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Original Article

Closed Kinetic Chain Exercises Therapy Versus Wii-Based Exergame Therapy in the Treatment of Knee Osteoarthritis: Randomized Controlled Trial

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ABSTRACT

Objective: One of the most prevalent musculoskeletal conditions that impair function and cause discomfort is osteoarthritis in the knee. The purpose of this study was to examine the effects of closed kinetic chain exercises and Wii-based exergame treatment on knee osteoarthritis (OA) patients' pain, joint range of motion, muscle strength, joint position sense, functioning, and motor performance.

Methods: This study included 56 patients diagnosed with knee OA. Participants were randomly divided into 2 groups: a Wii-based exercises (WBE) group and a closed kinetic chain exercise (CKCE) group. Exercises continued 5 days a week for 3 weeks. Participants were examined before the therapy, afterward, and in the eighth week. Pain threshold, joint range of motion, muscle strength, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), the Timed Up & Go test (TUG), and joint position sense were alternately examined.

Results: A statistically significant difference was obtained in pain threshold results after treatment compared to before treatment ($P < .05$) in the intra-group comparison and at the eighth week ($P < .05$). After treatment, joint position sense was significantly better in the CKCE group than in the WBE group ($P < .05$). Statistical significance was achieved in the WOMAC values after treatment in both groups ($P < .05$). Intragroup comparisons revealed that the improvements in the WOMAC and TUG tests in the WBE group were statistically better than those in the CKCE group ($P < .05$). In the analysis of the difference between groups after treatment and at week 8, the results were significantly better in the WBE group than in the CKCE group in terms of the TUG test values ($P < .05$).

Conclusion: We concluded that, among patients with knee OA, WBE programs can be of great use for pain reduction and for functionality and balance exercises in rehabilitation.

Keywords: Active-video gaming, exercise, osteoarthritis, pain

Introduction

Osteoarthritis (OA) is a chronic, degenerative joint disease that affects the knee and hip joints and progresses slowly.[1] The illness progressively worsens a person's capacity for self-sufficiency, mobility, and social interaction, which lowers the quality of life overall.[2] In addition to pain, accompanying symptoms include edema, stiffness, range of motion (ROM), instability, decreased muscle strength, and proprioceptive system disorder with an increased rate of falling.[1,2]

Clinical guidelines on OA, based on evidence-based therapy, include patient training and weight management, structured exercise, and self-coordination programs that integrate physical activity.[3] In studies on patients with knee OA, kinetic chain exercises significantly reduced pain, increased ROM, and significantly improved functionality; however, it was determined that there had been no discernible increase in muscle strength.[4,5]

Over the past 2 decades, closed kinetic chain exercises have emerged as a significant component in the rehabilitation of various musculoskeletal disorders, becoming established as a favored method in this domain. An analysis of research on closed kinetic chain exercises reveals a predominant

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focus on lower extremity pathologies. These exercises are recognized for their efficacy in enhancing muscle strength and augmenting proprioceptive function, which is attributed to their ability to stimulate a greater number of muscle spindles and joint proprioceptors.[6]

At the same time as technology is developing, there has been a growing use of technology-infused exercise programs, like video-based exercises. These days, technology-assisted rehabilitation is acknowledged as a complementary approach for individuals requiring rehabilitative care. In this context, motion-sensitive sensors play a pivotal role, especially in camera system-based rehabilitation, eliminating the need for additional devices. Rehabilitative technology is a developing field, and devices like the Nintendo Wii and Microsoft Kinect are highlighted as examples.[7,8]

The term "exergaming," which refers to a relatively new kind of entertainment that combines video gaming and physical activity, was created by researchers and developers.[9] Exercises based on video games have the potential to improve exercise quality, motivation, and adherence to physical activity. Exergames have been shown in systematic reviews to enhance daily functioning, balance, walking speed, cognitive and physical function, and depression in older persons.[10] Several studies have examined the benefits of video game-based exercise and its impact on health. In the results, video game-based exercise is potentially a major strategy for helping improve physical activity levels. In addition, it is considered to be an alternative to conventional exercises.[11]

Few studies in the literature focus on which video-based game exercises are administered to patients with knee OA. Various games have been designed to develop physical aptitude and balance; however, there is uncertainty regarding the extent to which exercise programs are functional, reliable, and optimal for patients with knee OA. Up until now, there has not been enough data to back up the idea that physical functioning may be improved by video game exercises in a way that is comparable to or even better than normal exercise regimens.[11]

