International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Effect of Pilates Training and Quadrupedal Movement Training (QMT) on Functional Movement Screening (FMS) in Recreational Athletes – A Randomized Controlled Trial

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Abstract

Background: Functional Movement Screening is a tool to identify the risk of any injury by the basic functional movements of athletes. A recreational athlete does not perform all the movements in a correct manner which increases the chances of muscle imbalance. To improve this various training programs can be followed which include Pilates, QMT, etc. In this study we compare which exercise program, either Pilates, QMT or a regular workout regime show better results in the FMS score. There are several fitness training programs to improve performance in athletes as well as reducing the risk of injury. But exercise like Pilates and QMT are gaining more popularity in the fitness industry because of its breathing and animal flow pattern of exercises. Unfortunately, there were less evidence to support the effect of QMT in corelation with injury prevention and improvement in fitness. The aim of this study was to compare the effect of Pilates training and Quadrupedal Movement Training (QMT) on Functional Movement Screening (FMS) score in recreational athletes.

Method: 54 recreational athletes aged between 18 to 35 years were randomly assigned to all three groups: Pilates (n=18), QMT (n=18) and control group (n=18). Each training intervention consisted of 45 mins of training, 10 mins of warmup and 5 mins of cool down. The FMS score was assessed before and after 4 weeks of intervention using FMS tool kit.

Results: The within group test results also show a difference in the FMS scores but were less significant for control group. There was a significant difference observed between the Pilates, QMT and control groups ($p<0.05$). Pilates group showed the most significant difference in the FMS score than either QMT or control group.

Interpretation and conclusion: Our results indicate that both Pilates and QMT can be used for improving the functional movement of an athlete. But as there is control of breathing involved in Pilates, it is more effective. For an interesting workout regime, these results can serve as a guide.

Keywords: FMS, Pilates, QMT, Recreational athletes

INTRODUCTION

A recreational athlete is a person who gets involved in physical activities/sport 3 times a week for at-least 20 minutes, but does not follow any professionally designed training regime [1,2]. Many recreational

athletes and individuals are achieving high levels of performance even while their basic movements are inefficient; hence, these individuals are unknowingly trying to combine dysfunction with fitness [3]. It is important to workout on different planes of motion as athletes are constantly moving in them. So for these athletes, screening should include a study of fundamental movements to identify individuals who possess or lack the capacity to do specific key movements in order to prepare athletes for the wide range of activities required to participate in or return to their sport [3].

These individuals who aren't able to perform simple movements are sacrificing efficient movements by utilizing compensatory patterns. This mechanism of inefficient movement patterns can lead to poor biomechanics and increase risk of injury [3,4]. Therefore, an important factor in prevention of injuries and improving performance is to quickly identify deficits in symmetry, mobility, and stability because of their influences on creating altered motor programs throughout the kinetic chain [4].

Functional Movement Screening (FMS) is a movement-competency-based test in widespread clinical use. The FMS is a battery of seven movement tasks and three additional clearing tests, assessed by observation using standardized criteria[5]. Screening tests like Functional Movement Screen (FMS) that might identify modifiable intrinsic risk factors for musculoskeletal injury are appealing to applied practitioners working in sport and exercise medicine [5]. Asymmetry and physical dysfunction can also be assessed separately using FMS. Individual dynamic movement—including balance, stability, and mobility—was the foundation of the test of principle [6].

Young, healthy, and active people's mean FMS scores vary from 14.14 ± 2.85 points to 15.7 ± 1.9 points. According to this, the majority of inexperienced individuals have scores that are marginally higher than the threshold of ≤14 points, which is considered a sign of compensating trends, a higher chance of injury, and a lower level of performance [6].

Muscle imbalance correction and strength and flexibility restoration are the main objectives in order to prevent sports-related injuries. More body awareness training, is advised to practise breathing and neuromuscular synchronisation by executing smooth and accurate movement from a strong core [7].

