The Impact of Aromatherapy on Dementia-Induced Agitation

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by

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Abstract

While dementia is known for its impact on memory and cognitive functioning, mood and behavioral changes, known as neuropsychiatric symptoms (NPS), cause great distress and negatively impact the lives and wellbeing of patients, families, and caregivers. Agitation is a specific form of NPS that is the result of patients externalizing their anxiety into behavioral symptoms, such as restlessness or aggression. With no pharmacological treatments available to treat these symptoms, non-pharmacological approaches, including aromatherapy, have been proposed. This study recruited participants within a memory care facility as a way to examine the effects of lavender essential oils on these symptoms. The observers utilized the Observed Emotion Rating Scale (OERS) and the Cohen-Mansfield Agitation Inventory Short Form (CMAI-SF) to measure their moods and frequency of agitated behaviors. A vignette is featured to provide the reader with a vicarious experience and analyze qualitative results. Quantitative results were determined by comparing means for each item of the OERS and CMAI-SF between the baseline and aromatherapy conditions. Major findings indicated that the anxiety/fear item (OERS) had decreased from 3.1 to 2.1, and the general restlessness category (CMAI-SF) had nearly halved, with 7.2 in baseline reduced to 3.7 following the introduction of aromatherapy into the facility. Based on the data, lavender essential oils may be able to curb some negative emotions and agitation in dementia patients, but efficacy varies between individuals and day-by-day. However, the numbers indicate that there is a positive outlook for aromatherapy as a way to reduce patient NPS, caregiver burden, and as a safer and cheaper alternative to pharmacological treatments.

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Introduction

Background

As one ages, it is common for changes in cognition to occur. This is a natural process known as cognitive aging, or the natural changes in cognitive functioning over the course of the life span (Institute of Medicine [IOM], 2015). This leads to uncertainty for older individuals and their families, unsure if the change is simply due to the natural aging process or something more sinister (IOM, 2015). This is attributable to the fear of neurodegenerative diseases, which typically begin in later life. Neurodegenerative diseases are incurable, progressive conditions wherein an individual's neurons gradually begin to lose function and die off (Gadhave et al., 2024). While this encompasses a wide variety of conditions, the most concern is for dementia. Dementia refers to a group of neurodegenerative diseases that form due to brain disease or injury, and is most commonly known for its impact on memory (Arvanitakis et al., 2019).

With advancements in medicine and technology, life expectancy is rising and people are living longer than ever before. Of course, aging is one of the strongest risk factors for the development of dementia (World Health Organization [WHO], 2025; Arvanitakis et al., 2019). Thus, longer lives do not come without difficulty. With a growing percentage of the population as elders, there is a rise in cases of cognitive decline (Phan et al., 2019). In a 2019 report by Arvanitakis et al., there were 47 million people around the globe living with dementia. By 2021, WHO reported 57 million individuals with dementia worldwide, and adding nearly 10 million new cases each year. This is expected to rise to 131 million cases by 2050 (Arvanitakis et al., 2019).

The WHO declared dementia a public health priority in 2017 due to the scope of its problems for not only elders, but also their families and healthcare workers who experience caregiver burden. The cost economy of dementia worldwide totalled $1.3 trillion USD in 2019. Additionally, half of these costs were attributed to non-professional caregivers, such as family or friends (WHO, 2025). As of 2022, there were over 11 million caretakers for individuals suffering from dementia (Reuben et al., 2024).

Due to the many concerns regarding dementia, treatment of these conditions have become a widely studied topic across fields like neuroscience and medicine, yet findings remain lacking and inconclusive. Unfortunately, there is no cure for dementia, and few medications have been approved to maintain or improve cognitive symptoms (Arvanitakis et al., 2019). Yet, these symptoms are far from the only ailment in these diseases. Occurring in over 90% of dementia patients, neuropsychiatric symptoms (NPS) include any symptoms that are unrelated to cognitive decline, such as depression, sleep disturbances, aggression, agitation, and psychosis, and are among the most distressing for both patients and their caregivers (Tampi et al., 2022; Phan et al., 2019).

Dementia

As mentioned previously, dementia is the umbrella term for various neurodegenerative diseases. The manifestation of symptoms vary greatly by person due to the wide range of syndromes and the location of the damage or disease. Typically, dementia includes a progressive loss of memory, but that is not always the case. Rather, it is characterized by a loss of cognitive

ability in at least two domains (such as memory), a decline from prior functioning, and impairment in day-to-day living (Arvanitakis et al., 2019). WHO reports some early symptoms of dementia as “forgetting things or recent events,” “getting lost when walking or driving,” “difficulties solving problems or making decisions,” and “losing track of time.” However, some cases may start more subtly, showing changes in mood and behavior that will worsen over time (WHO, 2025).

Most commonly, this decline is due to Alzheimer’s disease (AD), contributing to over 60% of dementia cases worldwide (WHO, 2025; Reuben et al., 2024). This is also the deadliest form of dementia, being the sixth leading cause of death worldwide and accounting for over 120 thousand deaths in 2019 (Arvanitakis et al., 2019; Gadhave et al., 2024). In the United States alone, AD affects 5.8 million people and 15% of the adult population over age 68 (Arvanitakis et al., 2019). Memory loss is a major symptom of this condition as the hippocampus, or the main memory “hub,” begins to lose neurons early in AD’s progression due to the presence of beta-amyloid proteins, seemingly only present in those with the disease (Gadhave et al., 2024; Harada et al., 2013). Additionally, there are early decreases in volume of the entorhinal cortex, which is the part of the brain that relays information between the hippocampus and other areas of the brain involved in memory (Harada et al., 2013). Other causes of dementia besides AD include Lewy body disease, frontotemporal lobar degeneration, repeated brain injuries, strokes, and even alcohol abuse (Arvanitakis et al., 2019; WHO, 2025).

Contrary to common belief, dementia is not a disease exclusive to the elderly. Early onset dementia refers to cognitive decline that begins prior to age 65 and accounts for up to 9% of dementia cases (WHO, 2025). While this does not appear to be a great risk, it accounts for over 5

million cases worldwide. In fact, the pathology of AD may originate decades prior to the onset of any symptoms (Harada et al., 2013). This means that dementia can “grow” for many years, leading to a desire for early prevention strategies even beginning in childhood (Livingston et al., 2020).

A variety of factors play a role in the development of dementia. Some individuals may be more at risk due to their biological or genetic predispositions. For example, risk is higher for people of color and those who were born as female; however, this risk may also be due to social and economic inequalities, making these individuals less likely to receive quality medical treatment (Arvanitakis et al., 2019; Livingston et al., 2020). The strongest known genetic factor for the development of AD is a particular, uncommon allele of the apolipoprotein E gene (Arvanitakis et al., 2019; Serrano-Pozo et al., 2021). Furthermore, an estimated 60% of cognitive abilities are due to genetic factors (Harada et al., 2013). In addition to genetics, certain medical and psychiatric conditions play a role. For example, hypertension, depression, diabetes, and traumatic brain injury increase the risk of developing dementia (Reuben et al., 2024; WHO, 2025; Livingston et al., 2020). Impairments in sensory processes, such as hearing loss, are also contributing factors. This risk may be treatable with hearing aids, but clinical trials remain divided (Harada et al., 2013; Reuben et al., 2024). Also playing a role is the individual’s physical and the social environment. An increase in social activity and a quality education may reduce the risk of dementia and improve upon cognitive ability (Reuben et al., 2024; WHO, 2025; Livingston et al., 2020). On the other hand, air pollution significantly increases an individual's likelihood of developing dementia (Reuben et al., 2024; WHO, 2025).