Closed kinetic chain exercises are exercises that can be performed functionally, safely, and effectively. Studies have demonstrated that including closed kinetic chain movements in a rehabilitation program helps people with osteoarthritis (OA) feel less pain and have stronger muscles and improved proprioception.[6]

Wii-based games improve neuroplasticity in the individual through specific therapeutic exercises that involve carefully performed tasks. Studies are showing that Wii-based games improve lower extremity muscle strength in the elderly.[11] Active video gameplay is affordable, practical, pleasurable, and fun. It might be a substitute for sticking to a fitness regimen by boosting rewards and self-efficacy through encouraging visual and audio feedback.[12]

Therefore, the purpose of this study was to examine the impact of Wii-based games created specifically for knee OA patients. In this study, we tested the hypothesis that patients with knee osteoarthritis could benefit from a Wii-based balancing training program in terms of pain, ROM, muscle strength, joint position sensing, functioning, and motor performance. Additionally, by evaluating the eighth week, we hoped to compare the long-term effects of video-based therapies and closed kinetic chain exercises and determine whether the therapy program was more successful in the rehabilitation of knee OA.

Methods

Participants

This was a single-blind, randomized study in which participants (1 : 1) were allocated to 1 of the 2 groups. In compliance with the study's inclusion criteria, 56 volunteers who had been diagnosed with bilateral knee OA by a qualified medical professional and given exercise after electrotherapy applications were suggested for physiotherapy and rehabilitation in the İstanbul Medipol University laboratory participated in this investigation. Before conducting the research, the application process to the İstanbul Medipol University Non-interventional Clinical Research Ethics Committee was completed and approved (Approval no: 10840098-772.02-65142, Date: December 15, 2020). The clinical trial number of this study is NCT05601947. Every participant in the research was diagnosed with medial–lateral OA. Every research participant signed an informed consent form. This study used the CONSORT reporting guidelines.[13]

Demographic data for the participants were collected, and 56 participants were included and divided into 2 groups using a randomization method. Before the randomization process, envelopes with the letters A and B were prepared to be chosen by the patients of each group. The patients in this study randomly selected 1 of the 2 envelopes. Patients who picked envelopes with the letter A were allocated to the Wii-based exercises (WBE) group (n = 28), and those who selected letter B were allocated to the closed kinetic chain exercises group (n = 28).

The study's inclusion criteria required participants to have experienced OA-induced knee pain for a minimum of 6 months, be diagnosed with primary OA according to the American College of Rheumatology criteria, have stage 2-3 knee OA based on the Kellgren–Lawrence classification, be aged between 55 and 65, have no history of neurological disease, indicate a desire to take part in the research, and achieve a score of ≥23 on the Mini-Mental State Examination Scale.

The exclusion criteria included a diagnosis of secondary OA, previous knee, hip, and/or spine surgery; receipt of physiotherapy for serious knee trauma or knee physiotherapy within the past year; a neurological history that could affect balance and joint position sense; the presence of vertigo, hearing, or vision problems; genu varum and/or genu valgum and scoliosis; a body mass index (BMI) of ≥40 kg/m^2; and a visual analog scale of ≥8/10.

Out of a total of 64 patients, three patients were excluded because they failed to meet inclusion criteria, and 5 patients were excluded because they declined to participate in the research. By utilizing randomization, the remaining 56 participants were divided into 2 groups. The unified criteria of reporting trials flow diagram (Figure 1) displayed a thorough study flowchart.

Intervention

All study participants completed 15 sessions of the electrotherapy program and physical modalities over 3 weeks, which entailed 5 sessions per week with a physiotherapist. The physical modality application was designed as a 20-minute hot pack. The electrotherapy program was designed as follows: 10 minutes of ultrasound (1.5 W/cm^2, 1 MHz, 5 minutes) with 5 minutes for each knee, and conventional transcutaneous electrical nerve stimulation (TENS), (50-150 Hz, 20 minutes).

