A

PROJECT REPORT

ON

EFFECT OF PILATES TRAINING AND QUADRUPEDAL MOVEMENT TRAINING (QMT) ON FUNCTIONAL MOVEMENT SCREENING (FMS) IN RECREATIONAL ATHLETES – A RANDOMIZED CONTROLLED TRIAL

By

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MPT II (Sports)

Dissertation Submitted to the

Utkal University, Bhubaneswar, Odisha.

In partial fulfillment of the requirements for the degree of

Master of Physiotherapy

In

SPORTS

Under the guidance of

Prof. Joseph Oliver Raj

Dean

2022 - 2024

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation/thesis entitled **"Effect of pilates training and quadrupedal movement training (QMT) on functional movement screening (FMS) in recreational athletes – a randomized controlled trial"** is a bonafide and genuine research work carried out by me under the guidance of Prof. Joseph Oliver Raj, dean, Abhinav Bindra Sports Medicine and Research Institute, Bhubaneshwar, Odisha.

Date:

Place: Odisha

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This is to certify that the dissertation entitled **"Effect of pilates training and quadrupedal movement training (QMT) on functional movement screening (FMS) in recreational athletes – a randomized controlled trial"** is a bonafide research work done by **Samruddhi Patil** in partial fulfilment of the requirement for the degree of **MPT - Master of Physiotherapy**.

Date :

Place:

Signature of the Guide

Prof. Joseph Oliver Raj
Dean, ABSMARI

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This is to certify that the dissertation entitled **"Effect of pilates training and quadrupedal movement training (QMT) on functional movement screening (FMS) in recreational athletes – a randomized controlled trial"** is a bonafide research work done by **Samruddhi Patil** under the guidance of **Prof. Joseph Oliver Raj**, Dean of Abhinav Bindra Sports Medicine and Research Institute, Bhubaneshwar.

Date :

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Dr. Chinmaya Kumar Patra (PT)

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In conclusion, this dissertation stands as a testament to the collaborative efforts of the individuals mentioned above, and I am deeply grateful for their contributions to my academic success.

Thank you.

Date:

Place:

Signature of the Candidate

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LIST OF ABBREVIATIONS USED

1. ABSMARI - Abhinav Bindra Sports Medicine and Research Institute
2. AF - Animal Flow
3. ANOVA – Analysis Of Variance
4. CON - Control
5. FMS - Functional Movement Screening
6. SPSS - Statistical Package for social science
7. SD - Standard Deviation
8. QMT - Quadrupedal Movement Training

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF GRAPHS

ABSTRACT

EFFECT OF PILATES TRAINING AND QUADRUPEDAL MOVEMENT TRAINING (QMT) ON FUNCTIONAL MOVEMENT SCREENING (FMS) IN RECREATIONAL ATHLETES – A RANDOMIZED CONTROLLED TRIAL

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.

METHODS:

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.

KEY WORDS:

FMS, Pilates, QMT, Recreational athlete

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.

NEED FOR STUDY

Pilates and QMT both are effective in improving the FMS score individually. But which one is better in improving the fundamental movements.

Hence, to compare the effect of Pilates and QMT on stability, mobility and flexibility of movement patterns on fundamental movements through FMS.

It is recommended to address the differences between effects of QMT and other types of training including Pilates. (9)

AIM AND OBJECTIVES

AIM :

To compare the effect of Pilates training and Quadrupedal Movement Training (QMT) on Functional Movement Screening (FMS) score in recreational athletes.

OBJECTIVES :

1. To observe the effect of Pilates training on FMS score in recreational athletes.

2. To observe the effect of QMT on FMS score in recreational athletes.

3. To compare the effect of Pilates training and Quadrupedal Movement Training (QMT) on Functional Movement Screening (FMS) score in recreational athletes.

HYPOTHESIS

H01 : There will be no significant improvement in FMS score after Pilates training and QMT.

H02 : There will be no significant difference between the improvement in FMS score after Pilates training and QMT

H11 : There will be significant improvement in FMS score after Pilates training and QMT.

H12 : There will be significant difference between the improvement in FMS score after Pilates training and QMT

REVIEW OF LITERATURE

1. Meghan Warren, Monica R Lininger, Nicole J Chimera & Craig A Smith (2022) , “Utility of FMS to understand injury incidence in sports: current perspectives”

   [Journal of Sports Medicine]

   The idea was to identify the accuracy of the FMS to understand injury incidence in sports. The study shows that FMS can identify movement dysfunction, the clinical application and implementation of targeted exercise program progression to improve movement patterns to decrease risk of injury.

2. Taylor a. kramer, ryan s. sacko, craig e. pfeifer, dustin r. gatens, justin m. goins, david f. stodden, (2019)

   “The association between the functional movement screentm, y-balance test, and physical performance tests in male and female high school athletes”

   [The International Journal of Sports Physical Therapy]

   The purpose of this study was to examine associations between movement ability , dynamic balance and physical performance in high school athletes. The study concluded that FMS can identify balance and movement patterns as a result of imbalance in mobility and stability, asymmetries in compensatory movement patterns.

3. **C.** Agresta , M. Slobodinsky , C. Tucker (2014)

   “Functional Movement Screen TM– Normative Values in Healthy Distance Runners”

   [International Journal of Sports Medicine]

   The primary aim of the study was to evaluate normative value of FMS in recreational runners and their injury risk. The study concluded that lower score of FMS may be reflection of single plane movement training for recreational athletes as FMS tests more multiplanar functional movements. Also concluded that, to increase score of FMS there is requirement of adequate multiplanar stability.

4. Orkun Akkoç1 , Özlem Kirandi1 (2019)

   “Investigation of the Effect of Long-Term Pilates and Step Aerobic Exercises on Functional Movement Screening Scores”

   [Journal of Education and Training Studies]

   This study was conducted to study the effect of Pilates exercises on mobility, stabilization and balance parameters in sports injuries. The study proved that 2-3 days of Pilates in a week is recommended to preserve functional movement abilities with reducing the risk of injury.

5. Sean C. Clark, MS 1 a , Nicholas D. Rowe, BA 1 , Mohamed Adnan, BA 1 , Symone M. Brown, MPH 2 , Mary K. Mulcahey, (2022)

   “Effective Interventions for Improving Functional Movement Screen Scores Among “High-Risk” Athletes: A Systematic Review”

   [International Journal of Sports Physical Therapy]

The study was conducted to evaluate effect of Pilates exercise to improve FMS score among high risk athletes. The study concluded that this intervention is useful for enhancing basic functional mobility rather than on isolated muscle strengthening in order to improve FMS scores. Also suggests that if FMS scores is less than 14 there is increased risk of injury in athletes.

6. Su Yeon Roh, PhD (2019)

   "A functional movement screening of college students performing Pilates exercise"

   [Journal Of Cosmatic Medicine]

   Study was conducted to check FMS score of college students who performs Pilates exercise. Study shows that as Pilates exercises are multidimensional ,it stabilizes the core and allow peripheral joint mobility which help to improve the functional movements evaluated by FMS score

7. Eun Ju Lim1 , Jeong Eon Park2, (2019)

   "The effects of Pilates and yoga participant's on engagement in functional movement and individual health level"

   [Journal of Exercise Rehabilitation]

   Study was conducted to evaluate effect of Pilates and yoga on FMS score. The result showed that Pilates group had significantly higher improvement on FMS score than yoga and control group as principle of Pilates exercises was based on individual dynamic movements balance,

stability and mobility together.