While the factors previously discussed are often not possible to avoid as a result of genetic make-up or access to resources, some risk or accelerating factors may also be the result of changeable behaviors. While it is not possible to get rid of dementia, steps can be taken to delay the onset, minimize the impact, and maintain well-being and quality of life (WHO, 2025; Harada et al., 2013; Reuben et al., 2024). A review by Reuben et al. evaluated proposed risk factors in dementia and cognition as a whole. Unsurprisingly, many studies find that the use of substances such as alcohol and tobacco greatly increase the likelihood of developing dementia (Reuben et al., 2024; Livingston et al., 2020). Furthermore, physical activity in later life and certain diets can reduce the risk (Reuben et al., 2024; Arvanitakis et al., 2019; Livingston et al., 2020). While physical activity is most often associated with maintaining health, it is also important to keep cognitively active throughout every stage of life (Livingston et al., 2020; IOM, 2015). Physical and cognitive health are deeply intertwined. In fact, individuals with dementia have more physical health problems and experience longer and more frequent hospitalizations than their peers (Livingston et al., 2020). However, the causal nature of this relationship is not known. Sustaining one's cognitive health includes engaging in learning, being social, maintaining physical health conditions (such as by taking prescribed medications), and getting adequate sleep each night (IOM, 2015). Cognitive decline worsens when the brain is not kept active, so it is particularly important for individuals who retired to continue engaging in day-to-day learning and interaction. In fact, problems with memory occur greater in individuals who retired versus non-retirees, highlighting the importance of keeping the brain active even after retirement (Livingston et al., 2020).

Despite preventative measures that can be taken, dementia cannot always be staved off. This means that, unfortunately, until there is a cure, dementia will be present in our lives. Knowing this, it is very important to take into consideration the management of its various conditions. Once dementia patients are no longer able to live independently, they will need a caregiver, whether in-home or in a facility. It is clear that both of these options require a lot of thought and emotion for the patient and their loved ones. However, often overlooked are the implications for the caregiver.

Caregiver Burden

Caregiver burden can be defined as a "...multidimensional construct encompassing caregiver struggles in fiscal, physical, psychological or emotional, and social well-being" as a result of demand exceeding available resources (Richardson et al., 2013, p. 367). Caregiver burden affects both professional and non-professional caregivers alike. There are three main dimensions of caregiver burden: stress burden, relationship burden, and objective burden. As per the name, stress burden refers to the emotional toll of caregiving while relationship burden regards the demand of the caregiver x care-recipient relationship. Objective burden encompasses a variety of concerns, referring to all other daily responsibilities outside of caregiving, often infringed upon by their caregiving duties (Richardson et al., 2013).

After professional caregivers, adult children provide the most care, followed by spouses (Richardson et al., 2013). There is also a clear indication of inequality within the caregiving system, with people of color providing more hours of care per week and experiencing more

caregiver burden, as well as over 50% of caregivers being female and/or having less than a college degree (Richardson et al., 2013).

The mental health concerns of caregivers are particularly important in caregiver burden. Caregivers are found to be at higher risk for depression, sleep disturbances, and feelings of isolation or loneliness (Richardson et al., 2013). Even besides the clear mental health impact of these issues, these factors also increase the likelihood of cognitive decline (Richardson et al., 2013). In all forms of caregiving, dementia caregivers are found to suffer the most and more severely from depression and anxiety (Cheng, 2017). To highlight this, 40% of dementia caregivers have reported depressive symptoms (Reuben et al., 2024). While it may seem simple for family members to place their loved one in a memory care facility to ease their stress, the solution is not that easy. Institutionalization of a relative is actually shown to also increase burden and depressive symptoms (Cheng, 2017; Richardson et al., 2013). Therefore, familial caregivers experiencing depression cannot alleviate their stress. This is especially likely as family members experience grief over the loss of who their loved one was in addition to experiencing caregiver burden (Richardson et al., 2013). This response may be just as bad as typical grieving, despite not having experienced their death. As their loved one has not yet passed, they do not gain social support and allowance for grievance that comes with a death, thus creating what is known as a “disenfranchised grief” (Papastavrou et al., 2007).

Furthermore, caregivers also have worsened physical ailments than non-caregivers. Due to chronic inflammatory response and sympathetic overactivation, they are more at risk for cardiovascular diseases such as hypertension (Cheng, 2017). Additionally, stress causes heightened cortisol levels, which can cause the caregiver to develop various conditions and risk

factors, including obesity and hyperinsulinemia (Richardson et al., 2013). These stress-induced changes can be particularly damaging for spousal caregivers, who are already at more risk for cognitive decline due to the aging process (Richardson et al., 2013). Even without the brain's biological changes from stress, caregiving is a physically demanding task. Physical exertion can directly harm physical health, and objective burdens can also limit caregivers' abilities to exercise or prepare healthy meals, leading to a less obvious, but still present decline in physical health (Richardson et al., 2013).

As per their name, caregivers must be able to care for the individual with dementia. Professional caregivers must do so for multiple patients at once, causing further difficulty. Dementia care is not a one-size-fits-all situation, so each patient's symptoms will manifest in different ways. Caregivers must know how to respond to all of these problems based on each individual's needs, which proves difficult to do with the wide variety of symptoms.

Symptoms

Cognitive Symptoms

Cognition as a whole extends to just about every basic function, having to do with abilities in aspects such as attention, memory, processing speed, and conceptual reasoning (Harada et al., 2013). In relation to dementia, cognitive symptoms include anything that has to do with declines in cognitive functioning. For example, some symptoms include difficulty in conversations, losing or misplacing belongings, being confused in familiar places, inability to perform simple tasks, and difficulties with spatial perception (WHO, 2025). Memory loss is, of

course, the most notorious symptom of dementia. It may manifest early on by an individual repeating conversations or forgetting to do important tasks such as taking medication, paying bills, or going to doctor's appointments (Arvanitakis et al., 2019). Even in the beginning, patients may find it difficult to learn new information, particularly failing to recall something they did recently (Arvanitakis et al., 2019). Throughout the progression of the illness, these symptoms will worsen and the patient will be unable to be independent or perform activities of daily living. For example, what may have been an inability to find the right words may develop into aphasia over time, and missing appointments progresses into forgetting loved ones' names or how to use basic appliances like telephones (Arvanitakis et al., 2019).

Neuropsychiatric Symptoms

As mentioned in the introduction, neuropsychiatric symptoms (NPS) are a frequent problem for dementia patients and their caregivers. The most common form of NPS varies based on the specific diagnosis of dementia. For example, apathy is most likely in AD patients, anxiety in dementia with Lewy bodies, and depression in those with vascular dementia (Tampi et al., 2022). Other kinds of NPS include sleep or motor disturbances, problems with eating or appetite, disinhibition, hallucinations, and even aggression (Tampi et al., 2022; Phan et al., 2019). NPS are associated with poor quality of life, worsened physical health, faster progression of the illness, institutionalization, greater degrees of disability, and greater morbidity and mortality rates (Beerens et al. 2016; Tampi et al., 2022).

NPS can be exacerbated or caused by a wide variety of stimuli, ranging from undiagnosed medical problems (like urinary tract infections or hypothyroidism) to miscommunication, and even environmental factors such as changes in routine and over- or under-stimulation (Tampi et al., 2022). As a result of this physical and mental frustration, the individual may display a negative mood, which is also a frequent NPS. Studies have found that negative affect is associated with increased agitated behaviors, thus creating a cycle of negative mood and NPS (Beerens et al., 2016).

NPS are oftentimes the most distressing ailments of dementia, both for the patient and the caregiver (Panza et al., 2015). A 2017 study by Cheng found that disruptive behaviors from NPS, rather than cognitive decline, are the most predictive factors of caregiver burden and depression. These symptoms are among the hardest to manage, placing strain on the emotional relationship between the caregiver and care-recipient due to their impact on every domain of living (Cheng, 2017). For example, a patient may require constant attention, activity, or stimulation, thus causing the caregiver to be unable to rest. NPS increase the incidence of stress in caregivers, leading to sooner institutionalization, and are the main cause of familial caregivers placing their loved ones in nursing homes (Phan et al., 2019; Tampi et al., 2022). As a result of this institutionalization, they make up one third of the entire cost of care for dementia (Tampi et al., 2022).