Closed Kinetic Chain Exercises Group

In addition to the electrotherapy program, research participants in the structured closed kinetic chain exercises (CKCE) group performed structured CKCE for 30 minutes, 5 days a week, for 3 weeks, under the supervision of a physiotherapist. The resting period between exercises was set at a break time of 10 seconds. In the CKCE group, the exercises were integrated from easy to difficult each week for 3 weeks. The exercise program is detailed in Figure 2.

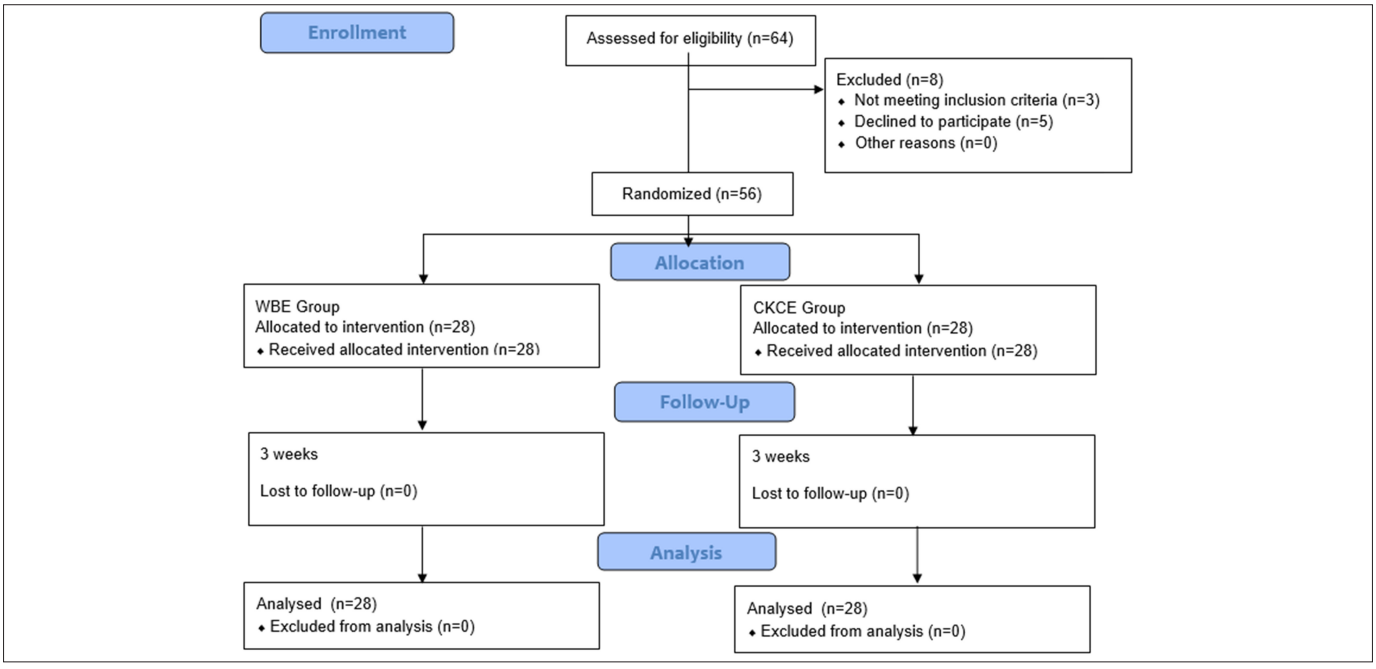

Figure 1. Flow diagram of study participants. WBE, Wii-based exercise; CKCE, closed kinetic chain exercises.

Ist Week:	IInd Week:	IIIrd Week:
1. On a flat surface staying balanced for 20 seconds when eyes closed 2. On a flat surface walking straight for 30 meters 3. Walking on a single line for 30 meters 4. Walking lateral-cross on a single line for 30 meters 5. Walking tiptoe for 30 meters 6. Walking on toes for 30 meters 7. Walking backwards for 30 meters 8. Staying balanced on single foot for 20 seconds when eyes open 9. Sitting and standing up 20 times from height	After the first week; 1. 1-minute practice by loading towards from-back and right-left on a balance board 2. Sitting and standing from a low seat 20 times 3. For 2 minutes; placing a 30 cm diameter exercise ball on sole and releasing the ball after putting weight 4. 10-repeat mini squat exercise	After the first and second week; 1. 2 minutes long walk in between two barriers in 8 shape 2. Using a Stepper tool, 50 steps of moving still in a rhythmic pattern 3. Lateral step-up (for 1-minute rhythmic climb towards up and down taking lateral side on a 10 cm. height step.)