Core stability is seen as being pivotal for sufficient biomechanical function to minimize force generation and joint loads in all types of activities. Since Pilates improves core stability it will ultimately improve other joint mobility and decrease the load during activity [8].

The six guiding principles of the Pilates training approach are: centering concentration (i.e., maintaining mental focus and attention during exercise); control (i.e., posture control during the exercise, precision (i.e., correctness of exercise methods), and flow (i.e., fluid movement transitions within the exercise sequence), respiration in time with the exercise. Pilates enhances peripheral mobility, core strength, balance, and posture, all of which are beneficial for enhancing athletic performance [7,8].

Also, there is quadrupedal movement training or QMT a new bodyweight training method. Training for quadruples involves assuming positions and motions that resemble the neurodevelopmental process, as well as animal stances and motions such as rolling, crawling, postural changes, etc. [9]. It is important to workout on different planes of motion as athletes are constantly moving in them. QMT makes this easy and effective by improving proprioception and functional movement [9,10].

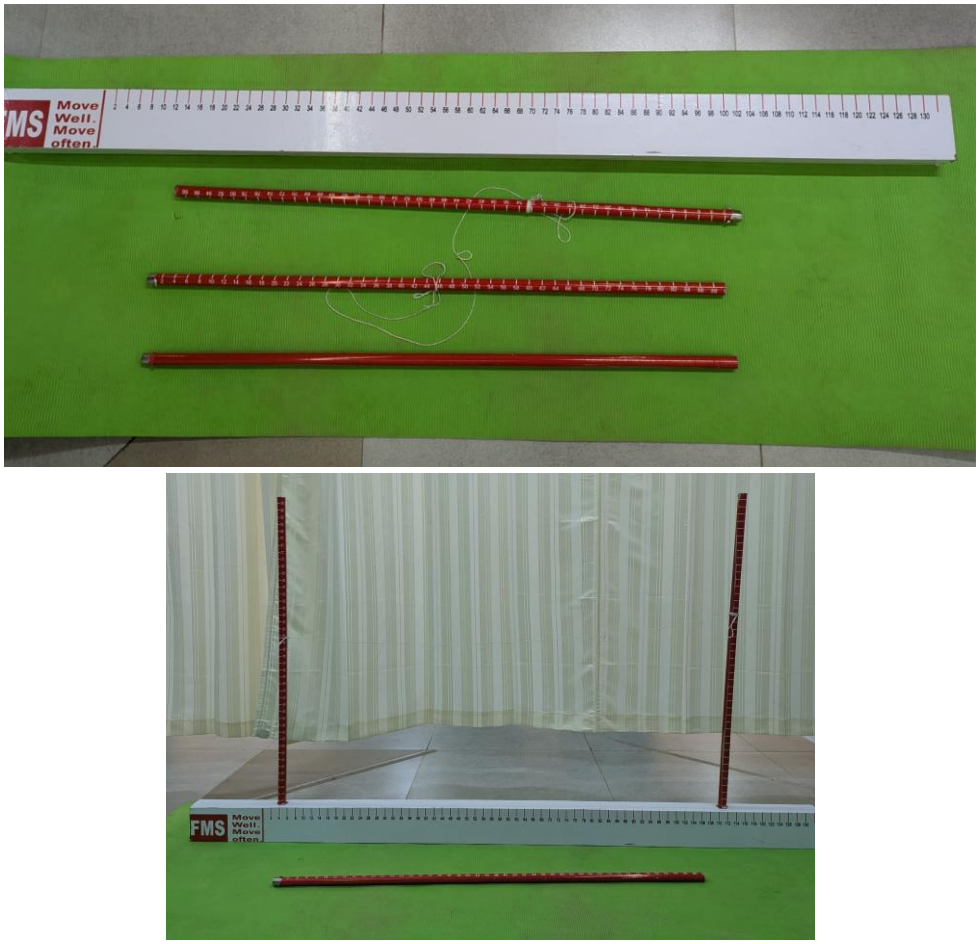
According to a recent study, fundamental stability, active joints range of motion functional movement screen scores, and overall stability improved much more after 8 weeks of QMT utilising the Animal Flow system. Further studies have revealed increased proprioception, cognitive flexibility and EMG activity of the core muscles after training with quadrupedal crawling exercises included in the AF system (10). The

