Effect of Virtual Reality treatment combined with exercises in fibromyalgia patients: A Meta-analysis of randomized controlled trial

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ABSTRACT

A meta-analysis was conducted to determine the impact of virtual reality versus traditional exercises on pain and functional aerobic capacity of fibromyalgia patient. Google Scholar, BioMed Central, and Medline databases were searched for relevant research articles. All studies in which effects of virtual reality vs. conventional exercises on pain and functional aerobic capacity of fibromyalgia patient were determined were included in the inclusion criteria. This meta-analysis included 93 patients from three randomised controlled trials (RCTs), including 50 in the virtual reality protocol and 43 in the conventional exercises protocol. Virtual reality training had a mild pool effect in decreasing pain and improving functional aerobic capacity calculated at random effect model (I^2 = 96.17%; $p < 0.0001$).

Keywords

Virtual reality, exercise, physical therapy, pain, functional aerobic capacity.

INTRODUCTION

Fibromyalgia syndrome (FMS) is one of the chronic musculoskeletal conditions that causes pain all over the body, also called widespread pain affecting 2% to 4 % of the population worldwide[1]. Fibromyalgia affects about 4 million US adults, about 2% of the adult population. Women are at a higher risk of having FMS as compared to men. According to one of the studies conducted in China, on average 0.7% - 20% of the population was affected with FMS affecting females 9 times more than men[2]. (YU, TC et al., 2020). According to a recent report it was revealed that in Pakistan one-third patients between the age of 18 – 75 coming to the hospital with different rheumatologic conditions has been diagnosed with FMS, with a prevalence of 0.2% - 6.6% in females[3]. The pathogenesis of FMS is still poorly understood, in addition to the pain that is regionally distributed and palpable tender nodules, the consensus amongst clinicians is that the diagnosis of FMS is recognize on the presence of widespread pain for more than three months with the expression of symmetrically distributed tender points (TPs) within the muscle. According to the current literature, self-management interventions consisting of multicomponent program for FMS can be effective in improving physical function and reducing[4]. Multiple treatment guidelines are available that focus on the combination of pharmacological and non-pharmacological intervention for the management of FMS, however most of them are addressing the somatic and psychological symptoms[5]. A study reported that VR-specific games are useful in improving physical symptoms and cardiovascular metrics such as VO2 max and physical mobility[6]. Virtual reality have been found to improve multiple physical measures that include pain, fibromyalgia symptom health status, daily living activities, cerebral blood flow, exercise capacity and body balancing, movement pattern, and fear of falling[7]. Furthermore, it promotes patient happiness and may improve patient compliance with exercise[8]. Although effect of exercise on pain and aerobic capacity among FMS patients has been done, yet there is not a single meta-analysis that has analyzed the effects of conservative management vs. immersive virtual reality on pain and aerobic capacity among FMS patients. Hence, this meta-analysis is aimed to determine the effects of exercise vs. immersive virtual reality on pain and aerobic capacity among FM patients.

MATERIALS AND METHODS

Two independent investigators conducted a comprehensive search using the key terms "pain" OR "aerobic capacity" OR "fibromyalgia syndrome" OR "exercise" AND "immersive" OR "virtual reality" OR "physical therapy" OR "Conventional physical therapy" OR "physiotherapy" OR "physical rehabilitation across 5 databases, including PEDro, PubMed, Web of Science, Cochrane and Library.

Two reviewers used the preset technique to find studies for the current meta-analysis from 2019 to 2022. The extracted data included the participants' age and gender, sample size, interventions utilised in the experimental and control groups, dosage used, outcome assessments, and findings (Table 1). The Cochrane Collaboration Tool was used to evaluate the risk of bias in the selection, performance, detection, attrition, and reporting domains[9].

MedCalc statistical software, version 18.11.3, was used to analyzed the data. The pooled impact was assessed in a random-effects model using the continuous measurement standardized mean difference (SMD) approach (I2 at 95% CI). Hedge's g statistics, SMD tables, and forest plots were used to analyse the data. The results were interpreted using Cohen's rule of thumb, which states that values of 0.2, 0.5, and 0.8 indicate low, medium, and high impacts, respectively. Cochrane's Q statistic was used to calculate the level of heterogeneity.