Figure 2. Structured closed kinetic chain exercise program.

Wii-Based Exercise Group

Participants in this group underwent WBE for 30 minutes, 5 days a week for 3 weeks, in addition to the electrotherapy program. In our study, the WBE program was implemented with the Becure Balance System. Becure (Becure Global, Mannheim, Germany) is a web-based platform designed for the field of physiotherapy, incorporating both assessment tools and rehabilitative games. The Becure balance system includes custom rehabilitative video games developed by physiotherapists and software developers using a Wii balance board. In our study, video-based game exercises developed by Becure were utilized. In the Becure Balance System, "Balance Surf," which involved mediolateral stability, "Balance Adventure," which involved multi-dimensional weight transference, and "Balance Bowling" games that involved static and dynamic postural control were administered. In the WBE group,

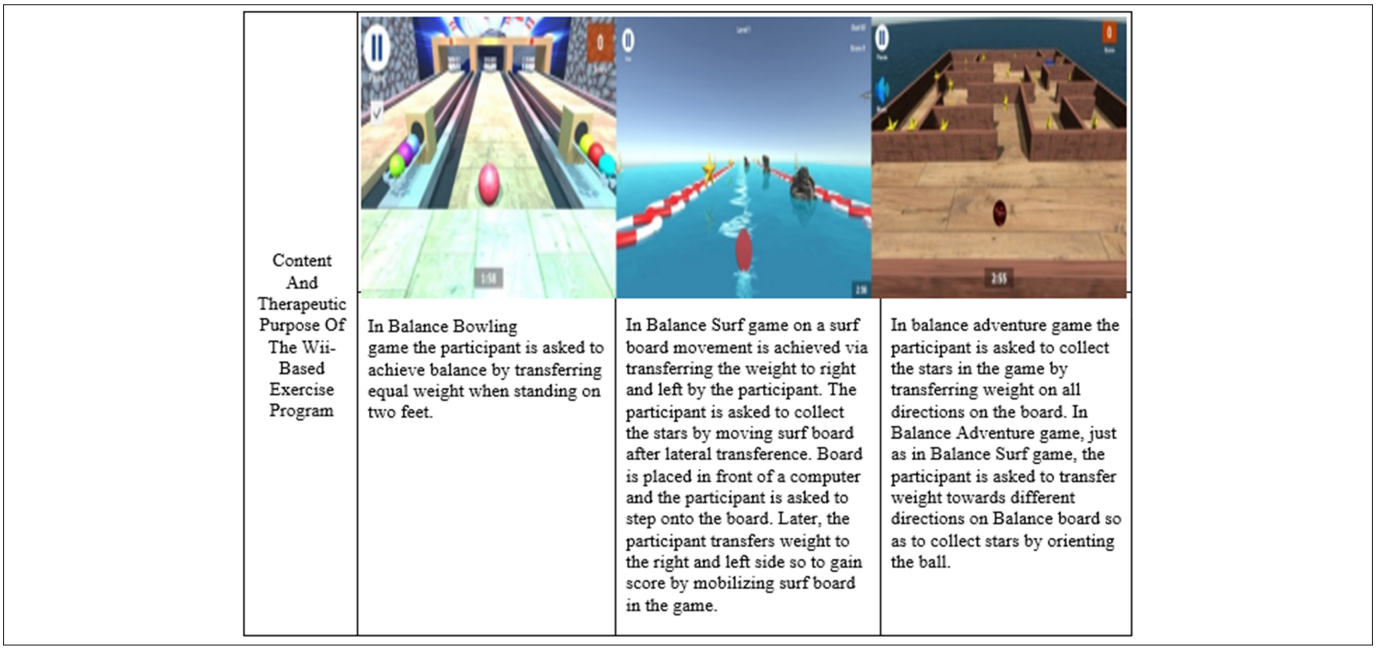

Figure 3. Wii-based games.

the program was applied in the same way for 3 weeks, and the level of difficulty was kept constant throughout the program. For 30 minutes, each game was played under the guidance of a physiotherapist. The content and therapeutic purpose of the games are illustrated in Figure 3.

