The Effects of Aquatic Exercise in People with Dementia: A Systematic Review

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Abstract

Background: Over 50 million people worldwide have been diagnosed with dementia. Exercise has been shown to help slow cognitive decline and reduce neurobehavioral symptoms in older adults with dementia. Yet, performing exercise could be a challenging task for older adults with dementia due to their decline in cognitive and physical function. Aquatic exercise provides an interesting, low-impact, and relatively safe physical activity for this population. Increasing number of studies have examined the effect of aquatic exercise in dementia and show positive results. Yet, the evidence has not been systematically synthesized.

Purpose: This systematic review aimed to search and synthesize current evidence on the effect of aquatic exercise in people with dementia.

Methods: A comprehensive literature search was conducted in PubMed and CINAHL. The inclusion criteria were: 1) original research studies that examine the effect of aquatic exercise in people with dementia, 2) articles published in peer-reviewed journals, and 3) articles published in English. Article selection and data extraction was conducted by one reviewer and verified after a second review of the data. All articles were evaluated using the Johns Hopkins Evidence Level and Quality Grade.

Results: A total of six articles were reviewed. The findings showed that aquatic exercise was associated with reduced neurobehavioral symptoms, including apathy, depression, and agitation, as well as higher levels of activities of daily living, improved mood, and higher psychological well-being in people with dementia. Some mixed results were seen with cognition and physical function in performing timed up and go.

Conclusions/Implications: Aquatic exercise is a relatively new intervention for people with dementia. The results show that this intervention has positive impacts on neurobehavioral symptoms of dementia, physical function, mood, and quality of life in older adults with dementia. Findings support the use of aquatic exercise in people with dementia in clinical
practice. More research studies are needed to further evaluate the effect of aquatic exercise in a larger scale with more diverse participants. The feasibility of implementing aquatic exercise programs in clinical care settings need to be further evaluated.
# Table of Contents

Abstract.............................................................................................................................................. ii

List of Figures ...................................................................................................................................... vi

List of Tables ....................................................................................................................................... vii

Acknowledgements ........................................................................................................................ viii

Chapter 1 .............................................................................................................................................. 1
   Introduction ........................................................................................................................................ 1

Chapter 2 .............................................................................................................................................. 5
   Background ......................................................................................................................................... 5
   Diagnostic Criteria for Dementia ........................................................................................................ 5
   Behavioral and Psychological Symptoms in Dementia (BPSD) .......................................................... 9

Exercise and its Health Impact on Older Adults .................................................................................. 12

Exercise in Older Adults with Dementia ............................................................................................ 13

Limitations to Exercise in Dementia ..................................................................................................... 14

Aquatic Exercise ................................................................................................................................. 14

Summary .............................................................................................................................................. 15

Chapter 3 .............................................................................................................................................. 16

Methods .............................................................................................................................................. 16

Literature Search Methods .................................................................................................................. 16

Inclusion and Exclusion Criteria ........................................................................................................ 16

Article Selection Process .................................................................................................................... 17

Data Extraction .................................................................................................................................... 17

Quality evaluation ................................................................................................................................. 17

Chapter 4 .............................................................................................................................................. 20

Results ................................................................................................................................................. 20

Study Design ....................................................................................................................................... 20

Setting and Sample ............................................................................................................................ 20
   Setting ................................................................................................................................................ 20
   Sampling .......................................................................................................................................... 21
   Participant Characteristics .................................................................................................................. 22

Intervention ......................................................................................................................................... 23
   Intervention Design .......................................................................................................................... 23

Outcome Measures ............................................................................................................................. 25
   Physical Function .............................................................................................................................. 25
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognition</td>
<td>29</td>
</tr>
<tr>
<td>Behavioral and Psychological Symptoms of Dementia (BPSD)</td>
<td>30</td>
</tr>
<tr>
<td>Psychological Well-Being</td>
<td>31</td>
</tr>
<tr>
<td>Effect of Aquatic Exercise</td>
<td>31</td>
</tr>
<tr>
<td>Physical Function</td>
<td>31</td>
</tr>
<tr>
<td>Cognition</td>
<td>33</td>
</tr>
<tr>
<td>BPSD</td>
<td>34</td>
</tr>
<tr>
<td>Well-Being</td>
<td>34</td>
</tr>
<tr>
<td>Adverse Events</td>
<td>35</td>
</tr>
<tr>
<td>Chapter 5</td>
<td>42</td>
</tr>
<tr>
<td>Discussion</td>
<td>42</td>
</tr>
<tr>
<td>Physical Function</td>
<td>42</td>
</tr>
<tr>
<td>Cognition</td>
<td>43</td>
</tr>
<tr>
<td>BPSD</td>
<td>43</td>
</tr>
<tr>
<td>Well Being</td>
<td>43</td>
</tr>
<tr>
<td>Limitations</td>
<td>44</td>
</tr>
<tr>
<td>Implications for Clinical Practice</td>
<td>45</td>
</tr>
<tr>
<td>Future Directions of Research</td>
<td>45</td>
</tr>
<tr>
<td>Conclusion</td>
<td>46</td>
</tr>
<tr>
<td>References</td>
<td>47</td>
</tr>
</tbody>
</table>
List of Figures

Figure 3.1 PRISMA Flowchart of Article Selection ........................................... 19

Figure 4.11. Short Physical Performance Battery .............................................. 28
List of Tables

Table 2.1. Etiologies of Dementia ................................................................. 9
Table 4.1. BOOMER Scoring Scale .............................................................. 26
Table 4.2 Matrix Table .............................................................................. 36
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Chapter 1

Introduction

Every three seconds someone in the world is diagnosed with dementia, making this syndrome a harsh reality for many families across the globe (Alzheimer’s Disease International [ADI], 2015). According to the World Health Organization (WHO), there are an estimated 50 million people worldwide who have received a dementia diagnosis, with 10 million new cases diagnosed every year (World Health Organization [WHO], 2017). The frequency of dementia diagnosis increases with age, making older adults age 65 and greater the most at risk (Cunningham et al., 2015).

Dementia is a syndrome that can be caused by many different neurological conditions. Dementia is often referred to as an ‘umbrella term’ meaning that it encompasses many conditions. These conditions affect memory, cognition, behavior, and ability to perform everyday activities. Dementia is a progressive disease that evolves in stages. In each stage, the symptoms get progressively worse.

Risk factors for dementia include advanced age, a family history of neurological conditions that contribute to dementia, race (people from African descent are two times more likely to be diagnosed with dementia), poor cardiovascular health (e.g., high blood pressure, high cholesterol, and history of smoking), and a history of traumatic brain injury (Center for Disease Control, 2019). Dementia is not a normal part of aging, but many symptoms are overlooked due to the notion that older adults are ‘forgetful’ and possibly even ‘senile’.

There are many different diagnostic criteria for dementia. Patients must give a detailed history and show a change from baseline in mental status as well as functional decline. In order to rule out any other etiologies that may explain these symptoms, patients must provide drug
history, past medical history, current home circumstances, alcohol and substance use, and a family history. Upon a physical examination, patients may show extrapyramidal symptoms, focal neurological deficits, and an inability to follow some instructions. Providers will use formal cognitive testing, for example, the Mini Mental Status Exam (MMSE) (Folstein et al., 1975).

Currently there is no cure for dementia, however the progression of the disease can be slowed. There are many pharmacological treatments that are used to slow the progression of the disease. However, these drugs come with harmful side effects and are not always effective for every patient. In 2005, an analysis of 17 different studies that compared the effects of medications in dementia patients to a placebo (Food and Drug Administration, 2005). In this study, the Food and Drug Administration (FDA) was able to determine that atypical antipsychotics used to treat behavioral disturbances had adverse effects on older adults with dementia. This study showed a mortality rate for the medication that was 1.6-1.7 times that of the placebo. Those who took the medication were at a higher risk for cerebrovascular accidents (Food and Drug Administration, 2005). Conventional antipsychotic medications have shown adverse side effects such as increased fall risk, extra pyramidal syndrome, hyponatremia, tardive dyskinesia, and many more (Madhusoodanan & Ting, 2014). Other medications also show many adverse effects. Benzodiazepines have been shown to increase sedation and the risk of falls (Madhusoodanan et al., 2004). Non-pharmacological treatments have been shown to help slow cognitive decline and improve neurobehavioral symptoms in older adults with dementia. These interventions include strength training, aerobic exercises, and other forms of physical activity.

A dementia diagnosis can be life changing. The cognitive and physical decline that patients experience creates financial, emotional, and sometimes physical strain on the patient and their families. Direct medical care costs for those with dementia are approximately 163.6 billion
dollars worldwide and basic care and informal care costs are 327.2 billion dollars (ADI, 2015). Alzheimer's Disease International states that if dementia were a country, it would have the 18th largest economy in the world. As the disease progresses, costs rise for families and many times patients are admitted into nursing homes where their needs can be met, and they can be kept safe (ADI, 2015). Slowing the disease process means less costs for families up front, and better outcomes for those with the diagnosis.

