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Effectiveness of functional integration exercises on functional outcome among police recruits in Maharashtra state. An experimental study

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Abstract
Introduction: The measurement of physical fitness is an important part of the recruitment and training process of police officers because the job ranges from physically non-demanding (i.e., administrative work) to highly demanding (i.e., chasing, arresting the belligerent or controlling a riot). Accordingly, future police officers (i.e., police students, cadets or trainees) typically complete a physical training program to improve their fitness level before becoming sworn officers. To complete tasks given during police recruits physical exam needs more stability of spine and pelvis and our global muscles (slings of muscle system) helps to improves stability of spine and improves the movement pattern of the body. Introducing the functional integration exercises helps to improve the stability of spine and pelvis. The FMS aims to identify imbalances in mobility and stability during functional movements.
Aim & Objective: To find out effectiveness of functional integration exercises on functional outcome among police recruits in Maharashtra state by using functional movement screening (FMS) score over the period of 4weeks.
Methods: We conducted experimental study among 53 police recruits from Pune. Null hypothesis was created followed by alternative hypothesis. We collected data from the field as per inclusion criteria. We used Microsoft excel for data entry and Graph pad instat (version 3.0632) for statistical analysis.
Results: There was significant rise in score on FMS after functional integration exercises among participants.
Conclusion: The functional integration exercises proved to be effective for improving balance between the stability and mobility and also effective in core strengthening for a period of 4 weeks.

Keywords: Functional integration exercises, functional movement screening tool, police recruits fitness, slings of muscle system, myofascial slings

Introduction

Maharashtra, the third largest State in Republic of India, has one of the largest police forces in the country. Besides 302 Indian Police Service officers borne on the State Cadre, it consists of 282 Superintendents of Police, 523 Deputy Superintendents of Police, 3522 Inspectors, 3123 Assistant Police Inspectors, 6230 Sub Inspectors and 1,80,550 men (members of constabulary) [13, 14, 15].

The measurement of physical fitness is an important part of the recruitment and training process of police officers because the job ranges from physically non-demanding (i.e., administrative work) to highly demanding (i.e., chasing, arresting the belligerent or controlling a riot) [29, 30, 31, 35]. Therefore, next to health-related physical fitness, performance-related physical fitness is also required in certain police occupations [32, 33, 34, 35]. Accordingly, future police officers (i.e., police students, cadets or trainees) typically complete a physical training program to improve their fitness level before becoming sworn officers [29, 31, 35].

For the physical preparation of police officers require speed, strength, agility and stamina. The role of police officer is mostly active while working. physical fitness is an important component of being able to perform unusual and often vital tasks [24, 25, 26].

Physical Exam patterns for police recruitment are as follows–

1. 1600/800 meters running
2. 100 meters running
3. Throw ball
4. Long jump
5. 10 pool ups
6. Shot-put

But due to a lack of proper training and guidance, most of the recruits face difficulties in their job placement. To complete these above task, it needs more stability of spine and pelvis and our global muscles (slings of muscle system) helps to improves stability of spine and improves the movement pattern of the body. Introducing the functional integration exercises helps to improve the stability of spine and pelvis as soon as possible in exercises program [8].

Andry Vleeming, Diane Lee, and Thomas Myers states that anatomy slings are a large part of these systems and our ability to generate efficient dynamic movement. The superficial muscle activity should occur in synergy with the deep muscles, which is an integral part of dynamic movement. Anatomy slings can be otherwise known as the ‘myofascial slings’ and relate very closely to superficial muscle activity [1]. Slings are comprised of muscles, fascia and ligaments all working together to create stability and mobility. Is critical to understand how they connect and function together.

The body is a complex system made up of many of these anatomical slings.

As explained above, when the slings are working efficiently. They also help us move better, produce more force, and create more speed [4]. In physiotherapist Diane Lee's book, The Pelvic Girdle (2011), she discusses four important sling systems that work together for load transfer through the pelvic/lumbar region. A "hole" or weakness of a component in any of these systems can create dysfunction and resulting in poor performance and/or injury [3].

There are 4 slings of muscle system

Anterior Oblique Sling (AOS) [See figure]

The anterior oblique system (AOS) consists of the external oblique and internal oblique, connecting with contra lateral adductor muscles via the adductor-abdominal fascia.

