Long-Term Active and Passive Horticultural Therapy Intervention for Elderly Patients with Moderate Dementia and AI Analysis of Medical Records and Care Documents

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Abstract

Background: Previous studies have shown that Hand Care Treatment, a form of passive horticultural therapy, is effective in preventing dementia and MCI and reducing the rate of progression. Due to the Covid-19 pandemic, various activity restrictions were implemented in Japan from March 2020, and the number of elderly people without care and rehabilitation will the number of elderly people without care and rehabilitation has been increasing. **Purpose:** Progression of cognitive, physical, and mental disability was examined for long-term horticultural therapy study subjects by level of care required. **Methods:** One subject who had been diagnosed with dementia and was residing in an elderly care facility and consented to a long-term study was selected. In addition to assessments using various evaluation forms, data recorded from time to time, including changes in care plans, were analyzed using text mining methods. **Results:** This subject tended to progress slowly from 1 to 2 care needs, but progressed from 3 to 5 care needs over a 2-year period. The results of the assessment chart test showed that cognitive impairment and IADL decreased with each increase in the level of care required, but DBD remained the same at the time of admission, even at 5 years of care required. A comparison of HCT and aroma intervention with and without aroma intervention during the nursing care level 1 showed that the improvement in physical, mental, and cognitive function was expected to be higher at the time of intervention. Text-mining inspections have revealed that during the period of nursing

care level 1 - 5, active horticultural therapy techniques, and passive horticultural therapy techniques such as HCT and brain rejuvenation aromatherapy were found to betweenness centrality with each other. **Conclusion:** From the results of mean score of DBD, although the nursing care level has progressed from 1 to a maximum of 5, it can be concluded that the burden of care has not become heavier. There was no tendency for the progression of cognitive impairment in this subject to be faster than in the general AD population, despite the influences of Covid-19. The results indicated that caregiving techniques and active and passive horticultural therapy techniques in Japanese welfare facilities for the elderly are expected to be effective in preventing the progression of cognitive impairment.

Keywords

1. Introduction

In general, it is an easy way of thinking that people plant relationships (PPR) exhibit the activation of a past long-term memory and future hope to live for [1]. The global epidemic of Covid-19 has brought about lifestyle changes such as restrictions on the range of activities of citizens in each country. In Japan, there is concern about lack of verbal or nonverbal communications and exercise for the elderly, who are said to be prone to becoming severely ill [2] [3]. And psychogeriatric medical care often takes time. Particularly, the care for person with dementia takes more time. Therefore, not only the care of the psychological conditions of the elderly person, but also the care of the medical person side is important. Multi-sensory stimulation is beneficial to a wide variety of conditions typical of geriatric patients. Changes appeared in muscle tension, skin conductance and pulse that correlates with reduced blood pressure [4] [5]. Various studies of horticultural therapy programs have demonstrated the positive effects on dementia protection, schizophrenic behavior and those suffering from depression [6] [7].

Behavioral restrictions and lack of communication between humans caused by the spread of Covid-19 should be considered to have an adverse effect on various diseases. On the other hand, utilizing HCT that utilizes the power of nature and plants for the elderly, was expected to lead to prevention cognitive impairment and behavior such as depressive views and depressive tendencies by Covid-19 [8] [9]. It is one big characteristic of the horticultural therapy, and it is an advantage [10]. On the other hand, the dynamics of the senses plays an important role beyond mere reason and sensibility in people's lives. The hand care therapy (HCT) included in the horticultural therapy which is the alternative medicine that utilized a plant, or its essential oil is utilized in various application scenes.

In this study, we report a case in which active and passive horticultural thera-

py was introduced to one subject who was diagnosed with moderate dementia (AD) and moved into a special nursing home, in addition to the usual care time techniques. In addition to evaluations using various evaluation forms, we thought that AI analysis of the co-occurrence of language in materials recorded from time to time, such as changes in care plans, could be added to the evaluation of subjects with cognitive disabilities, etc., to make the evaluation more credible. During the long-term horticultural therapy intervention since her admission in 2015, a pandemic of Covid-19 in 2020 (a global pandemic) occurred in 2020, limiting the facility's events and family interactions.

2. Subjects and Methods

When examining the effectiveness of techniques for elderly people with cognitive disabilities, interviews with the subjects themselves, observational evaluation forms in activities of daily living and activities of daily living, and questionnaire evaluation forms are often used.

However, when only evaluation charts are used, there are concerns about the credibility of the evaluation when the elderly with cognitive disabilities are the subjects. On the other hand, care plans prepared by health and welfare specialists are set up for users of welfare facilities for the elderly, and daily changes are recorded by the nurse, care worker, or functional training technician in charge. Therefore, we thought that, in addition to the evaluation using various evaluation forms, the data recorded from time to time, such as changes in care plans, could be analyzed and added to the evaluation of subjects with cognitive disabilities, etc., to make the evaluation more credible.

