Original Research Article

Effects of Robotic Therapy Dog Interaction on Mood Among Nursing Home Residents with Dementia

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ABSTRACT

Dementia affects more than 55 million people worldwide and is frequently associated with social withdrawal, reduced emotional engagement, and declining quality of life. Although animal-assisted therapy has demonstrated benefits for individuals with dementia, many long-term care facilities face practical barriers that limit regular access to live animals. This study examined whether robotic therapy dogs could improve mood among nursing home residents with dementia. Forty residents with diagnosed dementia participated in a controlled repeated-measures study. Twenty participants received continuous access to individualized robotic companion dogs, while twenty participants continued to receive standard care. Mood was assessed at four separate time points, including two baseline observations and two post-intervention observations, using a clinician-administered 10-point observational scale supported by staff feedback. Following introduction of the robotic dogs, the treatment group demonstrated a statistically significant average mood improvement of 0.40 points, while the control group showed little overall change. *Comparison of mood change scores between groups revealed a statistically significant difference favoring the treatment group ($t(38) = 3.65$, $p = 0.0008$).* Positive changes were observed in most treatment-group participants rather than being concentrated among only a few individuals. The results indicate that robotic companion dogs may provide a feasible approach to supporting emotional well-being among residents with dementia in long-term care settings. *Although the magnitude of improvement was modest,* robotic companion technology may represent a practical option for expanding emotional support within care facilities.

Keywords: dementia; robotic therapy dogs; socially assistive robots; nursing homes; long-term care; mood; emotional well-being

INTRODUCTION

Roughly every 3 seconds another individual is diagnosed with dementia, a progressive neurological condition that affects over 55 million people worldwide along with 10 million new cases a year (1). In addition to the pronounced memory loss caused by dementia, common behavioral and psychological symptoms such as apathy, emotional withdrawal, agitation, anxiety, and decreased social engagement may be present in individuals. These symptoms significantly reduce the quality of life for dementia residents in long-term care (LTC) environments.

Although pharmacologic treatments do exist allowing for the reduction of some behavioral symptoms, they commonly come along with undesirable side effects such as sedation, increased fall risk, and cardiovascular complications. For this reason, there has been a growing

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interest in non-pharmacologic interventions to improve emotional well-being. Shibata described robot therapy as a promising nonpharmacological mental health intervention for elderly populations by promoting stimulation, comfort, and emotional stability without any medication related risks (2). Socially assistive robots (SARs), specifically robotic companion pets, are designed to simulate companionship and emotional engagement of live pets. They respond to touch and sound, provide sensory stimulation and emotional interaction, and avoid logistical challenges of live animals.

Researchers have increasingly explored non-pharmacologic interventions to improve emotional well-being for dementia patients. For example, Fogelson *et al.* examined the impact of SARs on depression and loneliness and found significant reductions in both, suggesting that robotic pets could potentially be a scalable non-pharmacologic alternative to live pet therapy (3). These findings are corroborated by Banks, Willoughby, and Banks through their randomized controlled trial (RCT) comparing live animal-assisted therapy (AAT) to SARs (4). The study found that both AATs and SARs greatly decreased loneliness but more importantly did so on comparable levels. This is significant due to the many challenges that are associated with successful AAT. LTC facilities must manage infection control concerns, resident allergies, fear of animals among certain patients, hire trained handlers, and provide ongoing care for animals. SARs, on the other hand, require none of these. Demange *et al.* and Pu *et al.* found that robotic animal-assisted interventions may reduce signs of acute pain and distress among dementia patients (5, 6). This suggests broader emotional and behavioral benefits beyond companionship for SARs. SARs have also been shown to create social stimulation by acting as a bridge between patients. Naganuma *et al*. studied SARs in nursing homes and found that they acted as a center of attention among residents and encouraged them to communicate and interact with one another (7). These effects were most prevalent in patients that were previously disengaged from social activities. Through interviews and self-reports, Hudson *et al.* found similar trends especially regarding the SARs acting as a “social bridge” for patients (8). Koh *et al.* studied multiple SAR companies and models to observe any potential inconsistencies but found that all SARs produced improvements in mood, social interaction, and feelings of companionship (9).