Agitation

Agitation refers to a syndrome and subset of NPS that is comorbid with various neuropsychiatric disorders, including dementia conditions (Cummings et al., 2014). The clinical and research definition characterizes dementia-induced agitation with four different criteria: "(1) occurring in patients with a cognitive impairment or dementia syndrome; (2) exhibiting behavior consistent with emotional distress; (3) manifesting excessive motor activity, verbal aggression, or physical aggression; and (4) evidencing behaviors that cause excess disability and are not solely attributable to another disorder (psychiatric, medical, or substance-related)" (Cummings et al., 2014, p. 7). For all forms of dementia, 20% to 60% of patients exhibit agitation behaviors (Panza et al., 2015). In particular, the prevalence of agitation is 40% in frontotemporal or vascular dementia patients, 30% for patients with Lewy body dementia, and 50% to 75% of AD patients (Carrarini et al., 2021; Mendez, 2021). Causes range from temporary mood states like loneliness or boredom, to discomfort from pain, fatigue, or side effects from medication. It could even be the result of serious, life-threatening conditions, like illnesses or infections (Phan et al., 2019).

Agitation has been proposed to be the result of patients externalizing their anxiety. (Carrarini et al., 2021). Anxiety is a preclinical symptom of AD, even before cognitive decline. This means that anxiety could be a warning sign for the presentation of agitation symptoms later on with a diagnosis, and can even increase the likelihood of developing dementia from mild cognitive impairment (Carrarini et al., 2021; Mendez, 2021). As a result, it has serious effects pre- and post- diagnosis. Past research has indicated that high levels of anxiety are associated with faster cognitive, and particularly, memory decline, even in patients with pre-dementia (Mendez, 2021). Therefore, while agitation does not directly affect cognitive functioning,

recurring agitation, as a form of anxiety, has prolonged effects on the brain that will have an impact over time.

This anxiety is oftentimes generalized, meaning it has no clear association (Mendez, 2021). Thus, agitation can occur at any time, regardless of the scenario. These symptoms can present themselves in a variety of ways. Facial expressions such as grimacing, wincing, and widened eyes are obvious signs of anxiety, but some may be more subtle, such as leg bouncing, hand wringing, or breathing rapidly (Lawton et al., 1999). On the other hand, symptoms may also be disruptive, with some individuals repeatedly calling out or shrieking, thus also causing distress and anxiety to those around them (Lawton et al., 1999).

From the broad definition, subtypes of agitation symptoms were created, identifying aggressive from non-aggressive types, and physical versus verbal types (Panza et al., 2015). Aggressive symptoms of agitation are the most simple to recognize. Physical aggression is meant to intentionally cause physical harm to self or others, including behaviors like hitting, kicking, grabbing, and biting (Cohen-Mansfield, 1991). On the other hand, verbally aggressive behaviors include that of screaming, outbursts, cursing, and making strange noises (Cohen-Mansfield, 1991). These behaviors are distressing and potentially harmful to the caretaker and other residents, as well as the aggressor. However, the intent to harm is not the cause of aggression. Patients are simply unable to express their needs in a healthy manner due to their altered cognitive state. Therefore, they utilize aggression to express their distress from pain, discomfort, or illness (Khachiyants et al., 2011).

While aggression is a well-known symptom, it does not occur in every case of dementia (Cummings et al., 2014; Panza et al., 2015). Unlike aggression, non-aggressive symptoms are

more subtle and may not even be noticeable unless under direct observation. Physically non-aggressive behavior may manifest itself in ways such as pacing, general restlessness, hiding things, and trying to get to a different place (Cohen-Mansfield, 1991). Verbally non-aggressive symptoms may appear as negativism, constant requests for attention, complaining or whining, and repetitive sentences (Cohen-Mansfield, 1991). While not directly harmful, these non-aggressive agitated behaviors are distressing to the individual, their caretaker, and others around them. Additionally, despite being non-aggressive, physical agitation may become dangerous, such as if the individual unintentionally wanders away or intentionally attempts to leave their place of residence.

Pharmacological Treatments

Cognitive Symptoms

Memantine and cholinesterase inhibitors like donepezil, galantamine, and rivastigmine have been created specifically to treat cognitive decline in those with AD. The impact of these medications varies by person, but they are associated with reduced caregiver burden and later institutionalization (Reuben et al., 2024). Still, the efficacy of donepezil and memantine still remains unclear, with some studies demonstrating an improvement in symptoms whereas others report a lack of efficacy (Tible et al., 2017). Cholinesterase inhibitors specifically have been linked to reduced mortality and moderate cognitive benefits (Reuben et al., 2024). However, of these treatments, a vast majority apply only to those with AD, leaving individuals with other forms of dementia without disease-specific care (Arvanitakis et al., 2019; Reuben et al., 2024).

In fact, rivastigmine is the only FDA-approved medication for Parkinson's disease and dementia with Lewy bodies, in addition to treating AD (Reuben et al., 2024). Despite not being FDA-approved, these medications are commonly used for patients with other forms of dementia, but its efficacy is minimal to none (Reuben et al., 2024). Furthermore, these medications still fail to benefit some of dementia's most distressing symptoms– agitation.

Neuropsychiatric Symptoms and Agitation

Effective treatments for agitation are yet to be found, with no FDA-approved pharmacological treatments currently available. This has led to the use of other forms of medication in the management of agitation (Kales et al., 2014). For example, trazodone, an antiepileptic mood stabilizer, has been utilized in treating patients with dementia. However, the improvement in agitation was little to none, caused mild side effects like dizziness and fatigue, and in fact, may worsen physical and cognitive decline (Phan et al., 2019; Carrarini et al., 2021; Reuben et al., 2024). Studies on benzodiazepines (sedatives) have also shown limited efficacy and similar side effects to antepileptics, but due to the nature of the drug, dependency is possible and thus can only be used for limited periods of time (Tible et al., 2017; Phan et al., 2019). Antidepressants such as citalopram have shown efficacy in improving agitation alongside the implementation of psychosocial treatment. However, the drug also resulted in impaired cognitive functioning, worsened apathy, and even caused cardiac disturbances (Phan et al., 2019; Carrarini et al., 2021). Therefore, it has been restricted to patients who have low cognitive impairment and moderate levels of agitation (Panza et al., 2015; Phan et al., 2019). Additionally, antipsychotic

medications like brexpiprazole have been used to treat agitation and found positive outcomes in decreasing agitated behaviors. However, brexpiprazole and other medications of its class are associated with serious adverse effects, including anticholinergic and extrapyramidal symptoms, seizures, strokes, and increased mortality rates (Reuben et al., 2024; Kales et al., 2014; Phan et al., 2019; Tible et al., 2017). As a result, they are only used in extreme circumstances where the patient is a harm to themselves or others (Kales et al., 2014; Phan et al., 2019). With these medications causing worsening of other symptoms and life-threatening health concerns, the dangers greatly outweigh the benefits.

Due to the risks of treatment, it is ruled that pharmacological management of NPS must only be used if the individual is a significant danger to themselves or others, is severely distressed by their symptoms, or if they are suffering from major depression (Kales et al., 2014; Phan et al., 2019). Even if the patient fits this criteria, pharmacological treatments should only be used temporarily due to their significant negative impact on an individual's health (Phan et al., 2019). With a lack of safe and effective treatments, it is particularly important to find an alternative way to manage agitation, leading to a push for non-pharmacological approaches.

Non-Pharmacological Treatments

Non-pharmacological treatments are built upon the idea that NPS stem from environmental factors and unmet needs, rather than a biological complication (Kales et al., 2014). Large organizations such as the American Psychiatric Association, the Alzheimer's Association, and the American Association for Geriatric Psychiatry, all emphasize the

importance of non-pharmacological treatments as a “first-line management” for agitation and other NPS (Phan et al., 2019; Kales et al., 2014; Dyer et al., 2018). It is important to note that this is only the case for NPS. Pharmacological treatments do not have a significant impact on NPS, but cognitive symptoms cannot be managed through the use of non-pharmacological treatments. Therefore, it is suggested to utilize non-pharmacological treatments in addition to medications, rather than replace them entirely (Cerejeira et al., 2012).