Posterior oblique sling (POS) [See figure]

This sling system consists of the latissimus dorsi (LD), the gluteus maximus (GM), and the inter-connecting thoracolumbar fascia (TLF) [3]. The POS, otherwise known as the back functional line, crosses approximately at the level of the sacro-lumbar junction. The lower portion of the sling, consisting of the distal GM fibres, passes underneath the iliotibial tract to attach to the posterolateral edge of the femur, thus this system becomes linked with the lateral sling [10].

Deep longitudinal sling (DLS) [See figure]

The DLS connects the erector spinae, multifidus, thoracolumbar facia, sacrotuberous ligament and the biceps femoris.

Lateral sling [See figure]

The lateral sling consists of the gluteus medius, gluteus minimus, tensor fascia latae (TFL) and iliotibial band (ITB) [3]. The lateral sling begins at the origin of the gluteus medius and minimus on the external surface of the ilium, and ends at the insertion of the ITB on the upper tibia. This gives the lateral sling broad coverage of the lateral aspect of the hip and knee joint.

There are various treatment techniques to improve stability at spine and pelvis like motor control, acupuncture, dry needling, biomechanical analysis, Orthotics, electrotherapy, manipulation, muscle energy technique, core exercises, frictional massage, Functional Integration etc [12, 8, 40]. Manual therapy soft tissue release or massage for tight and sore muscle groups, manual therapy and muscle energy techniques are used to treat Spine and pelvic region movement patterns [12].

Functional Integration exercise involve activities that require the ability to maintain neutral spine while moving the trunk on the hips (squatting to sit down), moving the arms on the trunk (driving), or both of these movements simultaneously (lifting) [8, 12]. In order to facilitate the automatic and tonic function of the local stabilizing muscles, it is important to include Functional Integration exercises in the rehabilitation program as early as possible [8, 12].

These integrated muscle systems produce slings of forces that assist in the transfer of load.

Need of study

- The core is the group of trunk and hip muscles that surround the spine, abdominal viscera and hip. Core muscles are essential for proper load balance within the spine, pelvis, and kinetic chain. They spare the spine from excessive load and are essential for load transfer between the upper and lower body [27].
- Core muscles help to stabilize the spine, pelvis, and kinetic chain during functional movements [27].
- The movement and power is produced by the AOS which causes a rotation and forward movement of the pelvis, trunk and arm. However, the POS is also crucial during this action in order decelerate the movement when appropriate, using eccentric control. This helps to aid an individual in maintaining their balance during a highly dynamic movement such as this, whilst stabilising the lumbo-pelvic hip complex [38]
- To complete tasks given during police recruits physical exam needs more stability of spine and pelvis and our global muscles (slings of muscle system) helps to improves stability of spine and improves the movement pattern of the body.
- Introducing the functional integration exercises helps to improve the stability of spine and pelvis.
- The FMS aims to identify imbalances in mobility and stability during functional movements [28].

Aim

"Effectiveness of functional integration exercises on functional outcome among police recruits in Maharashtra state."

Objectives

To find out effectiveness of functional integration exercises on functional outcome among police recruits in Maharashtra state by using functional movement screening (FMS) score over the period of 4weeks.

Hypothesis

- **Null hypothesis (H0)**
  There will not be a significant effect of functional integration exercises on functional outcome among police recruits in Maharashtra state over the period of 4 weeks.

- **Alternative hypothesis (H1)**
  There will be a significant effect of functional integration exercises on functional outcome among police recruits in Maharashtra state over the period of 4 weeks.

Review of literature

1. In their book "The pelvic girdle. An approach to the examination and treatment of the lumbopelvic hip region", Third edition started that; the global system of muscles is essentially an integrated sling system, comprised of several muscles, which produces forces. Coordination between local and global system ensures stability without rigidity of postures and without episodes of collapse. Functional Integration is useful in loss of global orientation which requires specific cueing and attention to the muscles of global slings.