2.1. Subjects

The flowchart for the selection of the subjects is shown in **Figure 1**.

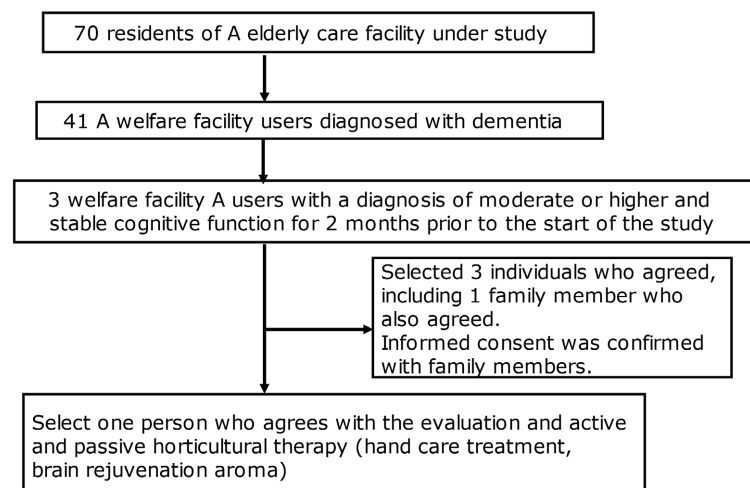Case: A woman in her late 80 s with no physical disability and nursing care level 1.

Figure 1. Flowchart of study participants.

Family demand: "She has preferred to do general housework, so we want her to do daily tasks."

2.2. Horticultural Therapy-Related Activities in This Welfare Facility

Active gardening technique: cultivation activity (once a week)

1) Autonomous walking to "Fureai Farm" (3 - 5 times a week).

2) Maintenance work in raised beds or cultivation of flowers and vegetables in the cultivation garden (1 - 2 times a week).

3) Fertilizer bag balcony cultivation (carrot, celery, lettuce + potato cultivation).

Passive horticultural techniques

1) Veranda cultivation and landscape observation from inside the room.

2) Observation of the communal farm after wheelchair transfer.

3) Hand care treatment (HCT, once or twice a week).

4) Aroma for brain rejuvenation + Aroma for sleep environment (daily).

2.3. Equipment and Scales

The assessment data were taken over from the previous hospital personnel for December 2014 and January 2015 prior to admission. Immediately after admission and before the practice (February 2015), the facility's functional training instructor (Ns) or another nurse evaluated the patients monthly.

Specifically, the functional training instructors (Ns) at the facility conducted a preliminary assessment of the Mini mental State Examination (MMSE) and Dementia Behavior Disturbance (DBD) immediately after admission and before practical activities (February 2015), the Clinical Dementia Rating (CDR), and the Activities of Daily Living Assessment Chart (PSMS).

2.3.1. MMSE Screening Tool

MMSE was the most used instrument for the assessment of cognitive function in both clinical and research settings. It was usually used as a screening test for dementia and cognitive impairment or as a brief cognitive assessment that takes about 10 min to complete. MMSE were orientation (10 points), registration (3 points), at tension and calculation (5 points), recall (3 points), language and praxis (9 points) [11] [12] [13] [14].

2.3.2. CDR

The CDR is one of the scales used to evaluate the severity of dementia. The scale is characterized by an "observational method" in which six items related to cognitive function and living conditions are evaluated based on findings on examination and information from family members and others around the patient. Each item is classified into five levels, from "healthy" to "severe dementia". Classification based on the evaluation chart helps to determine not only the degree of dementia, but also particularly impaired functions, and helps to establish a prog-

nosis. The CRD was found to distinguish unambiguously among older subjects with a wide range of cognitive function, from healthy to severely impaired [15] [16].

2.3.3. DBD13

The DBD13 is an evaluation index that can concisely detect peripheral symptoms (behavioral and psychological symptoms) of dementia. The Dementia Behavior Disturbance scale (DBD), which consists of 28 items, was published in 1990 as an evaluation scale that can sensitively detect peripheral symptoms (behavioral and psychological symptoms) of dementia. The DBD13 is an abbreviated version of the DBD that uses a 5-point scale to rate the items in the questionnaire. It is said to cover behavioral abnormalities from the mildest to the most severe forms of dementia [17] [18] [19].

2.3.4. PSMS

The PSMS evaluates the level of independence in six basic ADL activities including self-care (toileting, eating, dressing, grooming, mobility, and bathing) based on information obtained from family members and caregivers [20] [21].

2.4. Text Mining

When examining the effectiveness of techniques for elderly people with cognitive disabilities, interviews with the subjects themselves, observation evaluation forms in activities of daily living and activities of daily living, and questionnaire evaluation forms are often used. However, when only evaluation charts are used, there are concerns about the credibility of the evaluations when the elderly with cognitive disabilities are the subjects. On the other hand, medical records and care plans prepared by health and welfare specialists are set up for users of welfare facilities for the elderly, and daily changes are recorded by nurses, care workers, and functional training technicians in charge. Therefore, in addition to evaluations using various evaluation forms, we thought that AI analysis of the co-occurrence of language in materials recorded from time to time, such as changes in care plans, could be added to the evaluation of subjects with cognitive disabilities, etc., to make the evaluation more credible.

