Comparison of different Virtual Reality Exercises compared to Conventional Physiotherapy for chronic Low back Pain: A feasibility study

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Abstract

One of the most common health problems that seriously impairs people's lives and frequently defies medical care is chronic low back pain. Currently, Virtual reality (VR) has been administrated for different musculoskeletal disorders including chronic low back pain.

Objective- The study aim was to determine and compare the effects of different games on pain and physical disability with conventional physiotherapy on low back pain.

Methods- In this study, 40 patients with chronic low back pain were equally allocated in five groups, A, B, C, D and E. The first four groups received virtual reality exercises and back strengthening exercises along with transcutaneous electrical nerve stimulation (TENS). Rally ball, reflex ridge, river rush and fruit Ninja were the games played by Group A (n=8), Group B (n=8), Group C (n=8) and Group D (n=8) respectively. While group E 'Treatment as usual' received only conventional Physiotherapy. Pain through visual analogue scale (VAS) and functional status through back pain functional scale (BPFS) were measured at baseline and after 9th session.

Results- The mean age of participants was 41.10±6.68 years. The post mean of back pain functional scale (BPFS) for Group E, was significantly lower 24.38±3.02 than those for virtual reality games like "Reflex Ridge" 50.25±5.2, "Rally Ball" 48.00±3.07, "Fruit Ninja" 40.63±5.55, and "River Rush" 34.50±5.35. No significant differences was found between Group A and Group B ($p>.05$). Group A and B scored significantly higher on the back pain functional scale (BPFS) than groups C and D. Similar findings were seen on pain intensity, which revealed differences across group E that were noticeably less significant than in other virtual reality games. The back pain functional scale (BPFS) scores significantly increased for all groups as p values were $p<.05$

Conclusion-The results showed that Virtual reality significantly reduced pain intensity and functional impairment. Virtual reality games performed better than conventional treatments in reducing pain severity**.**

Key words:

Virtual Reality, Chronic Low Back Pain, Fruit Ninja, Low Back Pain, Rally ball, Reflex ridge, River rush

I. Introduction:

The term "chronic low back pain" (CLBP) refers to back pain that lasts longer than 12 weeks.[1]This is one of the most common musculoskeletal conditions for which medical attention is sought.[2] In comparison to diabetes (38.6 million), chronic obstructive pulmonary disease (30.6 million), and other chronic diseases or disorders in 2017, it accounts for the majority of years spent living with a handicap globally (64,9 million) approximately 20% of the global population is affected by persistent low back pain.[3][4]Chronic low back pain (CLBP), which affects 85–90% of patients, is characterized as nonspecific pain since it is unable to identify the exact nociceptive etiology as pain not caused by a specific condition like an infection, tumor, fracture, or inflammation.[5]

Low back pain (LBP) is a burden not just on the person, but on society, healthcare systems, and economies as well. CLBP has a significant influence on quality of life and functional status, and is the major cause of excessive therapeutic interventions and excessive job absences.[6]Low back pain (LBP) is discomfort in the sacral spine, or S1-sacrococcygeal junction, and lumbar spine/L1-5 vertebrae region. As a result of activation of the nerve or dorsal root ganglion, leg pain with radicular distribution travels along a dermatomal distribution into the extremity. The referred pain may travel along a non-dermatomal trajectory to a distant place.[7]Pain in these three areas is fairly prevalent in both the United States and internationally. CLBP has a significant impact on the social, psychological, and physical dimensions, making it necessary to establish an effective treatment.[8]In clinical settings, treatment options for CLBP include surgery, medication, and physical therapy. In addition to analgesic drugs, substantial evidence supports the use of early physical activity including coordination, strengthening, stretching exercises and manual therapy. The majority of the approaches focus on teaching patients how to manipulate their thoughts, emotions, and behaviors to control their pain experience. It has been demonstrated that these techniques are moderately successful at alleviating persistent low back pain.[9]Virtual reality (VR), a relatively modern technology, is the alternate method that can alter CLBP.[10]VR immersive mechanism vary, ranging from non-immersive to immersive. The patient can interact with a computer-generated world using this technology as rehabilitation strategy. When using non-immersive VR, body tracking technology translates movement to alter the virtual avatar on screen.[11]Immersive environment can be administered, such as a head-mounted display (HMD) or wearable haptic devices, incorporates multi-sensory experiences (such as those that are visual, aural, and tactile) into the simulation. This combination of experiences is linked to a higher sense