AF system's components includes a)wrist mobilisations b) activations c) form-specific stretches d) travelling forms e) transitions and switches and f) flow movements [10].
This study observes the difference created by Pilates and QMT on FMS after undergoing these trainings for a time period of 4 weeks. As mentioned, the outcome will give results to predict the risk of injury. Pilates is a type of exercise which focuses on breathing control while performing any action. Whereas QMT is a type of exercise which focus on movements which follow a pattern of animal flow. Comparing these exercises will guide the therapist/athletic trainer to add either of these exercises in the regular workout regime of an athlete.

MATERIALS AND METHOD

Permission to conduct this study was obtained from the institutional ethical committee. 54 recreational athletes were screened and selected based upon the criteria that they were between the age group of 18 – 35 and were free of any physical limitations. The recreational athletes who had any recent injury, any pre-existing neurological condition or any experience in yoga, dance and gymnastics were excluded. The equipment's used were: FMS test kit, FMS scoring sheet, mat, green and blue resistance bands, 2kg medicine ball, pilates ring and weights. After collecting the pre-exercise data of the included recreational athletes, they were randomized into three groups by picking a chit in a random manner. Functional Movement Screening was the only outcome measure used for Pilates, QMT and control groups.

Figure No.1 - FMS Test Kit



The present study was reviewed and approved by the Institutional Ethical Committee of the Abhinav Bindra Sports Medicine and Research Institute (ABSMARI), located in Pahal, Bhubaneswar. A randomized controlled trial was conducted at the same institute. A total of 54 participants were selected through purposive sampling based on specific inclusion and exclusion criteria. Eligible participants were recreational athletes who had not experienced any musculoskeletal injuries in the past six months. Demographic details such as age, height, and weight were collected prior to the intervention. The study procedures were explained in detail to all participants, and written informed consent was obtained. Participants were then randomly assigned to one of three groups—Group A (Pilates), Group B (Quadrant Movement Training/QMT), or Group C (Control group)—using a simple randomization method via the chit system. Each participant drew a chit from a total of 54, with 18 allocated to each group. Following group allocation, baseline assessment of Functional Movement Score (FMS) was conducted using the Functional Movement Screening tool. Participants were then informed about the tests and exercises they would be performing over the four-week intervention period.

- **Group A (Pilates Group):** Underwent Pilates training three times a week for four weeks. Each session included an 8–10 minute warm-up, 45 minutes of Pilates exercises, and a 5–8 minute cool-down. The exercises progressed weekly in difficulty.
- **Group B (QMT Group):** Participated in Quadrant Movement Training three times a week for four weeks. Sessions followed a similar structure: 8–10 minutes of warm-up, 45 minutes of QMT, and a 5–8 minute cool-down. In this group, the exercises remained mostly consistent, but progression was achieved by increasing the number of sets and reducing rest intervals.
- **Group C (Control Group):** Did not participate in any training or intervention protocol.

All sessions for Groups A and B were conducted under the supervision of qualified therapists to ensure proper execution and participant safety. After the completion of the four-week period, all participants underwent a post-intervention FMS assessment. Pre- and post-test values were recorded and maintained in an Excel spreadsheet for analysis.