The push for research on non-pharmacological therapies is due to the non-invasive and less risky nature of these treatments in comparison to medications (Yang et al., 2015; Cerejeira et al., 2012). In fact, in a review by Dyer et al., there were no adverse side effects reported for any of the non-pharmacological studies. These findings are particularly important since, while not a full cure, there is no serious danger in utilizing a non-pharmacological intervention. While health-related adverse reactions are not present, some patients may respond negatively in terms of mood and behavior, meaning that in addition to successful implementation, treatment must be tailored to the individual and may not be applicable outside of clinical research settings (Phan et al., 2019; Kales et al., 2014).

A variety of non-pharmacological treatments have been proposed to manage NPS. Approaches such as virtual reality therapy, music therapy, animal-assisted therapy, and reminiscence therapy are being evaluated (Carrarini et al., 2021; Phan et al., 2019). Many of these alternative treatments have shown efficacy in research, alongside minimal, if any, adverse effects (Kales et al., 2014; Dyer et al., 2018). However, the impact of these treatments has tended to focus on mood, rather than agitation. Music therapy, for example, has been found to benefit depressive symptoms, and virtual reality therapy has improved social and emotional well-being,

but neither appear to have any impact on agitation (Zucchella et al., 2018). Aromatherapy is a strong contender to non-pharmacologically treat agitation, and therefore is the focus of this research study.

Aromatherapy

Aromatherapy is a non-pharmacological treatment derived from a form of herbal medicine that has been used across various cultures and for thousands of years (Holmes & Ballard, 2004; Li et al., 2021). In the modern age, aromatherapy is defined by the use of essential oils, or fragrant, natural extracts from plants (Holmes & Ballard, 2004). Its usage is widespread throughout research trials, as well as in recreational use. There are many different techniques to use these oils, including diffusers, oil burners, topical application, or even soaked into bedding (Holmes & Ballard, 2004; Li et al., 2021). As a result of its accessibility, ease, and relatively affordable and unprocessed nature, contemporary use of aromatherapy has become widespread.

One of aromatherapy's most popular scents, lavender, has even been traced back as far as ancient Greece, where it was used for therapeutic purposes (Cavanagh & Wilkinson, 2002). In the last hundred years, herbal remedies have fallen out of fashion in favor of modern medicine. However, lavender has remained a constant in many people's homes. There are a variety of lavender products ranging from pleasantly smelling candles to scented pillows specifically made to improve sleep (Cavanagh & Wilkinson, 2002). Lavender aromatherapy's reach has since spread from recreational use to research settings. Giving explanation to the effects of lavender, it has been found that the flower naturally contains linalyl acetate and linalool, which are shown to

have calming effects in preliminary studies (D'Andrea et al., 2022). There are also many clinical studies examining the impact of lavender on people's wellbeing, focusing on factors like pain, anxiety, and sleep (Cavanagh & Wilkinson, 2002). These projects have been conducted for those in good health, as well as those with medical conditions. For example, patients with chronic rheumatoid arthritis perceived less pain, better sleep, and improved overall well-being after lavender oil massage (Cavanagh & Wilkinson, 2002). This even extends to patients in more serious, life-threatening scenarios, with cancer patients experiencing reduced pain and anxiety associated with chemotherapy, and long-stay neurology in-patients showing improved mood and reduced distress (Cavanagh & Wilkinson, 2002). Because of these positive findings, in the recent decades, lavender aromatherapy has gained popularity in extended nursing care, being used in settings like rehabilitation or palliative care facilities (Cavanagh & Wilkinson, 2002).

Overall, essential oils have gained popularity due to their suspected and potential healing properties (Holmes & Ballard, 2004). Many proponents praise and vouch for the oils' efficacy in treating various mental and physical ailments. However, some are skeptical, questioning its true effectiveness. As a result, studies have been conducted across a variety of medical fields to determine its legitimacy.

Aromatherapy has been of interest in dementia research, and in fact, it has been used in research settings over the past two decades, specifically to examine its impact on NPS (Li et al., 2021). In particular, because lavender oil is believed to have calming properties, it has been used in a significant number of these studies (Li et al., 2021; D'Andrea et al., 2022; Yang et al., 2015). Aromatherapy's popularity in dementia treatment is due to the relationship between olfactory senses, mood, and memory. Psychological studies have shown a connection between exposure to

odors and positive emotions, as well as the triggering of past memories. Confirming this, neurological studies have discovered brain activation in the same areas of the brain when experiencing smells as with memories (D'Andrea et al., 2022). However, aromatherapy is highly debated due to dementia's impact on the olfactory system, which detects and processes scents (Fatuzzo et al., 2023). Impaired olfactory functioning is an early biomarker of many neurodegenerative diseases' development and indicates disease progression and cognitive impairment (Murphy, 2019; Fatuzzo et al., 2023). AD in particular is found to significantly weaken odor memory and identification (Murphy, 2019). Taking this into consideration, it is possible that dementia patients are unable to feel the effects of aromatherapy due to their weakened or non-existent sense of smell. However, there is research indicating that some oils, even through an inhalation approach, work by entering the bloodstream, rather than simply stimulating the olfactory nerve. Therefore, it is possible that aromatherapy could work even for someone with complete anosmia, or a loss of smell (Holmes & Ballard, 2004).

Despite skepticism, there are strong proponents for the efficacy of aromatherapy. In a systematic review of various non-pharmacological treatments, aromatherapy was found to have the strongest evidence in improving quality of life as compared to other approaches such as music or reminiscence therapies (Hui et al., 2021). Another study measured and compared the effectiveness of aromatherapy with aroma-acupressure, finding that both treatments improve patients' agitation levels. In particular, this is true of aroma-accupressure, which had a greater effect in reducing agitation (Yang et al., 2015).

A major benefit of aromatherapy is that essential oils do not cause many adverse effects. The main reported complication is skin irritation caused by the topical application of oils, but in

studies that featured an inhalation method, side effects were not present (Li et al., 2021). These same findings were supported in this study, as no adverse effects to inhalation were observed. Most aromatherapy studies have been conducted using an inhalation approach, and with a lack of adverse effects, aromatherapy inhalation may currently be the safest NPS intervention (Li et al., 2021).

Due to the nature of aromatherapy through an inhalation approach, not only is the patient receiving treatment, but it also has an impact on caregivers. As a result, some aromatherapy studies have measured caregiver stress and burden. In quantitative studies, caregiver distress was shown to be reduced, and in qualitative studies, caregivers reported emotional and relational benefits (Li et al., 2021). This may also be true in the instance of this research study, with staff commenting on the pleasant smell. Even if this impact is solely in caregivers, there is a clear potential benefit to the usage of essential oils in reducing stress. As non-pharmacological treatments aim to not only minimize NPS, but also to reduce caregiver burden (Kales et al., 2014), the usage of aromatherapy shows some semblance of efficacy.

Based on past research, there is reason to believe that aromatherapy could have a positive impact on patients' NPS, particularly in terms of agitation. Therefore, the purpose of this study was to explore the potential effects of aromatherapy in the treatment of agitation, specifically regarding the inhalation of lavender essential oil. Particularly, it was hypothesized that when compared to the baseline, aromatherapy using lavender oils would reduce signs of agitation and negative affect.

Method

Participants

Participants were recruited from two different Fox Trail Memory Care locations in New Jersey– Montville and Green Brook. To be eligible for the study, participants must have shown an interest in interacting with us, had an awareness of their surroundings, and had signed consent from their power of attorney. Six residents in the Montville location participated in the study. In the Green Brook facility, we received signed consent for four residents. However, one of these residents was excluded from the study as he was asleep for all but one visit. Another two residents were excluded due to incomplete data collection in either the baseline or aromatherapy condition. In total, seven participants were included in both the baseline and aromatherapy condition of the study, and thus, the data analysis.