Despite this, many studies contain methodological limitations that restrict generalizability and real-world implementation. Out of thirty studies related to SAR assessment, almost half of them relied on less than two dozen patients, qualitative observations, and short time frames that were not able to create any long-term findings. Additionally, many of these studies relied on self-reported data and lacked a control group which together limited the ability to draw strong conclusions about their effectiveness (3, 8). Additionally, although RCT trials effectively demonstrate that robotic companions have the ability to produce measurable improvements in both loneliness and neurobehavioral symptoms, they are weakened by time-limited sessions rather than continuous or freely accessible use (4, 10). Comparatively, studies in real nursing-home settings showed that free accessible use of SARs among patients may allow for a far more natural, repeated interaction with robotic companions, influencing emotional outcomes differently and potentially enhancing their effectiveness (11-13). McGlynn *et al.* found that interaction with SARs improved emotional responsiveness and relaxation among older adults, showing that robotic companions may positively influence mood even outside dementia populations (14). Robinson *et al.* similarly showed that companion robots improved psychological well-being while simultaneously reducing loneliness among older adults in LTC environments (15). Abbott *et al.* found through a systematic review that SAR pets showed consistent improvement to emotional well-being, social interaction, and overall engagement among older adults in LTC environments (16). In addition to this, studies such as Bradwell *et al.* relied on shared SARs rather than individualized companions (17). This reduced both the frequency and personalization of interaction. Similarly, many studies use SARs such as PARO which are seals. These SARs compared to ones with the appearance and form of dogs for example are far more unfamiliar, especially in terms of being a companion animal. This may potentially affect user engagement and/or emotional response. Furthermore, many studies have focused on broad neurobehavioral symptoms, cognition, or general quality of life rather than isolating mood as a principal outcome measured across multiple points. While systematic reviews confirmed overall positive trends, they also highlighted the limitations of variability in methodology and a lack of consistent, repeated quantitative mood measurements that would allow for clear comparisons over time (9, 18). As a result of this, there is a need for research that combines a controlled design with repeated, quantitative mood assessments while examining the effects of continuous access to individualized SAR companions in a real-world nursing home setting.

The objective of this study was to determine whether interaction with individualized robotic therapy dogs was associated with improved mood among nursing home residents with dementia. It was hypothesized that participants receiving robotic therapy dogs would demonstrate greater mood improvement than participants receiving standard care.

METHODS AND MATERIALS

Study Design

This study used a controlled repeated-measures intervention design with the purpose of evaluating whether interaction with SAR dogs changed mood in nursing home residents with dementia. The two groups present were the control group (n = 20) in which they did not receive any intervention, and the treatment group (n = 20) in which they each received their own SAR dog. The control group acted as a basis to compare the treatment group to. Standard care was continually provided such as but not limited to: continuation of existing medications, daily routines, and standard social programming. The repeated-measures approach allowed for the observation of gradual mood changes within each patient over time and between the treatment and control groups. Mood observations were collected at 4 separate time points spaced 2-4 weeks apart which allowed for observation of pre-intervention and post-intervention trends.

Participants

The population of this study were nursing home residents with diagnosed dementia. The inclusion criteria included clinical dementia diagnosis in their medical record, that the patient remained a resident of the facility during the entire period of the study, and was able to participate in observational mood assessments. Exclusion criteria included severe acute medical illness, inability to participate in observational mood assessments, and not providing consent to participate in the study. The sample size of the study was 40 patients. After consent was obtained, participants were randomly assigned to either the treatment group (n = 20) or the control group (n = 20). Patient characteristics included residents with various levels of cognitive impairment and common dementia types in LTC environments–note that this study did not analyze mood differences by dementia subtype.

Intervention

The SAR used was a Joy for All (JfA) robotic therapy dog produced by Ageless Innovation. They were specifically designed for older adults with dementia and were commonly used in assisted living facilities or nursing home settings. The JfA robots responded to touch and sound and simulated pet behaviors such as head and tail movements and vocalizations. The goal of the JfA design was to replicate the emotional experience of interacting with a live pet without the logistical challenges. For the treatment group each patient received their own dog in which they were allowed to hold, pet, and observe the dog whenever they wanted. This is exceptionally notable because in the studies mentioned above SARs were provided as a group tool and many patients had to share them in common spaces. The individuality and continual presence of the SAR strengthen that simulation of owning a pet for that patient. The control group, just like the treatment group, would continue with normal routines but would not receive a JfA dog.