   [Diane Lee (2004)]

2. In their study Functional integration and stability of Hypermobile Sacroiliac joint stated that Global muscle stabilization and functional integration showed significant effect on active SLR test and functional

outcome (Oswestry Low back Pain Questionnaire, Pelvic Girdle Questionnaire) while treating hypermobile SI Joint in young females.

[Sheetal Bamhane, Abhijit Satralkar, Gauri Kulkarni (2017)]

3. In their article "The Effect of Specific Sling Exercises on the Functional Movement Screen Score in Adolescent Volleyball Players: A Preliminary Study" said that The analysis showed that between the first and the second measurement, no significant differences occurred. The use of specific sling exercises caused a significant improvement in FMS results ($p \leq 0.01$) between the first and the third, as well as the second and the third measurement. The applied stabilisation exercises based on the NEURAC method positively influenced the FMS test result in male subjects practicing volleyball. Performance of such exercises also resulted in more than 90% of the subjects having a total FMS test score ≥ 17, which may be important in the prevention of injuries. The preliminary results indicate that this type of exercise should be included in a teenage volleyball training routine.

[Linek P, Saulicz E, Myśliwiec A, Wójtowicz M, Wolny T (2016)]

4. In their article "The Functional Movement Screen as a predictor of police recruit occupational task performance", results are Eleven percent failed the marksmanship and baton strike assessments, 21% failed defensive tactics and 36% failed the tactical options assessment. Mean Functional Movement Screen score was 13.96 points (±1.99 points). Only the tactical options assessment approached a significant difference ($p = 0.077$) between pass/fail recruits. When Functional Movement Screen scores when graded as pass (14+) or fail (<14) again only the tactical options assessment approached significance ($p = 0.057$). And at end of this study they conclude that the results of this study suggest that a relationship between an officer's movement patterns and occupational performance, most notably choice of tactical options, may exist.

[Bock C, Stierli M, Hinton B, Orr R (2016)]

5. In their article "Use of a functional movement screening tool to determine injury risk in female collegiate athletes", found that Compensatory fundamental movement patterns can increase the risk of injury in female collegiate athletes, and can be identified by using a functional movement screening tool.

[Chorba RS, Chorba DJ, Bouillon LE, Overmyer CA, Landis JA (2010)]

6. In their article "Comparison of the Therapeutic Effects of a Sling Exercise and a Traditional Stabilizing Exercise for Clinical Lumbar Spinal Instability", founds that sling exercise with elastic bands leads to a reduction in pain and disability compared with a traditional stabilizing exercise, although traditional stabilizing exercise also shows good results in chronic LBP patients with clinical spinal instability. A sling exercise with an elastic band could be a useful treatment for chronic LBP with clinical spinal instability.

[Kim YW, Kim NY, Chang WH, Lee SC (2017)]

7. In their study The Pelvic girdle – An approach to the examination and treatment of the lumbopelvic hip region stated that Functional integration exercises help in treating pain in lumbopevic-hip region.

[Diane lee and Paul Hodges]

8. In their study "Effects of special exercise programs on functional movement screen scores and injury prevention in preprofessional young football players" found that At the end of 12-week intervention and control groups were re-evaluated with FMS protocol. Contact and noncontact sports injuries recorded during one season. In intervention group there was statistically significant difference in increase in total FMS scores ($P< 0.01$), deep squat ($P\leq 0.001$), hurdle step ($P< 0.05$), inline lunge ($P< 0.01$), and trunk stability push-up ($P< 0.01$). In control group total FMS, deep squat, and trunk stability push-up scores increased with a statistical difference ($P< 0.01$, $P< 0.05$, $P \leq 0.01$, respectively). The incidence of noncontact injury in control group was higher than intervention group ($P< 0.05$). Periodic movement screening and proper corrections with functional training is valuable in order to create better movement capacity to build better physical performance and more effective injury prevention.

[Engin Dinc, Bekir Eray Kilinc, Muge Bulat, Yunus Turgay Erten]

Methodology

- **Study design**
  Pre-Post Experimental study
- **Sample size**
  53 (both male and female)
- **Sampling method**
  Purposive sampling.
- **Study population**
  Police Recruits in Maharashtra state.
- **Study setting**
  Police trannie academies in and around Pune
- **Study duration**
  6 months.
- **Intervention duration**
  45 min per day/ 3 times in a week/ 4 weeks.

