other ex-aqua-exercisers. During the focus group, perceived benefits of aqua exercise will be discussed as well as reasons for withdrawing from this form of exercise. The session will be audio-taped and will be transcribed in order to identify the key themes discussed by the group.

What are the discomforts and risks?

Such discussions may result in psychological distress or bring up potentially painful memories.

How will these discomforts and risks be alleviated?

AUT University can provide online counselling free of charge if required.

What are the benefits?

The results of this study will be used to help increase our knowledge of the perceptions of people with osteoarthritis regarding aqua exercise and will be used to help develop suitable aqua-based exercise programmes for older adults. The combined results may help exercise instructors to develop and implement effective aqua-based exercise programmes which can help improve strength, balance, functional ability and quality of life and reduce pain and fear of falling in older adults with osteoarthritis.

What compensation is available for injury or negligence?

In the unlikely event of a physical injury as a result of your participation in this study, rehabilitation and compensation for injury by accident may be available from the Accident Compensation Corporation, providing the incident details satisfy the requirements of the law and the Corporation's regulations.

How will my privacy be protected?

On completion of data collection, your name will be replaced on the data sheets with an identification code and stored on the primary investigators' computer. The primary investigators will be the only people to have access to the coded data, with this data to be stored on a password-protected computer and in a locked cabinet, respectively. When presenting the results, your name will not be identified.

What are the costs of participating in this research?

There are no costs involved in the participation in this study, except your time commitment. The focus group will take approximately 60-90 minutes.

Tea/Coffee will be provided.

What opportunity do I have to consider this invitation?

You will have two weeks to consider your participation in this study

How do I agree to participate in this research?

You will need to complete a Consent Form if you wish to participate in this study.

Will I receive feedback on the results of this research?

If you wish, at the completion of the study you will be sent a short summary of the results as a whole. No individuals' names will be identified in the summary results.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, *Dr Justin Keogh,* justin.keogh@aut.ac.nz, 09 921 9999 x7617 .

Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEC, Madeline Banda, *madeline.banda@aut.ac.nz* , 921 9999 ext 8044.

Whom do I contact for further information about this research?

Alison Fisken

Division of Sport and Recreation

Auckland University of Technology

Private bag 92006

Auckland 1020

Email: alison.fisken@yahoo.co.nz

Project Supervisor Contact Details:

Assoc Professor Justin Keogh

Division of Sport and Recreation

Auckland University of Technology

Private bag 92006

Auckland 1020

Phone: 09 921 9999 ext 7617

Email: justin.keogh@aut.ac.nz

Approved by the Auckland University of Technology Ethics Committee on, 28 September 2010 AUTEC Reference number *10/153*

Appendix 9 : Consent form study 2

Consent Form	AUT UNIVERSITY TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

Project title: Study 2: Perceived and measured health benefits of aqua exercise for older adults with osteoarthritis.

Project Supervisor: Associate Professor Justin Keogh & Dr Debra Waters

Researcher: Alison Fisken

○ I have read and understood the information provided about this research project in the Information Sheet provided

○ I have had an opportunity to ask questions and to have them answered.

○ I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.

○ I agree to take part in this research.

○ I am aged 60 years of age or older.

○ I wish to receive a copy of the report from the research (please tick one): Yes○ No○

Participant's signature : ....

Participant's name : ....

Participant's Contact Details (if appropriate):

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Approved by the Auckland University of Technology Ethics Committee on

28 September 2010

AUTEC Reference number 10/153

Note: The Participant should retain a copy of this form.

Appendix 10: Information sheet study 3

Participant Information Sheet

Date Information Sheet Produced:

22 March 2011

Project Title

Perceived and measured health benefits of aqua exercise for older adults with osteoarthritis

An Invitation

You are invited to participate in a study which aims to examine the effects of a variety of aqua-based exercise sessions on exertion levels and perceived pain among older adults aged 60 years plus with osteoarthritis. Your participation in this study is completely voluntary and you may withdraw at any time without giving a reason or being disadvantaged in any manner. You may also withdraw any information you have provided at any time up until data collection is completed.

What is the purpose of this research?

The purpose of this research is to investigate the effect different modes of aqua exercise have on heart rate response and perceived exertion and pain amongst older adults aged 60 years and older who have osteoarthritis..

How was I identified and why am I being invited to participate in this research?