Mood Measurement Schedule

The mood of each patient was measured at four observation points: baseline 1 (B1), baseline 2 (B2), post-intervention 1 (P1), and post-intervention 2 (P2). The baseline interventions occurred before the introduction of all SARs and were used to determine the typical emotional state of each patient. The post-intervention observations were conducted after treatment group exposure to SARs. Each observation was spaced about 2-4 weeks apart from each other with the inconsistency being attributed to unplanned conflicts and therefore a tighter timeframe. The control and treatment groups were both observed at the same time points which allowed comparison with natural mood variation.

Mood Assessment Procedure

To assess the mood of each patient a single clinician conducted all assessments to reduce observer variability and bias. Each mood score was based on direct patient interaction of at least 15 minutes and one or more consultations with the nursing home staff to discuss the patient's behavioral and emotional patterns over the previous 2 weeks. The purpose of having a dual evaluation is to capture both the immediate emotional state as well as the recent behavioral trends. This combined with using the same clinician ensures the most consistency and accuracy in interpretation.

Mood Scale

The mood score that the clinician assigned to each patient was based on a 10-point observational score, from 1-10, with a 10 representing the greatest emotional engagement and behavioral responsiveness and 1 the least. Some examples of interpretations were: (patient received a 1) withdrawn, distressed, minimal response; (patient received a 3) low engagement, limited interaction; (patient received a 5) moderate engagement, some responsiveness; (patient received a 7) active interaction with both environment and caregivers; (patient received a 10) highly engaged, alert, calm, socially responsive.

Data Processing

The baseline mood average (BA) was calculated from ($B1 + B2$) / 2. The post-intervention mood average (PA) was calculated from ($P1 + P2$) / 2. *Mood change (MC) was calculated as the difference between the post-intervention average and baseline average (MC = PA − BA). A positive mood change score indicated overall mood improvement, whereas a negative score indicated a decline in mood. The resulting mood change scores were used for all subsequent statistical analyses and comparisons between the treatment and control groups.*

Statistical Analysis

The primary objective of the analysis was to determine whether interaction with socially assistive robotic companion dogs was associated with overall mood improvement among nursing home residents with dementia.

The primary outcome measure was mood change (MC), calculated as the difference between each participant's average post-intervention mood score and average baseline mood score. The two baseline observations and two post-intervention observations were averaged to create a single baseline score and a single post-intervention score for each participant. This approach helped reduce the influence of short-term fluctuations in mood and provided a clearer picture of overall change throughout the study period. Since the goal of the study was to compare overall mood improvement between groups rather than differences at individual observation points, the average scores were used for subsequent analyses.

The primary comparison of interest was the mean mood change of the treatment group relative to the control group. An independent-samples t-test was used to determine whether the average mood change differed significantly between the treatment and control groups. The null hypothesis (H_0) stated that there would be no difference in mood change between the treatment and control groups. The alternative hypothesis (H_1) stated that participants receiving robotic therapy dogs would demonstrate greater mood improvement than participants receiving standard care. Statistical significance was evaluated at $\alpha = 0.01$. In addition to hypothesis testing, a 95% confidence interval and Cohen's d effect size were calculated to provide additional information regarding the magnitude and reliability of the observed treatment effect.

Ethical Consideration

The study was approved by the participating nursing home administration, and consent was obtained from the legal guardians of all participants before the study began. All mood assessments and data collection were completed by a licensed nurse practitioner who was responsible for the care of the participating residents. The investigator attended a single robotic dog adoption event during which treatment-group residents received their robotic companion dogs donated through a local nonprofit organization. The investigator did not participate in any mood assessments, clinical evaluations, data collection, or resident care activities. The investigator received only de-identified data for analysis. To protect confidentiality, each participant was assigned a numerical identifier, and no names or personal health information were included in the dataset. The study did not affect any medications, medical treatments, or routine care provided to residents. Because only de-identified data were analyzed and the investigator was not involved in participant assessment or data collection, formal Institutional Review Board (IRB) review was not required.