Materials and Measures

We used a mini plug-in diffuser similar to Asakuki's 300ml essential oil diffuser on Amazon, and Whole Foods's 365 brand lavender essential oil. The LEDs were always set to a light violet color as a way to neutralize the stimuli as much as possible. In an attempt to reduce the Hawthorne Effect, during observation periods, the research team used plain notebooks to not draw attention to the measures. In each observation period, one individual from our team, the engager, would interact with the participant. The observer would then use two scales to measure the participants' agitation and mood.

The Observed Emotion Rating Scale (OERS) was used to measure the amount of time a particular emotion was displayed. There were five emotions used on the scale, measuring pleasure, anger, anxiety or fear, sadness, and alertness. The original scoring system was meant for ten minute observation periods, so the scale within this study was converted to measure during 20 minute sessions. A score of 1 on the scale represents that the emotion was never shown during the observation period, and a score of 2 indicates that the mood was displayed for up to 60 seconds. Following this, each score increased by five minute increments, up to a score of 6. For example, a score of 3 means that the emotion was displayed for one to five minutes. See Appendix A for the full scoring system and criteria for each emotion category.

To measure agitation, the Cohen-Mansfield Agitation Inventory Short Form (CMAI-SF) was used. Werner et al. created a modified, shortened version of the original Cohen-Mansfield Agitation Inventory, which featured 29 agitated behaviors and was to be performed over the course of two weeks. Within the CMAI-SF, there are 14 unique item categories that correspond to different agitation symptoms. While the original scoring system is measured on a seven-point scale over the course of a week, the observers collected raw data in the form of tally marks each time the behavior was observed. Each time an individual displayed one of these behaviors in the 20 minute observation period, a tally would be marked for that item. If it would continue for over one minute, it would be counted as another tally. This raw data was converted to an adjusted, six-point version of the scale's scoring system to be used over the span of 20 minutes. Appendix B displays the scale in its entirety alongside the adjusted scoring system.

Design and Procedure

Participants were observed for 20 minutes each while interacting with another person or engaged in an activity of their choice, such as coloring or watching the television. If a resident went to their room mid-observation period, they were not followed out of respect for privacy. The order in which we chose to observe participants depended on who was active at the time. During the observation, their behavior was measured and recorded using the OERS and CMAI-SF items. Any data that could not be captured in these measures was recorded qualitatively as "additional comments". For example, it would be documented if a participant walked out of view, thus losing time on the observation period or even ending it entirely. Similarly, notes would be taken if the participant received food, medication, or grooming before, during, or even after the observation period. These instances will be further discussed in the results section.

First, baseline data for each participant was gathered. Each participating resident was observed for two to four baseline periods. In total, 26 baseline observations were made. In the following weeks, aromatherapy was implemented. In the aromatherapy condition, each participant was observed for at least three sessions. Overall, 41 aromatherapy observations were made over the course of data collection.

During the aromatherapy sessions, upon arrival, a plug-in diffuser was filled with water to the max line and 7 drops of lavender oil were added. It was emptied before departing from the facility. This was done to ensure that the oil and water ratio was the same each day and was not more potent nor subtle. Prior to the observation periods, the diffuser ran for 15 minutes in order to allow the scent to fully spread throughout the room.

Analysis

Following observations for the day, the recorded data was entered into a spreadsheet. Each individual observation was manually added by the primary investigator or the research assistant. A duplicate document was created to manually adjust the CMAI-SF tally score into the transformed scoring system.

A vignette has been prepared to illustrate what a typical day in the facility may have looked like and provide readers with a vicarious experience. This vignette was written roughly three months after the events of the research study, so rather than based on a specific day, the story regards frequent happenings and events across various observation periods. Details such as the house layout, safety protocol, and caregiver tasks were included to describe the facility and depict the environment outside of resident interactions. The vignette describes challenges faced by the patients, the caregivers, and the research team. It provides examples of behaviors that were ambiguous, which would then be coded as per the discretion of the observers based on the surrounding context. Specific participant examples were chosen to showcase the large range of symptoms and manifestations of dementia. Of the seven participants in the study, three were included– these portray the most cognitively aware individual, the most restless individual, and an individual in-between. The four other participants were not included in order to create a concise picture, but behave similar to at least one of the represented residents. Due to the nature of the study, more severe cases of cognitive impairment were unable to be studied, and therefore, while present, were not included in the vignette. Portraying these residents in the vignette thus provides a stronger understanding of the facility dynamic.

Qualitative Analysis: Vignette

We drove into a suburban neighborhood. On the left was a two-story house made of brick and cream-colored panelling. Around the house was a white picket fence. The front yard was mowed and plants were in plots around the fence. To the left of the house was a small driveway, fitting just about four cars. We parked along the side of the street and made our way to the entrance. At the gate, there was a doorbell and a sign that read “for the safety of our residents, you will be buzzed in by a staff member“. I pressed the bell and waited for a few moments before the gate swung open. We walked to the front door, where we were greeted by a woman in a purple shirt. The workers all wear a purple uniform so the residents know who can help them. We entered and she closed the door behind us, before locking the door and entering a code into the alarm system.

Only a dozen residents live there, making them close enough to call each other family. To the right was a hallway, where about half of the residents live. The rest of the rooms were upstairs. Every door is a different color, each with a name tag and a mailbox. We walked the other way, into a large, open room. There was a long, L-shaped couch and three armchairs. A game show played on the television. A woman was sitting in one of the chairs, watching the screen. A couple was napping together on the couch, holding hands. Right beside the couch was a long table, fitting about 14 people. There, a woman sat, coloring a large sheet of paper. At the other end of the table, another woman was talking to a cat plush she was holding against her chest. To the left was a small kitchen where all the meals are made, and a worker was putting together a dozen sandwiches. There was a rope barrier to keep the residents away from the cooking equipment. On the other side of the room was a sliding glass door, leading to a

backyard. Outside, there were two tables, each with a small floral centerpiece, next to a small garden filled with herbs. A walking path weaved around the trees and bushes. A bench sat facing the back of the house.

We went to the facility to collect data at least three times a week, so we had a standard routine. As we walked in, we greeted everyone with a friendly "good morning!" and proceeded to the table. The woman, who will be referred to as Theresa, stopped coloring and stood up, before giving us both a hug. She looked at me and exclaimed, "it's been so long! You have gotten so tall since the last time I saw you!". I smiled and laughed, despite knowing I saw her the previous morning. While my partner continued the conversation, I got the diffuser ready and plugged it in beside the table. We chose to observe her first for the day since she was already engaged in conversation.

My partner became "the engager" since she was already speaking with Theresa, while I observed their interaction as "the observer". We always had the engager sit next to the participant and the observer sit at a seat across from them, as a way to best view their facial expressions and body language. "Do you want to do some more coloring?," my partner asked her. "I've already colored everything on this paper." "Okay, what would you like to do today instead?" "I don't know." The two of them would end up talking for a few minutes before she picked up a colored pencil and began to color another sheet. Once she got invested, her face would turn deadpan and she would sit in silence, not acknowledging any conversation. It was unclear whether to mark this behavior as unalertness. However, we decided not to as she was engaged in an activity. Since it was not marked in either scale, behaviors like these were written down under an "additional notes" section. Theresa could never sit still for long. It was only a matter of time before she

would stand up, and either take a walk outside or fold laundry. If she left the main room before 20 minutes were over, it would compromise our data for that observation period and we would have to restart or try again another day.

The most active of the residents was a man with aphasia, who we will call Richard. He was often the easiest to get engaged for an observation. While his speech was not clear, he loved to talk. He had a few characteristic phrases that he would always go back to. He would walk aimlessly around the living room while rubbing his hands together, talking to himself, and looking for someone to interact with. The other residents didn't know how to respond, leading to a few disagreements and lots of confusion on both sides. He often tried to cross the rope into the kitchen to talk with a worker or two. We debated whether or not to count these kinds of behaviors as "pacing, aimless wandering, [or] trying to get to a different place" since it was goal-oriented. We decided not to tally these behaviors because it was done with purpose– to fulfill a social need. Once engaged with, he would smile and laugh at just about everything. These expressions were then coded into the OERS by timing how long they were displayed. We would do this by counting in our heads, but if the display was for longer than 30 seconds, a timer would continue counting for accuracy. This would often happen during one of his favorite activities, which was rolling a ball back and forth. But sometimes as he waited for his turn, he would begin to repeat words in rapid succession, pound on the table, or vigorously rub his hands together, shaking his whole body in the process. Each time he would begin a restless behavior like this, we would make a tally on the corresponding CMAI-SF item.