of realness and presence[12].Non-immersive Virtual Reality (VR) apps have been developed for the treatment of a broad variety of ailments, including back pain, and have been demonstrated to be useful for enhancing motor function in LBP patients. Immersive VR has been utilized to alleviate severe pain during medical interventions such as burn care. VR can therefore be utilized as a pain distraction to interrupt the cycle of pain apprehension.[13] By using immersive or non-immersive VR to distract patients from their pain, patients could perform the required therapeutic tasks unknowingly. This reduces discomfort and boost functional capacity. The treatment of symptoms typically depends on whether they are acute (lasting less than 12 weeks) or persistent. Symptoms caused by both mechanical and non-mechanical conditions may last for months or even years. Those with chronic low back pain can be classified according to six criteria. (1) Back and leg pain associated with standing; (2) persistent morning stiffness; (3) nocturnal pain; (4) localized spinal column discomfort; (5) fever; and (6) visceral pain. 14. There is evidence that VR-enhanced environments can alleviate chronic pain, either during VR workouts or after 3 to 10 days of rehabilitation.[14]

The study aim was to compare the effects of different games on pain and physical disability related to low backache. This research will aid in the administration of such games for musculoskeletal rehabilitation as few games was administered first time in terms of establishing a foundation for its potential use in future.

II. Methodology

This was a feasibility study, was conducted in the physiotherapy department of Lahore's Government Services Hospital. A total of 40 individuals, eight in each group, were selected by based on predetermined criteria. Participants in the study experienced back discomfort for more than twelve weeks. Lower limb pain, pathology, or musculoskeletal illnesses, virtual reality gaming phobia, and pregnant women were excluded. Before receiving virtual therapy, each subject provided informed consent and was recruited according to inclusion criteria. A baseline evaluation was conducted before first session. Participants were equally assigned in five groups after the initial evaluation (Group A: Rally ball, Group B: Reflex Ridge, Group C: River Rush, Group D: Fruit Ninja, and Group E: treatment as usual). Pain and functional impairment were the main outcomes. The visual analogue scale (VAS) was used to measure pain, while the back pain functional scale (BPFS) was used to measure functional impairment. Post-treatment readings were taken after the 9th session of intervention.

After the baseline assessment, Groups A, B, C, and D received 10 minutes of VR balance games along with 30 minutes of routine physical therapy rehabilitation program. VR games displayed through Kinect Xbox 360 Device V.2 Model. Kinect Adventures games use whole-body motion to let the player engage in a range of games, which are gathered in a variety of ways.[15] In the game "River Rush," the player's avatar is in a boat and must move downstream. To move the boat, the player must move their body to each side. In the ‘‘Reflex Ridge’’ game the player moves around on a platform on a track and avoid obstacles by moving sideways or bending down. In fruit ninja game the participant were told to avoid the "bombs" in the game while attempting to break the fruit by waving their hands as much as they could.

Participants were required to complete nine VR training sessions, which were split into two weekly sessions. To avoid fatigue, there was a one-minute break in between each 5 minute session. All groups got moist heat therapy, transcutaneous electrical never stimulation for 10 minutes, after that Virtual reality exercise. Group E, however, only undertook a routine physical therapy rehabilitation program.

The data was analyzed by using SPSS 26.0. Mean and standard deviation of quantitative data was withdrawn. However, frequency and percentages of the categorical data was analyzed. Parametric test repeated Measurement ANOVA was applied for Pain and Back pain functional scale (BPFS) for inter group comparison and to measure mean differences between groups. The tests were conducted at CI 95% ($P \leq 0.05$)**.**

III. RESULTS

The study was conducted on 40 subjects with low back pain, information was equally gathered from each group. In each group, there are four males and four females. The mean age of selected participants was 41.10 ± 6.68 years.

1. Within Group Pain and Low back functional Index

Within group analysis showed that there were improvements in all groups.One-way analysis of variance (ANOVA) results revealed that the means of the five groups varied, with a visual analogue scale (VAS) of $F(4, 35) = 4.87$, $p = .003$.The post-hoc comparison using Tukey HSD showed that Group E experienced less improvement in VAS compared to VR games. In addition, the virtual reality games "Reflex Ridge" and "Rally Ball" showed a greater reduction in pain than

"River Rush" and "Fruit Ninja," respectively. Scores on the back pain functional scale (BPFS) significantly increased for groups A and B before increasing for groups C, D, and E, respectively **(Table No.1)**