RESULTS

For each participant, the two baseline scores were averaged to produce a pre-intervention mean score. Similarly, the two post-intervention scores were averaged to produce a post-intervention mean. Mood change was calculated as the difference between the post-intervention average (PAvg) and the baseline average (BAvg). Mean change scores were then compared between the treatment and control groups using an independent-samples t-test to evaluate whether the intervention was associated with statistically significant differences in mood outcomes. Additional descriptive and graphical analyses were performed, such as distribution plots, box plots, and percentage-improvement comparisons. These graphs allow better visualization of response variability across participants.

Mood outcomes differed between the treatment and control groups across the study period. After averaging the two pre-intervention and two post-intervention observations for each participant, the control group exhibited a mean mood change of -0.075 points. The treatment group, in contrast, demonstrated a mean mood improvement of +0.40 points. This resulted in a mean difference of 0.475 points between groups.

An independent-samples t-test revealed a statistically significant difference in mood change between the treatment and control groups, $t(38) = 3.65$, $p = 0.0008$. The 95% confidence interval for the mean difference ranged from 0.21 to 0.74 points. The calculated effect size was large according to conventional benchmarks (Cohen's $d = 1.15$). Therefore, the null hypothesis was rejected, *providing support for the research hypothesis that participants receiving individualized robotic therapy dogs demonstrated greater mood improvement than participants receiving standard care.* As shown in Figure 1, the treatment group demonstrated a greater average improvement in mood than the control group. The error bars indicate variability within each group.

Figure 2 further illustrates mean mood scores across baseline and post-intervention periods. While the control group remained relatively unchanged over time, the treatment group demonstrated an increase in average mood score following the intervention. Error bars represent standard deviation for each group.

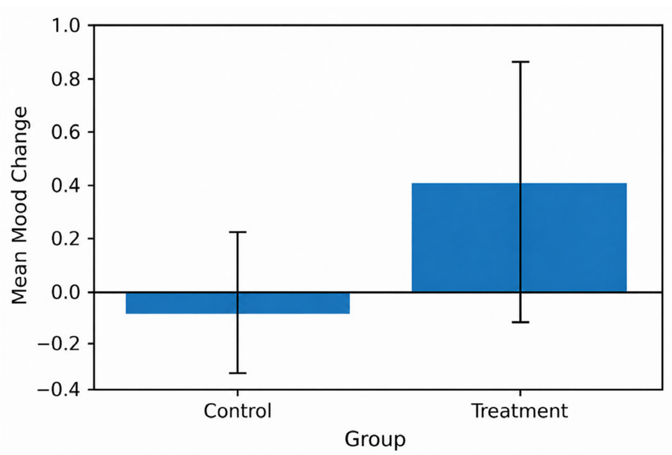

Figure 1. *Mean mood change among nursing home residents with dementia in the treatment and control groups. Mood change was calculated as the difference between each participant's average post-intervention mood score and average baseline mood score. Positive values indicate mood improvement while negative values indicate mood decline. Error bars represent one standard deviation. Participants receiving robotic therapy dogs demonstrated a greater average mood improvement than participants receiving standard care.*

When reviewing data at the individual participant level, treatment responses showed variability. As shown in Figure 3, the majority of residents in the treatment group demonstrated positive mood changes, while a few remained unchanged or showed negative changes.