AI analysis tool: KH-corer3 [22] [23] [24].

Number of occurrences: 5 or more.

Jaccard coefficient: 0.2 or more.

2.5. Statistical Analysis

Comparison results of MMSE, CDR, DBD, and PSMS by care requirements are presented as mean ± SD (min-max), interquartile range, and median, and statistical significance was confirmed by the Steel-dwass method. Comparisons between patients with and without HCT during the first period of nursing care were also presented as mean ± SD (min-max), interquartile range, and median, and statistical significance was confirmed by the Steel-dwass method. Compari-

sons between patients with and without Aroma during the nursing care level 1 are presented as mean ± SD (min-max), interquartile range, and median, and statistical significance was confirmed by the Mann-Whitney U test. The statistical analysis software used was SPSS ver. 19.

2.6. Ethical Considerations

We strictly observed the Helsinki Declaration of 2015 (revised in 2013), explained the purpose and outline of this study to them and obtained informed consent from them beforehand. We explained in writing to the subjects and her family the purpose and content of the study, that the data obtained would not be used for any purpose other than the study, and that we would be careful not to leak any personal information and sought their cooperation after obtaining their understanding. We also explained in writing and orally that participation in the study was voluntary and that they would not be disadvantaged even if they did not become subjects. All procedures were approved by the Kyushu University of Health and Welfare (Miyazaki, Japan) Ethics Committee (13-001) and Nishi-Kyushu University (Saga, Japan) Ethics Committee (H29-5, H30-14). The authors have no conflicts of interest directly relevant to the content of this article.

3. Results

3.1. Assessment Table Scores by Nursing Care Level

The nursing care level 1 and 2 was long and the cognitive decline was gradual, but the duration of care required 3 - 5 was relatively short and the symptoms progressed in a relatively short time. There was no nursing care level 4 that the patient needed nursing care level the next level after nursing care level 3 was determined to be 5. Observational and questionnaire assessments were conducted once a month immediately after admission and during the period of nursing care level 1 - 5. Figure 2 shows the application period of each passive horticultural therapy technique and the changes in each indicator over time. The patient was certified as requiring long-term care 1 immediately after admission, with an improvement trend in both physical and cognitive aspects compared with the information before admission and was certified as requiring long-term care 2 in October 2017, 3 in October 2019, and 5 in October 2021.

A comparison of the average evaluation chart scores by nursing care level was shown in Figures 3-6.

3.2. Comparison of Assessment Chart Scores with and without Passive Horticultural Therapy at the Time of Nursing Care Level 1

HCT and aroma as passive horticultural techniques were started during the period of nursing care level 1, and HCT was interrupted for 10 months during the period of nursing care level 1 (Figure 7).
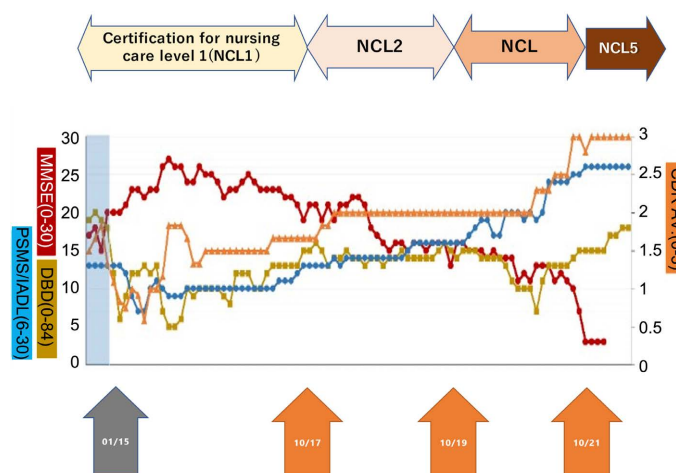
Figure 2. Time course by nursing care level. NCL: Nursing Care Level.
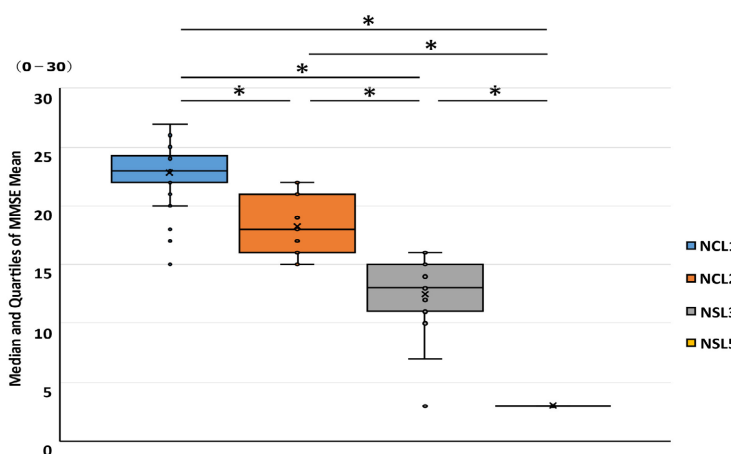