2. Between Group Comparison for Pain and back pain functional scale among (n=40)

There were differences in the means among the five groups, with a back pain functional scale score of F (4, 35) =42.160, p=.000. Tukey HSD post-hoc analysis showed there were no significant differences between Group A and Group B (p>.05). On the back pain functional scale (BPFS), Group A performed much better than Groups B, C, D and E with mean difference of -2.25, 13.50, 7.38 and 23.63respectively. Additionally, the BPFS of Group B was significantly greater than that of Groups C, D, and E, with mean differences of 15.75, 9.63, and 25.88, respectively. **(Table No.2)**

Table 1: Within Group Comparison for Pain and back pain functional scale among (n=40)

Outcomes	Groups	Evaluation	t(7)	Mean	Std. Error Mean	Mean± Std. Deviation	P value
Visual analogue scale(VAS)	**Group A** Rally ball game	At baseline	6.33	2.375	.693	7.13±1.96	.000
		After 9th session			.750	4.75±2.12	
	Group B Reflex ridge game	At baseline	17.00	2.125	.680	6.38±1.92	.000
		After 9th session			.701	4.25±1.98	
	Group C River rush game	At baseline	5.92	1.000	.515	8.13±1.46	.001
		After 9th session			.515	7.13±1.46	
	Group D Fruit ninja game	At baseline	6.18	1.625	.398	6.13±1.13	.000
		After 9th session			.500	4.50±1.41	
	Group E Treatment as usual	At baseline	4.583	.750	.500	7.50±1.41	.003
		After 9th session			.559	6.75±1.58	
Back pain functional scale(BPFS)	**Group A** Rally ball game	At baseline	-8.53	-21.63	3.327	26.38±9.41	.000
		After 9th session			1.086	48.00±3.07	
	Group B Reflex ridge game	At baseline	-7.434	-19.25	3.556	31.0±10.05	.000
		After 9th session			**1.839**	50.25±5.20	
	Group C River rush game	At baseline	-5.169	-10.13	1.034	24.38±2.92	.001
		After 9th session			1.889	34.50±5.34	
	Group D Fruit ninja game	At baseline	-25.33	-17.75	2.191	22.88±6.198	.000
		After 9th session			1.963	40.63±5.55	
	Group E	At baseline	-12.32	-7.88	1.296	16.50±3.66	.000

	Treatment as usual	After 9th session			1.068	24.38±3.02	

Table 2: Between Groups comparison for Pain and back pain functional scale (n=40)

Group Differences for Visual analogue scale						Group Differences for Back pain functional scale(BPFS)			
Groups	**Compared Group**	**Mean Difference**	**Sig.**	**95% Confidence Interval(LL-UL)**		**Mean Difference**	**Sig.**	**95% Confidence Interval(LL-UL)**	
Group A Rally ball game	Group B	.500	.978	-1.99	2.99	-2.25	.862	-8.839	4.34
	Group C	-2.38	.068	-4.87	.12	13.50	.000	6.911	20.09
	Group D	.250	.998	-2.24	2.74	7.38	.022	.786	13.96
	Group E	-2.00	.167	-4.49	.49	23.63	.000	17.04	30.21
Group B Reflex ridge game	Group A	-.500	.978	-2.99	1.99	2.25	.862	-4.34	8.84
	Group C	-2.88	.017	-5.37	-.38	15.75	.000	9.16	22.34
	Group D	-.250	.998	-2.74	2.24	9.63	.002	3.04	16.21
	Group E	-2.50	.049	-4.99	-.005	25.88	.000	19.29	32.46
Group C River rush game	Group A	2.38	.068	-.12	4.87	-13.50	.000	-20.09	-6.91
	Group B	2.88	.017	.38	5.37	-15.75	.000	-22.34	-9.16
	Group D	2.63	.035	.131	5.12	-6.13	.079	-12.71	.464
	Group E	.375	.992	-2.12	2.87	10.13	.001	3.54	16.71
Group D Fruit Ninja game	Group A	-.250	.998	-2.74	2.24	-7.38	.022	-13.96	-.786
	Group B	.250	.998	-2.24	2.74	-9.63	.002	-16.21	-3.04
	Group C	-2.63	.035	-5.12	-.131	6.13	.079	-.46	12.71
	Group E	-2.25	.094	-4.74	.244	16.25	.000	9.66	22.84
Group E Treatment as usual (TAU)	Group A	2.00	.167	-.49	4.49	-23.63	.000	-30.21	-17.04
	Group B	2.50	.049	.006	4.99	-25.88	.000	-32.46	-19.29
	Group C	-.375	.992	-2.87	2.12	-10.13	.001	-16.71	-3.54
	Group D	2.25	.094	-.244	4.74	-16.25	.000	-22.84	-9.66