Outcome Measurements

The participants in the study were assessed with a physiotherapist before and after the therapeutic intervention and during the eighth week. The eighth week was determined starting from the first week.

Pain Threshold

In the evaluation of the pressure pain threshold (PPT), a digital algometer (Baseline® Dolorimeter USA 60 pound/27 kg capacity) was used. The study participants' most sensitive locations served as a reference for assessing their pain thresholds. Three measurements were obtained, and the average was determined. Rest periods of 10 seconds were given between measurements, and the results were recorded in kg/cm².[14,15]

Range of Motion

A digital goniometer (Baseline® digital Absolute+Axis goniometer, USA) was used to evaluate the active and passive knee flexion ROM of the participants. The measurements were adapted to Kendall–McCreary criteria.[16]

Muscle Strength

A muscle strength evaluation was conducted via a calibrated manual muscle dynamometer MicroFET® 2 (Hoggan Scientific; USA) by creating maximum isometric contraction. Maximum isometric knee extensor forces, knee flexor forces, hip flexor forces, and hip abductor forces were measured on both legs according to a pre-approved method used in the elderly community with individuals who have fallen.[17]

Joint Position Sense

Joint position sense was measured using a digital goniometer (Baseline® digital absolute+axis goniometer) and an active knee joint axis derivation test. The subjects sat with their hips flexed 85° and their knees flexed 0°. To avoid any visual input, the subjects' eyes were covered with a blindfold. They were asked to feel the joint position when their knee was first positioned at a passive angle and subsequently at goal angles of 15°, 45°, and 75° knee flexion. Next, they returned to a neutral position again and were asked to return to their target angles.[18,19]

Functional Level

The functional level of patients was assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Patients with knee osteoarthritis frequently use the WOMAC Index, a specialized medical assessment tool for osteoarthritis. This form has 24 questions divided into 3 sections: pain, stiffness, and physical function. Responses are computed using a 5-point likert scale. High WOMAC values point to increased pain and stiffness and degraded physical function.[20,21]

Motor Performance

The Timed Up & Go Test (TUG) was used to evaluate the patient's motor function. The patient stands up from the chair, walks 3 m, turns in a circle, and sits back in the chair. If the task is completed in longer than 14 seconds or the subject fails to complete the task, it is classified as an increased risk of falling.[22,23]

Statistical Analysis

In the detection of the sample size, the G-Power 3.1.9.2 program was utilized.[24,25] In a 2023 study that was similar to this one, Alpay and Sahin[26] intended to enroll 40 patients in total, with at least 20 patients in each group, in order to detect changes with 80% power and a 95% CI. To exceed the 95% value in determining the power of the research, it is necessary to reach a total of 56 people with an effect size of 90% with 28 people per group. The data significance level was taken as $P < .05$ and analyzed via the Statistical Package for Social Sciences version 20.0 software (IBM Corp.; Armonk, NY, USA). The arithmetic means are presented as arithmetic means ± SD. To compare the groups' demographics, a student's *t*-test was employed. Shapiro–Wilk test was performed to evaluate the data's distribution before statistical analysis. It was seen that our data was not normally distributed, and thus a nonparametric test was used for the statistical analysis. The Wilcoxon test was applied for comparisons within groups. To investigate intergroup comparisons, the Mann–Whitney *U*-test was employed.

Results

Baseline Characteristic

Each group consisted of all 28 female participants diagnosed with bilateral knee OA, and the leg with the most clinical complaints such as pain and joint movement limitation was analyzed. Individuals participating in the study did not receive painkillers or other pharmacological treatment for the diagnosis of knee osteoarthritis. The baseline characteristics were similar for both groups. Demographics are shown in Table 1.

Effect of Intervention

Intragroup comparisons before, after, and at the eighth week of therapy are shown in Tables 2 and 3. All groups in the research achieved significant improvement, as seen in the comparison of pre-treatment, post treatment, and in the eighth week.

When comparing the pain threshold of both groups at the end of treatment and the beginning of the treatment, there were notable changes. Knee flexor muscle strength values showed a substantial increase in the CKCE group and a significant decrease in the WBE group following therapy ($P < .05$). While hip abductor muscle strength increased significantly ($P < .05$) in the CKCE group, hip flexor muscle strength increased significantly in the WBE group. Following the structured CKCE and WBE training programs, it was reported that no significant increase was measured in ROM and knee extensor muscle strength. Only in the group with the structured CKCE program, there were significant improvements in joint position sense values after therapy ($P < .05$). The WBE program did not create any significant changes in ROM and joint position sense. In the WOMAC evaluations, there were greater improvements in post-treatment values compared to the values before treatment.