Figure 3. Median and quartile comparison of mean MMSE scores by nursing care levels (0 - 30). Steel-dwass method was used for statistical comparison among the four groups. Not stated: no significant, *p < 0.05.
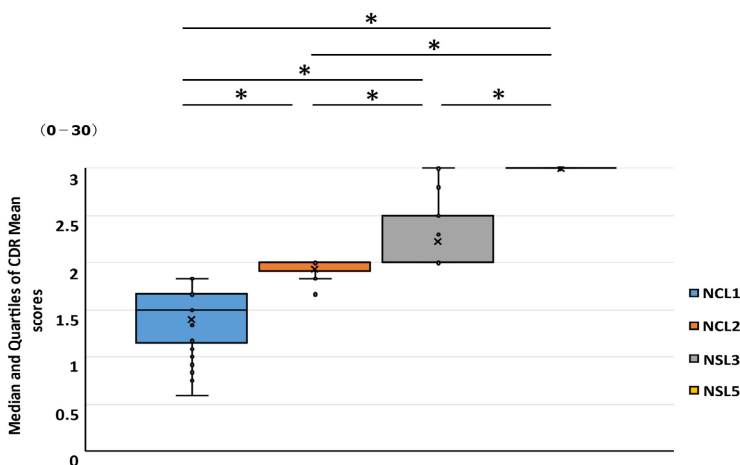

Figure 4. Median and quartile comparison of mean CDR scores by nursing care levels (0 - 3). Steel-dwass method was used for statistical comparison among the four groups. Not stated: no significant, *p < 0.05.
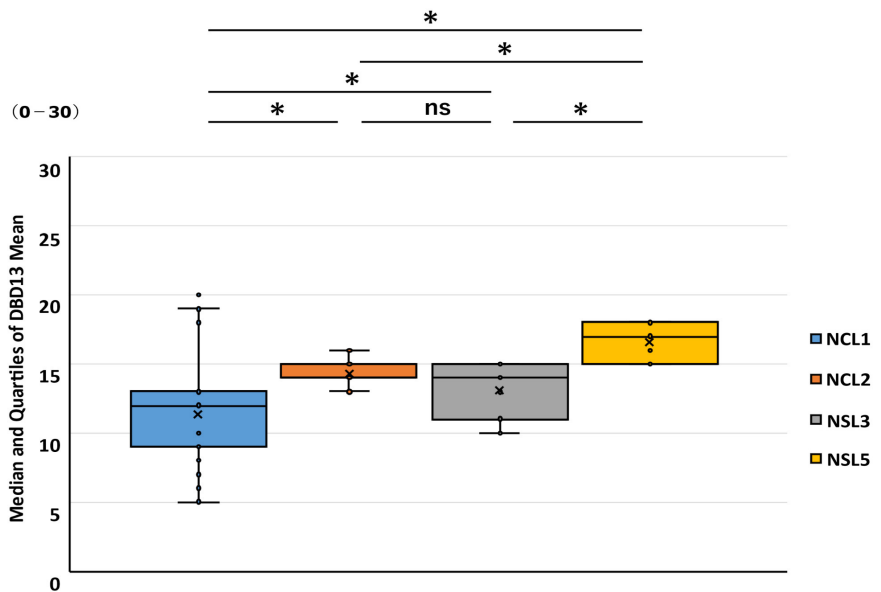
Figure 5. Median and quartile comparison of mean DBD13 scores by nursing care levels (0 - 52). Steel-dwass method was used for statistical comparison among the four groups. Not stated: no significant, *p < 0.05.
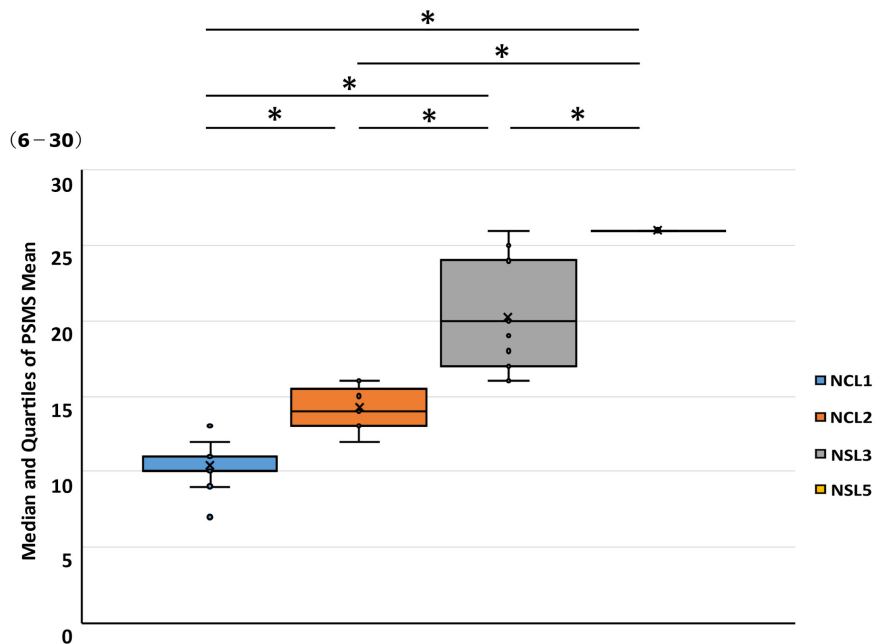