8. Jerey D. Buxton1*, Sally A. Sherman2 , Micah T. Sterrett1 , Kristia D. Kannel1 , Morgan E. Blanchflower1 , Kelli T. Jancay1 , Anna K. Jenkins1 , Troy P. Donofrio1 and Philip J. Prins1 (2022)

   " A comparison of the energy demands of quadrupedal movement training to walking"

   [The journal Frontiers in Sports and Active Living]

   The study was conducted to assess the effect of QMT program on functional movements, dynamic balance, ROM, muscular strength and endurance.based on this study QMT would be used as alternative strategy in training programs as accessory exercise or as stand alone training session for the purpose of improving ROM and whole body stabilization.

9. Martyn J. Matthews , Mohamed Yusuf, Caron Doyle, Catherine Thompson (2016)

   "Quadrupedal movement training improves markers of cognition and joint repositioning

   [Human movement science]

   The study was conducted to determine the effect of QMT on cognitive function and joint repositioning sense. This study shows that as QMT is progressive and challenging task requires coordination of all 4 limbs with trunk control , has beneficial impact on cognitive flexibility and joint repositioning or proprioception.

METHODOLOGY

Study design : A Randomized Controlled Trial

Study population : Recreational athletes

Sampling technique : Purposive sampling

Sample size is : 54

Study setting : ABSMARI (Abhinav Bindra Sports Medicine and Research Institute)

Study duration : 1year

Ethical clearance : 6 months

Sample selection, data collection : 4 months

Statistical analysis, results, discussion : 2months

INCLUSION CRITERIA :

1. Recreational athletes

2. Free of any physical limitations that will prohibit the exercise.

3. Both males and females

4. Age : 18 - 35

EXCLUSION CRITERIA :

1. Recreational players having any recent injury, fracture, over the past 6 months.

2. Recreational players with pre-existing neurological condition affecting balance and co-ordination during the scoring and intervention.

3. Recreational players who had experience in gymnastics, dance, yoga within the last one year.

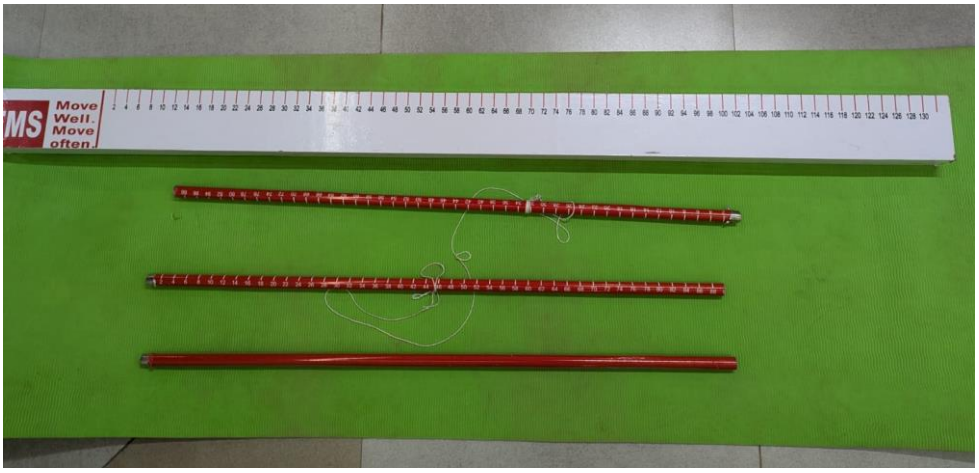
MATERIALS USED :

1. FMS test kit
2. FMS scoring sheet
3. Mat
4. Resistance bands (Green and Blue)
5. Medicine ball (2kgs)
6. Pilates ring
7. Weights

OUTCOME MEASURES :

Pre and Post intervention:

1. FMS (Functional Movement Screening)



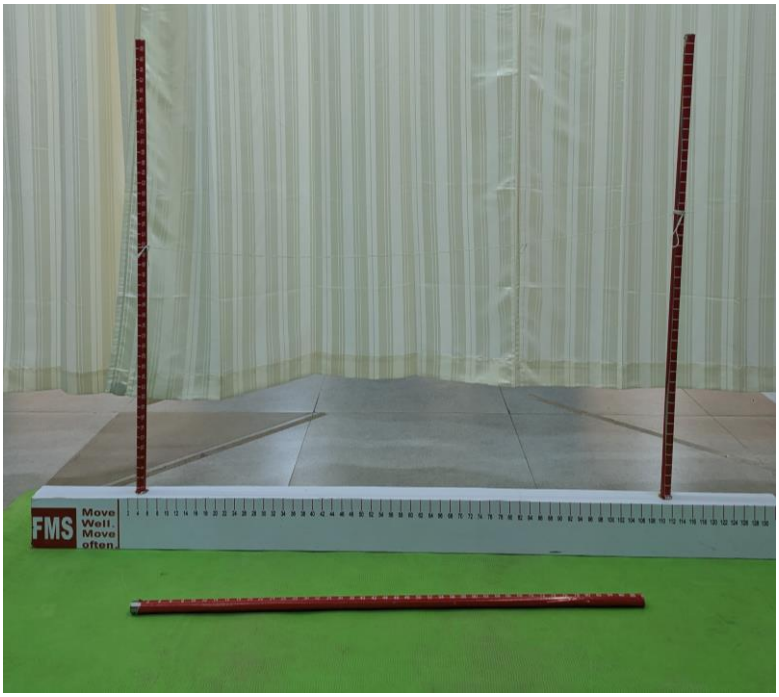


FIG NO. 1: FMS Test Kit

Flow Diagram

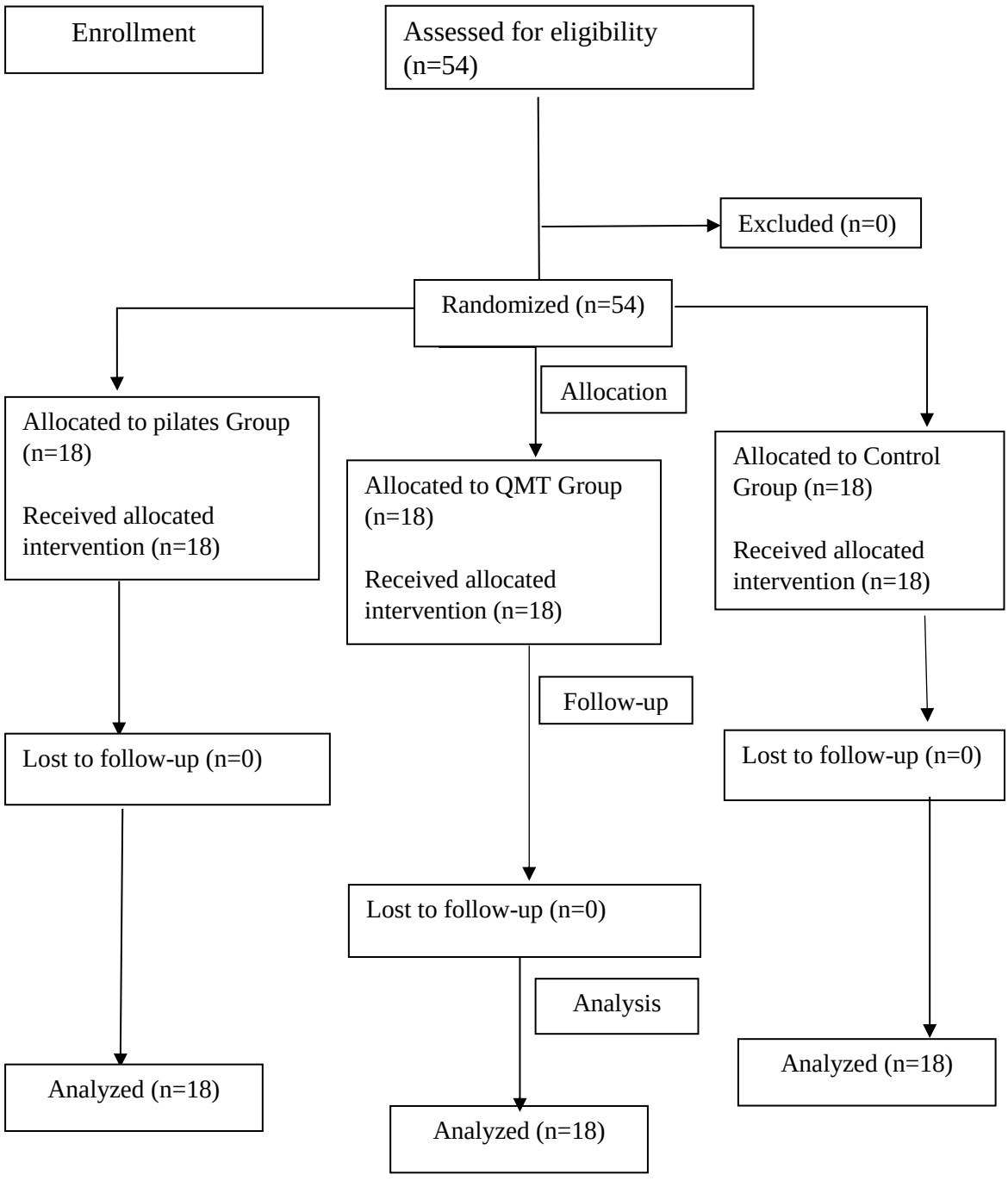


FIG NO. 2: Flow chart

PROCEDURE

The present study was reviewed and approved by institutional ethical committee Abhinav Bindra Sports Medicine and Research Institute (ABSMARI), Pahal, Bhubaneshwar.

A randomized trial was performed at Abhinav Bindra Sports Medicine and Research Institute (ABSMARI), Bhubaneshwar.

The total 54 samples were selected by using purposive sampling based on inclusion and exclusion criteria. They were included in this study with some criteria like recreational athletes who were free from any musculoskeletal injuries past 6 months. The demographic data of the participants was taken like age, height and weight.

Then the study protocol was explained to all the participants and informed consent was obtained from all the participants.

The group allocation was done by using simple randomization by chit method. There were 54 chits in which 18 of each group A, B, C where A= Pilates, B= QMT, C= Control group.

After that demographic data was taken, participants were asked to pick one chit and then they were allocated in the same group. The baseline assessment was taken for Functional movement score (FMS) by Functional movement screening.

All the participants were explained about the tests and exercises they would have to perform over a time period of 4 weeks.

(Group A) will undergo Pilates training (3 days per week for 4 weeks) which includes Warm up = 8-10 min, Pilates = 45 min, Cool down = 5-8 min.

(Group B) will undergo QMT (3 days per week for 4 weeks) which includes Warm up = 8-10 min, QMT= 45 min, Cool down= 5-8 min.

(Group C) which is Control group will not undergo any training protocol.

For Pilates there were different exercise for all 4 weeks according to difficulty level for exercise progression.

But, in QMT some of the exercises were same for all 4 weeks and for progression the number of sets were increased, rest time between the exercise was reduced.

All the exercise were performed under the therapist observation. After 4 weeks, all the participants were retested for Functional movement score (FMS) by Functional movement screening. All the pre and post- exercise values were recorded and an excel sheet was maintained.

FMS :

The purpose of movement screening using fundamental movements is to attempt to identify deficient areas of mobility and stability in the asymptomatic active population that may be overlooked with typical impairment-based testing.
The purpose of movement screening using fundamental movements is to attempt to identify deficient areas of mobility and stability in the asymptomatic active population that may be overlooked with typical impairment-based testing.

The Functional Movement Screening (FMS) score is a widely used assessment tool designed to evaluate an individual's movement patterns, identify functional limitations, and detect potential risks for injury. The FMS involves a series of seven tests that assess fundamental movements essential for daily activities and athletic performance. These tests include the deep squat, hurdle step, inline lunge, shoulder mobility, active straight-leg raise, trunk stability push-up, and rotary stability. Each test is scored on a scale from 0 to 3, with a higher score indicating better movement quality and lower risk of injury.

A perfect FMS score of 21 reflects optimal movement efficiency and suggests that the individual has a well-balanced and functional movement pattern. Lower scores can highlight areas of weakness or imbalance, which may require targeted intervention through corrective exercises or physical therapy. The FMS is valuable for athletes, fitness enthusiasts, and individuals undergoing rehabilitation, providing a baseline for monitoring progress and designing personalized training programs. By addressing identified movement deficiencies, individuals can improve their overall functional performance and reduce the likelihood of injuries.

In addition to its use in sports and rehabilitation, the FMS is also employed in general fitness assessments and injury prevention strategies. It helps practitioners and trainers design exercise programs that enhance functional movement and promote better physical health. Regular re-evaluation using the FMS can track improvements and adjust training strategies accordingly. Overall, the FMS is a practical and insightful tool for optimizing movement patterns and enhancing overall physical performance.