The intra-group differences in the post-treatment and eighth-week values and a comparison of differences between groups are shown in Table 4. In the comparison of pain thresholds, the improvement in the CKCE group was much greater than that in the WBE group ($P < .05$). A comparison of the posttreatment and eighth week difference

Table 1. Baseline Characteristics of the Participants

Characteristic	WBE Group (n = 28) Mean ± SD	CKCE Group (n = 28) Mean ± SD	*P*
Participants			
Age (years)	58.85 ± 3.57	60.25 ± 3.74	.162
BMI (kg/m^2)	29.24 ± 3.83	30.78 ± 4.36	.164

Student *t*-test.
BMI, body mass index.
*$P < .05$.

Table 2. Comparison of Values Pre-treatment, Post-treatment, and Eighth Week Within WBE Group

Variable	Pre-WBE Group Mean ± SD	Post-WBE Group Mean ± SD	Eighth Week WBE Group Mean ± SD	*P*
Pain threshold	4.32 ± 1.67	4.72 ± 1.94	5.02 ± 2.29	**T0-T1: .001*** **T0-T2: .001*** **T1-T2: .001***
ROM-Knee flexion	115.35 ± 13.09	116.96 ± 13.14	116.00 ± 12.36	T0-T1: .502 T0-T2: .82 T1-T2: .76
Knee flexion (kg-force)	17.39 ± 5.96	15.15 ± 2.13	15.80 ± 2.28	**T0-T1: .016*** T0-T2: .873 T1-T2: .927
Knee extension (kg-force)	14.37 ± 2.90	14.94 ± 3.47	18.42 ± 2.27	T0-T1: .254 **T0-T2: .001*** **T1-T2: .001***
Hip flexion (kg-force)	17.54 ± 2.15	19.84 ± 2.72	19.48 ± 1.45	**T0-T1: .025*** **T0-T2: .007*** T1-T2: .508
Hip abduction (kg-force)	18.42 ± 5.39	18.55 ± 2.17	20.36 ± 3.77	T0-T1: .6 **T0-T2: .072*** T1-T2: .186
15° joint position sense	4.57 ± 3.06	3.60 ± 2.13	3.78 ± 2.74	T0-T1: .201 T0-T2: .414 T1-T2: .779
45° joint position sense	3.64 ± 2.16	3.71 ± 2.14	2.57 ± 1.79	T0-T1: .944 **T0-T2: .037*** T1-T2: .079
75° joint position sense	3.50 ± 2.42	2.64 ± 1.83	1.96 ± 1.52	T0-T1: .091 **T0-T2: .016*** T1-T2: .131
WOMAC Index	47.07 ± 12.06	41.50 ± 10.55	39.60 ± 10.25	**T0-T1: .001*** **T0-T2: .001*** **T1-T2: .012***
TUG test (seconds)	11.91 ± 4.89	10.92 ± 3.23	10.92 ± 3.23	T0-T1: .079 T0-T2: .475 **T1-T2: .008***

ROM, range of motion; T0, pre-WBE group; T1, post-WBE group; T2, eighth week WBE group; TUG, timed up and go test; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.
*$P < .05$, Wilcoxon test.

Table 3. Comparison of Values Pre-treatment, Post Treatment, and Eighth Week Within CKCE Group