Figure 6. Median and quartile comparison of mean PSMS scores by nursing care levels (6 - 30). Steel-dwass method was used for statistical comparison among the four groups. Not stated: no significant, *p < 0.05.

The MMSE scores were significantly (at the 5% level) higher with HCT intervention than without HCT intervention, and significantly (at the 5% level) lower with HCT intervention than without HCT intervention. DBD was also significantly lower at the HCT intervention than at the reintroduction and no intervention (**Figure 8** and **Figure 9**).
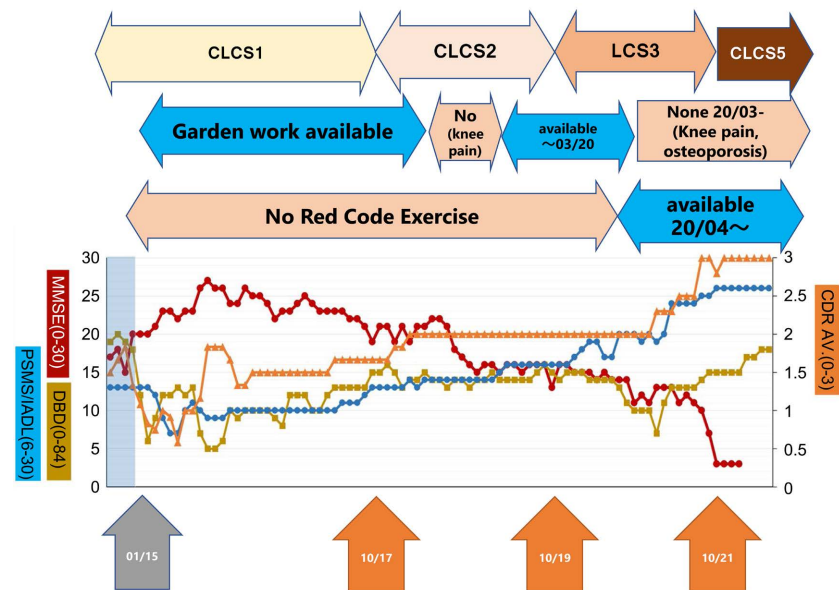
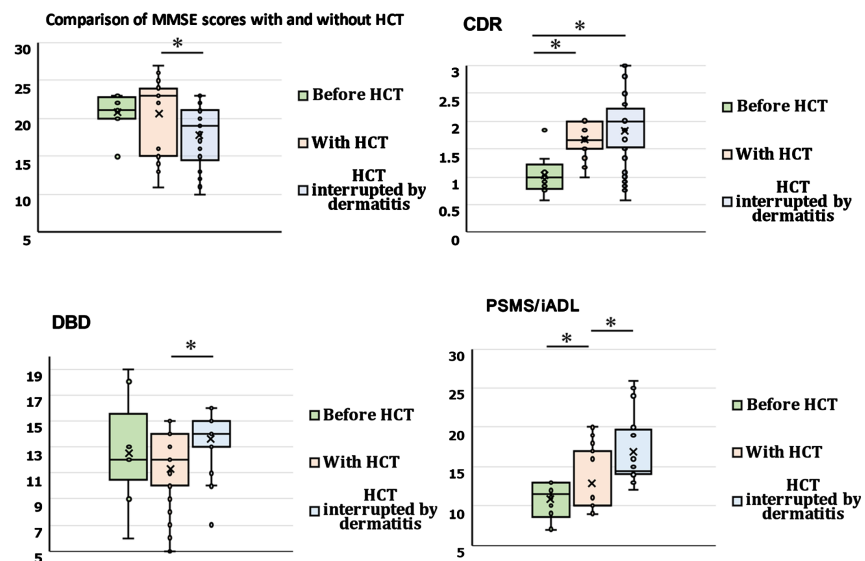**Figure 7.** Time course by passive horticultural therapy activities.