Another resident, Ruby, sat on an armchair with her feet outstretched onto an ottoman, where she wrapped herself in a blanket and stared at nothing. Participants tended to be alert for

most of the time, so unlike other OERS items, unawareness was subtracted from the 20 minute alertness total. Her lack of response to stimuli would then be timed, oftentimes reducing her alertness score. On occasion, she hid bags of chips by her chair, smiling to herself as she snacked on them. No matter how small the response, it would be counted in the OERS. Some days, she would sing along to the oldies station on the radio. Other days, she sat there and cried. But as soon as she was engaged in conversation, she would smile and talk about what she could remember from her life.

When it was time for lunch, we began to pack up the diffuser and our papers. We helped set the table and situate the residents in their seats. Richard repeatedly stood up and walked back to the couch, only satisfied with sitting when reassured many times that the food was for him. It was around this time when some of the residents were given medication. A nurse would mix the medicine with a cup of applesauce or pudding, making it more tolerable. When everyone in the house was situated, we would leave for the day. A worker input a code to turn off the alarm system and open the gate. On the way out, we made sure to close the gate, ensuring the residents stayed safe.

Quantitative Analysis: Results

Statistical Significance

Due to the nature of this study, statistical significance is not present within any of the analyses. Significance cannot be determined with the limited number of participants in the study, as there are only seven in total. This is due to the limitations in regards to the number of consent forms, as well as these residents' willingness to participate. Instead, a comparison of mean values and qualitative analysis have been conducted.

The Observed Emotion Rating Scale

The OERS measures the amount of time pleasure, anger, anxiety or fear, sadness, and alertness were displayed during the observation. This study transformed the original scale to measure during 20 minute observation periods, as opposed to ten minutes. Table 1 displays the averages for each emotion during the baseline versus the aromatherapy condition.

Table 1

Average OERS Score Before and After Aromatherapy Treatment

OERS Item	Baseline condition	Aromatherapy condition
Pleasure	3.3 (1.1)	2.9 (1.6)
Anger	1.9 (0.7)	1.1 (0.4)

Anxiety/fear	3.1 (1.3)	2.1 (1.2)
Sadness	2.1 (0.9)	1.6 (1.3)
Alertness	6.0 (0.6)	5.9 (0.5)

Note. Numbers in parentheses indicate the standard deviation

Analysis

In terms of the OERS, small, but consistent differences were recorded. The anger, anxiety, and sadness measures seemed to, for the most part, decrease in a majority of participants. The averages for each, respectively, decreased from 1.9 to 1.1, 3.1 to 2.1, and 2.1 to 1.6. The overall difference is present but not particularly meaningful for the anger and sadness measures. However, the reduction in anxiety/fear is of note and will be discussed further in the analysis of the CMAI-SF. As for the scores on pleasure, there does not appear to be a meaningful difference between the baseline and observation periods, showing only a small, 0.4-point reduction. Similarly, alertness does not have a significant difference between the two conditions. The baseline condition has the highest possible score of 6.0, while the aromatherapy condition has a mean of 5.9, only 0.1 points less than the other.

On an individual level, it was recorded that participant #3 had even displayed virtually no negative emotions during 3 different observation periods. This participant already had lower scores on negative emotions prior to the treatment, but still displayed some form of negative emotion during the baseline. However, in some participants, there seems to be an almost sedative effect. For example, after the introduction of aromatherapy, participant #2 had begun to have a flat affect and was not as talkative. Opposite of what was expected or observed in others, one

participant had cried for the entirety of multiple observation periods after the introduction of the aromatherapy, but the observers are unsure if there was another underlying cause. These strongly contrasting observations could be the result of a variety of individual differences.

Cohen-Mansfield Agitation Inventory

The CMAI-SF items correspond to different agitation symptoms. In our study, raw data was collected in the form of tally marks every time a behavior item was observed, and was later converted into a scale. Unlike the original, week-long scoring, our system was adjusted for use over a 20 minute period. Analysis has been done with both the raw data, as well as the transformed scale. Table 2 indicates the baseline and treatment's average scores before converting the tally marks into the new scale. Table 3 shows the same, but after using the six-point scoring system.

Table 2

Average CMAI-SF Tally Score Before and After Aromatherapy Treatment

CMAI-SF item	Baseline condition	Aromatherapy condition
Cursing/verbal aggression	0.1 (0.2)	0.0 (0.0)
Hitting, kicking, pushing, biting, scratching, aggressive spitting	0.1 (0.2)	0.0 (0.0)
Grabbing onto people, throwing things, tearing things, or destroying property	0.0 (0.0)	0.0 (0.0)

Other aggressive behaviors or self-abuse including: intentional falling, making verbal or physical sexual advances, eating/drinking/chewing inappropriate substances, hurt self or other	0.6 (2.5)	0.0 (0.0)
Pace, aimless wandering, trying to get to a different place (e.g. out of the room/building)	0.4 (1.0)	0.1 (0.4)
General restlessness, performing repetitious mannerisms, tapping, strange movements	7.2 (5.9)	3.7 (5.4)
Inappropriate dress or disrobing	0.0 (0.0)	0.0 (0.0)
Handling things inappropriately	0.2 (0.5)	0.0 (0.0)
Constant request for attention or help	0.2 (0.7)	0.0 (0.0)
Repetitive sentences, calls, questions, or words	0.8 (1.5)	1.7 (3.8)
Complaining, negativism, refusal to follow directions	0.1 (0.3)	0.2 (0.8)
Strange noises (weird laughter or crying)	0.7 (1.1)	0.1 (0.6)
Hiding things, hoarding things	0.0 (0.0)	0.0 (0.0)
Screaming	0.0 (0.0)	0.0 (0.0)

Note. Numbers in parentheses indicate the standard deviation

Table 3

Average CMAI-SF Score Before and After Aromatherapy Treatment on the Adjusted Scale

CMAI-SF item	Baseline condition	Aromatherapy condition
Cursing/verbal aggression	1.1 (0.2)	1.0 (0.0)
Hitting, kicking, pushing, biting, scratching, aggressive spitting	1.1 (0.2)	1.0 (0.0)

Grabbing onto people, throwing things, tearing things, or destroying property	1.0 (0.0)	1.0 (0.0)
Other aggressive behaviors or self-abuse including: intentional falling, making verbal or physical sexual advances, eating/drinking/chewing inappropriate substances, hurt self or other	1.2 (0.7)	1.0 (0.0)
Pace, aimless wandering, trying to get to a different place (e.g. out of the room/building)	1.2 (0.4)	1.0 (0.2)
General restlessness, performing repetitious mannerisms, tapping, strange movements	3.2 (1.6)	1.6 (1.7)
Inappropriate dress or disrobing	1.0 (0.0)	1.0 (0.0)
Handling things inappropriately	1.2 (0.4)	1.0 (0.0)
Constant request for attention or help	1.1 (0.2)	1.0 (0.0)
Repetitive sentences, calls, questions, or words	1.4 (0.6)	1.5 (1.1)
Complaining, negativism, refusal to follow directions	1.1 (0.3)	1.1 (0.3)
Strange noises (weird laughter or crying)	1.4 (0.5)	1.2 (0.2)
Hiding things, hoarding things	1.0 (0.0)	1.0 (0.0)
Screaming	1.0 (0.0)	1.0 (0.0)

Note. Numbers in parentheses indicate the standard deviation

Analysis

The biggest impact was in the CMAI-SF category labeled as “general restlessness, performing repetitious mannerisms, tapping, [and/or] strange movements”. For ease of reading, this will be referred to as restlessness. In terms of restlessness, the CMAI-SF tally score had decreased from 7.2 to 3.7 after the introduction of aromatherapy treatment. This means that prior

to aromatherapy exposure, on average, a participant would display a sign of restlessness 7.2 times per 20 minute observation period. During aromatherapy treatment, participants would, on average, display 3.7 signs of restlessness during the 20 minute period. The adjusted scoring system displayed similar results. During the baseline, participants scored 3.2 on restlessness, and decreased to 1.6 following treatment.