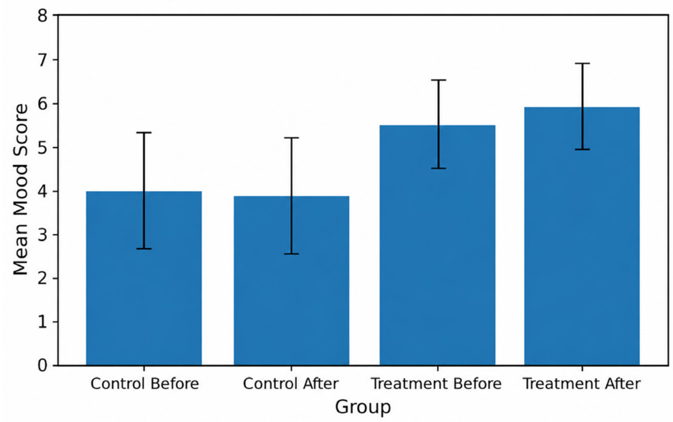

Figure 2. *Mean baseline and post-intervention mood scores for the treatment and control groups. Baseline scores represent the average of the two pre-intervention observations while post-intervention scores represent the average of the two post-intervention observations. Error bars represent one standard deviation. The treatment group demonstrated an increase in mean mood following the introduction of the robotic therapy dogs while the control group remained relatively constant across the study period.*

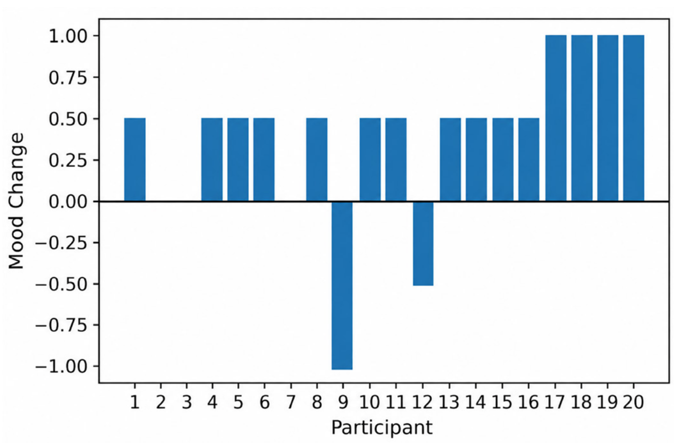

Figure 3. *Individual participant mood change within the treatment group. Each bar is representative of the difference between the average post-intervention and average baseline mood scores for a singular participant. Positive values indicate improvement in observed mood while negative values indicate a decline. Most treatment-group participants demonstrated a stable or improved mood following exposure to individualized robotic therapy dogs.*

The control group showed minimal change in mood with the majority showing a mood change of zero (Figure 4), while the treatment group clearly had mood scores that shifted toward positive values (Figure 5). This suggests that improvement was observed across much of the treatment group rather than only being driven by a small number of outliers.

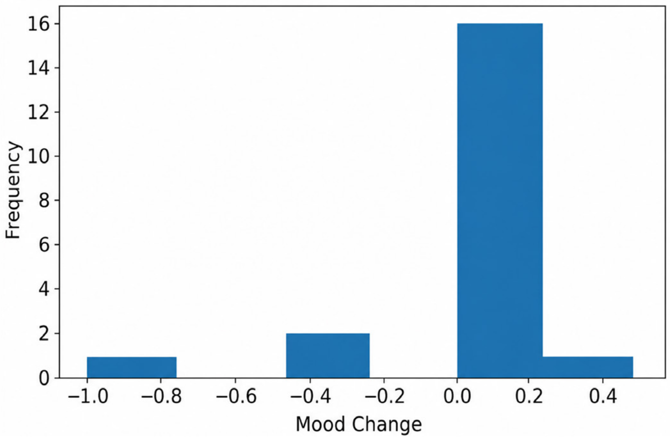

Figure 4. *Distribution of mood change scores within the control group. The histogram displays the frequency of participant mood changes over the study period. Most control-group participants demonstrated little or no measurable change in mood which resulted in a distribution centered near zero.*

