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Occupation-Based Hydroponic Gardening to Improve Endurance and Functional Mobility in a Client with Suspected Bilateral Knee Osteoarthritis: A Case Report

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ABSTRACT

Background: Knee osteoarthritis (OA) is a degenerative disease characterized by pain, joint stiffness, and limited range of motion, which subsequently reduces endurance and functional mobility.
Case Study: Mrs. N**,** a 65-year-old female farmer with suspected bilateral knee osteoarthritis, presented with limited joint range of motion, impaired functional mobility, and reduced endurance during activities of daily living due to pain. An eight-session occupational therapy intervention was implemented using the Biomechanical Frame of Reference, with the aim of improving endurance and functional mobility through engagement in hydroponic gardening activities.
Results: Improvements in functional mobility and endurance were observed, as indicated by an increase in the 6-Minute Walk Test (6MWT) distance from 80 meters to 205 meters. Pain intensity decreased from 5 to 4, the WOMAC score decreased from 36 to 33, and an increase in knee joint range of motion was also observed.
Conclusion: The findings suggest that hydroponic gardening, when applied within the Biomechanical Frame of Reference, may be an effective occupational therapy intervention for enhancing endurance and functional mobility in individuals with suspected bilateral knee osteoarthritis.

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1. INTRODUCTION

Osteoarthritis (OA) is a disease characterized by the degeneration of articular cartilage, which may be accompanied by subchondral bone thickening, osteophyte formation, ligament damage, and mild synovial inflammation, resulting in joint effusion. In individuals with knee OA, common clinical manifestations include pain, limited Range of Motion (ROM), and decreased muscle strength. The prevalence of OA increases with age and is more common in the hands and knees of women than men. OA generally begins to develop after the age of 50 years, with a prevalence exceeding 10% among individuals aged over 60 years [1]. In older adults, mobility limitations caused by pain and restricted joint range of motion due to OA may increase the risk of dependence in functional abilities and activities of daily living, thereby requiring appropriate management to prevent a decline in quality of life.

One of the risk factors associated with OA is engagement in occupations involving heavy physical workloads. According to the World Health Organization, working as a farmer for 1–9 years increases the risk of OA by 4.5 times, while farming for 10 years or more increases the risk

by 9.3 times [2]. This finding is relevant to the client presented in this case study, who had a history of working as a farmer.

Several studies have demonstrated that physical exercise is both relevant and effective in managing OA symptoms. Findings from a systematic review and meta-analysis indicated that exercise programs significantly improve physical function and reduce pain in individuals with OA [3].

Although previous studies have shown that exercise interventions can successfully reduce symptoms such as pain and joint stiffness, these improvements do not necessarily translate into enhanced performance in meaningful functional activities. One study found that a *Physical Activity on Prescription* program, which recommended regular physical activity for individuals with OA, was more effective in increasing physical activity levels than providing education and activity advice alone [4].

In principle, frames of reference that focus solely on correcting impairments and preventing further decline in body functions may not be sufficient to fully improve or restore occupational performance. Some individuals require a period of adaptation to resume daily activities while coping with their existing limitations. Therefore, interventions that combine physical exercise with practice through meaningful daily activities are needed.

In this regard, occupational therapy plays a vital role in enhancing and maintaining clients' functional performance through a variety of intervention approaches, including the application of the Biomechanical Frame of Reference. The biomechanical frame of reference is applied to address musculoskeletal impairments that affect occupational performance, including reduced muscle strength, limited joint range of motion, pain, and decreased endurance. This frame of reference focuses on restoring or enhancing movement capacity, strength, and endurance [5]. Pain and reduced ROM during activity may alter gait patterns and body posture, thereby restricting movement and reducing endurance during task performance.

Although exercise-based and biomechanical interventions have been widely implemented for individuals with knee osteoarthritis, limited evidence exists regarding their integration with meaningful occupations using a graded, context-specific activity approach. Most studies emphasize impairment-based outcomes, while occupational performance outcomes in real-life work-related activities remain underexplored. Therefore, this case report aims to address this gap by describing the application of the biomechanical frame of reference combined with activity grading in hydroponic gardening to improve functional mobility, endurance, and occupational performance in a client with suspected knee osteoarthritis.