3.1 - Deep Squat

3.3 - Inline Lunges

3.2 - Hurdle Step

3.4 - Shoulder Mobility

3.5 - Active Straight Leg Raising

3.6 - Trunk Stability Push Up

3.7 – Rotational Stability

FIG NO. 3: FMS test

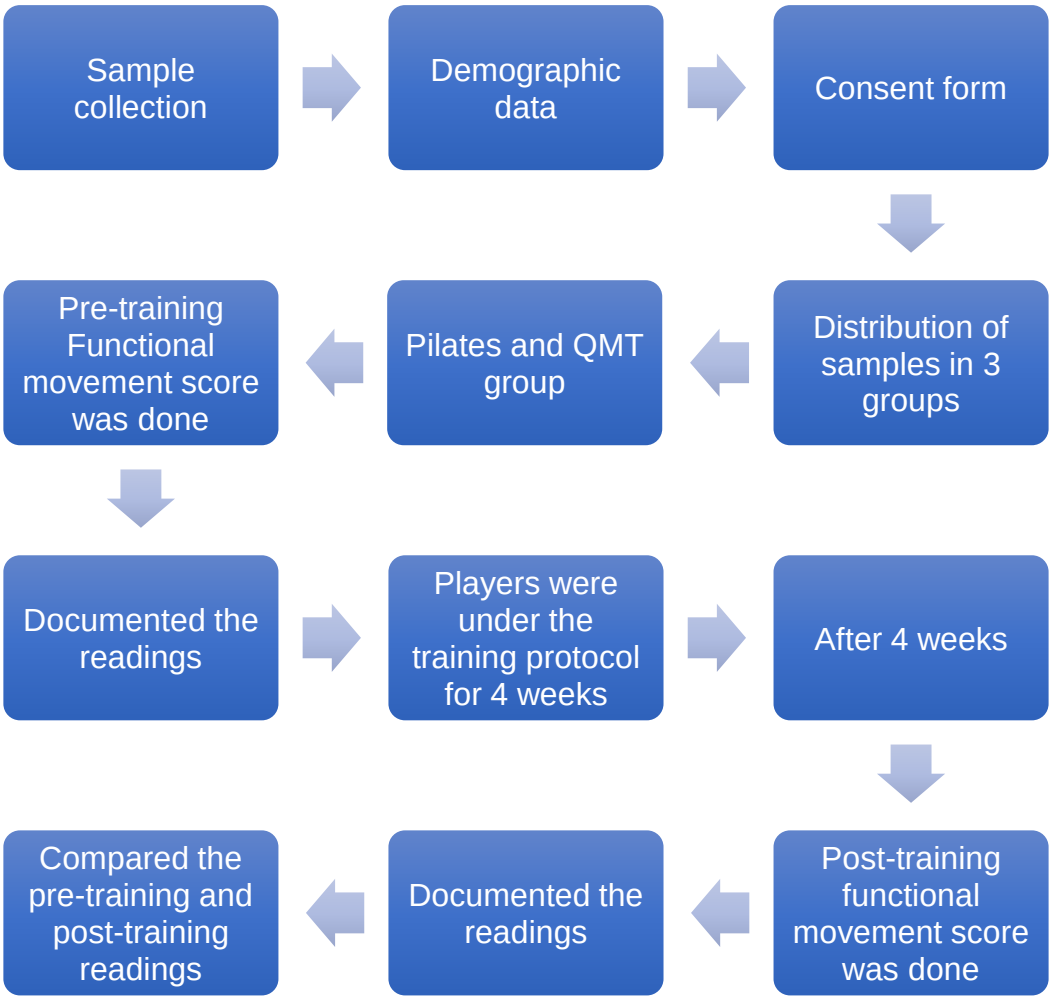


FIG NO. 4: FLOW CHART OF STUDY PROCEDURE

Group A Experimental group 1	Group B Experimental group 2	Group C Control group
Pilates training (18 recreational athletes)	Quadrupedal movement training (18 recreational athletes)	No intervention (18 recreational athletes)
This group underwent Pilates training (3days per week for 4 weeks). Warmup – 10 mins Pilates – 45 mins Cooldown – 5-8 mins	This group underwent QMT training (3days per week for 4 weeks). Warmup – 10 mins Pilates – 45 mins Cooldown – 5-8 mins	This group did not undergo any training protocol
The pre and post training, Functional movement screening was done	The pre and post training, Functional movement screening was done	The pre and post training, Functional movement screening was done

TABLE NO. 1: TABLE OF GROUP DISTRIBUTION

TRIANING PROGRAM :

1.Pilates training:

	Exercise	Sets
Warmup **(8-10 mins)**	Stretching Footwork Huggiing 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

Week	Exercise	Repetitions	Sets	Rest
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	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 : Pilates Training Program

2. QMT Training

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 unl oad Loaded beast wa ve Ape reach	3-5 2-3 3-5	1 1 1	30-60
Traveling forms	Forward/ Revers e beast Forward/ Revers e Ape	10 yards 10 yards	1-3 1-3	30-60
Switches & transitions	Under switch Side kick through	10-20	1-3	30-60

AF Categories	AF Movements	Repetition/ Time	Set	Rest (sec)
Wrist Mobilization	Wrist rolls Wrist waves Prayer stretch Wrist shakers Wrist relief Quadruped wrist	30 sec	1	0
Form stretches flow (Perform as a circuit 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

AF Categories	AF Movements	Repetitions / Time	Set	Rest (sec)
Switches and tr ansitions	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 throug h to front kick thr ough	5-10 per side	2-3	60
Flows	Beast flow 1	2-4 rounds		60

TABLE NO.3: QMT Training Program

5.1 - Criss Cross

5.2 - Bridging (With Pilates Ring)

5.3 - Spinal Twist (With Pilates Ring)

FIG. NO. 5: PILATES EXERCISES

6.1 - Ape Reach

6.2 - Loaded beast unload

6.3 - Switches & transitions - Under switch

FIG NO. 6: QMT EXERCISES

STATISTICAL ANALYSIS

The statistical analysis was performed using SPSS statistical package for social sciences version 25. Level of significance was set at $p < 0.05$. The normality of data was calculated using Shapiro Wilk test. Descriptive statistics was done to assess the mean and standard deviation of the specific groups. The interferential statistics that is the Paired t-test was used for analysis within the group and One way ANOVA was used for the group factor analysis.

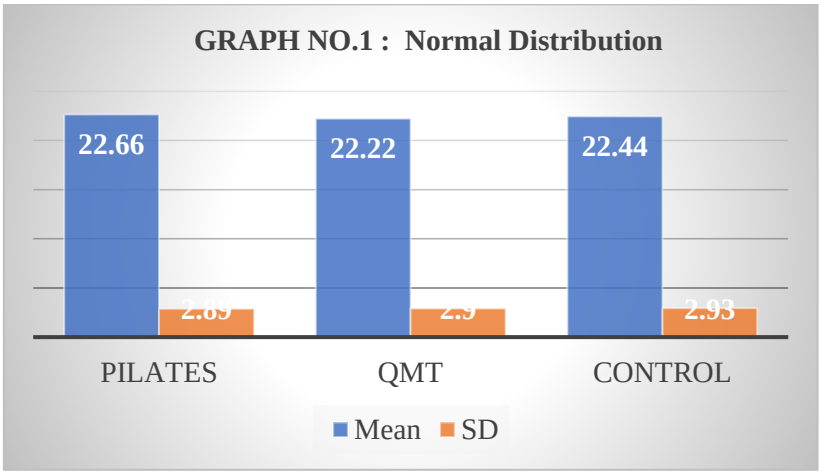
RESULTS

- The current study included 54 participants aged between 18-35 years.

The baseline data of age is shown in **TABLE NO.4.** The mean age and SD of pilates, QMT and control groups is mentioned in the **TABLE NO.4** and **GRAPH NO.1** with **(P>0.05)** which shows there is no significant difference in the mean age among Pilates QMT, Control group.