IV. Discussion:

The use of VR is explored in relation to the treatment of anxiety and physical dysfunction as well as the relief of neck pain, [16] Chronic lower back pain, [10]sprained ankles, frozen shoulder,

phantom limb syndrome, akinesia, and phobias.[17] Virtual reality demonstrates how immersive VR may help persons with chronic low back pain feel less pain and less catastrophizing.[18]Recontextualizing the sensory feedback from the lumbar spine while completing functional rehabilitation activities in a virtual reality leads to improvements in chronic pain symptoms.[19]

M. Czub et al. claim that even when users are not aware that the virtual avatar's movement is exaggerated or under exaggerated in relation to their actual physical movement, the visual feedback of an embodied virtual avatar can have an impact on physiology and motor activity. Additionally, greater movement in VR results in more accurate judgments of pain intensity.[20]According to the results of our study, that were presented, the effects of VR therapy on the reported VAS and BPFS were better than those of other physical therapy treatments given as usual in all of the evaluated measures of pain severity.

France CR et al used virtual reality games to assist persons with chronic low back pain and mobility anxiety. Participants played Matchality game three times during the first week and second week, they used fishality games and in last dodgeball. The study's findings suggest that playing virtual reality games help players feel less pain and disability by promoting spinal motion and giving them the implicit knowledge that they can move their lumbar spine normally in daily life without running the risk of developing back problems.[21]The results of the current study, which used virtual reality games including River Rush, Reflex Ridge, Fruit Ninja, and Rally Ball for chronic low back patients, were very comparable. In contrast Gordon et al. found that the way a virtual avatar movement had no bearing on how painful anything felt. The findings suggest that movement and immersive VR may affect how painful things appear. Repeatedly engaging in immersive VR experiences has been found to lessen the self-rated pain intensity in chronic pain, which adds to the body of research proving that virtual embodiment can be utilized as a treatment for chronic pain in actual settings. [20]Gracia LM et al comparison to sham VR, Ease VRx showed superior and clinically significant symptom reduction for average pain intensity and pain-related interference with activity, mood, and stress, but not for the use of over-the-counter medications ($p=.01$).[22]Utilizing home-based VR may expand the range of effective non-pharmacologic treatments for chronic low back pain. Participants in the current study, with mean ages of 41.10 ± 6.68 years, reported having chronic low back pain. When normal therapy groups and VR - based games were combined, the results of the VR games were noticeably different from those of the

standard therapy groups, a study by Yilmaz Yelver GD stated that that virtual walking integrated physiotherapy is effective in improving function and lowering pain and kinesiophobia in people with sub-acute and chronic non-specific low back pain.[23] In the current study, virtual reality games and conventional therapy (TAU, group E) were used. Pain intensity and functional status were assessed using the visual analogue scale (VAS) and the back pain functional scale (BPFS), which produced remarkably similar results. According to Li et al patients receiving VR therapy had inferior quantitative results than both motor control exercises and a control group, although there was no statistically significant difference between the three groups' data. The authors suggested that one reason for the failure of the interventions to reduce self-reported pain in comparison to the control was the relatively brief duration of the pain-management intervention (reported duration of a total of two weeks with five days per week).[24]In contrast, the current study's findings showed that VR therapy had superior impacts on all of the evaluated measures of pain severity than other physical therapy treatments administered as normal. Bordeleaue recently demonstrated the potential value of VR therapy for therapeutic aims.[25]Grassini in contrast to other studies, this one focuses on literature that describes specific cases of pain diagnosis that are labelled as chronic in the researches or that expressly identifies pain syndromes that continue longer than three months. There was no quantitative aspect of pain severity that suggested VR therapy affected reported VAS more than other types of treatment.[26]

Limitation: The study was only focused on pain and disability index, but range of motion and other outcomes can also be used to further evaluate these games.

Recommendation These VR games has proven to be satisfactory in terms of pain and disability although longer follow-up time are needed and on variety of other VR games with large sample size is recommended

V. Conclusion:

Virtual reality significantly reduces pain intensity and functional impairment both after the session and during the follow-up. Virtual reality games performed better than conventional treatments in reducing pain severity.

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