2. MATERIALS AND METHODS

2.1. Client's Profile

This study employed a case study design involving Mrs. N, a 65-year-old woman who previously worked as a farmer in Sobokerto Village, Boyolali. The client presented with symptoms consistent with knee osteoarthritis, including pain, joint stiffness, and limited knee joint mobility. However, the condition had not been medically confirmed, as the client had not undergone a physician's evaluation because of financial constraints. The symptoms affected her mobility and endurance during daily activities. Excessive physical workload, non-ergonomic body posture during work activities, and repetitive movements performed throughout her farming career were considered contributing factors to the development of the OA symptoms in both knees. The client's condition resulted in pain, which contributed to reduced knee joint range of motion, impaired functional mobility, and decreased endurance during activities of daily living. Accordingly, the primary therapeutic focus was to improve endurance and functional mobility by

managing pain and increasing the range of motion of both knee joint.

2.2. Evaluation

The evaluation included measurements of joint range of motion (ROM) using a goniometer, muscle strength testing, functional independence assessed with the Functional Independence Measure (FIM), pain intensity measured using the Visual Analog Scale (VAS), functional disability evaluated with the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and functional endurance assessed using the Six-Minute Walk Test (6MWT). The assessment findings revealed bilateral knee pain, limited knee joint range of motion, and reduced standing and walking endurance, all of which adversely affected the client's performance of activities of daily living.

To minimize measurement bias, all assessments were conducted before and after the intervention using the same outcome measures and standardized procedures. Evaluations were performed by the same occupational therapist under comparable environmental conditions. Standardized instructions were provided during each assessment, and all outcome measures were administered in accordance with their established protocols to ensure the reliability and consistency of the findings.

2.3. Intervention Strategy

The intervention was implemented using the biomechanical frame of reference, which aims to improve joint range of motion, flexibility, and endurance during functional activities. The strategies employed included active and passive stretching before the initiation of activities, as well as activity grading by gradually increasing the workload and duration according to the client’s capabilities. In addition to these strategies, the application of Joint Protection Techniques (JPT) was considered essential for managing pain and protecting the joints during activity performance. JPT focuses on the appropriate use of joints during activities to reduce joint loading and mechanical stress. The implementation of JPT included maintaining proper standing posture, distributing body weight evenly, and avoiding sudden changes in position. These techniques helped prevent an increase in pain during activity performance.

2.4. Intervention Program

The therapy program consisted of eight sessions, conducted three times per week, with each session lasting 45–60 minutes. The therapy was conducted in the client's yard. The main activity implemented during the intervention was hydroponic gardening. Therapeutic media used in the activity included modified used plastic water bottles as planting containers, vegetable seedlings, AB mix nutrient solution, a bucket, and a dipper.

The intervention program consisted of four stages: adjunctive methods, enabling activities, purposeful activities, and occupational performance. During this stage, the principle of activity grading was applied by gradually increasing the duration of activities and the number of planting units according to the client's abilities. Activity grading was implemented progressively throughout the eight therapy sessions. During sessions 1–2, the client performed simple hydroponic gardening activities with a limited number of planting units and shorter activity durations. In sessions 3–4, the number of planting units and the duration of activities were gradually increased. During sessions 5–6, the client engaged in additional planting and plant-care tasks with longer periods of standing and walking. In sessions 7–8, the client was able to perform most planting and plant-care activities more independently with longer activity durations. Furthermore, the principle of activity grading was applied across all stages of the intervention, including adjunctive methods, enabling activities, purposeful activities, and occupational

performance. Grading was achieved through the gradual increase in stretching repetitions, the complexity of exercises using therapeutic media, and the duration and complexity of hydroponic gardening activities according to the client's abilities and tolerance.