Groups	AGE	
	Mean	**SD**
Pilates	22.66	2.89
QMT	22.22	2.90
Control	22.44	2.93

TABLE NO. 4: Normal Distribution



- The results for within group analysis for all the three were as follows:

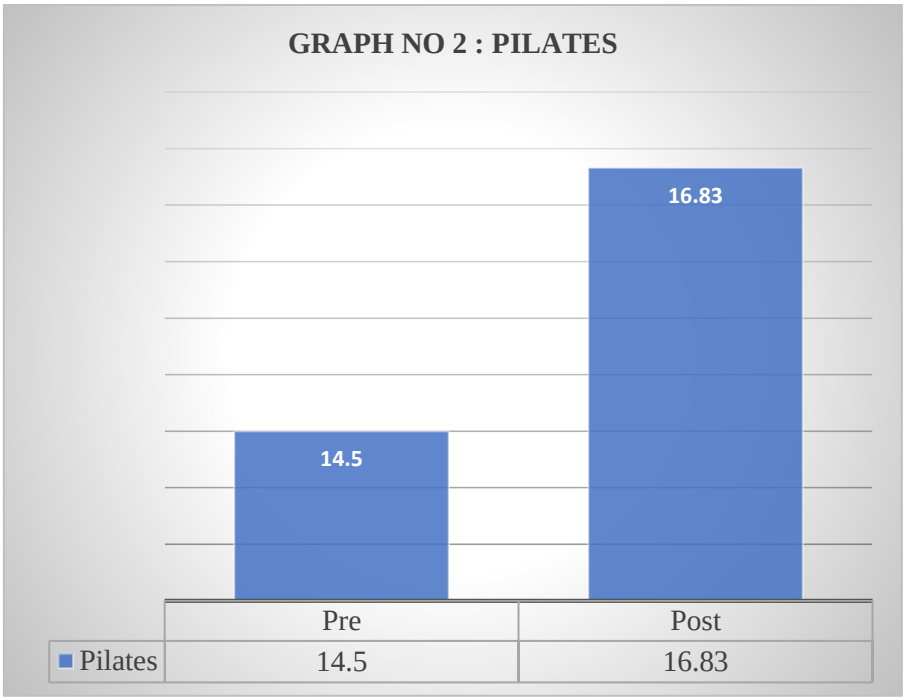
Pilates group -

There was a significant statistical difference observed in the group performing Pilates exercises in FMS score for a time interval of 4 weeks with a (**P<0.05)**

Here, the **TABLE NO. 5** and **GRAPH NO. 2** shows same;

PILATES			
Pre	**Post**	**Mean Difference**	**p Value**
14.5	16.83	2.33	**p < 0.05**

TABLE NO. 5: Pilates



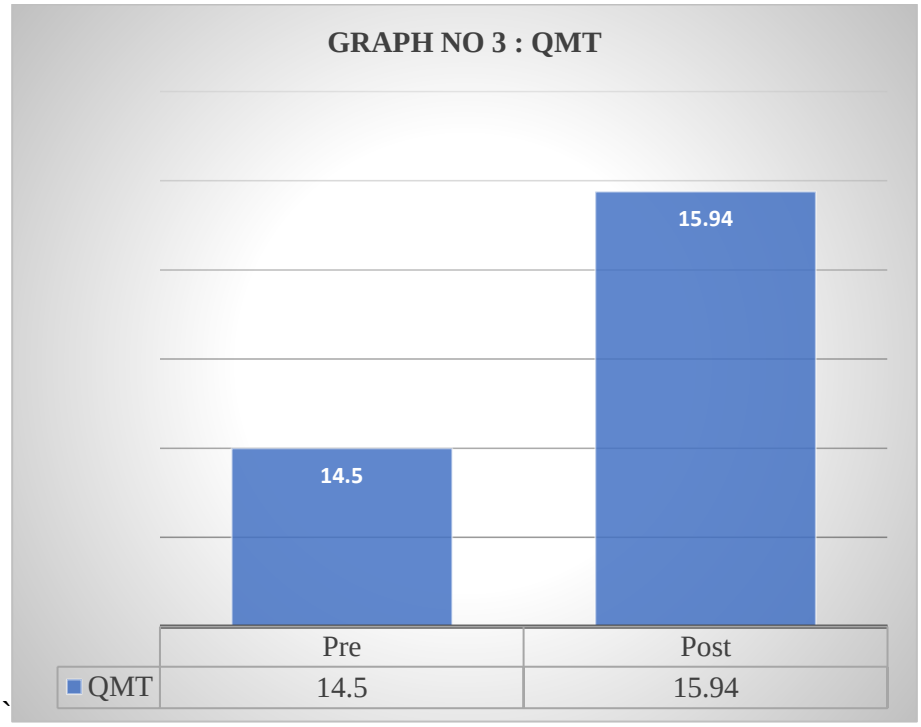
QMT group -

There was a significant statistical difference observed in the group performing QMT exercises in FMS score for a time interval of 4 weeks with a (**P<0.05)**

Here, the **TABLE NO. 6** and **GRAPH NO. 3** shows same ;

QMT			
Pre	**Post**	**Mean Difference**	**p Value**
14.5	15.94	1.44	**p < 0.05**

TABLE NO. 6: QMT



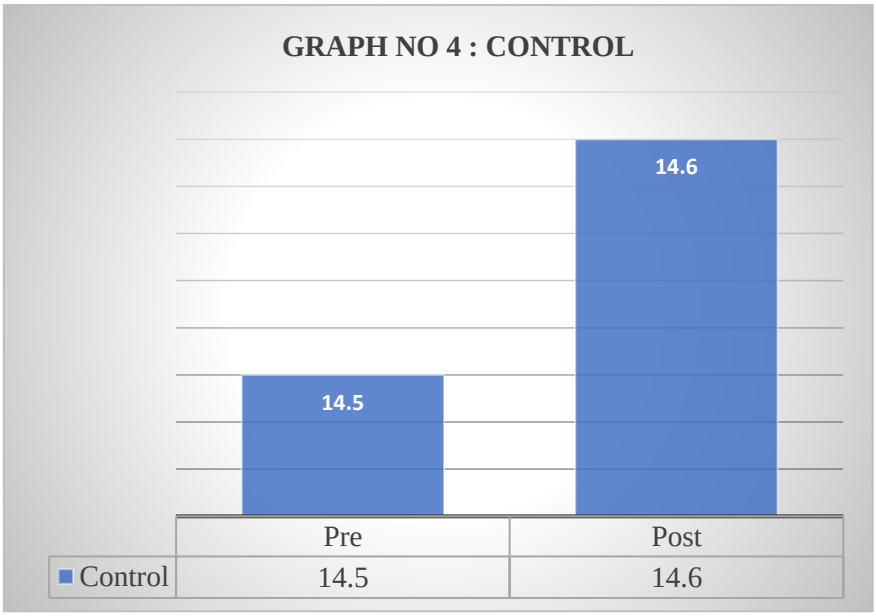
Control Group –

This particular group was asked to follow only their normal playing routine. The score for this group also showed a minimum significant difference with a p value < 0.05**.**