As an adult aged 60 years or more, who has osteoarthritis, living in the Tauranga region you are eligible to participate in this study.

What will happen in this research?

You will be asked to complete a (screening) Questionnaire, based on the answers to this questionnaire, you may be required to obtain medical clearance from your GP if you wish to participate in the study. Once this has been done, you will then be asked to attend 5 different aquatic exercise sessions which will take place within 14 days of each other, with a minimum of 48 hours between each session. Sessions will take place in a randomised order and will consist of; Condition 1: Low intensity aqua aerobics, Condition 2: High-intensity aqua aerobics, Condition 3: Low-intensity aqua jogging, Condition 4: High-intensity aqua jogging and Condition 5: A hydrotherapy session. The aqua aerobics and aqua jogging sessions will last for 60 minutes and the hydrotherapy session approximately 45 minutes. You will be asked to rate your pain levels before and after each session and levels of perceived exertion will be measured at various points during each exercise condition. Heart Rate (HR) will be monitored throughout each session by means of the Polar Team HR monitor system which measures heart rate through a transmitter which is attached to an elastic belt and worn around the chest. The transmitter must be in direct contact with the skin, however this does not cause any harm or pain to the wearer. In addition, you will be asked to rank your enjoyment of each session.

What are the discomforts and risks?

There is a slight risk of discomfort or injury when performing the exercise sessions. This could include loss of balance and/or musculoskeletal discomfort or pain. The elastic belt of the heart rate monitor may rub against the skin and cause minor discomfort during exercise.

How will these discomforts and risks be alleviated?

Screening prior to participation will help to minimise any risks that may be associated with exercise. A thorough warm-up session will take place prior to the aqua exercise sessions. Each exercise session will be supervised by a trained exercise professional who is experienced in working with older adults and instructing this form of exercise. They will ensure a safe environment, and one in which you feel comfortable.

What are the benefits?

The results of this study may have benefits to you as an individual and to other older adults with osteoarthritis as well as organisations involved with the health and well being of older adults. The results may help towards development and implementation of more effective aqua-based exercise programmes for individuals with osteoarthritis, with such programmes becoming more accessible in public pools and retirement villages. The benefits to you may include:

You will receive knowledge on the potential benefits of a variety of aqua-based exercises. Participation may also give you some information that may be helpful in alerting you to possible limitations that you may be beginning to (or have already started) experiencing. With this knowledge, you will be in a position to make a change (if you wish) to improve your functional ability and reduce your levels of pain and your risk of falls.

What compensation is available for injury or negligence?

In the unlikely event of a physical injury as a result of your participation in this study, rehabilitation and compensation for injury by accident may be available from the Accident Compensation Corporation, providing the incident details satisfy the requirements of the law and the Corporation's regulations.

How will my privacy be protected?

During data collection, your name will be replaced on the data sheets with an identification code and stored on the student and project supervisor(s)' computer. The student and the project supervisor(s) will be the only persons to have access to the coded data, with this data to be stored on a password-protected computer and in a locked cabinet, respectively. When presenting the results, your name will not be identified.

What are the costs of participating in this research?

The primary costs involved in the participation in this study are; obtaining medical clearance (should it be required), which you will have to pay for yourself, transport to and from each aqua session and your time commitment.

What opportunity do I have to consider this invitation?

You will have two weeks to consider your participation in this study.

How do I agree to participate in this research?

You will need to complete the attached Consent Form if you wish to participate in this study.

Will I receive feedback on the results of this research?

If you wish, at the completion of the study you will be sent a copy of your results and a short summary of the results as a whole. No individuals' names will be identified in the summary results. The overall group results of this study will be included in the student's PhD thesis and submitted for publication in academic journal(s) and for presentation at national / international conference(s). It is not unusual for there to be a substantial delay between the end of the data collection and publication or presentation of this data in these scientific forums.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, *Dr Justin Keogh,* justin.keogh@aut.ac.nz, 09 921 9999 x7617 .

Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEC, Madeline Banda, *madeline.banda@aut.ac.nz* , 921 9999 ext 8044.

Whom do I contact for further information about this research?