All but two participants had a decreased restlessness score with aromatherapy when compared to their lowest baseline score. Participant #6, who previously had some of the highest scores of restlessness, had shown less signs after treatment. Prior to treatment, this participant had an average of 9.3 signs of restlessness per observation period, with the two observations measuring 10 tallies and another at eight tallies. Following the addition of aromatherapy into the environment, their score decreased to an average of 6.0 times, and the participant even displayed zero signs of restlessness during one observation period. However, there was one day where their score was higher than the baseline observations, with a total of 13 tallies for restlessness. Two other CMAI-SF categories had increased during this session as well, indicating that there was likely an underlying cause of increased agitation. Another case, participant #11, had shown increased restlessness following treatment, with a baseline average at 10.7 displays of restlessness, to 16.7 times during the aromatherapy observation periods. However, this may be caused by a highly increased score during just one session, with a total of 25 tallies. After said observation period, a family member visited and noticed a change in the participant's demeanor. Still, there was not a consistent nor meaningful change between the baseline and aromatherapy conditions, with baselines measuring 13 and 19 tallies, while aromatherapy reported 16, nine, and 25 tallies. On the other hand, most participants, such as participant #5, had little, but still

improved restlessness tallies. Their average tally score in the baseline was 3.3, and decreased to 1.0 following treatment. This falls in line with the fact that many patients will respond well to non-pharmacological treatments, but some may be distressed by the intervention, thus exacerbating their symptoms (Phan et al., 2019). Overall, this shows that there is a wide variety of impact between participants, as well as day-by-day. While not an effective treatment for all residents or at all times, the average decrease supports the idea that restlessness may be minimized by lavender oils in certain situations. This supports some previous research and may explain why overall findings have not been consistent across studies.

One category on the CMAI-SF, “repetitive sentences, calls, questions, or words”, increased from 0.8 to 1.7 following treatment. This appears to have been due to a single participant whose score increased drastically, and this idea is supported through the large standard deviation. The observers presume this change to have been attributed to the addition of a robotic pet stimulus, as the participant would repeat phrases related to the animal. However, this may be beneficial as it is possible that she had been more excited to interact with the pet, rather than repeating these phrases in an agitated way.

There does not appear to be a noticeable difference in other CMAI-SF items. The average score for all items on the scale decreased overall, but not substantially. Specifically, scores for the raw data decreased from 0.7 to 0.4, and from 1.3 to 1.1 on the adjusted scale. The average of 0.7 indicates that when taking all items into consideration, there was less than one sign of agitation during the entire observation period; however, this is far from the case. This is likely because of a floor effect, as some categories did not have any, or very few of the behaviors observed throughout the course of the study. Contributing to this effect, categories that were

never recorded (in neither the baseline nor the aromatherapy condition) include “screaming”, “hiding things, hoarding things,” “inappropriate dress or disrobing,” and “grabbing onto people, throwing things, tearing things, or destroying property.” The categories of “cursing/verbal aggression” and “hitting, kicking, pushing, biting, scratching, aggressive spitting” each have one isolated instance during the baseline observations.

Some participants also have a higher average score than others across all items. In the baseline measurements, the average score for each participant’s general agitation ranged from 0.0 to 2.8, indicating a wide range of agitation levels. Due to this, those with abnormally high scores, as well as those with abnormally low scores, skew the data.

There are also some observation periods where the participant acted out of character, or otherwise differently than what was expected based on previous observations. It is difficult to know whether these differences are due to another stimulus or underlying circumstance. For example, during one baseline, participant #6 had a high agitation day, with a total tally average of 1.9 across all CMAI-SF items. Immediately following the observation period, the participant was administered a Xanax due to their anxious behavior. During the aromatherapy condition, the same participant was given medication just prior to the observation period. Their total agitation score (in tallies) for that day was 0.6, notably lower than their baseline measurements. However, it is not possible to know whether this difference is due to a calming effect from the aromatherapy or due to the medication.

After removing the three explainable abnormal observation periods from the data (two from the aromatherapy treatment and one from the baseline), the average tally score for restlessness went from 7.0 in the baseline to 2.9 in the aromatherapy condition, compared to 7.2

to 3.7 in the original analysis. Those excluded include an outside individual (such as a family member) commenting on strange behavior, or the administering of medication just before or after observation. There was a small change (0.2-point decrease) in the baseline, indicating that the extraneous circumstance did not skew the data, but it did slightly overestimate the restlessness score. On the other hand, the average of the aromatherapy condition decreased by 0.8 points after the removal of atypical observations, signifying a positive skew of the data in the original analysis. In other words, these extenuating circumstances led to an underestimate of aromatherapy's impact on restlessness.

Discussion and Conclusions

Analysis of Results

The slight decrease in the mean for the pleasure category indicates that displays of happiness could potentially be muted while exposed to aromatherapy. Little to no change in pleasure was expected as the oils are used as a calming agent, rather than as a way to improve mood. Due to its calming properties, alertness was expected to have a slight decrease, but this was not supported by the data as there was virtually no change between the baseline and aromatherapy observations.

Of note, however, is the anxiety/fear averages pre- and post- treatment. Having been reduced by 1.0 point, there is an indication that aromatherapy helped to alleviate signs of anxiety. While it may not seem like a lot, the decrease by one full point indicates that up to five less minutes of anxiety were displayed per observation period. This difference may be due to diminished displays of restlessness, like lessened leg bouncing, tapping, or fidgeting. The criteria for each OERS item featured a variety of possible manifestations, from clear facial expressions to subtle body language cues. Signs of restlessness, repeated or agitated movement, and other forms of agitation were within the anxiety/fear category. Therefore, as a participant's CMAI-SF restlessness score decreased, so did their OERS anxiety/fear score. Within this study, restlessness decreased in most cases, leading to a decline in average scores on both scales.

While a majority of cases showed a decline, there were some where the participant had a higher total score than the baseline. Some days, a participant may have had increased anxiety solely due to circumstances such as illness, pain, hunger, or simply having a worse symptom day.

This could also be due to external factors, including changed routines, weather, and interactions with caregivers or other residents. While it did not include participants within the experiment, resident hospitalizations and death occurred during the time of the study, resulting in stress or unease for our team, the caregivers, and some of the residents during these periods.

Some patients experienced a flat affect after the introduction of aromatherapy. It is possible that the oil was used in too high of a concentration. It has been reported that high concentrations of lavender may reduce cognitive functioning, and can even cause convulsions in some patients (Holmes & Ballard, 2004, Cavanagh & Wilkinson, 2002). Within our study, no such side effects were documented. However, some individuals' flat affect may be explained by this factor. As previously stated, lavender has a natural presence of linalyl acetate and linalool, which have presumed calming effects (D'Andrea et al., 2022). Specifically, linalool is a natural sedative while linalyl acetate is a natural narcotic agent (Cavanagh & Wilkinson, 2002). Due to the lipophilic properties of linalool, it is easily and rapidly absorbed and transported through the body to the brain, meaning that limited olfactory processing is not weakening its effects (Holmes & Ballard, 2004; Cavanagh & Wilkinson, 2002). With these properties, it is possible that a high concentration created a sedative effect.

This study's results support the findings from the experimental design by Yang et al., finding that aromatherapy has evidence in improving patients' agitation. These improvements were present in many of the participants, leading to an overall decline in mean rates of agitated behaviors. Similarly, by considering the participants' overall reduction in negative moods, this study's results may indirectly corroborate Hui et al.'s findings that aromatherapy can improve patients' quality of life. Additionally, findings are in line with Li et al.'s review, regarding that

aromatherapy is effective for some patients, but may not have an effect for others. Furthermore, it is a safe intervention as there are very few, if any, side effects, and may even have a positive impact on caregivers.