The **TABLE NO. 7** and **GRAPH NO. 4** show the same ;

CONTROL			
Pre	**Post**	**Mean Difference**	**p Value**
14.5	14.6	0.16	**p < 0.05**

TABLE NO. 7: Control



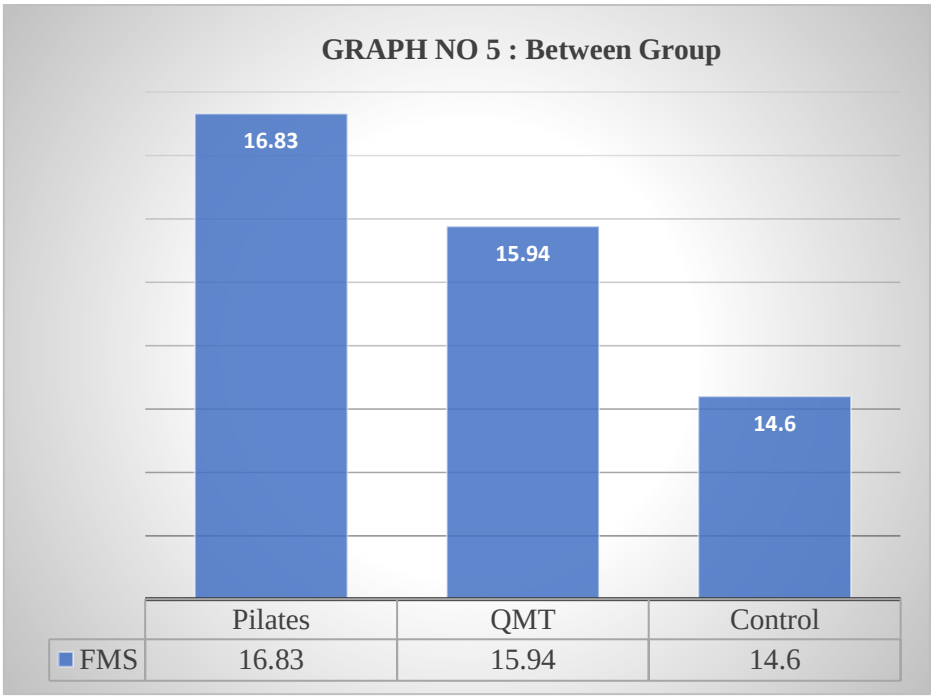
- For the analysis of between group, ANOVA was used as there were three groups to be compared.

According to ANOVA test performed, there was a statistically significant difference observed between the all three groups, where Pilates group showed the maximum improvement, followed by QMT group. Control group showed the least changes.

TABLE NO. 8 and **GRAPH NO. 5** shows the same ;

	Pilates	QMT	Control	p Value
FMS	16.83	15.94	14.6	**p < 0.05**

TABLE NO. 8: Between Group



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.

LIMITATIONS AND SCOPE FOR FUTURE STUDY

LIMITATIONS :

1. Duration of Intervention:

The intervention duration can be extended to fully capture the long term effects of Pilates and QMT. Short-term improvements might not reflect sustained benefits.

2. Variability in Intervention Delivery:

Differences in how the Pilates and QMT sessions were delivered (e.g., instructor experience, session quality) could introduce variability in the results.

3. Control Group Activity:

The control group might not have had a completely passive role. Differences in the control group's activity levels could influence the results.

SCOPE FOR FUTURE STUDY :

- Additional Outcome Measures :

Include additional measures of functional performance, such as strength, flexibility, or endurance tests, to provide a more comprehensive evaluation of the interventions' effects

- Long-Term Impact :

Extend the study duration to assess the long-term sustainability of improvements in FMS scores and functional movement. This can help determine whether the benefits persist over time

- Population Variability:

Explore the effects of Pilates and QMT in different populations, such as athletes of varying levels, age groups, or those with specific physical conditions or injuries.

By addressing these limitations and exploring these areas, future research can build on your findings, providing deeper insights and potentially optimizing training protocols for recreational athletes.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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ANNEXURE 1

CONSENT FORM

Study Title: Effect of Pilates Training and Quadrupedal Movement Training(QMT) on Functional Movement Screening (FMS) in recreational athletes – A Randomized Controlled Trial

Study Number:

Subject ‘s Name:

Date of Birth / Age:

Address of the Subject

Occupation:

(i) I confirm that I have read and understood the information sheet dated above study and have had the opportunity to ask questions.

(ii) I understand that my participation in the study is voluntary and that I am [ ]

free to withdraw at any time, without giving any reason, without my

medical care or legal rights being affected.

(iii) I understand that the Sponsor of the clinical trial, others working on the [ ]

Sponsor ‘s behalf, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I

withdraw from the trial. I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published.

(iv) I agree not to restrict the use of any data or results that arise from this [ ] study provided such a use is only for scientific purpose

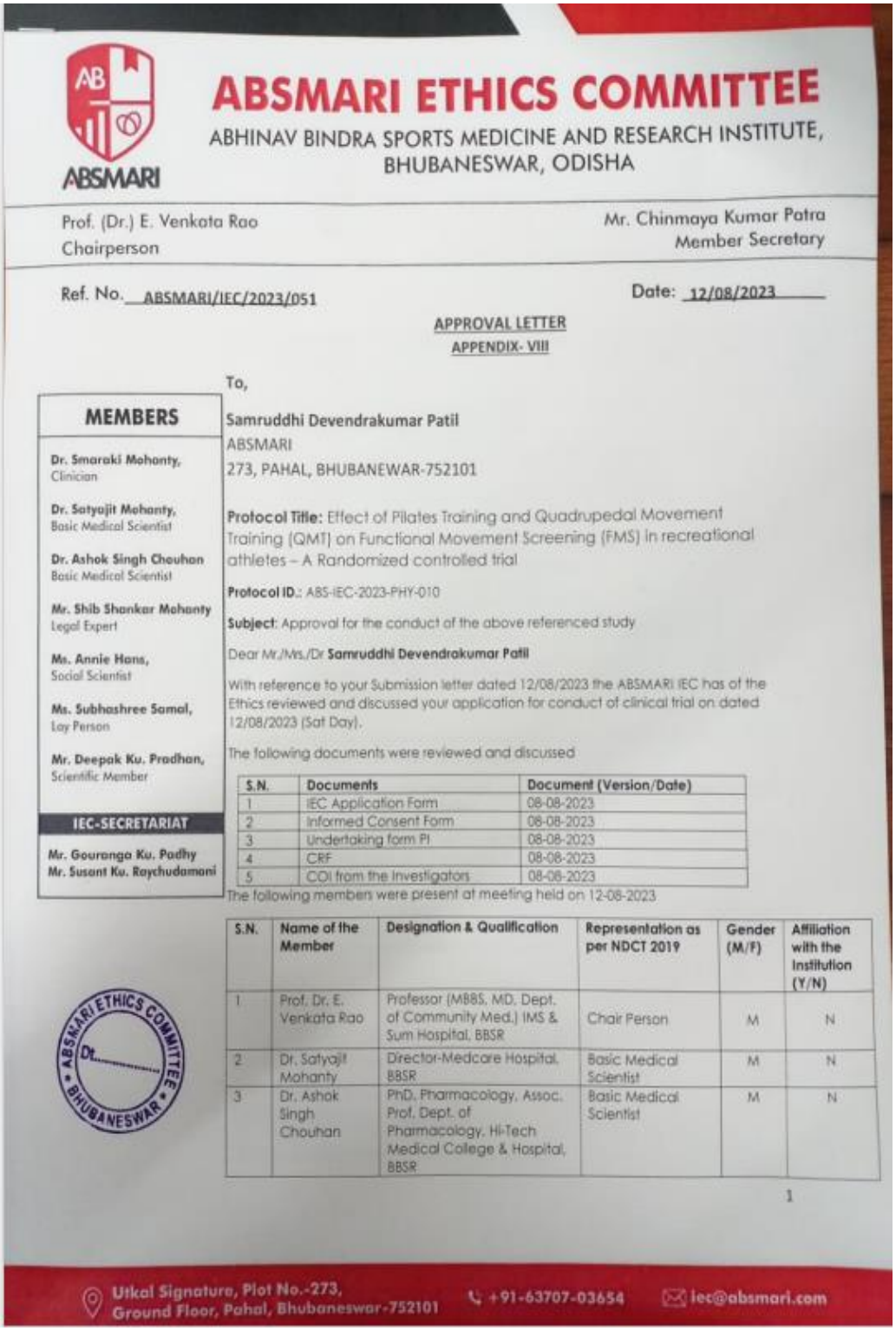
(v) I agree to take part in the above study