Variable	Pre-CKCE Group Mean ± SD	Post-CKCE Group Mean ± SD	Eighth Week CKCE Group Mean ± SD	*P*
Pain threshold	4.86 ± 2.27	5.31 ± 2.73	6.09 ± 2.90	**T0-T1: .001*** **T0-T2: .001*** **T1-T2: .001***
ROM-knee flexion	113.46 ± 8.75	111.25 ± 9.68	111.07 ± 13.63	T0-T1: .084 T0-T2: .393 T1-T2: .805
Knee flexion (kg-force)	13.82 ± 3.88	18.2 ± 6.94	14.98 ± 1.86	**T0-T1: .004*** T0-T2: .151 T1-T2: .648
Knee extension (kg-force)	17.01 ± 2.44	18.26 ± 3.41	16.37 ± 2.83	T0-T1: .201 T0-T2: .431 T1-T2: .052
Hip flexion (kg-force)	19.65 ± 4.55	21.66 ± 7.52	17.35 ± 1.48	T0-T1: .837 **T0-T2: .017*** **T1-T2: .007***
Hip abduction (kg-force)	19.23 ± 1.92	23.46 ± 7.41	19.92 ± 2.66	**T0-T1: .018*** T0-T2: .305 T1-T2: .84
15° joint position sense	4.64 ± 2.79	3.57 ± 1.61	2.78 ± 1.10	**T0-T1: .001*** **T0-T2: .001*** **T1-T2: .001***
45° joint position sense	4.28 ± 2.05	3.57 ± 1.70	3.14 ± 1.43	**T0-T1: .004*** **T0-T2: .001*** **T1-T2: .008***
75° joint position sense	3.07 ± 2.41	2.78 ± 2.58	1.71 ± 2.24	**T0-T1: .005*** **T0-T2: .001*** **T1-T2: .001***
WOMAC index	53.03 ± 11.15	48.50 ± 9.22	49.85 ± 10.21	**T0-T1: .001*** **T0-T2: .001*** **T1-T2: .009***
TUG test (seconds)	9.6 5± 1.95	9.43 ± 2.59	8.31 ± 2.17	T0-T1: .554 **T0-T2: .001*** **T1-T2: .024***

ROM, range of motion; TUG, timed up and go test; T0, pre-CKCE group; T1, post-CKCE group; T2, eighth week CKCE group; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.
*$P < 0.05$, Wilcoxon test.

Table 4. Intra-Group Differences of Post-treatment and Eighth Week Values and Comparison of Differences Between Groups

Variable	WBE Group Mean ± SD	CKCE Group Mean ± SD	*Z*	Diff. *P*	*P*
Pain threshold	−0.29 ± 0.09	−0.77 ± 0.11	−3.495	**<.005**	**.001***
ROM-knee flexion	0.96 ± 2.49	0.17 ± 1.57	−0.174	>.05	0.862
Knee flexion (kg-force)	0.65 ± 0.65	−3.28 ± 1.38	−2.432	**<.05**	**.015***
Knee extension (kg-force)	3.47 ± 0.57	−1.88 ± 0.94	−4.267	**<.005**	**.001***
Hip flexion (kg-force)	−0.35 ± 0.55	−4.30 ± 1.51	−1.773	>.05	.076
Hip abduction (kg-force)	1.81 ± 1.02	−3.54 ± 1.81	−1.414	>.05	.157
15° joint position sense	−0.17 ± 0.49	0.078 ± 0.16	−1.728	>.05	.084
45° joint position sense	1.14 ± 0.61	0.42 ± 0.15	−0.832	>.05	.406
90° joint position sense	0.67 ± 0.49	1.07 ± 0.26	−0.888	>.05	.374
WOMAC index	1.89 ± 0.63	−1.35 ± 0.55	−3.375	**<.005**	**.001***
TUG test (seconds)	−0.24 ± 0.57	1.11 ± 0.43	−2.905	**<.05**	**.004***

ROM, range of motion; TUG, timed up and go test; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.
*$P < .05$, Mann–Whitney *U*-test.

analyses between the 2 groups demonstrated that, in the group that practiced WBE, there was superior development in knee flexion ROM and muscle strength evaluations in comparison to the structured CKCE group, and this superiority was more notable in knee flexor and knee extensor muscle strength ($P < .05$). There was no discernible difference in the joint position sense evaluation values between the groups after the eighth week of treatment and following the therapy. In the analysis of the TUG test difference, the improvement in the CKCE group was much more significant that in the WBE group. In the WOMAC difference analyses, the improvement in the WBE group was significant (Table 4).

Discussion

This study showed the positive effects of different rehabilitation programs on pain, ROM, strength, and functional performance of the knee in patients with knee OA.