Limitations

As found in many studies, including this one, verbally or physically non-aggressive behaviors are most common, as anxiety will oftentimes manifest itself as restlessness. This finding may be due to the fact that this study did not investigate at nighttime, when sundowning occurs. Sundown syndrome refers to the phenomenon of worsened NPS, including agitation and disruptive behaviors, starting in the late afternoon (Khachiyants et al., 2011; Bachman & Rabins, 2006). While unknown what causes sundowning, it is presumed to be the result of unmet needs, either psychologically or physically (Bachman & Rabins, 2006). Because this study did not observe aggressive behaviors and only took place in the mornings or afternoons, it is possible that aggressive symptoms may be most common during the night, hence why they were not recorded during the observation periods. Therefore, it is not possible to conclude from this study whether or not aromatherapy works during sundowning hours, or if aggressive behaviors can be diminished through its use.

Due to the person-by-person and day-by-day variations in dementia manifestation, difficulty arises in determining effects. Data continues to be divided in existing dementia and aromatherapy studies, having not shown consistent efficacy from the use of essential oils, meaning there is insufficient evidence to make a conclusive claim (Livingston et al., 2014; Dyer

et al., 2018; Ball et al., 2020). Many of this results from the fact that study designs vary greatly as a result of factors like different facilities, disease types, or oil choices and concentrations, thus leading to a lack of generalizability (Tible et al., 2017). However, even with these inconclusive results, it is generally determined that the usage of aromatherapy is found to have at least some small short-term effects, and is better than having no treatment (Zucchella et al., 2018).

There are also methodological concerns within aromatherapy studies. Due to the nature of essential oil diffusion, double-blind studies cannot be performed, potentially creating observer bias (Holmes & Ballard, 2004). Similarly, within this study, both caregivers and participants acknowledged the diffuser. Some participants commented on the visuals, enjoying the colored light. Others were able to smell the oils depending on the day, sometimes noting the pleasant scent, but not on other days. In other studies, placebo responses have been recorded. This is potentially due to participants' awareness of the study, but this idea cannot be determined (Holmes & Ballard, 2004).

Furthermore, small sample sizes and a lack of physiological parameters make interpretation of results difficult (Ball et al., 2020; Yang et al., 2015). Both of these are true in the case of this study, with a total of seven participants, and some potential factors that cannot be determined solely through observation, and therefore, were not recorded. For example, a participant could have had a racing heartbeat from anxiety, but without the physical evidence, it cannot be known.

Additionally, as per the guidelines of non-pharmacological treatments, the goal of aromatherapy is to avoid the use of medications that cause more harm (Cerejeira et al., 2012). Since cognitive symptoms cannot be treated using non-pharmacological interventions,

medication was not, and should not, be replaced with aromatherapy. Therefore, to our awareness, there were no participants within this study that did not take medication. However, this may have a confounding effect on patients' behavior, particularly in acute situations where medicine was administered as a last resort. Moreover, privacy restrictions hinder the ability to determine the extent of factors like medications, age, and diagnosis on participants' behaviors. This further limits the interpretation and generalizability of results.

There were also multiple observers in this study. While measurement was practiced and compared to improve interrater reliability, it is possible that behaviors were characterized differently depending on the observer. If this study were to be repeated, it may be beneficial to have one individual do the observations while another interacts each time.

Additionally, with the unpredictability of memory care facilities, there are various factors that could have been present in one observation period and not another. Therefore, confounding factors between observations, particularly between baseline and treatment, may have skewed the data. For example, a facility has holidays, delivery days, doctors visits, and medical emergencies. All of these events create different emotions that are unable to be controlled as compared to a typical laboratory setting. However, this also shows how applicable the results could be to a real life scenario.

Implications and Future Directions

Based on the data, lavender essential oils may be able to curb some negative emotions and agitation, but its efficacy varies between individuals. While some participants had minimal

response, there are some who had significantly reduced symptoms both in terms of mood and NPS. These mood-boosting effects can also benefit caregivers, who are exposed to the aromatherapy treatment in addition to the patients. More research needs to be done to determine the nature and extent of these effects. However, even without fully conclusive data in that aspect, lessened patient agitation implies reduced caregiver stress. In addition, essential oils are much less expensive, less risky, and potentially more effective than the use of medication. Based on these findings, there is a positive outlook for aromatherapy as a way to reduce patient NPS, caregiver burden, and as a safer and cheaper alternative to pharmacological treatments.

Albeit unlikely, it is important to watch for adverse reactions to the scent and ensure that it is not worsening these symptoms. If a facility wishes to continue the use of aromatherapy, it may be beneficial for the oils to be administered only in the individual rooms of participants who react positively to treatment, so it does not impact those who have a negative response.

Conclusions

This study examined the impact of aromatherapy using lavender essential oils on dementia patients' NPS, particularly focusing on agitation. Data from the CMAI-SF indicated that restlessness decreased between the baseline and aromatherapy conditions, while other factors had minimal to no change. The OERS scores show that anxiety was lessened after the introduction of aromatherapy, with the decrease in CMAI-SF restlessness contributing to this. Other mood scores generally had a small, but still present change, with anger, sadness, and pleasure decreasing, potentially due to the sedative effect of lavender. The impact of

aromatherapy was also found to spread to caregivers, and while not studied, could potentially decrease caregiver burden. Additionally, the side effects of aromatherapy are non-existent in most, if not all, of the individuals in the facility. In all, aromatherapy can be used as a safe way to at least slightly mitigate agitation and provide a better experience for families, caregivers, and individuals with dementia.

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Appendix

Appendix A

The Observed Emotion Rating Scale and Adjusted Scoring System

		1	2	3	4	5	6
		Never	≤1min.	1min. - 5min.	5 min. - 10 min.	10min. - 15min.	15 min. - 20 min
PLEASURE Signs: Laughing; singing; smiling; kissing; stroking or gently touching other; reaching out warmly to other; responding to music (**only** counts as pleasure if in combination with another sign).							
ANGER Signs: Physical aggression; yelling; cursing; berating; shaking fist; drawing eyebrows together; clenching teeth; pursing lips; narrowing eyes; making distancing gesture.							
ANXIETY/FEAR Signs: Shrieking; repetitive calling out; restlessness; wincing/grimacing; repeated or agitated movement; line between eyebrows; lines across forehead; hand wringing; tremor; leg jiggling; rapid breathing; eyes wide; tight facial muscles.							
SADNESS Signs: Crying; frowning; eyes drooping; moaning; sighing; head in hand; eyes/head turned down and face expressionless (**only** counts as sadness if paired with another sign).							
GENERAL ALERTNESS Signs: Participating in a task; maintaining eye contact; eyes following object or person; looking around room; responding by moving or saying something; turning body or moving toward person or object.							

Appendix B

The Cohen-Mansfield Agitation Inventory Short Form and Adjusted Scoring System

Rating	Behavior
	cursing/verbal aggression
	hitting, kicking, pushing, biting, scratching, aggressive spitting
	grabbing onto people, throwing things, tearing things, or destroying property
	other aggressive behaviors or self-abuse including: intentional falling, making verbal or physical sexual advances, eating/drinking/chewing inappropriate substances, hurt self or other
	pace, aimless wandering, trying to get to a different place (e.g. out of the room/building)
	general restlessness, performing repetitious mannerisms, tapping, strange movements
	inappropriate dress or disrobing
	handling things inappropriately
	constant request for attention or help
	repetitive sentences, calls, questions, or words
	complaining, negativism, refusal to follow directions
	strange noises (weird laughter or crying)
	hiding things, hoarding things
	screaming

1: Never/0 times
2: 1-4 times
3: 5-8 times
4: 9-12 times
5: 13-16 times
6: More than 16 times