Non-pharmacological interventions can help slow the progression of dementia and help both the patient and their families. Some non-pharmacological methods of treatment include reminiscence therapy, validation therapy, reality orientation, and cognitive stimulation therapy (Berg-Weger, 2017). Reminiscence therapy encourages patients to recall past events, memories, and activities through familiar and tangible aids. These aids include photographs, items from their past, music, movies, and more. Studies have shown that this therapy increases mood in patients with dementia and showed a small positive effect on cognitive function (Berg-Weger, 2017). Validation therapy is as form of therapy that focuses on validating the patient, their personhood, and their emotions. This reduces stress and decreases behavioral disturbances (Berg-Weger, 2017). Reality orientation orients a group of patients to time and place. This takes place in 30-minute sessions that use games, puzzles, and reality orientation boards. Reality orientation has been shown to increase cognition and provide behavioral benefits (Berg-Weger, 2017). Cognitive Stimulation Therapy is typically delivered in groups. Cognitive stimulation therapy uses strategies from other non-pharmacological treatments to create a program for patients to follow. This therapy improves processing and recall for individuals with dementia (Berg-Weger, 2017).
Aquatic exercise, also called water aerobics or aqua aerobics, is a non-weight-bearing aerobic exercise that takes place in shallow water (Cambridge Dictionary). Aquatic exercise has been found to aid in weight loss, regain joint function, decrease falls, and improve balance in those over the age of 65 (Kim, 2013). Aquatic exercise places little stress on joints, making it safe for older adults with arthritis and various other gait issues.

Until recently, there has been very little focused research into the effect of aquatic exercise for older adults diagnosed with dementia. With the incidence of dementia being so high, more interventions need to be studied in order to provide the best care for those diagnosed with dementia. This review was conducted in order to search and synthesize all available research evidence on water exercise and its impact on in older adults with dementia.
Diagnostic Criteria for Dementia

Dementia is a progressive disease that impacts the cognitive and behavioral function of patients. The DSM-5 reclassified dementia as a ‘major neurocognitive disorder’ (American Psychiatric Association [APA], 2013). This is a change from previous literature which classified dementia as a main diagnosis under ‘mild cognitive impairment’. This small reclassification was put in place to reduce stigma associated with dementia and update the diagnostic criteria that are used to diagnose a patient with dementia. While the technical term for dementia has changed, the term ‘dementia’ is still widely accepted in the medical and research community.

The DSM-5 outlines the diagnostic criteria that must be present in order for a patient to receive a diagnosis of dementia. First is significant cognitive decline in one or more of the following domains: complex attention, executive functioning, cognitive, language, perceptual-motor functioning, and social cognition. Decline in the cognitive domain is typically the first noticeable sign of decline for many people, with complaints of ‘forgetfulness’ being the first symptom that is reported to a health care provider. Cognitive decline can be based on concern about decline from the patient them self, a reliable informant (like a family member or caretaker), or the clinician themselves. Dementia is diagnosed when this memory loss begins to interfere with social or occupational functioning (Hugo, 2014). The patient must also show modest to substantial impairment upon cognitive assessment. In earlier stages of dementia, impacts on these domains may be less severe or non-existent. Due to the progressiveness of the
Disease, it is important to note any cognitive changes in the patient, no matter how small (Hugo, 2014).

The first domain is complex attention. This domain is categorized by sustained attention, divided attention, selective attention and processing speed. (Sachdev, 2014). Sustained attention is defined as the ability to focus on one task at once. Divided attention is the ability to focus on multiple tasks at once. Selective attention is the ability to focus on one task while there are other stimuli in the environment. Finally, processing speed is how long it takes to process and understand stimuli. This domain is tested through completing normal everyday tasks with and without other distractions in the room. In a patient with dementia these tasks will begin to take longer, especially where there are other competing stimuli around the patient. Another way to test this domain is through mental math calculations or dialing a phone number they have attempted to memorize.

The second domain is executive functioning. This domain is categorized by planning, decision making, working memory, or immediate processing of events and language, responding to feedback, inhibition, or self-control, and flexibility (APA, 2013). A patient with dementia may experience difficulty with multi-stage tasks, planning, organizing, multi-tasking, processing and understanding conversations that switch through many different topics, and following directions. This domain can be tested through the clock drawing test (CDT) by asking the patient to draw a clock at various different times (Faria, 2015).

Learning and memory is the third cognitive domain. This domain includes cued recall (i.e., the ability to recollect a desired memory following provision of a word or cue; recognition memory (i.e., the ability to recognize previously encountered events or people); long-term memory; and implicit learning (i.e., processing and learning information passively) (APA,
In patients with dementia, clinicians mainly test their free recall by giving the patient a list of words to remember and then asking the patient to repeat the words later in the session (e.g., apple, penny, pencil) (Cullen, 2006). In a patient with dementia, this will be very difficult for them to complete and they may not be able to recall all of the words that were provided to them. Other learning and memory changes in patients with dementia are misplacing objects and losing track of what actions they have already completed. These behaviors typically result in the patient relying heavily on checklists and reminders around their environment to prompt them about what they need to do. There is evidence that cued recall is stronger than free recall in older adults with dementia, which is why these many reminders can prove useful in the early stages of dementia. (Hugo, 2014).

The fourth cognitive domain is language. This domain is categorized by the ability to name objects, find appropriate words to describe a situation or to use in a conversation, fluency in speech, proper use of grammar and syntax, and being able to receive and process language (Hugo, 2014). In patients with dementia, finding words becomes more difficult. They may use very general phrases and use wrong words in speech. Writing may be filled with grammatical errors and they may have difficulty comprehending spoken language and written material. One test used to test for language impairment in patients with dementia is the Boston Naming test. In this test, patients are presented with line drawings (graded by difficulty) of everyday objects. The patient then names what the drawing is of. In patients with dementia, recall of the words is difficult (Otfried Spreen, 1998).

The fifth domain of cognition is perceptual-motor functioning. This domain includes visual perception, visuoconstructional reasoning, or the ability to organize spatial information, and perceptual-motor coordination, or visual perception and motor processing (Hugo, 2014).
This domain can be tested through miming gestures like ‘salute’ or ‘use a screwdriver’. Patients may also be asked to draw, copy, or assemble blocks. In patients with dementia, they may display an increased use of notes and maps due to the fact they get lost in familiar places and/or have difficulty using familiar tools and appliances (APA, 2013).

The final domain is social cognition. This domain includes the recognition of emotions and theory of mind. This domain (change language for variation) is tested through recognizing emotions. Patients are asked to identify different pictures that display different emotions (e.g., happy and sad). Theory of mind is tested by asking the patient to consider the emotions of another while looking at a story card. For example, they would be asked ‘why is this person upset?’ Patients with dementia may display apathy, or a general lack of interest, loss of empathy or compassion for others, inappropriate behaviors, and loss of judgement (APA, 2013).

Finally, these cognitive impairment symptoms cannot be better explained by another mental disorder nor exclusively during a state of delirium. Delirium is an acute cognitive disorder that involves inattention and a state of confusion. If the symptoms of dementia are only present during this time, then the patient cannot be diagnosed with dementia. Some patients will experience states of delirium with their diagnosis of dementia. This is referred to as delirium superimposed on dementia (APA, 2013).

Additionally, to be diagnosed with dementia, the symptoms have to be severe enough to interfere with the patient's ability to complete everyday tasks independently. Tasks may begin to take longer, and the patient may start to compensate. Examples of compensation may include leaving instructions and reminders around the house and avoiding more difficult, planning based tasks (APA, 2013).
If a patient is able to meet all of criteria listed, then they can be diagnosed with Major Cognitive Impairment (Dementia) (APA 2013). The final piece of a dementia diagnosis is to specify an etiology. There are 10 etiologies that may be considered. These are outlined in table 2.1.