Figure No.2 - FMS test procedure

2.1 – Deep Squat

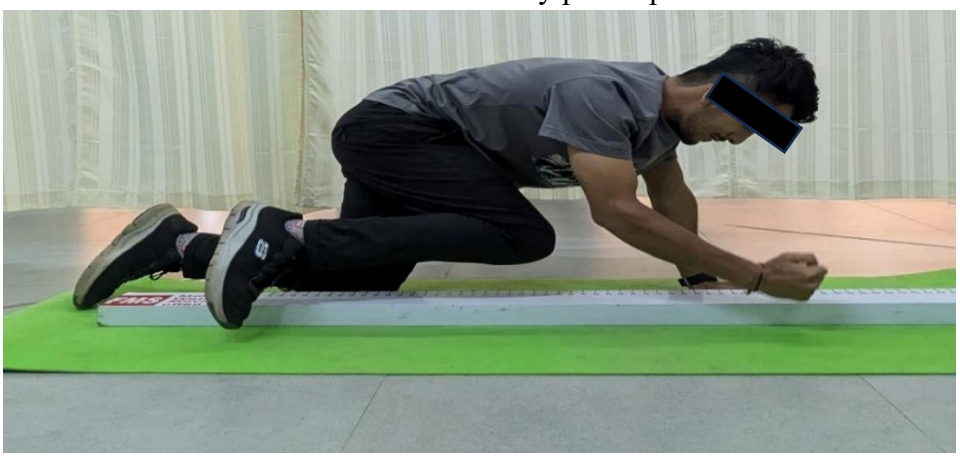
2.3 – Inline lunges

2.2 – Hurdle step

2.4 – Shoulder mobility

2.5 – Active straight leg raising

2.6 – Trunk stability push-up



2.7 – Rotational stability

Exercise Protocol

1. Pliates training

Table No.1 - Pilates Training Program

	Exercise	Sets
Warmup (8-10 min)	Stretching Footwork Hugging knees Supine knee side to side Pelvic clock Bridging Breathing exercises	10 * 3
Cooldown (5-8 mins)	All stretches	

Week	Exercise	Repetitions	Sets	Rest
1	Table top Toe tap Prone hip extension Cervical nods Knee sway Rib cage arm AB prep flight Scapular isolation Lumbar cat	10	3	30 sec

2	Half roll down The hundreds Single leg stretch Roll up Modified can can Spine twist Heel beats Modified swan Leg beats Inner thigh	10	3	30 sec
3	2. QMT Training Hot potato Shoulder bridge Neck pull Hip circle Leg pull front Leg pull back Twist Side bends Criss cross Roll over	10	3	30 sec
4	With props (swiss ball/ mini ball, therabands, foam rollers, wrights, pilates ring)			

Table No.2 - QMT Training Program

AF Categories	AF Movements	Repetition/ Time	Set	Rest(sec)
Wrist mobilization	Wrist rolls, waves Prayer stretch Wrist shakers, relief Quadruped wrist	30 secs	1	0
Activations	Beast 1 Crab 1 Beast 2 Crab 2	10-15 secs	2	30—60
Foam stretches	Loaded beast unload Loaded beast wave Ape reach	3-5 2-3 3-5	1 1 1	30-60
Traveling forms	Forward/ Reverse beast Forward/ Reverse Ape	10 yards 10 yards	1-3 1-3	30-60

Switches & transitions	Under switch Side kick through	10-20	1-3	30-60

Wrist Mobilization	Wrist rolls Wrist waves Prayer stretch Wrist shakers Wrist relief Quadruped wrist	30 sec	1	0
Form stretches flow (Perform as a circ uit 2 * through)	Loaded beast unload Wave unload Beast reach Ape reach	1 1 1 2	2	0
AMM circuit 1	Perform as a circuit 3 with 30–60 s rest b/w circuits			
Activate Mobilize Move	Beast 3 Crab reach Lateral ape 1	10 10 10	3	15
AMM Circuit 2	Perform as a circuit 3 with 30–60 s rest b/w circuits			
Activate Mobilize Move	Crab 3 Scorpion reach Forward/ reverse beast	10 6 20 (10 each)	3	15
Switches and tran sitions	Perform all sets of combo 1 then perform all sets of combo 2			
Combo 1	side kick through to full scorpion	5-10 per side	2-3	60
Combo 2	front step through to front kick through	5-10 per side	2-3	60
Flows	Beast flow 1	2-4 rounds		60