Materials

- Consent form
- Pen
- Paper

- Measuring tape
- Hurdle stepper
- Stick
- Theraband (Red colour)
- FMS scoring sheet

Study criteria

Inclusion Criteria

- Age: 18-30 yrs [13].
- BMI between normal range i.e. from 18 to 24.9 kg/m2 [16, 17, 23]
- Males & Females
- Participants not engaged in any other treatment protocol apart from their training protocol.
- ROM for bilateral upper limb, lower limb and spine should be full
- MMT for bilateral upper limb, lower limb and spine should be 4 and above [18].
- Sit and reach test should be above (average and above range i.e 34-35 cm) [19, 20]

Exclusion criteria

- History of orthopaedic or neurological disorders related to upper and lower extremities and spine [22]
- Sacroiliac dysfunction [22]
- History of any fractures or recent injuries to upper and lower extremities and spine [22]
- Days of active menstrual period (for female participants) [21]
- Limb length discrepancies [22]

Procedure

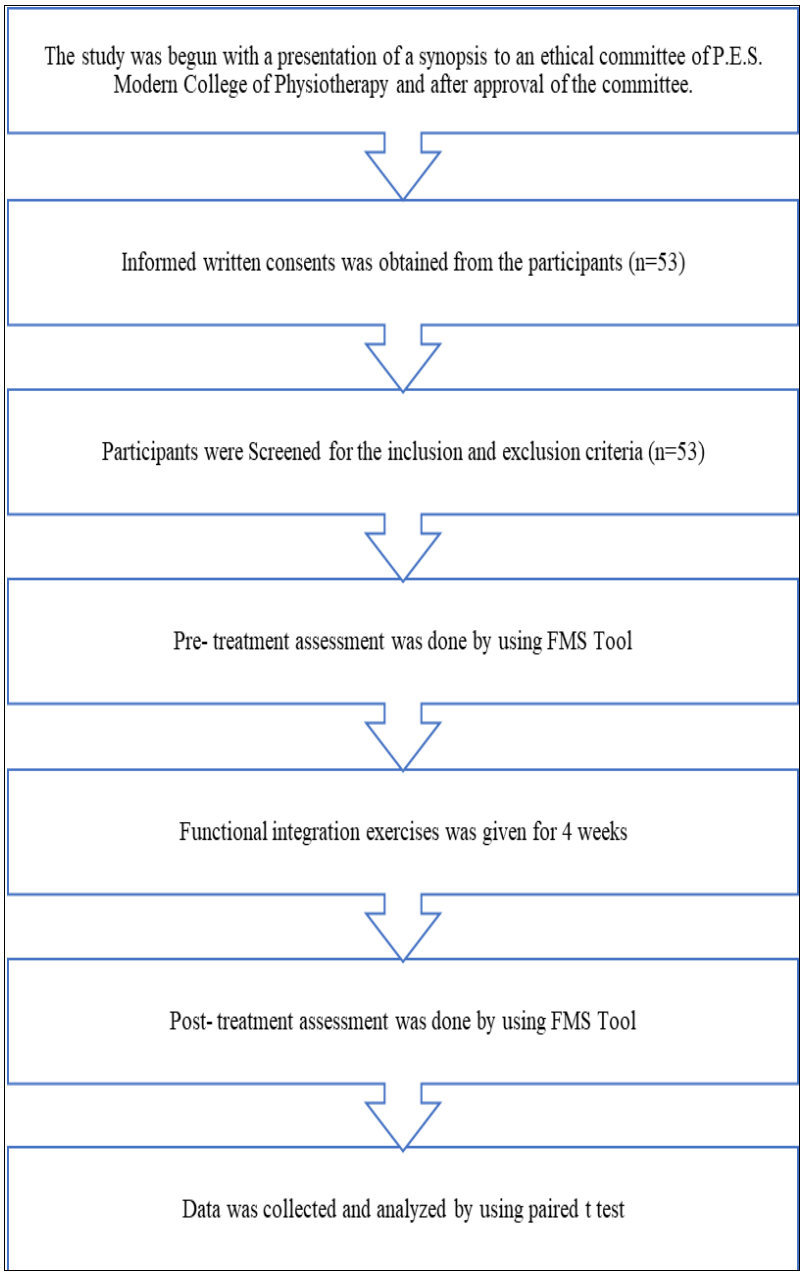

Fig: Flow diagram showing the process used in the study

The study was conducted after obtaining the approval from the Institutional Ethical Committee. The participants from training academies in and around Pune was selected and screened for the inclusion and exclusion criteria. Those subjects who satisfied the inclusion criteria were included for the study. Total 53 participants (n=53), were included

for the study and the written informed consent was obtain from all of the fifty three participants after they were explained about procedure of the study.