Table 2.1. Etiologies of Dementia

<table>
<thead>
<tr>
<th>Etiology</th>
<th>Description</th>
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<tr>
<td>Alzheimer’s Disease</td>
<td>Characterized by the progressive loss of synapses and neurons in the brain. (APA, 2013)</td>
</tr>
<tr>
<td>Frontotemporal Lobar Degeneration</td>
<td>Deterioration of the frontal and/or temporal lobes of the brain. Results in changes in personality, social behavior, and/or aphasia (Rabinovici, 2010)</td>
</tr>
<tr>
<td>Dementia with Lewy Bodies (Neurocognitive Disorder with Lewy Bodies)</td>
<td>Abnormal buildup of the protein alpha-synuclein in the brain. Disrupts chemicals in the brain responsible for thinking, movement, behavior and mood. (National Institute of Neurological Disorders and Stroke, 2019)</td>
</tr>
<tr>
<td>Parkinson’s disease</td>
<td>Brain cells become damaged in the area of the brain that produces dopamine. This results in a variety of motor system disorders. (National Institute of Neurological Disorders and Stroke, 2020)</td>
</tr>
<tr>
<td>Huntington’s disease</td>
<td>Degeneration of nerve cells in the brain caused by a rare, inherited disease. (NIH, 2020)</td>
</tr>
<tr>
<td>Traumatic Brain Injury (TBI)</td>
<td>An acquired brain injury that typically occurs with sudden trauma to the brain. This can result in damage to various parts of the brain. (NIH, 2019)</td>
</tr>
<tr>
<td>Prion Disease</td>
<td>A family of rare progressive neurodegenerative disorders. (CDC, 2018)</td>
</tr>
<tr>
<td>Multiple Etiologies</td>
<td>More than one cause.</td>
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Adapted from the DSM-5 (APA, 2013).

Behavioral and Psychological Symptoms in Dementia (BPSD)

Neurobehavioral symptoms can be defined as mental and behavioral changes that occur due to a disorder or disease. The non-cognitive symptoms and behaviors that result from dementia are referred to as BPSD (Cerejeira et al., 2012). BPSD symptoms are very prevalent in
those diagnosed with dementia and can have very large impacts on how dementia is diagnosed and treated (Cloak, 2019). The DSM-5 states that clinicians must specify if BPSD symptoms are present and how serious they are. BPSD encompasses many different emotional, behavioral, and perceptive changes and disturbances for the patient.

There are five main behavioral and psychological symptoms commonly seen in patients with dementia. These symptoms are psychosis, agitation, aggression, depression, and apathy. While patients may not experience a variety of symptoms, 97% of patients diagnosed with dementia experience at least one behavioral or psychological symptom. The most common symptoms are depression, agitation, or apathy (Cloak, 2019). One-third of patients with dementia display delusions, agitation, and motor disturbances (Cloak, 2019).

The first main BPSD is psychosis. Psychosis includes symptoms such as delusions and hallucinations. Delusions can be described as a false and irrational belief that the patient is convinced to be true (Holroyd, 2000). The common delusions that have been noted in patients with dementia are believing that someone has stolen from them, spousal infidelity, danger, fear of the caregiver planning to leave (Fischer et al., 2004). Gormley et al. found that the most common delusion, was delusions of theft. Hallucinations are false perceptions that the patient experiences. These perceptions can impact any of the five senses. These symptoms can have a significant impact on the patient, family members, and the caregivers. One study reported that patients with dementia who experienced delusions had significantly worse functional performance than their counterparts (Fischer et al., 2012). While there are many factors that contribute to the mental state of caregivers, studies have shown that in a little over half of the participants, psychiatric symptoms were the strongest predictor of caregiver burden (Meiland et al., 2005).
Agitation is one of the most common symptoms of dementia. Agitation is defined as exhibiting behavior constant with emotional distress and inappropriate or excessive motor activity (Cummings et al., 2014). Research showed that 76% of patients with Alzheimer’s disease experience agitation (Van der Mussele et al., 2015). Agitation typically worsens as dementia progresses, making agitation a lasting problem for many patients and caregivers. When patients experience agitation, caregiver stress increases. This can lead to earlier admittance to a nursing home, and caregiver anxiety and depression (Koening et al., 2016). A 2018 study showed that patients who experienced agitation as a symptom had a 17% increase in care costs, creating even more of a financial strain on patients and families (Costa et al., 2018).

Aggression is another common BPSD that impacts many patients with dementia. Aggression can manifest in two forms. There is physical aggression which can be described inappropriate contact that the patient initiates that harms someone else physically. Some examples of physical aggression are hitting, punching, scratching, hair pulling, and biting. Verbal aggression can be described as inappropriate verbal interactions initiated by the patient that may cause emotional harm to others. Some examples of verbal aggression are swearing, making threats, shouting, and screaming. Aggression has been shown to significantly increase the caregiver burden over time (Berger, 2005).

Depression is extremely prevalent in patients diagnosed with dementia. While a large range of depression prevalence has been reported, one study showed that 85.7% of patients with dementia also met the criteria for major depressive disorder and 92.6% of participants showed a loss of interest and pleasure in activities (Merriam et al., 1988). However, many studies have shown this rate at closer to 40-50% (Landes at al., 2005). Depression is a mood disorder that can be described as a loss of interest or pleasure, feelings of sadness or emptiness, hopelessness,
and/or feelings of worthlessness (APA, 2013). Many studies suggest that dementia and depression may be linked, however there is little evidence to support this theory. Depression can have a negative impact on both patients and caregivers. Depression can lead to decreased self-care, behavioral disturbances, and falls (Lyketsos et al., 1997). Depression in patients can also lead to increased caregiver burden, which can lead to depression, poor physical health, and poor social and work functioning in caregivers (Lyketsos et al., 1997).

Finally, apathy is a persistent loss of or diminished motivation (Robert et al., 2009). Apathy has been shown to occur in 61% to 92% of patients with Alzheimer’s Disease (Landes et al., 2005). Apathy has been shown to lead to decreased self-care activities in people with dementia and can result in a deterioration of functioning and even increased risk for death (O’Connor et al., 2016). For caregivers, apathy in their patients can lead to higher risk of depression, burden, and stress (Dauphinot et al., 2015).

**Exercise and its Health Impact on Older Adults**

Exercise is one of the leading preventative measures for many different medical conditions. By staying active, quality of life, health and physical function can be maintained in the later years of life. In older adults, strength and aerobic exercises have been shown to significantly reduce fall risk and incidence as well as improved joint health. In a 2017 study of 19,478 participants, fall risk was reduced by 21% with the implementation of an exercise program (Sherrington, 2017). Regular physical activity has also been shown to reduce risk of heart disease, stroke, diabetes, breast cancer, and colon cancer (World Health Organization [WHO], 2018). Exercise also has the ability to benefit the brain centers that exhibit executive control. Research has shown that increased cardiovascular exercise led to faster reactions on the Stroop test (Dupuy, 2015). The Stroop test is a test that tests the participants ability to inhibit
cognitive interference and stay focused on a single task (Stroop, 1935). Depression symptoms are also significantly reduced with the implementation of physical exercise. A meta-analysis showed that depression symptoms decreased when patients participated in aerobic exercises (Schuch, 2016).

**Exercise in Older Adults with Dementia**

Exercise has been shown to have benefits for older adults diagnosed with dementia. Exercise programs have shown to increase independence in activities of daily living (ADL) through strengthening limbs and improving balance (Toots, 2016). Trials have displayed the cognitive scores for patients with dementia who are enrolled in exercise programs perform better on a wide variety of cognitive tests (Ahlskog, 2011). One year of aerobic exercise specifically was able to increase the size of the hippocampus and improve spatial memory. There was also significantly less grey matter volume loss with aerobic exercise (Ahlskog, 2011). Regular exercise has also been shown to improve memory, executive functioning, attention, and behavioral problems in patients diagnosed with dementia (Law, 2018).

A meta-analysis found many positive outcomes for older adults who engage in exercise (Lorito et al., 2020). This analysis found that many of the studies analyzed showed that muscle strength improved with exercise. It was also found that balance could be significantly improved with multimodal exercise and exercise-based active video games (Lorito et al., 2020). Participants who were allocated to the exercise interventions of studies were shown to have a significantly reduced fall risk and mobility was improved in these participants. Many reviews showed that independence in completing activities of daily living was shown in older adults in residential care facilities (Lorito et al., 2020). Aerobic exercise was shown to increase peripheral blood brain-derived neurotrophic factor (BDNF) concentrations (Lorito et al., 2020). BDNF
plays a key role in the peripheral and central nervous system. Low BDNF levels have been linked to Alzheimer’s Disease and cognitive impairment (Balietti et al., 2018).

**Limitations to Exercise in Dementia**

While exercise has many well established and positive effects, there are several barriers to participation for older adults. The Office of Disease Prevention and Health Promotion outlines the 6 leading barriers to physical activity for older adults as lack of interest, shortness of breath, joint pain, perceived lack of fitness, lack of energy, and doubting the impact of exercise (International Council of Active Aging, 2011). For older adults with dementia, there are even more barriers to exercise that exist. The severity of a patient’s cognitive defect can impede participation in exercise. Other barriers may include total reliance on their caregiver, forgetfulness, and not having exercise programs tailored to the needs of participants with dementia (Hobson et al., 2019). Therefore, it is important to find the right exercise for each older adult with dementia that fits the individual’s cognitive and physical function. Exercise that is safe and engaging, as well as match the individuals’ functional level and personal interests, would be a viable option for older adults with dementia.