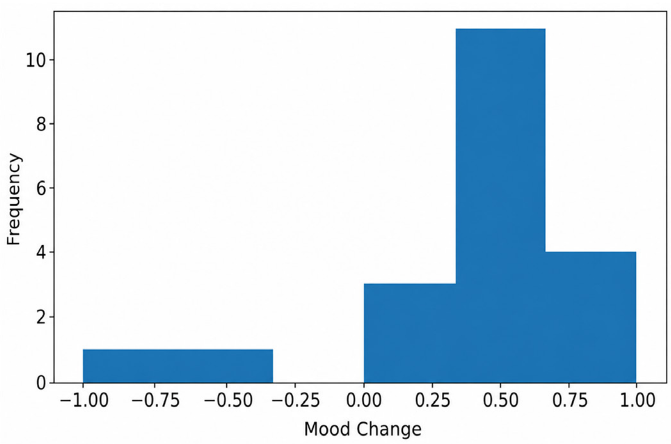

Figure 5. *Distribution of mood change scores within the treatment group. The histogram displays the frequency of mood change scores following the exposure to individualized robotic therapy dogs. The distribution is shifted toward positive values which indicates that mood improvement occurred among multiple treatment participants rather than being driven by only a minority of the treatment group.*

Figure 6 illustrates a box plot showing a higher median mood change and a broader positive distribution within the treatment group compared to the control group.

A scatter plot of baseline mood versus change score in the treatment group (Figure 7) suggested that improvements occurred across a range of baseline mood levels rather than being limited to participants with particularly high or low initial scores.

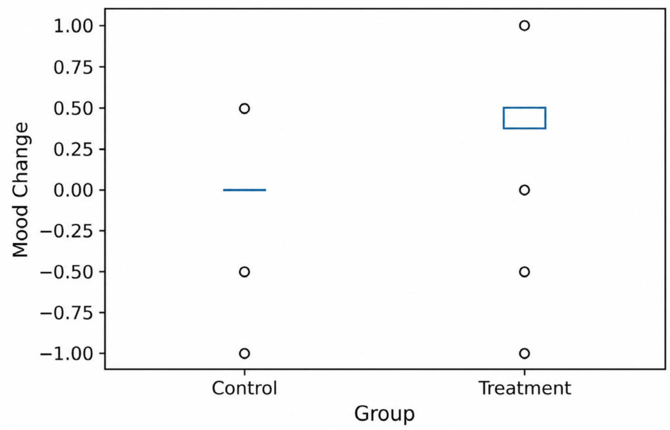

Figure 6. *Box plot comparing mood change distributions between the treatment and control groups. The central line represents the median, the box the interquartile range, and the whiskers the spread of data. The treatment group demonstrated an overall higher median mood change and a broader positive distribution than the control group.*

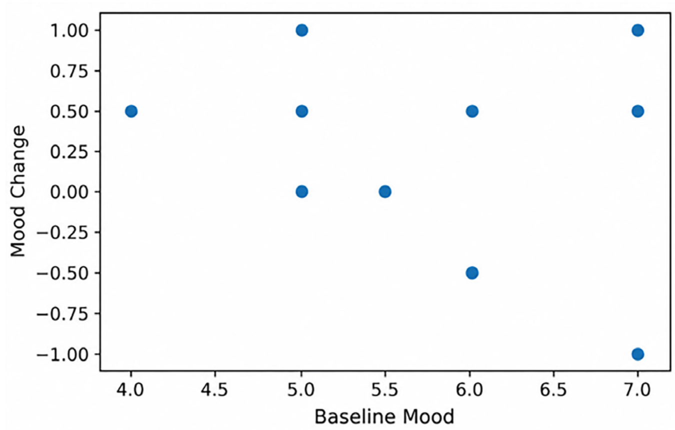

Figure 7. *Relationship between baseline mood score and mood change within the treatment group. Each point represents an individual participant. The absence of a strong linear pattern suggests that observed improvements occurred across a range of baseline mood levels rather than being limited to participants with particularly high or low initial mood scores.*

Figure 8 shows that a substantially greater proportion of patients in the treatment group demonstrated measurable improvement compared with the control group.