Alison Fisken
School of Sport and Recreation
Auckland University of Technology
Private bag 92006
Auckland 1020
Email: alison.fisken@yahoo.co.nz

Project Supervisor Contact Details:

Assoc Professor Justin Keogh
School of Sport and Recreation
Auckland University of Technology
Private bag 92006
Auckland 1020
Phone: 09 921 9999 ext 7617
Email: justin.keogh@aut.ac.nz

Approved by the Auckland University of Technology Ethics Committee on 28 September 2010, AUTEC Reference number *10/153*

Appendix 11: Consent form study 3

Consent Form	

Project title: Study 3: Perceived and measured health benefits of aqua exercise for older adults with osteoarthritis

Project Supervisor: Associate Professor Justin Keogh & Dr Debra Waters

Researcher: Alison Fisken

○ I have read and understood the information provided about this research project in the Information Sheet dated dd mmmm yyyy.

○ I have had an opportunity to ask questions and to have them answered.

○ I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.

○ I am not suffering from heart disease, high blood pressure, any respiratory condition (mild asthma excluded), any illness or injury that impairs my physical performance, or any infection.

○ I agree to take part in this research.

○ I wish to receive a copy of the report from the research (please tick one): Yes○ No○

Participant's signature:.........…………………………………………………………

Participant's name:...............................……………………………………………

Participant's Contact Details (if appropriate):

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……………………………………………………………………………………..

Date:

Approved by the Auckland University of Technology Ethics Committee on 28 September 2010, AUTEC Reference number 10/153

Note: The Participant should retain a copy of this form.

Appendix 12: Information sheet study 4

Participant Information Sheet

Date Information Sheet Produced:

25 January 2012

Project Title

Perceived and measured health benefits of aqua-based exercise for older adults with osteoarthritis: Study 3

An Invitation

You are invited to participate in a study which aims to examine the effects of aqua-based exercise sessions on a number of health measures among older adults aged 60 years plus with osteoarthritis. Your participation in this study is completely voluntary and you may withdraw at any time without giving a reason or being disadvantaged in any manner. You may also withdraw any information you have provided at any time up until data collection is completed.

What is the purpose of this research?

The purpose of this research is to examine the effects of aqua-based exercise on a number of health measures.

How was I identified and why am I being invited to participate in this research?

As an adult aged 60 years or more, who has osteoarthritis, living in the Tauranga region you are eligible to participate in this study.

What will happen in this research?

You will be asked to complete a (screening) health questionnaire, based on the answers to this questionnaire, you may be required to obtain medical clearance from your GP if you wish to participate in the study. If approved to take part in the study, you will be randomly allocated to an aqua-exercise group or active control group. A number of tests will take place in the week preceding the start of the intervention, the same tests will also take place at 12 weeks (post-intervention) and again at a 3-month and 6-month follow ups. These tests will include: Timed Up-and-Go Test (TUG), 30-sec Sit-to-Stand test, handgrip strength test, 15-sec Step Test, 6-minute walk test, height and weight measurements as well as some short questionnaires: Arthritis Impact Measurement Scales 2 (AIMS2), Falls Efficacy Scale (FES-I) and Rapid Assessment of Physical Activity (RAPA). Participants will be asked to keep a log of arthritis-related medicine taken throughout the study. The aqua-exercise group will take part in aqua exercise sessions twice weekly; these sessions will consist of a range of exercises including aerobic and muscle-strengthening exercises. The aqua control group will participate in once-weekly aqua-based exercise session at a hot pool, these sessions will consist primarily of low-intensity stretching and gentle strengthening exercises.

What are the discomforts and risks?

There is a slight risk of discomfort or injury when performing the testing activities and exercise sessions. This could include loss of balance and/or muscule or joint discomfort or pain. Screening prior to participation will help to miminise any risks that may be associated with exercise. A thorough warm-up session will take place prior to the testing sessions and aqua exercise sessions to help prevent this.

How will these discomforts and risks be alleviated?

Screening prior to participation will help to miminise any risks that may be associated with exercise. A thorough warm-up session will take place prior to the testing sessions and aqua exercise sessions. Trained exercise professionals who are experienced in working with older adults will be with you during the testing session. They will ensure a safe environment, and one in which you feel you can be relaxed and at ease. The aqua sessions will be taken by an experienced aqua instructor.

What are the benefits?