**Aquatic Exercise**

Aquatic exercise can be defined as a series of physical activities that are completed while in water (Nevia et al., 2018). By completing these activities in the water, there is significantly less stress on the joints. Aquatic exercise is widely recognized by various health professionals as a helpful exercise program (Nevia et al., 2018). Some examples of activities that may be incorporated into aquatic exercise programs are walking in the water, arm lifts, and wall glides. Walking in the water allows for the strengthening of the leg and core muscles through the water
providing some resistance to movement (Cronkleton, 2019). Arm lifts are a great way for participants to strengthen their arm muscles by starting with their hands in the water and lifting them up past their head. Wall glides help strengthen the lower body and core by encouraging participants to pull themselves close to the wall and use their legs to push off (Cronkleton, 2019).

Aquatic exercise provides a fun, safe, and interesting way for older adults to get exercise. It decreases incidence of joint pain due to the low-impact nature of being in the water. It keeps participants cool while allowing them to complete their workout. The class mentality holds participants accountable for participation while providing a fun social aspect to exercise. Water aerobics has been shown to increase limb strength, endurance, and increased cardiorespiratory capacity (Pereira, 2018).

**Summary**

In summary, exercise has been shown to have many different positive effects on older adults in general and older adults with dementia. However, there are many different limitations and barriers to participation. Aquatic exercise may help bypass many of these barriers to provide the aerobic exercise that has been proven helpful in older adults with dementia.

Aquatic exercise and dementia are a relatively new research topic. Some research studies have shown very promising results. Aquatic exercise has been shown to slow cognitive decline, decrease BPSD, and improve physical functioning. However, there are many gaps in the literature. While there has been an increasing amount of research studies that examine the effect of aquatic exercise and demonstrate positive outcomes in people with dementia, the evidence has not been comprehensively synthesized.
Chapter 3

Methods

The purpose of this project is to conduct a systematic review to synthesize research evidence on the effect of water exercise in people with dementia. Specifically, this review will address the following research question: What are the effects of water exercise on cognitive function and neurobehavioral symptoms in people with dementia? This chapter will outline how the searches were carried out and how articles were selected for analysis in this systematic review.

Literature Search Methods

The literature search was conducted on PubMed and CINAHL. The search terms were as follows (dementia OR Alzheimer) AND (water exercise OR water aerobics OR aquatic exercise). Articles were filtered to only include those published in English. No other filters were used.

Inclusion and Exclusion Criteria

The inclusion criteria were that articles must:

(1) study the impact of water exercise on people with dementia,
(2) be published in peer reviewed journals,
(3) be published in English,
(4) be original studies.

This review did not limit to specific study designs. To be inclusive, we broadly include qualitative, quantitative, and mixed methods research as well as case studies. Systematic reviews or other types of review articles were excluded but were used to help find relevant articles that studied water exercise and dementia.
Article Selection Process

The literature search yielded 58 articles in total with 43 articles from PubMed and 15 articles from CINAHL. First, duplicate articles were removed. Then all titles and abstracts were screened carefully. After screening titles and abstracts, 25 articles were excluded due to the fact that the studies examined other forms of exercise or other disorders (e.g., Parkinson’s disease), or did not fit into the inclusion criteria listed above. Next, all articles were read thoroughly to ensure that the articles fit the research criteria and 21 articles were excluded. This left 4 articles. Then, the references for each selected article were screened and two additional eligible articles were identified. After this, there were 6 articles available for this systematic review.

Data Extraction

Data was extracted from each article individually. The data extracted included authors, location of study, purpose of each study, participant characteristics, outcome measures, and relevant findings. Data extraction was completed by the author and was verified after a second review of all articles by the single author. An overall review was completed by an advisor to the paper.

Quality evaluation

Strengths and limitations were then evaluated by the researcher and each article was given a grade based off the Johns Hopkins Nursing Evidence Level and Quality Guide (Dang & Dearholt, 2018). This scale categorizes articles into five different levels of evidence based off of the design of study. All studies selected for this paper were either level 1, level 2 or level 5. Level 1 is categorized as experimental study, randomized controlled trial (RCT), or systematic review of RCTs, with or without meta-analysis. Level 2 includes quasi-experimental studies, a systematic review of a combination of randomized control trials, quasi-experimental and non-
experimental studies with or without meta-analysis. Level 5 is inclusive of studies based on experimental and non-research evidence. This includes literature reviews, quality improvement, case reports, and opinion pieces. The second part of the rating is a quality grade of either A, B, or C. A indicates that the study is of high quality with consistent and generalizable results with a sufficient sample size. B indicates a study of good quality with reasonably consistent results, with sufficient sample size for the study design. C indicates a low-quality study or one that includes major flaws.
Figure 3.1 PRISMA Flowchart of Article Selection

- 15 articles yielded from CINAHL
- 43 articles yielded from PubMed

- 58 potentially relevant articles recovered from CINAHL, and PubMed
  - 18 duplicates were removed
  - 40 potential articles were screened on title and abstract
    - 25 articles removed based off title and abstract screening
    - 15 potential articles were screened on full test
      - 11 articles removed based off full text screening
  - 4 eligible articles included.

- 2 eligible articles identified via ancestry search of relevant articles
  - 6 articles selected to be included in this review
Chapter 4

Results

Study Design

Six studies were included for this review (Henwood et al., 2017; Henwood et al., 2015; Myers et al., 2013; Neville et al., 2014; Schilling et al., 2018; Turnbull et al., 2018). All relevant data compiled from the analysis of the selected articles is included and reviewed in this chapter. Each article’s study design, sample, intervention, and results are described in this chapter. Table 4.2 includes a summary of all relevant information for each article. All articles were published between 2013 and 2018.

Among the six studies included in this review, one was a randomized control trial (Henwood et al., 2017), four were non-randomized controlled trials (Henwood et al., 2015; Neville et al., 2014; Schilling et al., 2018; Turnbull et al., 2018), and one was a case study (Myers et al., 2013). Of the four non-randomized control trials, one had a control group while the others used a pretest-posttest design with only one group.

Setting and Sample

Setting

Three studies took place in Australia and the other three took place in the United States (Henwood et al., 2015; Henwood et al., 2017; Neville et al., 2014). Two of the Australian studies were conducted in two residential aged care facilities in Queensland (Henwood et al., 2015; Neville et al., 2014), while the other study was conducted at seven different nursing facilities across Australia, including one in Gold Coast, one in Brisbane, and five in Toowoomba (Henwood et al., 2017). The three studies in the United States were conducted in Michigan (Schilling et al., 2018), Arizona (Myers et al., 2013), and one was conducted at an undisclosed location in the United States (Turnbull et al., 2018).
Five of the studies were conducted with participants from long-term residential aged care facilities or nursing homes (Henwood et al., 2017; Henwood et al., 2015; Myers et al., 2013; Neville et al., 2014; Schilling et al., 2018). Of these five studies, four were completed at municipal pools close to the facilities (Henwood et al., 2017; Henwood et al., 2015; Myers et al., 2013; Neville et al., 2014) and the fifth study utilized a pool on the campus of the facility (Schilling et al., 2018). The sixth study was conducted in a community pool (Turnbull et al., 2018).

**Sampling**

The sample sizes ranged from one to 56 participants in each study. Five of the studies had 12 or less participants with only one study having over 50 participants (Henwood et al., 2017). One study was a case study with only one participant (Myers et al., 2013).

All studies used convenience sampling. (Henwood et al., 2017; Henwood et al., 2015; Neville et al.; 2014; Schilling et al., 2018; Meyers et al., 2013; Turnbull et al., 2018). Five of the six articles specified that participants came from long-term or residential care facilities (Henwood et al., 2017; Henwood et al., 2015; Neville et al.; 2014; Schilling et al., 2018; Meyers et al., 2013). One study recruited older adults with dementia in the community. (Turnbull et al., 2018). Two studies reviewed the medical charts of those in the long-term care facilities who indicated a desire to participate (Henwood et al., 2017; Henwood et al., 2015). One of these selected willing participants who were regular attendees of the WaterMemories exercise program (Neville et al., 2014). The other study recruited members of the “Friends swim club” at their long-term care facility (Schilling et al., 2018). The final study was a case study that researched one participant who was participating in an aquatic exercise program (Myers et al., 2013).
Inclusion and exclusion criteria varied study by study. All of the studies required a formal diagnosis of dementia in order for participants to be included in the research. The inclusion criteria in one study included age over 65 and prior experience with swimming (Henwood et al., 2015). Two studies required the participant to be ambulatory (Henwood et al., 2015; Schilling et al., 2018). One study excluded people from participating due to an unstable or terminal illness (Henwood et al., 2015).