RESULTS

This meta-analysis included three articles published between 2019 and 2022. A total of 216 patients were included in three studies to determine the impact of immersive virtual reality vs. physical therapy-based care options for pain and aerobic capacity associated with FMS.

Following the initial search, n= 138 unique articles were included. Further review of the initially included studies results in the deletion of duplicates and all articles in which physical therapy management approaches were estimated following joint fusion procedures and other variables were evaluated, leaving n=31 articles.

Finally after further analysis all those articles that were published before 2019 and of not available in English language and for which no full-text was available after even contacting with authors and excluding all paid articles n=5 studies were included for analysis (Fig-1)

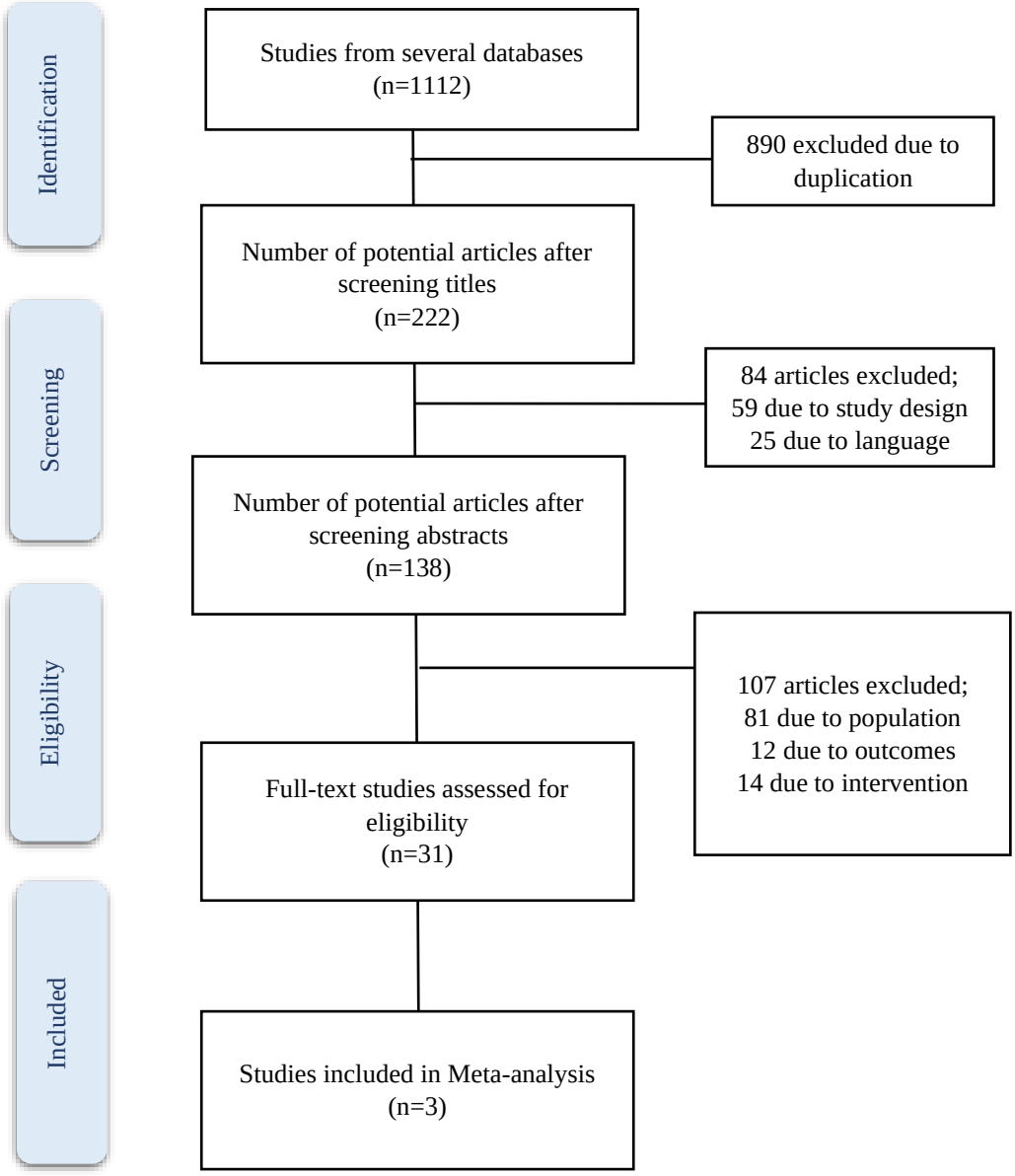

Figure 1. Depicting flow of included studies

Table-1 Depicting characteristics features of the included studies

Reference study	n	Population	Study Design	Age	Virtual Reality Group	Exercise Group	Outcome
Polat et al, 2021[8]	40	Patients with fibromyalgia	RCT	EG=42.6 ± 8.7 CG=47. ± 7.1	Patient did virtual reality exercise for 15 minutes three times a week, under supervision, after aerobic exercise.	The patients did 15-minute muscle strengthening, balance, and flexibility exercises three times a week.	Pain, aerobic capacity
Gulsen et al, 2020[10]	16	Patients with fibromyalgia	RCT	EG=46.50 CG=38.50	The Exercise+ IVR group followed the same protocol as the EG group, but added 20 minutes of IVR twice a week for 8 weeks.	The EG had combined exercise training, 30 minutes aerobic and Pilates each	Pain, functional exercise capacity