Figure No.3 - Pilates exercise

3.1 – Cirss cross

3.2 – Bridging (with pilates ring)

3.3 – Spinal twist (with pilates ring)

Figure No.4 - QMT exercises

4.1 – Ape reach

4.2 – Loaded beast unload

4.3 – Switches and transition - under switch

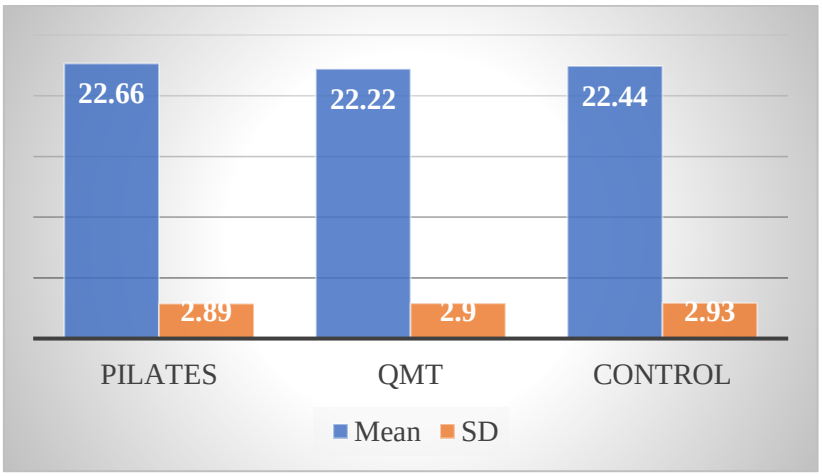
Statistical analysis

To calculate the normality of the data, Shapiro Wilk test was performed using SPSS software. Paired T-test was performed for within group analysis and One way ANOVA was used for between group analysis.

RESULT

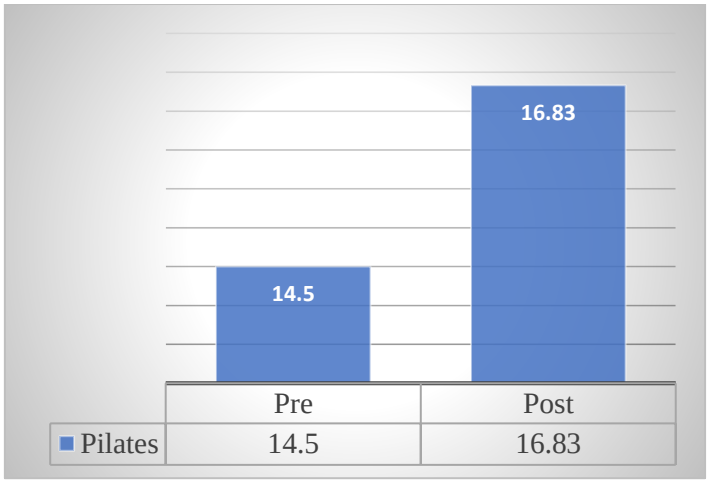
Recreational athletes within the age group 18-35 were screened and divided into three different groups. The following graph shows the normality of three groups.