**Participant Characteristics**

Participant characteristics varied from study to study, with all participant age means falling between 80-90. Four studies used a mix of male and female participants (Henwood et al., 2017; Henwood et al., 2015; Neville et al., 2014 & Turnbull et al., 2018). One studied used only a male participant (Myers et al., 2013), and the final study used all women (Schilling et al., 2018).

The first study, completed by Henwood et al. (2017), involved 56 residents from 7 different nursing homes. There were 16 from Brisbane, 9 from the Gold Coast, and 31 from five facilities in Toowoomba. All participants had a mean Psychogeriatric Assessment Scale (Jorm et al., 1995) of $12.4 \pm 4.1$. Ten participants were lost for various reasons (death, stroke, agitation, or family obligations.) This left the final analysis with 46 participants. The mean age for participants was $82.4 \pm 6.6$. There were 18 males and 28 females. Participants were in residential care for an average of $459.2 \pm 458.1$ days (Henwood et al., 2017). The second study, completed by Henwood et al. (2015), had 10 residents from two different nursing homes. There were 9 females and 1 male. These participants had a mean age of $88.4$ years and all were diagnosed with moderate to severe dementia (Henwood et al. 2015.)
The third study was a case study with one participant. This participant was an 89-year-old man with advanced Alzheimer’s Disease (Myers et al., 2013). The fourth study consisted for eleven participants, 10 females and one male. The mean age of these participants was 88.4. All participants were selected because they were regular attendees at the WaterMemories exercise groups (approximately 50% of classes). The mean Psychological Well-Being in Cognitively Impaired Persons Scale (PW-BCIP) was 32.5 at baseline (Neville et al., 2014). The fifth study was completed by Schilling et al. and utilized 5 different participants who were all members of the “Friends Swim Club” at their long-term care facility. All of these participants were Caucasian females aged 80-85 with moderate to severe dementia (Schilling et al., 2018). The sixth and final study consisted of nine participants with an average age of 81.63 years (range: 72-94). There were six male and three female participants (Turnbull et al., 2018).

**Intervention Design**

Three studies utilized a 12-week program known as Watermemories (Henwood et al., 2017; Henwood et al. 2015; Neville et al., 2014). Watermemories is an aquatic exercise program that was designed specifically for people with dementia (Neville et al., 2013). Watermemories session follow the same format which is a warm up consisting of water walking and toe raises, followed by aerobic and balancing exercise (high knee marching, weight transfer exercises, etc.). Then, participants complete upper and lower body resistance exercises like squats and arm swings. The session is then finished with stretching (Neville et al., 2014). This program took place in municipal pools outside of busy pool times and school breaks (Henwood et al., 2017; Henwood et al. 2015; Neville et al., 2014). All three studies consisted of 45-minute sessions held two times a week for the 12-week timeframe. Trained instructors and volunteers were there to
assist the participants in the water. Two studies specified the ratio of helpers to participants during the program. One study had a 1:1 or 1:2 patient to helper ratio (Henwood et al., 2017), while the other study maintained a 1:1 ratio for participants to helpers (Neville et al., 2014). One study participated in a similar aquatic exercise program for 3 months (Myers et al., 2013). This program consisted of two 30-minute sessions a week for the entire 3-month duration of the study.

Another study consisted of two different intervention groups. All participants completed both interventions in order to compare the two. The participants completed 2 months of intervention split between land exercises (crafts, special events, exercise, and physical activities, and community outings) and aquatic exercises (standing or vertically based aquatic exercise (water walking, arm exercises), and land exercises (playing catch, tossing a beach ball, modified water volleyball and other simple aquatic exercises and games) (Schilling et al., 2018).

The final study also completed an aquatic exercise program, however this program consisted of six, one-hour progressive strength, flexibility, and balance group aquatic sessions (Turnbull et al., 2018).

**Timeframe.**

Three studies utilized the 12-week WaterMemories program but varied in their data collection timeline. Two studies took measurements at baseline and post-intervention (Henwood et al., 2017, Henwood et al., 2015). While one study took measurements at baseline, week 6, week 9, and post intervention (Neville et al., 2014).

One study collected results after 1 month of aquatic exercise and then serially over the next two months (Myers et al., 2013). This study had a baseline measure on record for the participant due to the other therapies he was receiving prior to the beginning of aquatic therapy (Myers et al., 2013). Another study consisted of 2 months of intervention with outcome measures
taken 19 times during the study (Schilling et al., 2018). The final study took measurements at baseline and after the intervention period (Turnbull et al., 2018).

**Outcome Measures**

There were a variety of outcome measures utilized by the different studies. The outcome measures were divided into three different categories: physical function, cognition, and behavioral and psychological symptoms of dementia. Each category contained a variety of measures. Table 4.2 outlines the outcome measures for each individual study.

**Physical Function**

Physical function was measured in many ways in the different studies. Physical function was studied in four of the studies selected for this analysis.

The Balance Outcome Measure for Elder Rehabilitation (BOOMER) was utilized in three different studies (Henwood et al., 2017; Henwood et al., 2015; Schilling et al., 2018) This scale is used to measure the balance and coordination of older adults. The BOOMER Scale includes the step test, where one foot is placed on a 7.5cm step and returned to the ground as many times as the participant could for 15 seconds, then the average between the legs is utilized for scoring (Haines et al., 2007). The second part of the BOOMER scale is the Timed Up and Go (TUG), where the participant, from a seated position, stands and walks three meters. Then the participant turns around and walks back to the chair and sits. This is timed (typically with a stop watch) and the time it takes the patient from start to finish (sitting down with back against the backrest) is their score. One study did not use the BOOMER scale in its entirety and only utilized the TUG test (Turnbull et al., 2018). The third component of the BOOMER scale is functional reach. In this test the participant reaches as far forward as they can in a standing position without losing their balance. The final component of the BOOMER scale is the timed static stance. This test
involves the participant standing with their feet together with their eyes closed. The participant is then timed to see how long they can stand still in this position. The scores are then compiled, and the participant is given a score between 0 and 16. Each component of the scale is worth 4 points and ranges from 0, or unable to perform, to 4, or excellent. The BOOMER scoring scale is outlined in table 4.1

Table 4.2. BOOMER Scoring Scale

<table>
<thead>
<tr>
<th>Test</th>
<th>Scoring</th>
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<tbody>
<tr>
<td>Step Test (average number of steps)</td>
<td>0</td>
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<tr>
<td>TUG (seconds)</td>
<td>0-5</td>
</tr>
<tr>
<td>FR (cm)</td>
<td>1-15</td>
</tr>
<tr>
<td>Timed Static Stance (seconds)</td>
<td>0-30</td>
</tr>
</tbody>
</table>

(Adapted from Haines et al., 2007)

Another scale used to measure physical function is the Short Physical Performance Battery (Guralnik et al., 2000). This scale was utilized in two different studies (Henwood et al., 2017, Henwood et al., 2015). This test is used to determine the coordination and balance of the participant through a variety of tests. This test consists of three different components: The first is balance tests. These tests include a Side-by-side test where the participant stands with their feet together for 10 seconds. The second test is the semi-tandem stand where the participant stands with the heel of one floor against the side of the big toe for 10 seconds. The third test is the tandem stand, which requires the participant to stand with their feet aligned head to toe for 10 seconds. The next component is the gait speed test. This test measures the time required to walk 4 meters at the participants normal pace. This test is completed twice, and the best score is
counted. The final component is the chair stand test. In this test the participant folds their arms across their chest and tries to stand from a chair. The participant then repeats these 5 times as fast as possible. The scoring for this scale is outlined in figure 4.1.
Figure 4.12. Short Physical Performance Battery

1. Balance Tests

- **Side by Side Stand**
  
  - 10 sec (+1 pt.)
  
  - Go to Gait Speed Test

- **Semi-Tandem Stand**
  
  - 10 sec (+1 pt.)
  - Go to Gait Speed Test

- **Tandem Stand**
  
  - 10 sec (+2 pt.)
  - 3-9.99 sec (+1 pt.)
  - <3 sec (+0 pt.)

2. Chair Stand Test

- **Pre-Test**
  
  - Abl
  
  - 5 repeats (timed)
  
  - >16.7 sec 1 pt.
  - >60 sec or Unable 0 pt.

3. Gait Speed Test

- **4m Gait Speed Test**
  
  - <4.82 sec 4 pt.
  - 4.82-6.20 sec 3 pt.
  - 6.21-8.70 sec 2 pt.
  - >8.7 sec 1 pt.
  - Unable 0 pt.

(Adapted from Guralnik et al., 2000)
The next measure of physical function used was muscle strength. Muscle strength was measured through hand grip tests. Two studies utilized this outcome measure (Henwood et al., 2017, Henwood et al., 2015.) One study utilized a bioelectrical independence analysis (Henwood et al., 2017). The other study utilized a Jamar dynamometer, (Henwood et al., 2015.)