Participants were receive Functional Integration exercises (FI), which contains activities that require the ability to maintain neutral spine while moving the trunk on the hips, moving the arms on the trunk or both of these movements simultaneously.

Each participant was received an exercise activity booklet of the respective exercise program, with illustrations and instructions about the program. All the participant was instructed to wear comfortable clothing which should not be too tight or too loose while performing exercises. The participants in group were assessed for the baseline measurements with functional outcome (Functional Movement Screening Scale) before starting on with exercise program. The participants were explain about the study intervention in the language best understood by them.

They were encouraged to clarify questions regarding the study if any. The post intervention measurements were recorded 4 weeks after intervention.

Participants were received Functional Integration technique which includes following exercises and should be done for 15-20 repetitions. Rest break of 10 seconds after every 10 repetitions of each exercise and 30 seconds of rest break between two exercises were given.

Functional Integration technique includes

1. Squats. [See image]

Exercise instruction: The patient is asked to squat as if sitting in a chair, flexing at the hips, knees and ankles, while maintaining the neutral spine position and sliding the buttocks equally down the wall.

Patient position: Standing in neutral spine against the wall. The feet are approximately 15cm away from the wall. The hips should be in approximately 20* flexion, so that the pelvis and spine are inclined forward on the hips and the upper thorax and head are away from the wall. The hips should be in neutral rotation, the knees under the hips, the second toe of each foot in line with the middle of the patella, with equal body weight distributed over each foot.

Therapist palpates in the lumbar spine or at the sacrum and innominate to ensure that there is no loss of control during the movement [8, 12].

2. Step forward and step backward [See image]

Patient position: Stride standing

Exercise instruction: Patient palpates the key muscles to focus on. Ask patient to shift weight from front to back. Exercise is repeated with other leg [8, 12].

3. Lunges [See image]

Patient position: Standing in neutral spine

Exercise instruction: Cue a contraction of the lumbopelvic local stabilisers. The patient steps forward with one foot landing heel first and allowing the heel of the back foot to come off the ground so that weight bearing is performed through the ball of the back foot. Ask patient to bend both knees so that the body drops down between the legs, while keeping the weight equally distributed between both legs. The front knee should be vertically in line with the ankle joint as the knee bends [8, 12].

4. One leg squats [See image]

Patient position: Standing in neutral spine

Exercise instruction: Cue a contraction of the lumbopelvic local stabilisers. The patient steps forward with one foot landing heel first and allowing the heel of the back foot to come off the ground so that weight bearing is performed through the ball of the back foot. Ask patient to bend both knees so that the body drops down between the legs, while keeping the weight equally distributed between both legs. The front knee should be vertically in line with the ankle joint as the knee bends [8, 12].

5. Step up [See image]

Patient position: Standing in neutral spine in front of a step.

Exercise instruction: Cue a co contraction of the lumbopelvic local stabilisers. The patient steps with one foot, landing heel first and then transfer the body weight forward to perform the full step up. The other leg lifts from the ground and is then brought forward into hip and knee flexion to stimulate stepping up onto another step [8, 12].

6. Step down [See image]

Patient position: Standing in neutral spine.

Exercise instruction: Cue a co contraction of lumbopelvic local stabilisers. The patient lifts one foot off the step and then bends the weight bearing hip, knee and ankle to lower the foot to the ground, The ball of the foot should contact the ground first, then the rest of the feet together on the floor, then stepping back up on the step. The exercise is repeated on other leg [8, 12].