Figure 8. Comparison of overall points of MMSE, CDR, DBD, and PSMS with and without HCT during the nursing care level 1. Steel-dwass method was used for statistical comparison among the three groups. Not stated: no significant, *p < 0.05.

3.3. Text Mining through Medical Records, Service Plans and Caregiver Records

All elderly welfare facility users are set up with care plans (service plans) prepared by health and welfare specialists, and there are also records of daily changes made by the medical records of the physician in charge, the nurse in charge, the care worker, the functional training technician, and others. Therefore, in addition to evaluations using various evaluation forms, the data recorded from time to time, such as changes in care plans, were analyzed and added to the evaluation of subjects with cognitive disabilities, etc.
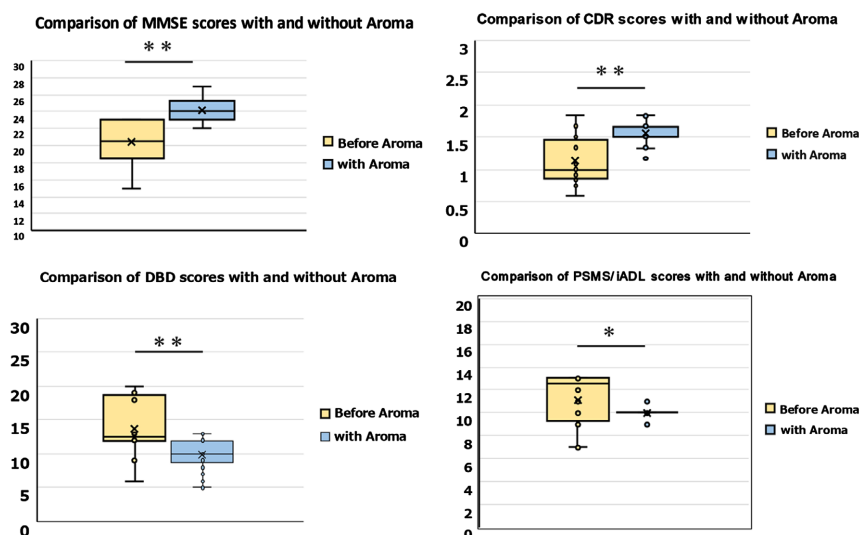
Figure 9. Comparison of overall points of MMSE, CDR, DBD, and PSMS with and without Brain Rejuvenation Aroma during the nursing care level 1. The Mann-Whitney U test was performed in comparison with Before. Not stated: no significant, *p < 0.05, ** p < 0.01.

During the period of nursing care level 1, active horticultural therapy techniques, and passive horticultural therapy techniques such as HCT and brain rejuvenation aromatherapy were found to betweenness centrality with each other. Co-occurrence with daily activities and WALK was also observed, although the betweenness centrality was lower (**Figure 10**). The betweenness centrality of Garden was highest for Therapy, followed by Work. The betweenness centrality of Aroma was highest for Therapy, followed by Rejuvenation. The betweenness centrality of HCT was highest for Aroma, followed by Therapy.

During the nursing care level 2, active horticultural therapy techniques such as garden activities were independent, but passive techniques such as HCT and brain rejuvenation aroma had numerous co-occurrences with other activities, health care, and daily living (**Figure 11**). The betweenness centrality of Garden was highest for Work, followed by Therapy. The betweenness centrality of Aroma was highest for HCC, followed by do. The betweenness centrality of HCT was highest for Activity, followed by Able.

At nursing care level 3, all horticultural therapy techniques co-occurred with each other and with other recreational activities and participatory events. Most of the garden activities were wheelchair garden walks. The betweenness centrality of Garden was highest for Therapy, followed by Wheelchair. The betweenness centrality of Aroma was highest for Therapy, followed by HCC. The betweenness centrality of HCT was highest for Garden, followed by Therapy (**Figure 12**).

At nursing care level 5, all horticultural therapy techniques co-occurred with each other and were even more likely to co-occur with other recreational activities (activities) and participatory events. The betweenness centrality of Garden was highest for Wheelchair, followed by plant. The betweenness centrality of Aroma was highest for Therapy, followed by Rejuvenation. The betweenness centrality of HCT was highest for Rejuvenation, followed by Brain (**Figure 13**).

Figure 10. Co-occurrence network during the period of nursing care level 1.

Figure 11. Co-occurrence network during the period of nursing care level 2.