Signature of the Subject : **Signature of the Investigator:**

Signatory ‘s Name:Date: **Study Investigator ‘s Name:**

ANNEXURE 2

ETHICAL COMMITTEE CLEARANCE CERTIFICATE



ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE, BHUBANESWAR, ODISHA

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2023/051

Date: 12/08/2023

APPROVAL LETTER
APPENDIX- VIII

MEMBERS

Dr. Smaraki Mohanty, Clinician
Dr. Satyajit Mohanty, Basic Medical Scientist
Dr. Ashok Singh Chouhan Basic Medical Scientist
Mr. Shib Shankar Mohanty Legal Expert
Ms. Annie Hans, Social Scientist
Ms. Subhashree Samal, Lay Person
Mr. Deepak Ku. Pradhan, Scientific Member

IEC-SECRETARIAT

Mr. Gouronga Ku. Padhy
Mr. Susant Ku. Raychudamani

To,

Samruddhi Devendrakumar Patil
ABSMARI
273, PAHAL, BHUBANEWAR-752101

Protocol Title: Effect of Pilates Training and Quadrupedal Movement Training (QMT) on Functional Movement Screening (FMS) in recreational athletes – A Randomized controlled trial

Protocol ID.: ABS-IEC-2023-PHY-010

Subject: Approval for the conduct of the above referenced study

Dear Mr./Ms./Dr **Samruddhi Devendrakumar Patil**

With reference to your Submission letter dated 12/08/2023 the ABSMARI IEC has of the Ethics reviewed and discussed your application for conduct of clinical trial on dated 12/08/2023 (Sat Day).

The following documents were reviewed and discussed

S.N.	Documents	Document (Version/Date)
1	IEC Application Form	08-08-2023
2	Informed Consent Form	08-08-2023
3	Undertaking form PI	08-08-2023
4	CRF	08-08-2023
5	COI from the Investigators	08-08-2023

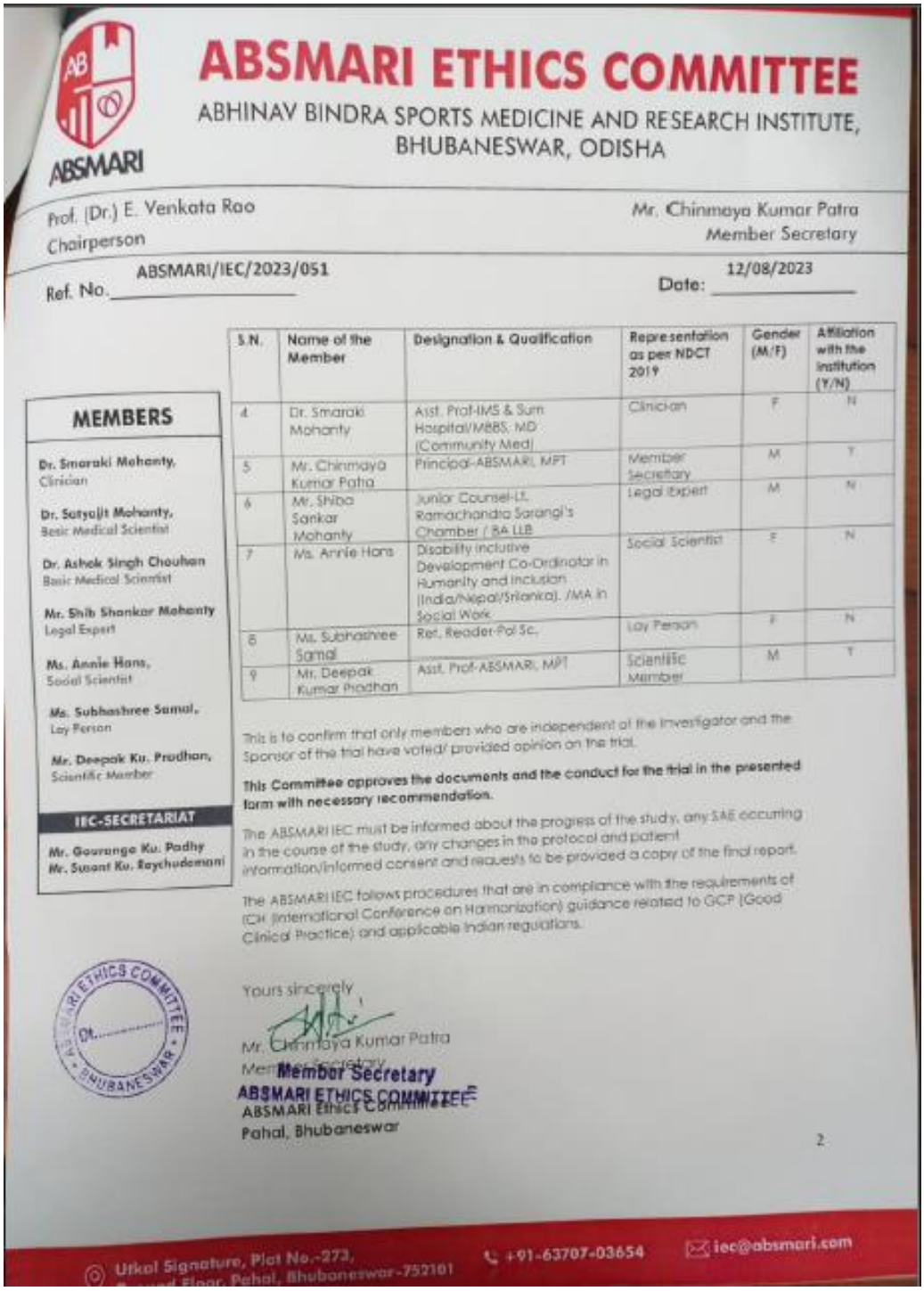
The following members were present at meeting held on 12-08-2023

S.N.	Name of the Member	Designation & Qualification	Representation as per NDCT 2019	Gender (M/F)	Affiliation with the Institution (Y/N)
1	Prof. Dr. E. Venkata Rao	Professor (MBBS, MD. Dept. of Community Med.) IMS & Sum Hospital, BBSR	Chair Person	M	N
2	Dr. Satyajit Mohanty	Director-Medcare Hospital, BBSR	Basic Medical Scientist	M	N
3	Dr. Ashok Singh Chouhan	PhD. Pharmacology, Assoc. Prof. Dept. of Pharmacology, Hi-Tech Medical College & Hospital, BBSR	Basic Medical Scientist	M	N

ABSMARI ETHICS COMMITTEE * BHUBANESWAR * Dt.