Outcome measures

Functional Movement Screening Scale (ICC – 95%)

Reliability

Multiple studies have demonstrated excellent reliability of the FMS screen [46]. A recent study by Teyhen *et al* [46] revealed that among novice raters, the FMS demonstrated moderate to good inter-rater and intra-rater reliability, even with minimal training (4 hours).

Validity

Although there is preliminary research by Kiesel *et al* [50] that suggests that NFL (National Football League) players who score <= 14 on the FMS had a positive likelihood ratio of 5.8 to sustain a time-loss injury. There are concerns remaining regarding the validity of the FMS [57]. Moran *et al* [48] suggest that the strength of association between FMS composite scores and subsequent injury does not support its use as an injury prediction tool. Furthermore, Alemany *et al* [49] suggest that pain occurrence may be a stronger indicator of injury risk than a low composite score and provides a simpler method of evaluating injury risk compared to the full FMS.

Data analysis

Data were analysed using Graph pad instat (trial version 3.0632). Paired t-test is used to analyse the difference

between pre and post measurements within the group, and paired t-test is performed to analyse the effectiveness of the functional integration exercises on functional outcome among police recruits. Functional outcome was analysed with the help of Functional movement screening tool. For this purpose, data was collected and the comparison of scores was made between the pre- and post-intervention measurements. The data was entered into an excel spread sheet, tabulated and subjected to statistical analysis. Various statistical measures such as mean, standard deviation (SD) and test of significance were utilized to analyse the data. The results were concluded to be statistically significant if, $p < 0.05$.

Results

Total 53 Participants of age group 18-30 years volunteered to participate in the study and have completed the 4 weeks of program.

Table 1: Demographic Data age wise distribution of subjects in the study

Age wise distribution	18-22yrs	23-26yrs	26-30yrs
No. of Participants	3	22	28

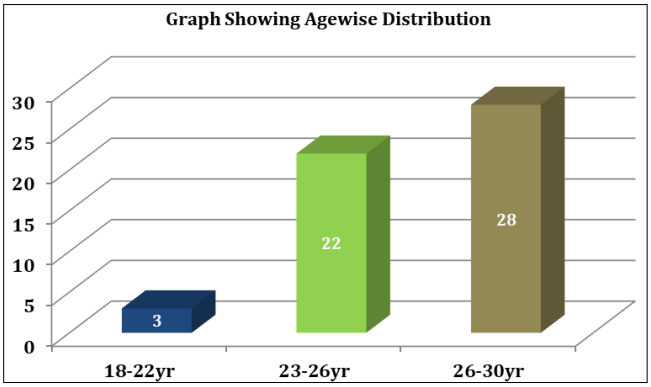

Fig 1: Demographic data

Table 2: Pre and Post treatment scores on functional movement screening tool comparing pre and post treatment scores on outcome measure functional movement screening tool

Parameters	Pre test		Post test		T Value	P value	Result
FMS Tool	Mean	SD	Mean	SD	18.54	<0.0001	Extremely significant
	16.566	±1.976	20.415	±0.691			

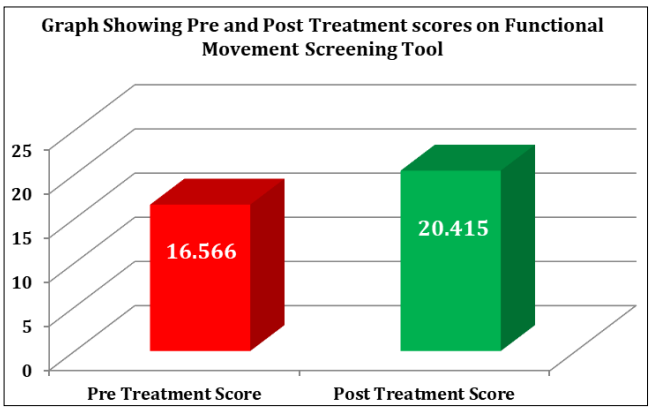

Fig 2: Pre and post treatment scores on functional movement screening tool

Discussion

Functional integration exercise (FIE) is a form of physical therapy that combines elements of manual therapy with exercise. It is designed to improve functional outcomes, such as mobility, strength, and coordination, and has been used to treat a variety of conditions, including musculoskeletal injuries, chronic pain, and neurological conditions.[8]

Functional Integration exercise involve activities that require the ability to maintain neutral spine while moving the trunk on the hips (squatting to sit down), moving the arms on the trunk (driving), or both of these movements simultaneously (lifting) [8].