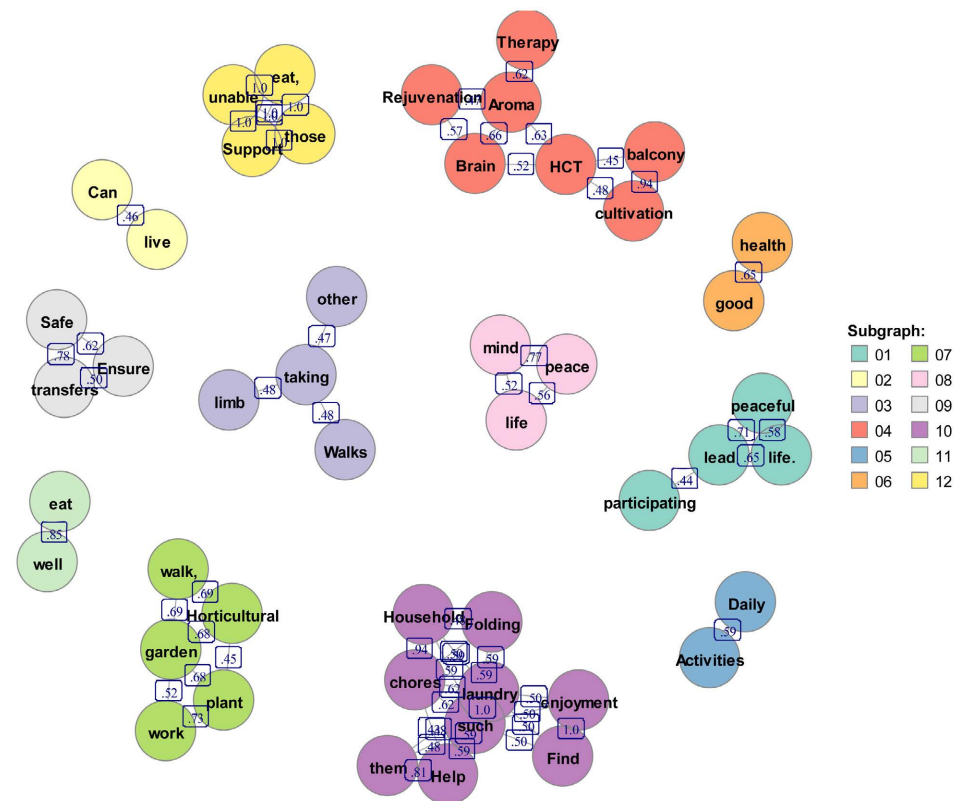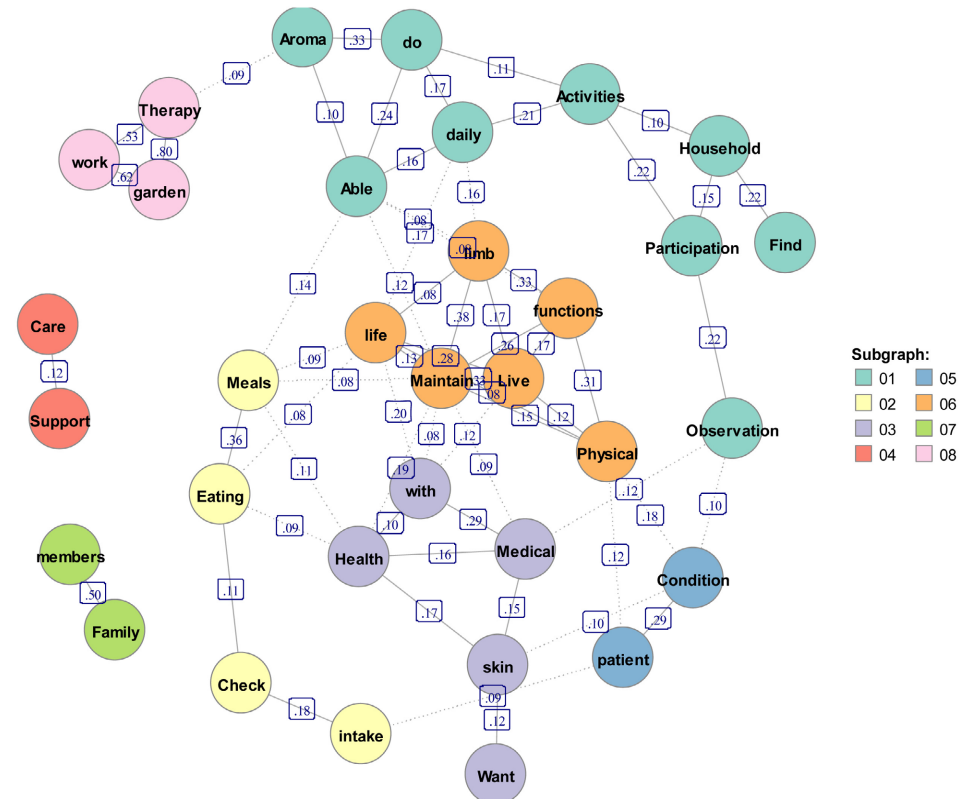**Figure 12.** Co-occurrence network during the period of nursing care level 3.

Figure 13. Co-occurrence network during the period of nursing care level 5.