The results of this study may have benefits to you as an individual and to other older adults. The results may also help exercise instructors to develop and implement effective aqua-based exercise programmes for older adults with osteoarthritis. The benefits to you may include:

You will receive knowledge of how you compare to other adults your age on strength, balance and levels of functional ability. This will give you some information that may be helpful in alerting you to possible limitations that you may be beginning to (or have already started) experiencing. With this knowledge, you will be in a position to make a change (if you wish) to reduce your risk of falls and improve functional ability.

The results of this study may also have many benefits to other older adults and organisations involved with health and well-being of older adults. These may include the following:

Gerontologists, exercise scientists and agencies like Tauranga City Aquatics Ltd (TCAL) will be formed on the possible use of a new aqua exercise training programme to maximise functional ability for older adults with osteoarthritis.

.What compensation is available for injury or negligence?

In the unlikely event of a physical injury as a result of your participation in this study, rehabilitation and compensation for injury by accident may be available from the Accident Compensation Corporation, providing the incident details satisfy the requirements of the law and the Corporation's regulations.

How will my privacy be protected?

For all data collected, your name will be replaced on the data sheets with an identification code and stored securely on the project supervisors' computer. The project supervisor will be the only people to have access to the coded data, with this data to be stored on a password-protected computer and in a locked cabinet, respectively. When presenting the results, your name will not be identified.

What are the costs of participating in this research?

The primary costs involved in the participation in this study are; obtaining medical clearance (should it be required), which you will have to pay for yourself, and your time commitment. You will be asked to attend up to 4 testing sessions, each of which will take approximately 40 minutes and one or two aqua exercise sessions per week, for 12 weeks.

What opportunity do I have to consider this invitation?

You will have a minimum of two weeks to consider your participation in this study.

How do I agree to participate in this research?

You will need to complete a Consent Form if you wish to participate in this study.

Will I receive feedback on the results of this research?

If you wish, at the completion of the study you will be sent a copy of your results and a short summary of the results as a whole. No individuals' names will be identified in the summary results. The overall group results of this study will also be submitted for publication in academic journal(s) and for presentation at national / international conference(s). It is not unusual for there to be a substantial delay between the end of the data collection and publication or presentation of this data in these scientific forums.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to *Associate Professor Wayne Hing, wayne.hing@aut.ac.nz*.

Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEC, Madeline Banda, *madeline.banda@aut.ac.nz* , 921 9999 ext 8044.

Whom do I contact for further information about this research?

Researcher Contact Details:

Alison Fisken

School of Sport and Recreation

Auckland University of Technology

Private bag 92006

Auckland 1020

Email: alison.fisken@yahoo.co.nz

Project Supervisor Contact Details:

Assoc Professor Wayne Hing

Dept of Physiotherapy, A-11

School of Rehabilitation & Occupation Studies

Faculty of Health and Environmental Sciences

AUT University

Private Bag 92006

Auckland, 1142

Email: wayne.hing@aut.ac.nz

Approved by the Auckland University of Technology Ethics Committee on *28 September 2010,* AUTEC Reference number 10/153.

Appendix 13 : Consent form study 4

Consent Form	AUT UNIVERSITY TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

Project title: The effects of an aqua-based exercise programme on functional ability, strength, balance and quality of life.

Project Supervisor*:* Associate Professor Justin Keogh & Dr Debra Waters

Researcher: Alison Fisken

○ I have read and understood the information provided about this research project in the Information Sheet dated dd mmmm yyyy.

○ I have had an opportunity to ask questions and to have them answered.

○ I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.

○ I am not suffering from heart disease, high blood pressure, any respiratory condition (mild asthma excluded), any illness or injury that impairs my physical performance, or any infection.

○ I agree to take part in this research.

○ I wish to receive a copy of the report from the research (please tick one): Yes○ No○

Participant's signature:...........……………………………………………………

Participant's name:…...........……………………………………………………………

Participant's Contact Details (if appropriate):

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Date:

Approved by the Auckland University of Technology Ethics Committee on 28 September 2010, AUTEC Reference number 10/153

Note: The Participant should retain a copy of this form.

Appendix 14 : Ethics approval memorandum

AUT UNIVERSITY
TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

MEMORANDUM

Auckland University of Technology Ethics Committee (AUTEC)

To: Justin Keogh

From: **Madeline Banda** Executive Secretary, AUTEC

Date: 28 September 2010

Subject: Ethics Application Number 10/153 **Reducing the risk of injury from falls in older women: an examination of changes in fear of falling, strength, balance, functional ability, bone mineral density and quality of life after intense aquatic exercise training.**

Dear Justin

I am pleased to advise that the Auckland University of Technology Ethics Committee (AUTEC) approved your ethics application at their meeting on 12 July 2010. Your application is now approved for a period of three years until 13 September 2013.