Villafaina, et al., 2019[11]	37	Patients with fibromyalgia	RCT	10-17 years	A total of 120 minutes per week, divided into two 60-minute sessions, was completed.	CG continued with their usual daily life.	Pain, aerobic capacity

Effect of studies on Aerobic Functional Capacity among FMS patients

Three randomized controlled studies' findings demonstrated that the immersive virtual reality intervention considerably improve Aerobic Functional Capacity in comparison to exercise group. Standardized Mean Difference suggested an effect size of 0.40 in random effect model (I^2 = 96.17%; p< 0.0001) depicted a small effect size (Table-2).

Table 2 showing SMD of Cobb angle with 95% CI

Study	N1	N2	Total	SMD	SE	95% CI	t	P	Weight (%)	
									Fixed	Random
Polat et al, 2021[8]	20	20	40	0.724	0.320	0.076 to 1.3			41.53	41.53
Gulsen et al, 2020[10]	8	8	16	0.312	0.476	-0.70 to 1.33			18.82	18.82
Villafaina et al, 2019[11]	22	15	37	0.116	0.328	-0.55 to 0.78			39.64	39.64
Total (fixed effects)	50	43	93	0.406	0.206	-0.0045 to 0.81	1.965	0.053	100.00	100.00
Total (random effects)	50	43	93	0.406	0.206	-0.0045 to 0.81	1.965	0.053	100.00	100.00
Q	1.8094									
DF	2									
Significance level	P = 0.4047									
I^2 (inconsistency)	96.17%									
95% CI for I^2	0.00 to 96.29									

The results of three randomized controlled trials suggested that the immersive virtual reality is effective in comparison to physical therapy intervention in improving Aerobic Functional Capacity among FMS patients. As per the Cohen's rule of thumb, a small pool effect on SMD of 0.40 in a random effect model was obtained in treatment group, as displayed in Table-2. Moreover, forest plot at 95% C.I was drawn to reflect the pool effects in the random effect model, as illustrated in Fig-2.

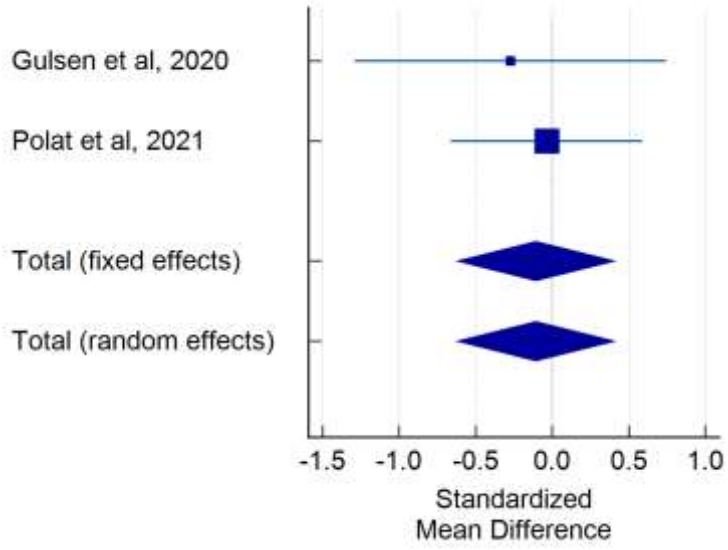

Fig 2 Pool Effect of Studies determining the effects of immersive virtual reality on Aerobic Functional Capacity among FM