Video game-based exercise is a newly used method, and it increases the motivation and exercise participation rates of subjects better than conventional treatments. It acts as a distractive tool to restrict users' processing of nociceptive stimuli, thereby causing pain to be felt less intensely.[27,28] Video game-based exercise creates a high amount of visual and sensory feedback,[28] and our findings are in agreement with this hypothesis. It can be argued that, in the WBE program administered complementary to the conventional physiotherapy program, there was a decreased level of pain complaints in patients with knee OA. Menek et al[8] reported that video-based exercises can be used in the treatment of pain in orthopedic patients.

Knee pain and weak quadriceps have been reported as the determinants of disability in knee OA.[29] After a complete knee arthroplasty, Silvia Gianola et al[30] compared the effectiveness of video-based workouts with standard therapy given by physiotherapists. They reported that there was no significant difference in empowering muscle strength between both groups. In our study, we assumed that the reason for increased muscle strength after treatment in all groups was due to the administration of strength exercises in both groups. Chi Jin et al[31] reported that video-based game exercises significantly increased ROM. However, in our study, in both groups, we did not find a statistically significant improvement in the intra-group comparison of post-treatment and eighth-week ROM. We attribute this finding to the fact that, in the CKCE group, the balance-coordination and joint position sense exercises that were administered with the Wii-based games failed to sufficiently develop ROM because they were not the kind of games that develop ROM.

In the treatment of osteoarthritis in the knee, joint position sensation plays a crucial role since it can change the patient's self-reported pain, disability, and other results. Reduced joint position sensation has been linked to an increased risk of falling, according to studies.[30] In our study, better outcomes were observed in the CKCE program for knee joint position sense values compared to Wii based exercises. We think that the reason for this is that the loads on the joint in the CKCE group improved the sense of joint position by stimulating the proprioceptive mechanism. In the WBE group, on the other hand, we expected to witness some improvement in joint position sense as these games require task-based, visual, and audio feedback. We believe that the reason that effective outcomes in joint position sense were not obtained was due to the short exercise duration. Additionally, in the WBE group, the same program was administered for 3 weeks, and, unlike in the other groups, the difficulty level remained stable throughout the program.

Western Ontario and McMaster Universities Osteoarthritis Index is a frequently used integrated measure in knee OA patients to assess how pain affects their functional impairment.[32] In our study, at the end of the 3-week therapy program, a significant development was observed in the WOMAC scores of both groups. Active video games can enhance dynamic balance, physical functional performance, and physical well-being more than therapeutic activities and provide a similar level of pain management, according to a study by Lin et al[12] based on patients with knee OA. When we look at the results of the TUG test that we used to evaluate the functional status in our study, our findings showed better results for TUG values in the CKCE group than for the WBE group. A significant increase in the TUG test was observed in the eighth week of evaluation. In our study, we think that adding new activities from easy to difficult every week to closed chain exercises applied for 3 weeks significantly increased the functional status at the end of the treatment. In the WBE group, the same application was made for 3 weeks, and the difficulty level of the exercises was kept constant throughout the application compared to the other group. We attribute this situation to its inadequacy in the development of functional status in the short term.

The TUG test, joint position sensation values, and pain level all showed significant improvement in the CKCE group when we examined the evaluation findings from the eighth week. In the WBE group, there was a significant development in the eighth-week pain and WOMAC scores. We suggest that both programs, integrated with conventional therapy, can be of great use in the long term to improve the functionality of patients with knee OA.

Conclusion

In this study, we proposed that WBE programs can be applied to orthopedic patients with OA as well as neurological and pediatric patients. The integration of WBE and CKCE applications into therapy programs can increase the chances of rehabilitation among patients with knee OA. Thus, these methods can be used as complementary therapies to conventional programs in the rehabilitation of OA.

Study Strengths and Limitations

We believe that our study has a unique value in that it was the first study to use video-based games developed in cooperation with physiotherapist engineers for Wii-based therapeutic purposes in knee OA and to compare the long-term effects of video-based treatments.

In terms of limitations, due to the pandemic, only a limited number of individuals could be in our study. Cost analyses of the treatment programs applied in the study during the rehabilitation process could not be made. Other limitations include the fact that only female patients participated in the study and that there was not a control group.

Ethics Committee Approval: Before conducting the research, the application process to the İstanbul Medipol University Non-interventional Clinical Research Ethics Committee was completed and approved (Approval no: 10840098-772.02-65142, Date: December 15, 2020). The clinical trial number of this study is NCT05601947.

Informed Consent: Written informed consent was obtained from participants who participated in this study.

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