The final test of physical ability is the Activities of Daily Living Scale developed by Katz in 1983. Two articles in this analysis utilized this scale to assess the participants cognitive and physical function (Henwood et al., 2017; Schilling et al., 2018) The Activities of Daily Living Scale is completed by asking the participant a series of 22 questions that assess a wide range of activities of daily living. The participant then ranks if/ how they complete the task (not at all, with help, on my own with difficulty, or on my own.) Then the participant is given a score out of 22.

Cognition

Cognition was evaluated in one of the studies selected for this analysis (Meyers et al., 2013). The assessment tool used to assess cognition is the Mini Mental Status Exam (MMSE) developed by Folstein in 1975. The MMSE is utilized in one article in the analysis (Myers et al., 2013). The MMSE is a 30-point test that measures the cognitive ability of the person taking it. This test is widely used to track the cognitive decline associated with dementia and assess the level of impact that dementia has on the participant. The MMSE measures orientation to time and place, short term memory, attention and problem solving, language, comprehension, and motor skills. The scoring of the MMSE is as follows; a score of over 24 is categorized as no dementia or ‘normal cognition’, a score of 19-23 indicates mild dementia, 10-18 indicated moderate dementia, while a score less than 9 indicated severe dementia.
Behavioral and Psychological Symptoms of Dementia (BPSD)

Behavior was studied in 4 of the studies included in this review (Henwood et al. 2017; Neville et al., 2014; Schilling et al., 2018; Turnbull et al., 2018). There were 3 different scales utilized to measure behavioral changes throughout the studies.

The first scale utilized was the Cornell Scale for Depression in Dementia (Alexopoulos et al., 1988). This scale was used by three different studies (Henwood et al., 2017, Schilling et al., 2018, Turnbull et al., 2018). This screening tool has two steps for assessment. The first step is an interview with the resident’s caregiver about 19 different behaviors that the caregiver may or may not have experienced. Then the clinician briefly interviews the resident. Each question is graded on a scale of 0-2 based on the severity of the symptom (0=absent, 2=severe). A score of more than 10 indicates that the person may be experiencing a major depressive episode while a score of over 18 is definitely indicative of a major depressive episode.

The final scale utilized to analyze behavior is the Revised Memory and Behavior Problems Checklist (Teri et al., 1992). This scale is also utilized to measure some cognitive outcomes as well. This scale was used in two studies included in this review (Henwood et al., 2017; Neville et al., 2014). The Revised Memory and Behavior Problems Checklist is a list of 24 behaviors that may be experienced by residents with dementia. These behaviors are rated based off frequency (0-9) and reactions to these behaviors (0-9). At the end the score will reveal the extent of the memory and behavioral problems. Some of these questions include, asking questions repeatedly, destroying property, talking loudly, verbal aggression, anxiousness, and a variety of others.
Psychological Well-Being

Well-being was studied in three of the articles selected for this analysis (Henwood et al., 2017; Neville et al., 2014; Turnbull et al., 2018). There were two different scales utilized to measure this variable of interest.

The first scale is the Psychological Well Being in Cognitively Impaired Persons to assess the participants’ affective states and behavioral engagement (PWB-CIP) (Bergner et al., 2005). This scale was utilized in two different studies that were included in the analysis (Henwood et al., 2017; Neville et al., 2014.) The PWB-CIP is a scale that can be completed in 5 minutes.

The second scale utilized in this analysis is the Warwick Edinburgh Mental Well-Being Scale (WEMEBES) (Stewart-Brown & Janmohamed, 2008). This scale was used in one article that was included in this analysis (Turnbull et al., 2018). The WEMEBES is a 14-item scale that has five different response categories. The items incorporate both feelings and functional aspects of mental well-being.

Effect of Aquatic Exercise

The results of the study were discussed based on the category of the outcome. One study did not report specific outcomes for the participants but did note that there was no difference in outcome for land based and aquatic based exercise (Schilling et al., 2018).

Physical Function

Physical function was studied in four articles selected for this systematic review (Henwood et al., 2017; Henwood et al. 2015; Myers et al., 2013; Turnbull et al., 2018). These studies showed overall positive but insignificant trends for the outcomes measures used.

Grip strength was a measure in two of the studies (Henwood et al., 2017; Henwood et al. 2015). Both studies noted improvement in both left and right-hand grip strength. One study noted
significant increased grip strength in both hands with a $7.7\pm 24.0\%$ (p=0.017) improvement in right hand grip strength and a $3.9\pm 23.6\%$ (p=0.003) improvement in left hand (Henwood et al., 2017). The second study noted significant improvement in left hand grip strength. Mean values for left hand grip strength significantly increased from 14.7kg to 16.4 kg (p=0.017) (Henwood et al., 2015). The right-hand grip strength also improved in this study, with mean values increasing from 9.7kg to 13.3kg, however these results were not significant (p=0.106) (Henwood et al., 2015).

Short Physical Performance Battery was used as a measure in two of the studies (studies (Henwood et al., 2017; Henwood et al. 2015). In one study, the summary score improved significantly in the intervention group by 12.4±35.2% and only improved by 4.01±34.63% in the control group (p=0.009) (Henwood et al., 2017). The individual measures also improved for standing balance (9.3±38.1%), 2.4-meter walk (-9.3±30.4%), and chair stand (-1.7±24.1%). In the second study, standing balance improved from 18.9 sec to 20.0 seconds (p=0.446), 2.4-meter walk improved from 0.5 m/s to 0.4 m/s (p=0.086), chair rise declined from 19.0 seconds to 20.4 seconds (p=0.093), and summary score declined from 5.2 to 4.5 (p=0.263) (Henwood et al., 2015).

The BOOMER scale was utilized in two different studies to measure physical function through various standing, reaching, and stepping exercises (Henwood et al., 2017; Henwood et al. 2015). In the first study, right step test improved 30±65.77% (p=0.818), left step test improved 20.3±65.3% (p=0.635), timed up and go declined with a change of -8.1±41.2% (p=0.396), functional reach improved 8.4± 48.1% (p=0.003), and static standing improved 39.6±158.3% (p=0.086) (Henwood et al., 2017). In the second study, right step test declined from 6.6 to 6.4 (p=0.748), left step test declined from 6.2 to 6.1 (p=0.864), timed up and go declined from
23.9 sec to 30.9 sec (p=0.051), functional reach declined from 16.4 cm to 14.1 cm (p=0.086), and static timed standing declined from 75.5 to 72.5 seconds (p=0.753) (Henwood et al., 2015). Another study did not state results for the entire BOOMER scale, however they did state results for the timed up and go test (Turnbull et al., 2018). In this study, the timed up and go improved by an average of 0.92 seconds (Turnbull et al., 2018).

Effect on participants’ activities of daily living was tested in one study measured by the Activities of Daily Living (ADL) (Henwood et al., 2017). This score declined from 7 to 5.5 in the intervention group while the control group score remained stable at 5.25 (Henwood et al., 2017). However, these results were not evaluated for statistical significance. The Apraxia Screen of TULIA (AST) was utilized in one study in order to measure the participants ability to follow commands with physical actions (ex. ‘brush your hair’) (Meyers et al., 2013). Scores for the one participant in this case study showed an AST score of 2/12 at baseline which increased to 5/12 after 2 months of intervention and then decreased to 1/30 3 months post intervention (Meyers et al., 2013).

Physical function was also noted in the case study through caregiver observation (Meyers et al., 2013). In this study, caregivers stated that post-intervention the participant would attempt to stand out of his wheelchair, which is something that he had never done before (Meyers et al., 2013). Another study stated that balance deteriorated in one of the seven participants; however, Conf-bal scores, or participants confidence in their balance, improved overall (Turnbull et al., 2018).

Cognition

Only one study evaluated the effect of aquatic exercise on a participant’s cognition (Meyers et al., 2013). This was a case study with only one participant. This study showed that
MMSE scores improved from 2 pre-intervention to 8 after 2 months of intervention on a 1-30 rating scale. These scores then began to decrease to 7 during the third month of intervention and then to 4 at three months post-intervention (Meyers et al., 2013). This study also utilized caregiver observations. Caregivers noted that the participant’s speech patterns were much clearer and that the participant had less trouble finding words (Meyers et al., 2013).

**BPSD**

Behavioral and psychological symptoms of dementia (BPSD) were studied in two studies (Henwood et al., 2017; Neville et al., 2014). Both of these studies utilized the Revised Memory and Behavior Checklist (RMBPC). One study noted that the frequency of overall BPSD declined from 11 to 7 times per week in the intervention group, and that this measure declined from 11 to 10 times per week in the control group (Henwood et al., 2017). The second study noted that the frequency of various BPSD behaviors significantly decreased from 2 (which indicated the behaviors occurs infrequently throughout the week) to 0 (indicating no presence of the behavior) after 9 weeks of intervention point (p=0.001) (Neville et al., 2014). Staff reaction to these BPSD were also noted and the staff ‘reaction’ (or how much each behavior bothered them), also reduced from 4 (which indicated that the behaviors were extremely upsetting to caregivers) to 0 after 9 weeks of intervention (p=0.001) (Neville et al., 2014). A third study utilized caregiver observations to measure BPSD. In this study, caregivers reported that the participant was much more expressive and talkative after each aquatic exercise class (Meyers et al., 2013).