Two randomized controlled studies' findings demonstrated that immersive virtual reality decrease pain in comparison to physical therapy intervention. Standardized Mean Difference suggested an effect size of -0.107 in random effect model (I^2 = 91.43%; p< 0.67) depicted a small effect size (Table-3, Figure 3).

Table 2 showing SMD of Cobb angle with 95% CI

Study	N1	N2	Total	SMD	SE	95% CI	t	P	Weight (%)	
									Fixed	Random
Gulsen et al, 2020	8	8	16	-0.273	0.475	-1.29 to 0.74			29.86	29.86
Polat et al, 2021	20	20	40	-0.0363	0.310	-0.66 to 0.59			70.14	70.14
Total (fixed effects)	28	28	56	-0.107	0.260	-0.62 to 0.41	-0.41	0.68	100.00	100.00
Total (random effects)	28	28	56	-0.107	0.260	-0.62 to 0.41	-0.41	0.68	100.00	100.00

Q	0.1742
DF	1
Significance level	P = 0.6764
I^2 (inconsistency)	91.43%
95% CI for I^2	0.00 to 0.00

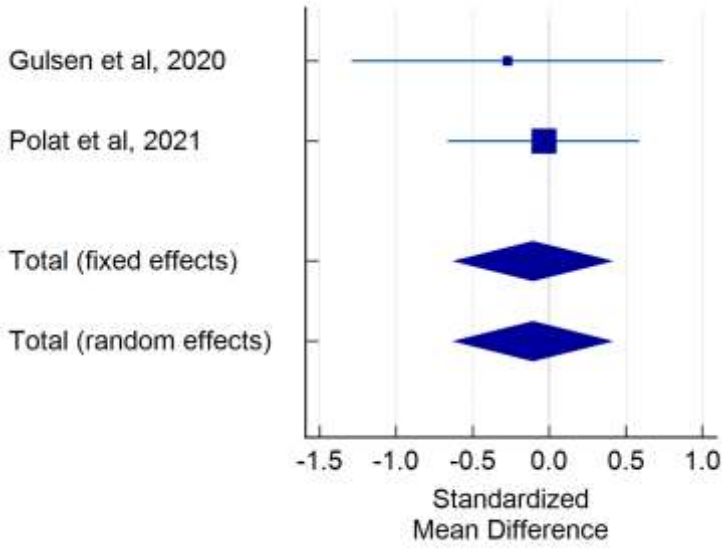

Fig 3 Pool Effect of Studies determining the effects of immersive virtual reality on pain among FM

Critical appraisal of the studies

Author's Judgment of risk of bias analysis based on guidelines of Cochrane was provided in (table 4 fig 4).

Randomization

Randomization was done in all studies [8,10, 11] suggesting a low risk of bias

Allocation Concealment

Two studies [8, 10] reveled low risk of bias, and one study [11] showed high risk of bias.

Blinding of Participants and Personnel

Blinding was done in all 3 studies[8,10,11].

Outcome Assessment Blinding

In study [8] outcome assessors were blinded. In the other two studies [10, 11] blinding was not done.

Incomplete Outcome Data

All studies depicted low risk of bias [8,10, 11].

Reporting Selection Bias

Two studies [8, 10] reveled low risk of bias, and one study [11] showed high risk of bias.

Table 4 shows the Cochrane Collaboration's Tool for Assessing the Risk of Bias in Included Studies.