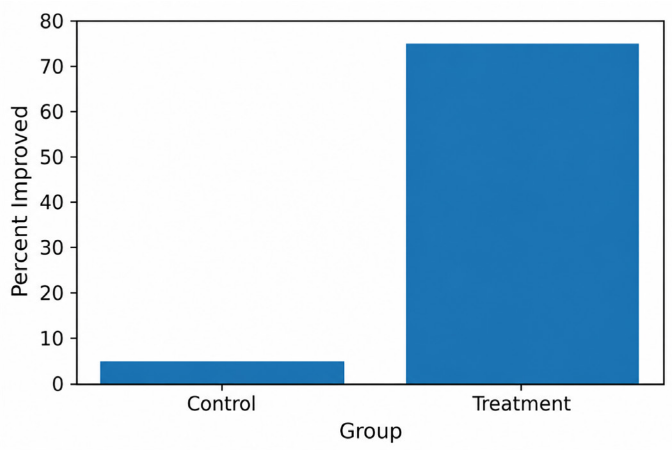

Figure 8. *Percentage of participants demonstrating mood improvements in the treatment and control groups. Improvement was defined as any positive change between average baseline and average post-intervention mood scores. A substantially greater proportion of treatment-group participants demonstrated measurable improvement compared to participants receiving standard care.*

Mood change was calculated for each participant as the difference between the average of two post-intervention assessments and the average of two baseline assessments (Table 1). Positive values indicate improved mood, whereas negative values indicate mood decline. Values are presented as the group mean and standard deviation (n = 20 per group).

Table 1. *Mean change in observed mood scores among nursing home residents with dementia in the treatment and control groups.*

Group	Mean Change	Standard Deviation
Control	-0.075	0.29
Treatment	+0.40	0.50

DISCUSSION

The findings of this study suggest that SARs may be associated with modest but measurable improvements in mood among dementia patients in the skilled nursing facility setting. When compared with the control group, participants who received robotic companion dogs demonstrated greater improvement in average mood scores during the post-intervention period.

These observed improvements may reflect sustained emotional benefit rather than a temporary effect because participants had continuous access to their SARs for at least one month during this study. It can be noted that these improvements were not limited to only a few individuals. The distributional analysis and percent distribution findings suggest that positive effects were seen across a substantial portion of the treatment group. *However, although the difference between groups was statistically significant, the absolute magnitude of improvement was relatively modest (0.40 points on a 10-point observational scale). Therefore, additional research using larger samples and validated assessment instruments is needed to better determine the clinical significance of these findings.*

This study's findings are consistent with prior literature on both AAT and SAR pets. Prior studies involving live therapy animals demonstrated reductions in agitation and depressive symptoms among dementia patients (19). Similarly, studies of SARs, including those done on JfA devices, have shown improvements in emotional engagement, socialization, and anxiety reduction. The present study extends this literature by evaluating SARs under real-world conditions in a skilled nursing facility using pre- and post-intervention observations over an extended period of time. There are various components to help explain the observed effects. The robotic dogs likely provided sensory stimulation, perceived companionship, routine interaction, and emotional familiarity. These attributes may be particularly meaningful for patients experiencing signs of dementia such as social withdrawal and cognitive decline. Another study observed SARs' ability to frequently trigger positive emotional responses such as smiling, verbal engagement, and calmness among dementia patients during repeated interaction (20).

Even in cases where patients may recognize the device is not a true live animal, the tactile and response features still promote calmness, engagement, and positive affect. One important aspect of these findings is the scalability that SARs can provide. SARs help avoid the logistical challenges that are attached to live-therapy animal programs such as infection control, removal of constant maintenance, and access to an individualized pet. This makes them especially attractive in LTC facilities seeking practical and repeatable nonpharmacological interventions that are both cost-effective and proven to be significantly beneficial. Other studies have emphasized that SAR pets should be used to enhance emotional support rather than fully replace meaningful human interaction (21). This positions robotic companion pets as a potentially valuable tool for improving dementia care in LTC settings.

Limitations

Several limitations should be considered when interpreting the findings of this study. The first major limitation was how mood scores were assessed. This study used a simplified mood score (1-10) attributed by the same clinician during repeated observations over the time of the study. While these mood scores proved to be a practical and efficient way to track emotional changes during clinical rounds, they do not capture the full complexity of mood and behavioral expression in dementia patients.

Future studies would benefit from using more standardized assessment tools used in dementia studies such as the Observed Emotion Rating Scale (OERS). This scale evaluates multiple emotional domains affecting dementia patients including pleasure, anxiety, sadness, anger, and alertness. Using OERS rather than a simple mood score could help provide a deeper understanding on how SARs companion interventions influence various emotional states related to dementia patients.