Graph No. 1- Normal Distribution

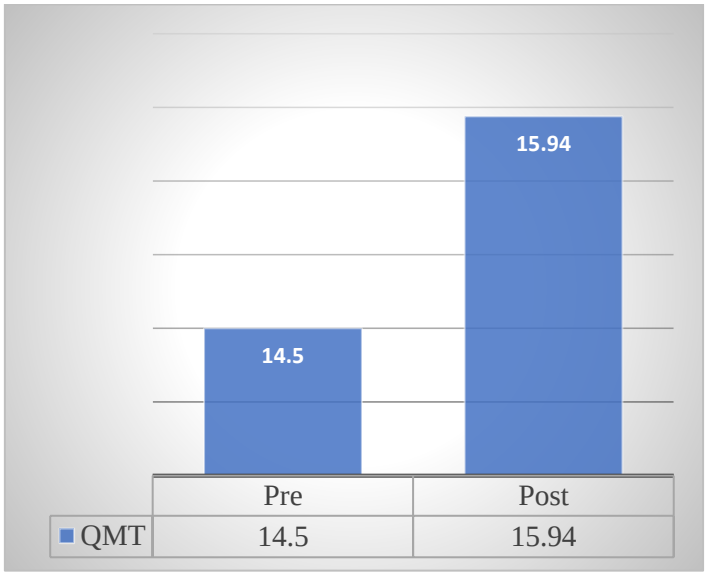


Pilates, QMT and control; all the three groups individually depicted difference in the FMS scores recorded pre and post the intervention. Graphs 2, 3 and 4 depict the differences observed in the individual Pilates, QMT and control groups respectively.

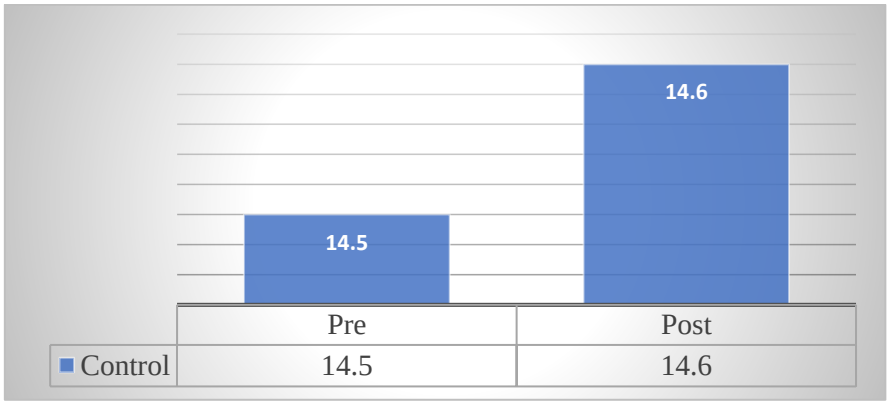
Graph No. 2 - Pilates



Graph No.3 - QMT

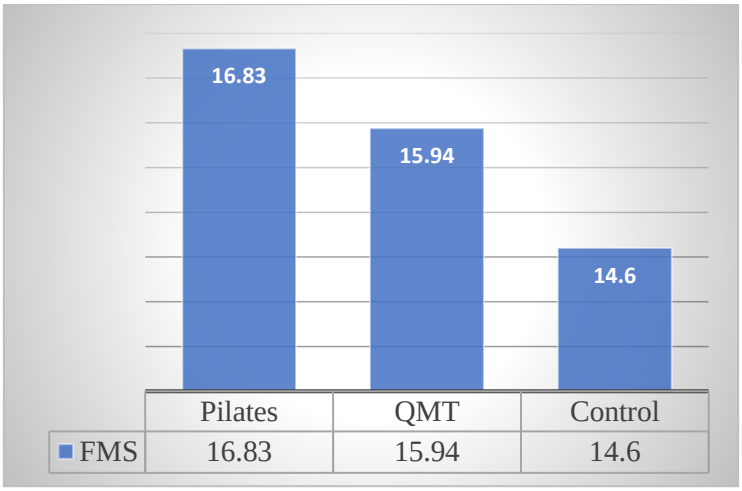


Graph No.4 – Control Group



According to the results of ANOVA test which was performed for the within group analysis, Pilates group yielded the highest difference in the FMS scores followed by QMT group and with the control group showing least changes amongst the three. Graph 5 interprets the same.

Graph No.5 – Between group analysis



DISCUSSION

The present study investigated the effect of Pilates and QMT training on FMS score in recreational athletes. The result of this study reveals an important effect of both Pilates and QMT training on FMS which includes components like stability, mobility and flexibility. The findings presented in this study fill a knowledge gap regarding the concepts like, Pilates and QMT on injury prevention program or assessment of risk of injury by FMS.