**Well-Being**

Median values of the Psychological Well Being in Cognitively Impaired Persons Scale improved significantly in one study (Neville, 2014). This rating was improved from 32.5 to 38.5 after 9 weeks of intervention. During the fourth measure of outcomes (12 weeks of
intervention), the value decreased to 36.0, however this could have been influenced by the quarantine that the participants were placed in due to an outbreak of a GI infection in the facility (Neville, 2014). The participants’ well-being showed a slight improvement in another study, but the significance was not calculated (Turnbull et al., 2018). While the results were not statistically significant, the study reported that participants enjoyed the aquatic exercise and found it exciting (Turnbull et al., 2018).

**Adverse Events**

Four of the six studies research stated that the aquatic exercise activities were safe and that no adverse effects were noted in the participants (Henwood et al., 2017; Henwood et al. 2015; Neville et al., 2014 & Turnbull et al., 2018).
Table 4.2. Matrix Table

<table>
<thead>
<tr>
<th>Author(s)/ Year</th>
<th>Setting</th>
<th>Sampling</th>
<th>Design</th>
<th>Intervention and Control</th>
<th>Measures</th>
<th>Results</th>
<th>Strengths and limitations</th>
<th>Evidence Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henwood 2017</td>
<td>Nursing Homes 7 different facilities in Australia</td>
<td>56 Residents 29 allocated to experimental group 27 allocated to control group</td>
<td>Randomized Control Trial</td>
<td>Intervention: Watermemories: -twice weekly for 12 weeks -45 minutes -1:1 or 1:2 participant to staff ratio Control: participated in regular activities for 12 weeks.</td>
<td>-Grip Strength -SPPB -BOOMER -ADL Scale -RMBPC: frequency of BPSD</td>
<td>-Grip Strength: right hand grip strength improved by 7.7±24.0% (p=0.017) Left hand grip strength improved 3.9±23.6% (p=0.003) in intervention group -SPPB: Summary score improved by 12.4±35.2% in intervention group (p=0.009) -BOOMER: Right step test improved 30±65.77% (p=0.818) Left step test improved 20.3±65.3% (p=0.635) TUG declined with a change of -8.1±41.2% (p=0.396) Functional reach improved 8.4±48.1% (p=0.003) Static Standing improved 39.6±158.3% (p=0.086) -ADL Scale: Score declined from 7-5.5 in intervention group</td>
<td>Strengths: -Multiple facilities used -Only included participants who attended more than 40% of the classes -One specific program was used, which limited variations in how the exercise program was conducted from subject to subject Limitations: -Small sample size -large discrepancies between groups in some measures. -only pre and post intervention measures taken</td>
<td>Level 1, B</td>
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<tr>
<td>Henwood T</td>
<td>Two Nursing Homes Queensland, Australia</td>
<td>-10 Residents selected, all receiving the intervention -Inclusion Criteria: Over 65, residing in a nursing home, past history of swimming, dx of dementia -Exclusion criteria: wheelchair bound, unable to stand and walk &gt;6m, unstable or terminal illness, medications with exercise contraindications, behavioral fluctuations</td>
<td>Purposeful non-randomized trial</td>
<td>- 10 participants participated in a 12-week aquatic exercise program -Utilized the Watermemories Swimming Club program</td>
<td>-Grip Strength: Jamar dynamometer (hand grip muscle strength) -SPPB -BOOMER</td>
<td></td>
<td>and remained stable in control group at 5.25</td>
<td>-RMBPC: Frequency of BPSD declined from 11 to 7 in intervention group and declined from 11 to 10 in control group</td>
</tr>
<tr>
<td>Myers, K.</td>
<td>Case Study</td>
<td>-1 patient participated in 3 months of aquatic exercise</td>
<td>-MMSE -AST -BPSD: caregiver observations</td>
<td>Timed up and go declined from 23.9 sec to 30.9 sec (p=0.051) Functional reach declined from 16.4cm to 14.1 cm (p=0.086) Static timed standing declined from 75.5 to 72.5 seconds (p=0.753)</td>
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<td>Capek, D.</td>
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<td>Sabbagh, M.</td>
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<tr>
<td>2013</td>
<td>Dementia unit in Arizona</td>
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<tr>
<td>1 resident with Alzheimer’s disease, who resided on the dementia unit for one year -89-year-old man with advanced AD</td>
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<tr>
<td>Neville, C.</td>
<td>Pilot Study</td>
<td>-all participants participated in the 12-week WaterMemories aquatic exercise program</td>
<td>-PW-BCIP -RMBPC</td>
<td>Strengths: -Systematic review of various studies -Personal story (shows true impact, not just numbers)</td>
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<td>Henwood, T.</td>
<td>Cross-over design</td>
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<tr>
<td>Clifton, K.</td>
<td>Quasai experimental</td>
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<td>2 residential aged care facilities in Queensland, Australia</td>
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<td>-Eleven participants (10 female, 1 male) -Inclusion Criteria</td>
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<td>-PW-BCIP: mean value improved throughout the study Time 1: 32.5 Time 2: 33.0 Time 3: 38.5</td>
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<td>Strengths: -Specific protocol put into place to reduce variation from exercise plan. -Dementia specific</td>
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<td>Limitations: -Needs further studies to arrive at any conclusions -Very small sample -No statistical conclusions</td>
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<td>Level 5, B</td>
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<tr>
<td>Level 2, B</td>
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<td>Beattie, E.</td>
<td>-Were regular attendees at the WaterMemories aquatic exercise (at least one session a week for most weeks, at least 50% attendance rate), diagnosis of dementia, past history of or interest in swimming, were ambulatory (could use walking assistance devices), passed a physical wellness test done by their doctor</td>
<td>Time 4: 36.0 (p=0.034)</td>
<td>study with logical inclusion and exclusion criteria</td>
<td>Limitations: -A randomized control trial is still needed to confirm the findings -Small sample size -Only included those with moderate to severe dementia</td>
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<tr>
<td>Schilling, M L Coles, R. Simons, C. Frost, R.</td>
<td>Long term care facility Participants live at the -5 participants -All members of the &quot;Friends Swim Club&quot; -All</td>
<td>-Single-subject, alternating treatment design -single participant completed both aquatic and land exercises -19 observations made over a 2</td>
<td>-Balance: BOOMER Scale -Physical function/ Cognition: Activities of -There was no significant difference between aquatic and land-based activity interventions.</td>
<td>Strengths: -Great adherence to the program</td>
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<td>Limitations:</td>
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<tr>
<td>Year</td>
<td>Location</td>
<td>Participants</td>
<td>Inclusion Criteria</td>
<td>Activities</td>
<td>Outcome Measures</td>
<td>Findings</td>
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<td>2018</td>
<td>Michigan, United States</td>
<td>Caucasian females - All with moderate to severe dementia</td>
<td>Inclusion criteria: - Ambulatory - moderate to severe dementia</td>
<td>- Land based activities comprised of crafts, special events, exercise, and physical activities, and community outings - Aquatic activity included standing or vertically based aquatic exercise (water walking, arm exercises), playing catch, tossing a beach ball, modified water volleyball and other simple water exercises and games</td>
<td>- Daily living scale (Katz et al.) - Depression: Cornell Scale for Depression in Dementia (Alexopoulos et al.)</td>
<td>- Very small sample size - No members attended the same number of sessions - No further statistical analysis was attempted after reaching the conclusion that neither intervention had greater effect on the participants</td>
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</table>

Turnbull, J. Salwan, Community members in - 9 participants selected (6 male, 3 female) | Purposeful control trial | - 9 participants all participated | - BPSD: Warwick Edinburgh | - AT programs are safe and feasible for those diagnosed with dementia | Strengths: - Well rounded study | Level 2, B |
S. Pattman, J.  
2018  
the United States  
females)  
-Inclusion Criteria:  
-dementia diagnosis  
did NOT live in a long-term care facility  
-Convenience Sample  
Quasai Experimental  
in an aquatic exercise program  
-Six, one-hour progressive strength, flexibility, and balance group aquatic sessions.  
Mental Well-being Scale (WEMWBS)  
-Balance: Confidence During Balance (Conf-bal)  
-Balance/Movement: Timed Up and Go (TUG)  
-Physical function-Activities of Daily Living Scale  
-TUG improved by an average of .92 seconds  
-Conf-bal and WEMWBS showed small improvement  
-Of 7 people:  
• One Balance deteriorated  
• 5 flexibility stayed the same  
• All other measures improved  
Great Inclusion/exclusion criteria  
Focused on people with dementia  
Able to draw conclusions  
Limitations:  
Very small sample size
Chapter 5

Discussion

The overall finding of this systematic review of the effect of aquatic exercise on people with dementia yielded promising but inconsistent results. All studies reviewed showed some improvement in at least one area of the participants well-being, and no adverse effects were reported. However, three studies could not conclusively report significant positive results of the program. In these studies, insufficient small sample sizes may have contributed to the results failing to achieve statistical significance.