The use of the simplified mood score scale in this study was dictated by the time constraints placed by the clinician providing the assessments and feedback while conducting routine rounds at the skilled nursing facility. Ideally, a future study could use a dedicated and funded research staff to spend the necessary time to collect more data points. Additional limitations should also be considered. This study was conducted within a single skilled nursing facility, which may limit the extent to which the findings can be generalized to other long-term care environments. Although using the same clinician throughout the study helped improve consistency, relying on a single evaluator may have introduced some observer bias. In addition, neither the participants nor the clinician were blinded to treatment assignment, which may have influenced observed outcomes. It is also possible that part of the improvement observed in the treatment group was related to the novelty of receiving a robotic companion rather than the long-term therapeutic value of the device itself. Finally, while participants were given continuous access to their SARs, the actual amount of time spent interacting with the devices was not measured. Future studies should examine whether differences in interaction frequency or duration influence emotional outcomes.

Another limitation of this study was the sample size. Due to budgetary constraints the treatment group was limited to 20 participants. The cost of the SARs, while not substantial, did constrain the study to a smaller sample size. Funding for these SARs was obtained through a local nonprofit with a limited budget. In a similar way, had the study used a longer observation period, different findings may have been discovered. Although relatively long compared to most studies in this field, a further increased period could create valuable insights. Future studies should utilize a larger sample size, longer observational period, and multiple facilities to improve the generalizability of the findings.

Patient demographics were not looked at on a detailed level. These include gender, race, income, and ethnicity. Additionally, medical factors such as stage of dementia and medication usage were not observed and compared. Future studies may benefit from evaluating whether specific patient characteristics such as baseline cognitive severity, social withdrawal, anxiety symptoms, current prescriptions, or prior exposure to animals may predict stronger response to SAR interventions. This may also help optimize patient selection and improve efficiency of outcomes.

Another limitation was that the study only used SAR dogs. SARs are not limited to just dogs as there are models for cats, birds, seals, etc. Some patients could potentially have more positive mood changes if they were provided with a SAR model of another animal that is more suited to their preference. Similarly, the SAR model used in the present study had limited features. Future studies and technology may find different results when testing more advanced SARs.

While all patients were observed over the same time period, the amount of time each patient spent with their respective SAR was not tracked which could potentially affect mood change significantly. Additionally, consent was required in order for residents to participate in the study. The staff at the LTC facility approached over 50 initial candidates and closed the panel once 40 approvals were received. Note that partial selection bias may have occurred when the staff selected ideal candidates to participate in the study. For example, a candidate that would not be ideal and therefore unlikely to be selected by the staff would be a resident with advanced dementia or one whose family believed it would not help them.

CONCLUSION

This randomized controlled study found that SARs provided measurable improvements in mood among dementia patients residing in a skilled nursing facility. In comparison to the control group, participants in the treatment group demonstrated a statistically significant improvement in mood across the post-intervention period. *Although the magnitude of improvement was modest, the findings suggest that robotic companion dogs may provide a practical approach to supporting emotional well-being among dementia patients.* Robotic companion dogs offer a scalable, low-risk, and cost-effective nonpharmacological intervention that may improve emotional well-being while minimizing the many logistical barriers that are associated with traditional live animal assisted therapy programs.

Most importantly, this study supports the idea that robotic companion technology can help extend emotional support in long-term settings where withdrawal, loneliness, and mood decline are commonly found. As healthcare systems continue to seek sustainable ways to improve quality of life for aging populations, SAR devices may prove to be an increasingly valuable tool within dementia care.

In conclusion, this study provides an important foundation for future research into the growing dementia crisis. It was conducted with the hope of helping researchers identify ways to incorporate advancements in human-centered technology as scalable solutions to improve the quality of life for people in need. *Future studies involving larger samples, multiple facilities, and validated assessment instruments will help further evaluate the long-term effectiveness and clinical significance of SAR interventions.*

FUNDING SOURCES

No external research funding was received for this study. Funding for the robotic therapy dogs used in the study was provided through donations obtained by a local nonprofit organization.

CONFLICT OF INTEREST

The author declares no conflicts of interest related to this study.

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