I advise that as part of the ethics approval process, you are required to submit to AUTEC the following:

A brief annual progress report using form EA2, which is available online through http://www.aut.ac.nz/research/research-ethics/ethics. When necessary this form may also be used to request an extension of the approval at least one month prior to its expiry on 13 September 2013;

A brief report on the status of the project using form EA3, which is available online through http://www.aut.ac.nz/research/research-ethics/ethics. This report is to be submitted either when the approval expires on 13 September 2013 or on completion of the project, whichever comes sooner;

It is a condition of approval that AUTEC is notified of any adverse events or if the research does not commence. AUTEC approval needs to be sought for any alteration to the research, including any alteration of or addition to any documents that are provided to participants. You are reminded that, as applicant, you are responsible for ensuring that research undertaken under this approval occurs within the parameters outlined in the approved application.

Please note that AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to make the arrangements necessary to obtain this.

When communicating with us about this application, we ask that you use the application number and study title to enable us to provide you with prompt service. Should you have any further enquiries regarding this matter, you are welcome to contact Charles Grinter, Ethics Coordinator, by email at ethics@aut.ac.nz or by telephone on 921 9999 at extension 8860.

On behalf of the AUTEC and myself, I wish you success with your research and look forward to reading about it in your reports.

Yours sincerely

Madeline Banda

Executive Secretary

Auckland University of Technology Ethics Committee

Cc: Alison Fisken alison.fisken@yahoo.co.nz, Debra Waters, Tineke Water, J. Poulston

Appendix 15 : Ethics amendment approval

MEMORANDUM

Auckland University of Technology Ethics Committee (AUTEC)

To: Justin Keogh

From: **Dr Rosemary Godbold** Executive Secretary, AUTEC

Date: 8 February 2012

Subject: Ethics Application Number 10/153 **Perceived and measured health benefits of aqua exercise for older adults with osteoarthritis.**

Dear Justin

Thank you for your request for approval of amendments to your ethics application. I am pleased to advise that I have approved a minor amendment to your ethics application allowing changes to the research protocol. This delegated approval is made in accordance with section 5.3.2 of AUTEC's *Applying for Ethics Approval: Guidelines and Procedures* and is subject to endorsement at AUTEC's meeting on 27 February 2012.

I remind you that as part of the ethics approval process, you are required to submit the following to AUTEC:

A brief annual progress report using form EA2, which is available online through http://www.aut.ac.nz/research/research-ethics/ethics. When necessary this form may also be used to request an extension of the approval at least one month prior to its expiry on 13 September 2013;

A brief report on the status of the project using form EA3, which is available online through http://www.aut.ac.nz/research/research-ethics/ethics. This report is to be submitted either when the approval expires on 13 September 2013 or on completion of the project, whichever comes sooner;

It is a condition of approval that AUTEC is notified of any adverse events or if the research does not commence. AUTEC approval needs to be sought for any alteration to the research, including any alteration of or addition to any documents that are provided to participants. You are reminded that, as applicant, you are responsible for ensuring that research undertaken under this approval occurs within the parameters outlined in the approved application.

Please note that AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to make the arrangements necessary to obtain this. Also, if your research is undertaken within a jurisdiction outside New Zealand, you will need to make the arrangements necessary to meet the legal and ethical requirements that apply within that jurisdiction.

To enable us to provide you with efficient service, we ask that you use the application number and study title in all written and verbal correspondence with us. Should you have any further enquiries regarding this matter, you are welcome to contact me by email at ethics@aut.ac.nz or by telephone on 921 9999 at extension 6902. Alternatively you may contact your AUTEC Faculty Representative (a list with contact details may be found in the Ethics Knowledge Base at http://www.aut.ac.nz/research/research-ethics/ethics).

On behalf of AUTEC and myself, I wish you success with your research and look forward to reading about it in your reports.

Yours sincerely

Dr Rosemary Godbold

Executive Secretary

Auckland University of Technology Ethics Committee

Cc: Alison Fisken alison.fisken@yahoo.co.nz, Debra Waters