Weakness and imbalances between mobility and stability commonly affects performance in physical exam of police recruits which can be improved by various functional integration exercises. The present study was undertaken with the intention to compare effectiveness of the functional integration exercise on functional outcome (Functional Movement Screening Tool) among police recruits. Author Diane Lee In their book The pelvic girdle. An approach to the examination and treatment of the lumbopelvic hip region", Third edition stated that; the global system of muscles is essentially an integrated sling system, comprised of several muscles, which produces forces. Coordination between local and global system ensures stability without rigidity of postures and without episodes of collapse. Functional integration is useful in loss of global orientation which requires specific cueing and attention to the muscles of global slings [8, 12].

Certain activities may require more stability and mobility such as Running, throw ball, Shot put. These different functional conditions illustrate that both dynamic and static control of the spine need to be trained, in both the neutral and non-neutral position of the spine, in this study I have included Functional integration exercises such as wall squats, step forward, step backward, lunges, step up, step down-the Pelvic Girdle-An approach to the examination and treatment of the lumbopelvic hip region: Diane Lee, Paul Hodges. 3rd Edition [8, 12].

Certain activities may require more stability and mobility such as Running, throw ball, Shot put due to these activities there is risk of injury. These different functional conditions illustrate that both static and dynamic control of the spine need to be trained in both neutral and non-neutral position of the spine. In order to facilitate the automatic and tonic function of the local stabilizing muscles, it is important to include functional integration exercises in the training program as early as possible.

Depending on the patients level we chose an appropriate way to teach them how to hold cue contraction of core muscles for example patients who are unable to hold cue contraction of core muscles for those patients we start teaching core contraction and we trained them in maintaining contraction of core muscles and Later on we add the exercise with cue contraction.

In this study the functional integration exercises proved to be effective for improving balance between the stability and mobility and also effective in core strengthening for a period of 4 weeks.

A study by Sheetal Bamhane, Abhijit Satralkar, Gauri Kulkarni (2017) "Functional integration and stability of Hypermobile Sacroiliac joint stated that Global muscle stabilization and functional integration showed significant

effect on active SLR test and functional outcome(Oswestry Low back Pain Questionnaire, Pelvic Girdle Questionnaire) while treating hypermobile SI Joint in young females" shows similar results [12].

Another study by Diane Lee (2004) "The pelvic girdle. An approach to the examination and treatment of the lumbopelvic hip region", Third edition stated that; the global system of muscles is essentially an integrated sling system, comprised of several muscles, which produces forces. Coordination between local and global system ensures stability without rigidity of postures and without episodes of collapse. Functional Integration is useful in loss of global orientation which requires specific cueing and attention to the muscles of global slings [8].

Conclusion

- In this study, pre-treatment assessment and post treatment assessment showed significant results on Functional movement screening tool.
- The functional integration exercises proved to be effective for improving balance between the stability and mobility and also effective in core strengthening for a period of 4 weeks
- Hence, we are accepting alternate hypothesis which states that there was a significant effect of functional integration exercises on functional outcome among police recruits in Maharashtra state over the period of 4 weeks.

Limitations

- Lack of control groups which makes it difficult to determine if the observed changes are a result of the exercises or due to other factors such as motivation, self-efficacy, and physical activity levels.
- There is lot of diversity of the sample because police recruits in Maharashtra come from a wide range of backgrounds, including different levels of fitness and previous physical activity experience. This makes it difficult to determine the generalizability of the results to other populations.

Future scope

- Similar samples can be followed for longer duration to see long lasting effect of intervention.
- It can be further studied on combining functional integration exercises with other interventions, such as strength training or endurance training, to optimize functional outcomes.
- It can be further studied on comparison with other traditional methods such as obstacle courses or physical fitness tests, in preparing police recruits for the demands of the job.
- It can be further studied to explore the health benefits of functional integration exercises among police recruits, including injury prevention, improved cardiovascular health, and stress reduction.

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