Studies	" Random Allocation"	" Allocation Concealment"	" Participants Blinding"	" Outcome Assessment Blinding"	" Incomplete Outcome Data"	" Selective Reporting"
Polat et al, 2021[8]	+	+	+	+	+	+
Gulsen et al, 2020[10]	+	+	+	-	+	+
illafaina, et al., 2019[11]	+	-	+	-	+	-

−, bias at high risk

+, bias at low risk

? , unknown risk of bias

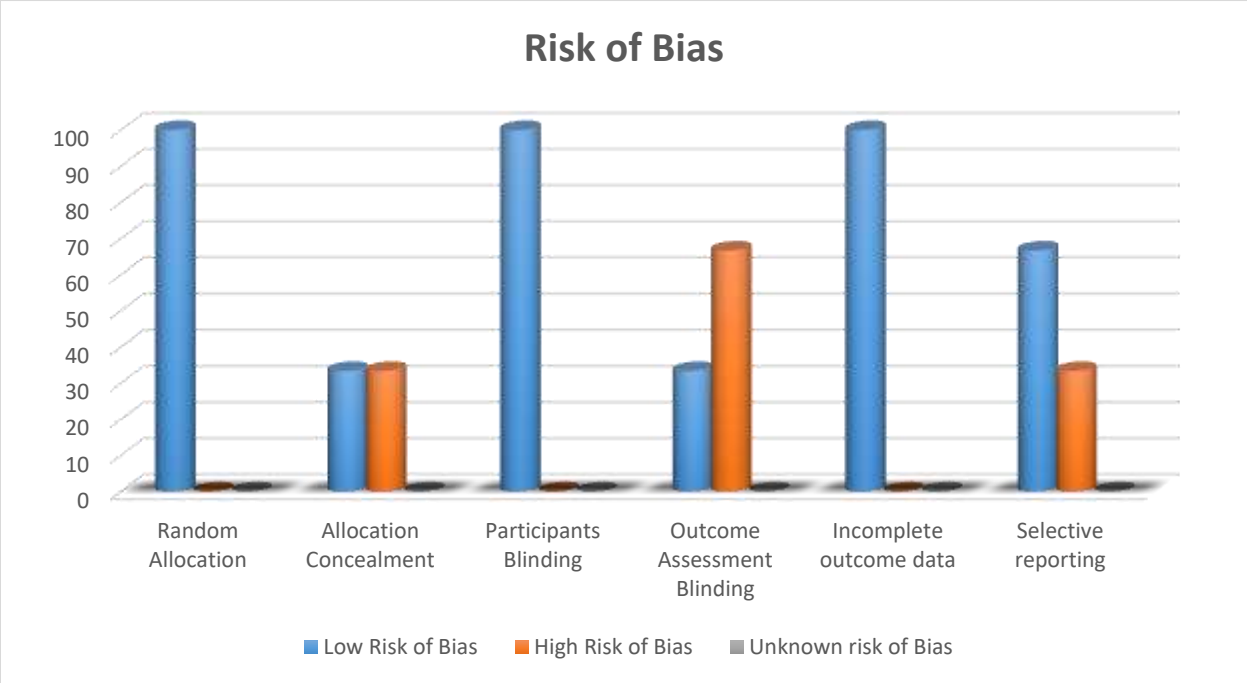

Fig 4 representing Cochrane risk of bias

DISCUSSION

The results of three trials included in this meta-analysis revealed evidence that immersive virtual reality is effective in reducing pain effect size of -0.107 (CI, -0.627 to 0.413, p=0.682; Random effect model) and improving the aerobic capacity effect size of 0.206 (CI -0.00450 to 0.816, p=0.05; Random effect model) among fibromyalgia patient all though the effect was small for both the variables. A number of researchers reported the role of virtual reality in increasing physical conditioning in both healthy and chronic pain populations[12]. A randomized control trial was carried out on FMS that revealed that physical exercise and non-immersive virtual reality was effective in decreasing the fear of fall, enhance mobility skills and improve the balance[13]. Another randomized control trial conducted on patients with FM to analyze the effectiveness of non-immersive virtual reality on perception of pain and cardiovascular parameters. The study demonstrated a significant improvement in fibromyalgia symptoms evaluated using Fibromyalgia impact questionnaire (FIQ). Moreover, improved cardiovascular adaptations were found that were reflected through reduction in blood pressure exercise capacity was also found improved in the intervention group measured through step[14].

In another study that was conducted among populations who are non-user of Exergames to analyze the heart rate response and peak oxygen uptake (VO2 max) while participating in Exergames and during the game with joystick .According to the findings, it was revealed that Exergames Which includes dancing video could be used as an effective intervention and better alternative to other traditional forms of exercise in improving cardiopulmonary fitness[15].

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