1

Utkal Signature, Plot No.-273, Ground Floor, Pahal, Bhubaneswar-752101 +91-63707-03654 iec@absmari.com



ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE, BHUBANESWAR, ODISHA

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2023/051

Date: 12/08/2023

MEMBERS

Dr. Smaraki Mohanty, Clinician

Dr. Satyajit Mohanty, Basic Medical Scientist

Dr. Ashok Singh Chouhan Basic Medical Scientist

Mr. Shib Shankar Mohanty Legal Expert

Ms. Annie Hans, Social Scientist

Ms. Subhashree Samal, Lay Person

Mr. Deepak Ku. Pradhan, Scientific Member

IEC-SECRETARIAT

Mr. Gouranga Ku. Padhy
Mr. Susant Ku. Rathudemani

S.N.	Name of the Member	Designation & Qualification	Representation as per NDCT 2019	Gender (M/F)	Affiliation with the institution (Y/N)
4	Dr. Smaraki Mohanty	Asst. Prof-IMS & Sum Hospital/MBBS, MD (Community Med)	Clinician	F	N
5	Mr. Chinmaya Kumar Patra	Principal-ABSMARI, MPT	Member Secretary	M	Y
6	Mr. Shiba Sankar Mohanty	Junior Counsel-Lt. Ramachandra Sarangi's Chamber / BA LLB	Legal Expert	M	N
7	Ms. Annie Hans	Disability Inclusive Development Co-Ordinator in Humanity and Inclusion (India/Nepal/Srilanka). /MA in Social Work	Social Scientist	F	N
8	Ms. Subhashree Samal	Ret. Reader-Pol Sc.	Lay Person	F	N
9	Mr. Deepak Kumar Pradhan	Asst. Prof-ABSMARI, MPT	Scientific Member	M	Y

This is to confirm that only members who are independent of the Investigator and the Sponsor of the trial have voted/ provided opinion on the trial.

This Committee approves the documents and the conduct for the trial in the presented form with necessary recommendation.

The ABSMARI IEC must be informed about the progress of the study, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent and requests to be provided a copy of the final report.

The ABSMARI IEC follows procedures that are in compliance with the requirements of ICH (International Conference on Harmonization) guidance related to GCP (Good Clinical Practice) and applicable Indian regulations.

ABSMARI ETHICS COMMITTEE Dt. BHUBANESWAR

Yours sincerely

Mr. Chinmaya Kumar Patra
Member Secretary
ABSMARI Ethics Committee

Member Secretary
ABSMARI ETHICS COMMITTEE
Pahal, Bhubaneswar

2

Utkal Signature, Plot No.-273, Pahal, Bhubaneswar-752101 | +91-63707-03654 | iec@absmari.com

ANNEXURE 3

ASSESSMENT FORM

THE FUNCTIONAL MOVEMENT SCREEN

SCORING SHEET

NAME _____ DATE _____ DOB _____

ADDRESS _____

CITY, STATE, ZIP _____ PHONE _____

SCHOOL/AFFILIATION _____

SSN _____ HEIGHT _____ WEIGHT _____ AGE _____ GENDER _____

PRIMARY SPORT _____ PRIMARY POSITION _____

HAND/LEG DOMINANCE _____ PREVIOUS TEST SCORE _____

TEST		RAW SCORE	FINAL SCORE	COMMENTS
DEEP SQUAT				
HURDLE STEP	L			
	R			
INLINE LUNGE	L			
	R			
SHOULDER MOBILITY	L			
	R			
IMPINGEMENT CLEARING TEST	L			
	R			
ACTIVE STRAIGHT-LEG RAISE	L			
	R			
TRUNK STABILITY PUSHUP				
PRESS-UP CLEARING TEST				
ROTARY STABILITY	L			
	R			
POSTERIOR ROCKING CLEARING TEST				
TOTAL				

ANNEXURE 4

MASTER CHART

Sr. No.	Height (CM)	Weight (KG)	Age(Years)	Pilates		
				Pre	Post	Difference
1	150	49	21	15	17	2
2	172	52	25	14	17	3
3	165	50	22	13	17	4
4	149	54	19	16	19	3
5	177	48	20	14	16	2
6	160	53	26	15	16	1
7	154	51	23	13	14	1
8	170	55	27	16	17	1
9	163	49	24	14	19	5
10	152	55	18	15	18	3
11	180	60	21	13	13	0
12	165	57	25	16	19	3
13	150	63	22	14	15	1
14	177	53	19	15	17	2
15	160	62	20	13	16	3
16	154	56	26	16	19	3
17	170	64	23	14	16	2
18	163	58	27	15	18	3

Sr. No.	Height (CM)	Weight (KG)	Age	QMT		
				Pre	Post	Difference
1	168	52	24	13	14	1
2	157	50	18	16	17	1
3	159	54	21	14	14	0
4	159	48	25	15	16	1
5	166	53	22	13	13	0
6	153	51	19	16	18	2
7	174	55	20	14	16	2
8	161	49	26	15	17	2
9	147	52	23	13	16	3
10	175	61	27	16	18	2
11	157	54	24	14	14	0
12	182	65	18	15	18	3
13	159	59	21	13	16	3
14	168	60	25	16	18	2
15	153	55	22	14	15	1
16	178	63	19	15	15	0
17	161	57	20	13	14	1
18	173	61	26	16	18	2

Sr. No.	Height (CM)	Weight (KG)	Age	Control		
				Pre	Post	Difference
1	169	50	23	14	14	0
2	155	54	27	15	16	1
3	175	48	24	13	13	0
4	158	53	18	16	16	0
5	162	51	21	14	14	0
6	164	55	25	15	16	1
7	171	49	22	13	13	0
8	167	52	19	16	16	0
9	152	50	20	14	14	0
10	169	53	26	15	15	0
11	155	62	23	13	14	1
12	176	58	27	16	16	0
13	158	64	24	14	14	0
14	162	56	18	15	15	0
15	167	59	21	13	13	0
16	172	60	25	16	16	0
17	164	54	22	14	14	0
18	156	65	19	15	15	0