4. Discussions

Immediately after admission, this patient's MMSE was at the dementia level (less than 23 points) and her CDR was 2 points (moderate dementia), probably because she was unfamiliar with the environment. Thereafter, due to the implementation of active and passive horticultural therapy in addition to her immediate familiarity with the environment. There was a period of increased MMSE scores, and the CDR was able to maintain this score for 6 years (more than 9 years after diagnosis of dementia). The mean score of DBD, a dementia behavioral disorder scale, has not worsened for this subject since his admission to an elderly care facility in 2015 until August 2022. Although the nursing care level has progressed from 1 to a maximum of 5, it can be concluded that the burden of care has not become heavier. This may include the effects of hand care and aromatherapy utilized prophylactically, and it was inferred that the effects of Covid-19 were also minimized.

A comparison of HCT and aroma intervention with and without aroma intervention during the nursing care level 1 showed that the improvement in physical, mental, and cognitive function after admission was expected to be higher at the time of intervention. Although it would be difficult to expect PSMS/iADL to be higher due to passive intervention, we believe that the overall physical and mental status was on the road to recovery and improved at the time of intervention.

It has been reported that HCT, both as brain rejuvenation aroma and gentle touch care, may also prevent cognitive decline [25]. It can be inferred that the combination of HCT as an active and passive horticultural therapy technique and brain rejuvenation aroma, in addition to factors such as the living environment of the facility and functional recovery training, showed a trend toward improvement in cognitive function. Therefore, HCT and aroma, which are passive horticultural techniques at the time of the nursing care level 1, were therefore expected to have a utility in supporting the maintenance of cognitive and physical functions by performing HCT and aroma, which are passive horticultural techniques. We would like to continue to apply HCT and aromatherapy to other cases with concerns about cognitive impairment, because we would like the patients to enjoy their daily lives by delaying the deterioration of their cognitive and physical functions. In addition, we believe that HCT and aromatherapy can be applied as early as possible to further ensure the prevention of dementia and other disorders.

We believe that the progression from 2 to 5 in need of care may be largely due to the restriction of interaction by Covid-19, which reduces the effectiveness of active and passive horticultural therapy in reducing the progression of cognitive impairment.

Based on the results of text mining with the AI analysis tool KH-corder, during the period of nursing care level 1, co-occurrence with daily activities and WALK was also observed, although co-occurrence was low. Since this was the period when horticultural therapy was introduced, it was thought that the ther-

apy was implemented in relation to other activities. The time when nursing care level 2 is also the time when their physical functions are beginning to deteriorate. The passive techniques HCT and Brain Rejuvenation Aroma had many co-occurrences with other activities, health care, and daily life, indicating that they were positioned as activities that could be safely introduced.

At nursing care level 3, all horticultural therapy techniques were found to co-occur with each other and with other recreational activities and participatory events. Most of the garden activities were wheelchair garden walks, which could be considered passive horticultural therapy techniques. This was thought to indicate that the passive activities were more applicable due to the decline in the physical aspect of the subject's life. The third stage of this subject's care needs is a period of increased physical limitations, and it would be more realistic to link activities with other activities rather than introducing them alone, while taking care not to place too much burden on the subject.

At nursing care level 5, all horticultural therapy techniques co-occurred with each other and with other recreational activities and participatory events. This may indicate that for this subject, activities other than passive horticultural therapy techniques, including wheelchair garden walks, are less applicable for this subject during a time of increased physical limitations. It also indicates that it is more realistic for this stage to be implemented in conjunction with other activities rather than as a stand-alone activity. It was thought that Aroma, after the time when the patient's level of care is 5, when it becomes difficult to introduce other preventive technologies for cognitive impairment, could take advantage of its characteristics, such as its ability to adapt to any situation of the user.

The results indicated that caregiving techniques and active and passive horticultural therapy techniques in Japanese welfare facilities for the elderly are expected to be effective in preventing the progression of cognitive impairment.

5. Conclusion

Progression of cognitive, physical, and mental disability was examined for long-term horticultural therapy study subjects by level of care required. The results of the DBD assessment showed that cognitive function and IADL declined with each progression of care requirements, but the burden of caregiving did not increase. A comparison of HCT and aroma intervention with and without aroma intervention during the nursing care level 1 showed that the improvement in physical, mental, and cognitive function was expected to be higher at the time of intervention. Based on the results of text mining with the AI analysis tool KH-corder, during the period of nursing care level 1, co-occurrence with daily activities and WALK was also observed, although co-occurrence was low.

Acknowledgements

Science (JSPS).

Disclaimer

Although this study is expected to contribute to case studies in clinical research and long-term sustainable studies, the results of one case study in Japan have not been sufficiently validated in regions with different medical, health, and welfare environments and cultures. Therefore, it is necessary to confirm the consistency with the results of other cohort studies in the future. Text-mining inspections have revealed that during the period of nursing care level 1 - 5, active horticultural therapy techniques, and passive horticultural therapy techniques such as HCT and brain rejuvenation aromatherapy were found to betweenness centrality with each other.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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