A recreational athlete was defined as a person who gets involved in physical activities/sport 3 times a week for at-least 20 minutes, but does not follow any professionally designed training regime [1,2]. A recreational athlete does not necessarily focus on the required movement patterns for the particular sport. This negligence increases a risk of injury for them. In order to avoid this and aid the return to sport assessment, a quick identification of the symmetry, mobility and stability throughout the kinetic chain, a Functional Movement Screening is done [3,4]. Along with risk assessment, FMS can also be used as a movement test battery. FMS is proven to be a standardized tool for this [5].

Pilates are basically mat exercises which can be further progressed using professional Pilates devices like 'Pilates ring'. The basic concept on which Pilates works is the strengthening and stretching of a muscle simultaneously using gravitational force. This simultaneous training of a muscles avoids easy fatigue of the muscles that are more loaded during any repetitive actions performed while playing sports [7]. In the study "Relationship Between Hip Muscle Imbalance and Occurrence of Low Back Pain in Collegiate Athletes: A Prospective Study" by Nadler, et. al; it was stated that there was asymmetry in the muscle strength of many recreational athletes [8]. To work on this asymmetry stated, we introduced QMT and Pilates exercises in this particular study. QMT is a form of training method which utilizes closed kinetic chain bodyweight exercises. The progression for these exercises include components like: wrist mobilization, activation, form specific stretches, traveling forms, switches and transitions and flows [9]. For this study, each QMT session began with general dynamic stretches followed by specific wrist mobility exercises and the mentioned progressions along with choreographed flows. These choreographed flows

were similar to the movements required during FMS. For example; the Loaded Beast movement places subjects in a prone version of a deep squat. Keeping the knees elevated off the ground in this position requires significant whole-body stabilization and mobility [10].

According to the study "The Effects of a Novel Quadrupedal Movement Training Program on Functional Movement, Range of Motion, Muscular Strength, and Endurance", there was a scope for comparison between various exercises including yoga, Pilates. With reference to this study, we compared the difference between QMT and Pilates on FMS [10]. From the statistical analysis of this study, we state that there is a difference observed within all the three groups. Pilates, QMT and control groups showed a difference between their pre and post-tests. According to the study "Pilates based exercise in muscle disbalances, prevention and treatment of sports injuries" by Metel, et. al, Pilates focuses on breathing, movement coordination and conscious body control while performing any given exercise [13]. This supports our results which show a significant improvement in FMS score of the group performing Pilates. Control group was not advised any specific exercise. But there was a small difference observed in it. This can be reasoned as getting acquainted with performing a particular task.

The statistical analysis done for between groups states that Pilates group shows a high significant difference in improvement of FMS score as compared to QMT or control group. With these results, our null hypothesis which stated that there will be no significant difference within or between the groups was rejected. From this we state that Pilates has more effect on FMS score than QMT. As mentioned earlier, Pilates focuses more on the breathing pattern while performing any movement which ultimately stabilizes the core. This makes Pilates a safe method of exercise. Functional Movement Screening does not only give a reference for risk of injury but also helps assess the independence of an individual towards performing any activity. Thus, screening of all the recreational athletes before and after the time period of performing the given exercises gave them a sense of independence, quality of life and better participation in daily activities along with an improvement in the athletic performance. This study features the importance of comparison between Pilates and QMT on FMS providing an evidence-based guidance for further clinical decision making. The outcome of this study can become a correct guide toward injury prevention as well as to understand how any type of exercise works in the favour of improving the functional movement in both sports and daily living. However, it is also essential to consider the limitations for this study.

CONCLUSION

Both Pilates and QMT emphasize the importance of repetitive practice. Both interventions involve task specific training targeting the functional activities that are relevant to athletic performance and individuals' daily life. Athlete also can improve their ability to perform to decrease risk of injury as well as increase the quality of life. According to the findings of current study, Pilates and QMT training can be included in an athlete's regular training regime to improve the quality of their basic functional movements thereby reducing the risk of injury.

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