During the adjunctive methods stage, the client was provided with active and passive stretching exercises targeting the knee joints. Active stretching involved performing knee flexion and extension movements actively for 8 repetitions in 3 sets on each lower extremity. In addition, a contract-relax technique was applied by providing light resistance during muscle contraction, followed by a relaxation phase. Subsequently, passive stretching was performed with assistance from the therapist to improve joint flexibility, reduce joint stiffness, and increase joint range of motion prior to the main activity.

During the enabling activity stage, the client engaged in exercise activities designed to improve the underlying skills required for hydroponic gardening. The activities included sliding a bottle and performing knee-swing exercises using a scarf as an assistive medium to facilitate repetitive knee flexion and extension movements. This stage aimed to improve activity tolerance, balance, and endurance as preparation for participation in more complex activities.

The next stage was purposeful activity. This activity served as a means of preparing the client to achieve the therapeutic goals by engaging in the sequential processes involved in the task from beginning to end. The client was instructed to perform simulated hydroponic planting and plant-care activities while standing and walking. These activities included transferring seedlings into hydroponic growing media, providing plant nutrients, and carrying out basic plant maintenance tasks. During this stage, the principle of graded activity was applied by gradually increasing the number of planting units and the duration of activity according to the client’s abilities.

The final stage was occupational performance, during which the client incorporated hydroponic gardening activities into her daily routine. The client was encouraged to perform hydroponic plant-care activities at least once per day to monitor the growth of the vegetables while simultaneously engaging in functional standing and walking practice through a meaningful gardening activity. This stage aimed to facilitate the achievement of the therapeutic goals within the client's natural daily environment.

Figure 1. Hydroponic gardening activity

Throughout the therapy program, Joint Protection Techniques (JPT) were implemented, including proper body positioning, balanced weight distribution, and the avoidance of movements that could place excessive stress on the knee joints. These techniques were applied to reduce pain and ensure the client's safety during activity performance.

Post-intervention evaluation was performed using the same outcome measures and assessment instruments as those utilized during the baseline assessment. The purpose of these evaluations was to determine changes in functional abilities and improvements in mobility and endurance following the intervention.

2.5. Informed Consent

Written informed consent was obtained from the client prior to participation in this case study. The client received a complete explanation regarding the purpose of the intervention, assessment and treatment procedures, and the use of anonymized data for publication. Confidentiality was maintained throughout the study, and all identifying information was removed to protect the client's privacy.

3. RESULTS

The results of the intervention are summarized in Table 1 below.

Table 1. Comparison of Pre- and Post-Intervention Assessment Results

Assessment	Pre Intervension	Post Intervension
Muscle Strength	5	5
VAS	5	4
FIM	123	123
WOMAC	36	33
6MWT	80 meters	205 meters

Based on Table 1, the pre-intervention assessment results indicated the presence of moderate pain, functional impairment, and limited walking capacity, as reflected by the distance covered. Following the intervention, improvements were observed in all identified problem areas. The pain score decreased from 5 to 4, while the functional impairment score measured using the WOMAC instrument decreased by 3 points, from 36 to 33. Improvements in functional mobility and walking endurance were also observed, as demonstrated by the results of the 6-Minute Walk Test (6MWT). The table further shows that no deficits were identified in muscle strength or functional independence. Muscle strength assessment revealed that all muscle groups examined—including knee flexion, knee extension, plantar flexion, dorsiflexion, ankle inversion, and ankle eversion—received a score of 5 during the pre-intervention evaluation, indicating normal muscle strength. Similarly, the assessment of independence using the Functional Independence Measure (FIM) yielded a score of 123, indicating that the client was functionally independent, although some activities were performed with modifications or the use of assistive devices.

Changes in joint range of motion (ROM) from pre-intervention to post-intervention are shown in the Table 2 below.