Physical Function

Overall, aquatic exercise had a positive impact on physical function in people with dementia. Grip strength was shown to improve in two different studies (Henwood et al., 2017; Henwood et al., 2015). This outcome is important to older adults due to the fact that grip strength is a vital component of many different activities. If this strength were to deteriorate, actions like opening a jar, operating a wheelchair, and even pulling up pants, would become more and more difficult.

Standing balance was shown to improve in two studies (Henwood et al., 2017; Henwood et al., 2015) and participant confidence in balance (Conf-bal) improved in another study (Turnbull et al., 2018). This shows that aquatic exercise can improve balance in people with dementia. This value is important in preventing falls in this population.

Significant changes were seen with functional reach in one study (Henwood et al., 2017) however, this value decreased in another study (Henwood et al., 2015). These conflicting results make it impossible to draw any conclusions about the impact on functional reach in this population. AST scores improved in one study, however these results only indicated an absence
of apraxia during one measure (Meyers et al., 2013). While these results show some promise, the small sample size of the case study makes these results unreliable.

**Cognition**

The effect of aquatic exercise on cognition was only tested in one case study. While the result showed positive impact on cognition; however, the evidence is too limited to make practice changes based upon it. The effect of aquatic exercise on cognition needs to be further evaluated in future research studies with larger sample sizes and more rigorous designs.

**BPSD**

The effect of aquatic exercise on BPSD was examined in two different studies; however, limited data was reported by each study (Henwood et al., 2017; Neville et al., 2014). No specific data about the types of BPSD were reported. While all results reported were positive, with one study reporting a decrease to 0 BPSD symptoms noted per week (Neville et al., 2014), more studies with intensive reporting are required to draw conclusions about aquatic exercise and BPSD.

**Well Being**

Well-being was measured in two different studies and showed positive results. One study showed an increase in well-being, which then dropped during the last measure; however, this could have been influenced by the quarantine that the participants were placed in due to an outbreak of a GI infection in the facility (Neville et al., 2014). In the second study, the results were not statistically significant, but the participants all reported that they found the aquatic exercise exciting and that they enjoyed the new way of working out (Turnbull et al., 2018). These results are promising; however, more studies needed in order to draw conclusions.
Limitations

There are only a few studies on aquatic exercise and its impact in people with dementia and the studies that do exist vary in methodology and area of study. This means that there are limited comparisons that can be made between studies. The studies also had limited sample sizes which makes generalization of the results impossible. These studies also focused only on those living in residential care facilities. Expanding the research to include members of the community would create more reliable results.

Several of the studies were also completed by the same lead authors (Henwood et al., 2015; Henwood et al., 2017; Neville et al., 2014). Neville and Henwood were authors on three of the six papers utilized in this review. A more diverse researcher pool is vital to producing reliable data.

There have also been issues that arose with studying exercise in this population. Older adults, especially those in residential care facilities, typically have higher dropout rates and lower attendance (Ouslander et al., 2011). When the participants have dementia, these problems are shown to increase (Burge et al., 2012). A 2011 review reported that only three of eight different studies were able to produce statistically significant results following a three-month program of a supported exercise (Littbrand et al., 2011). Another systematic review showed that while evidence was positive towards the effect of exercise in people with dementia, the various barriers to research in this population were too large to report any statistically significant results (Brett et al., 2016)
Implications for Clinical Practice

Aquatic exercise has been shown to be safe for people with dementia through the few studies that have been published on the topic. No adverse effects have been reported in any of the studies analyzed in this review and four of the six studies specifically stated that there were no adverse effects. There have been many positive results from these studies and it has been shown that the impact of aquatic exercise is no different than that of land exercise in terms of benefits, however aquatic exercise is low-impact, which is helpful for those with mobility and joint issues. This intervention should be implemented in people diagnosed with dementia in addition to their normal activities.

Aquatic exercise should be implemented to those residing in nursing homes first, so that the participants are under a more constant supervision to monitor for any adverse effects or risks that may arise after the program. This program should be implemented 2-3 times a week for 30-45 minutes a session. During these sessions, an instructor trained in the aquatic exercises should lead a small group of older adults (15-25) in aquatic exercise. A 1:1 or 1:2 ratio of staff to participant should be maintained in order to ensure the safety of all participants.

Medical care and other basic care costs for those with dementia are approximately 490.8 billion dollars worldwide per year (Alzheimer’s Disease International, 2015). As the disease progresses, so do costs of care. Aquatic exercise can provide a low-cost option to those diagnosed with dementia and give them a way to slow the progression of their disease. This will improve quality of life for these patients and provide more quality years of life.

Future Directions of Research

The impact of aquatic exercise in people with dementia needs to be investigated further. More studies with rigorous designs to study this topic are needed. Five of the six studies in this
AQUATIC EXERCISE IN PEOPLE WITH DEMENTIA

review had less than 30 participants, and only one of the studies was a randomized-control trial. Implementing more randomized-control trials with more participants will provide more reliable data.

All aspects of the impact of aquatic exercise in people with dementia need more studies. Cognitive impact was only investigated in one case study, so only one participant’s data was available for review. BPSD needs to be studied with a more rigorous design with better reporting practices so that frequency of specific BPSD can be studied.

Conclusion

Aquatic exercise shows promising results in improving physical function and BPSD in people diagnosed with dementia. These promising results however cannot conclusively answer the question of whether or not aquatic exercise provides significant and consistent positive impact on physical health, mental well-being, BPSD, and cognition in people with dementia. More research is required on this topic in order to draw a conclusion one way or another. However, the studies included in this review show promising results and provide hope that aquatic exercise programs can be implemented to improve the lives of people diagnosed with dementia.
References


Dupuy, O., Gauthier, C. J., & Fraser, S. A. (2015). Higher levels of cardiovascular fitness are associated with better executive function and prefrontal oxygenation in younger and older women. *Frontiers in Human Neuroscience.*


https://www.who.int/news-room/fact-sheets/detail/dementia
Academic Vita
Lauren McNally

Email: lem5581@psu.edu, laurenmcnally333@gmail.com

Education
The Pennsylvania State University | Schreyer Honors College
College of Nursing | Bachelor of Science, Nursing

Awards and Scholarships
- Dean’s List
- Schreyer Academic Excellence Scholarship
- Phi Eta Sigma Honors Society
- Center for Geriatric Nursing Excellence Scholar
- 3rd Place ENRS BSN Student Selected Poster Competition

Clinical Experience
Penn State Milton S. Hershey Medical Center | Clinical Rotation | Hershey, PA
Advanced Medical Surgical Nursing, Medical Intermediate Care Unit | 90 Hours | Fall 2020

Pennsylvania Psychiatric Institute | Clinical Rotation | Harrisburg, PA
Mental Health Nursing | 90 Hours | Fall 2020

Mount Nittany Medical Center | Clinical Rotation | State College, PA
Labor and Delivery Nursing | 45 Hours | Spring 2020

Various Locations | Clinical Observation Experiences | State College, PA
Pediatric Nursing | 45 Hours | Spring 2020

Mount Nittany Medical Center | Clinical Rotation | State College, PA
Medical Surgical Nursing, Medical Oncology | 90 Hours | Fall 2019

Centre Crest | Clinical Rotation | Bellefonte, PA
Nursing Care of the Older Adult | 90 Hours | Fall 2019

Work Experience
Pennsylvania State University Biology Department | University Park, PA.
Biology 162: Anatomy and Physiology Teaching Assistant | 2019-2020

Pennsylvania State University Biology Department | University Park, PA
Biology 142: Physiology Teaching Assistant | 2018-2019

Better Home Health Care, Rockville Centre, NY
Nursing Assistant | 2016-2019

Volunteer Activities/ Professional Experience
Springfield Benefitting THON | University Park, PA
Family Relations Chair (2019-2020) | Fall 2017-Present

Schreyer Honors Orientation | University Park, PA
Mentor for Incoming Schreyer Scholars | Spring 2018-2020

Nurse2B Program | South Nassau Community Hospital | Oceanside, NY
Shadowed nurses in various departments, participated in training courses pertaining to different skilled areas of nursing. | Fall 2016

Certifications
American Heart Association CPR/AED | Aug 2016- Present
American Red Cross First Aid Certification | Aug 2016-Present