Table 2. Comparison of Pre- and Post-Intervention Range of Motion (ROM) Results

Joint Movement	Normal ROM	Left ROM (Pre)	Left ROM (Post)	Right ROM (Pre)	Right ROM (Post)
Knee Flexion	135˚	80˚	94˚	110˚	121˚
Knee Extension	0˚	0˚	0˚	0˚	0˚
Plantar Flexion	50˚	25˚	31˚	40˚	40˚
Dorsal Flexion	20˚	10˚	12˚	14˚	15˚
Inversi Ankle	35˚	32˚	32˚	30˚	30˚
Eversi Ankle	20˚	18˚	18˚	20˚	20˚

Based on Table 2, an increase in the range of motion was observed in both knee joints, particularly in knee flexion. This improvement indicates enhanced joint flexibility, which supports the client's ability to perform functional activities.

4. DISCUSSION

Based on the therapy outcomes, the treatment goals were achieved, as evidenced by improvements in endurance and functional mobility, increased range of motion (ROM), and reduced knee pain intensity. These improvements were supported by the application of active and passive stretching exercises, which helped enhance tissue flexibility and joint range of motion. Activity grading enabled a gradual increase in activity tolerance, thereby improving endurance without causing excessive pain. The implementation of Joint Protection Techniques (JPT) also helped reduce mechanical stress on the joints during activity performance. Although the observed changes were relatively modest, the application of the biomechanical frame of reference demonstrated beneficial effects for the client. According to Schleimer *et al.*, therapeutic outcomes are influenced by the client's clinical condition, disease severity, and adherence to the prescribed therapy program [6].

In this case, the success of the therapy was supported by the client's strong expectations and motivation to return to meaningful activities, particularly farming. Meaningful goal setting can also enhance client participation and engagement in the rehabilitation process [7]. Hydroponic gardening was selected as the therapeutic activity because it aligned with the client's interests and occupational background as a farmer. Meaningful activities have been shown to increase client participation and motivation throughout the therapy process. Therefore, the combination of physical exercises and meaningful occupational activities yielded more optimal outcomes in improving the client's functional abilities.

The improvement in the client's abilities was also supported by the application of the biomechanical frame of reference, which was appropriately selected to address the client's problems and focused on enhancing joint range of motion (ROM), muscle strength, and endurance [8]. During implementation, the exercise program was designed in accordance with walking exercise guidelines for individuals with knee osteoarthritis, taking into account the intensity, frequency, and duration of activity. Budarick *et al.,* recommended that individuals with knee osteoarthritis engage in walking exercises 3–5 days per week at a moderate intensity for 30–60 minutes per day [9]. The implementation of these principles contributed to a gradual improvement in the client's activity tolerance and endurance. Lawford *et al.,* reported that exercise is effective in reducing pain and improving physical function in individuals with osteoarthritis (OA) [10]. Nevertheless, persistent pain, limitations in range of motion (ROM), and the degenerative nature of osteoarthritis (OA) remained challenges throughout the therapy process.

Despite the favorable outcomes observed, this case study has several limitations that should be considered. First, the intervention was conducted on a single client, which limits the generalizability of the findings to a broader population of individuals with knee osteoarthritis. Second, the intervention period was relatively short, consisting of only eight therapy sessions. In addition, no long-term follow-up assessment was performed to determine the sustainability of the outcomes. Therefore, further studies involving larger sample sizes and longer observation periods are recommended to provide stronger evidence regarding the effectiveness of hydroponic gardening as an occupation-based intervention for individuals with knee osteoarthritis.

5. CONCLUSIONS

The findings indicate that the application of the Biomechanical Frame of Reference through hydroponic gardening activities contributed to improvements in endurance and functional mobility in a client with suspected bilateral knee osteoarthritis. This improvement was demonstrated by an increase in the 6-Minute Walk Test (6MWT) distance from 80 meters to 205 meters, accompanied by reduced pain, a lower WOMAC score, and improved knee joint range of motion (ROM). This case study suggests that hydroponic gardening, when implemented within the Biomechanical Frame of Reference, may be an effective occupational therapy intervention for enhancing endurance and functional mobility in individuals with suspected bilateral knee osteoarthritis. Despite the positive outcomes observed in this case, further research involving larger and more diverse populations is necessary to establish the generalizability of these findings.

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