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A Study to Find Out Effect of Trunk Training Exercises on Trunk Control by using Swiss Ball in Parkinson's Patients: An Experimental Study

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Abstract

Background: The trunk being central key point of body, proximal trunk control is a pre-requisite for distal limb movement control, balance and functional activities. Sufficient trunk stability and control of trunk movements are essential for postural stability and normal gait as the upper body constitutes two thirds of the total body weight. In Parkinson's disease approximately 13% to 33% of patients present with postural instability as their initial Motor symptom. So, purpose of this study was to compare the effect of Swiss ball trunk training exercise and trunk exercise on a bed for trunk control in Parkinson's patients.

Method: Total 30 Parkinson's patient were selected for the study as per selection criteria and divided into two groups (15 in each group). group A was treated with trunk exercise on Swiss ball and group B was treated with trunk exercise on bed. each subject received treatment for 3 weeks,4 days/week. An assessment was done prior to treatment and after 3 weeks using Trunk Impairment Scale test. Inter-group analysis by unpaired t-test showed statistically significant improvement on Trunk Impairment Scale. (P value ≤0.05)

Conclusion: The Swiss ball trunk training exercise and trunk exercise on a bed had a significant effect on trunk control. Out of the two treatment Swiss ball trunk training had a more significant effect on improving trunk control.

Keywords: Parkinson's patient, Swiss Ball, Trunk Control, Trunk Training Exercise, Trunk Impairment Scale

Introduction

Parkinson's disease (PD) is a progressive disorder of the CNS with both motor and non-motor symptoms. Motor symptoms include the cardinal features of rigidity, bradykinesia, tremor and in later stages postural instability.

Early symptoms can include loss of sense of smell, constipation, sleep behavior disorder, mood disorder, Orthostatic hypotension cognitive problems.[1] Onset is insidious with slow rate of progression. As might be suspected from the review of functional physiology of the basal ganglia, the postural abnormalities include an assumption of a flexed posture. A lack of equilibrium reactions, especially of the labyrinthine equilibrium reactions, and a decrease in trunk rotation.[2] Disruption in daily function roles and activities and depressionis common in individuals with PD.[1]

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The average age of onset is 50 to 60 years.[1] Incidence increases with advancing age, and men generally have an increased age-adjusted prevalence that persists across ethnicities compared with women.[2] The Population of elderly Indians has increased from 5.6%(51 million) in 1961 to 7.1% (71 million) in 2001.PD was more prevalent in rural (41/105) than urban (14/10^5) population and was commoner among men.

The pathology of of Parkinson's disease consists of a decrease in the dopamine(DA) stores of the substantia nigra with a consequent depigmentation of this structure and the presence of lewybodies. The loss of DA from the substantia nigra leads to alterations in both the direct and indirect pathways of the basal ganglia, resulting in a decrease in excitatory thalamic input to the cortex and perhaps a decrease in the inhibitory surround that leads to the symptoms of Parkinson disease.[4]

Rigidity is one of the clinical hallmarks of Parkinson's disease and is defined as increased resistance to passive motion. Patients frequently complain of "heaviness" and "stiffness" of their limbs. It is felt uniformly in both agonist and antagonist muscles and in movements in both directions.

Tremor is the initial symptoms of Parkinson's disease in about 70 % of patient. It is an involuntary oscillation of a body part occurring at slow frequency of 4 to 7Hz.[2] Bradykinesia is one of the most disabling symptoms of Parkinson's disease, with prolong movement and reaction times resulting in increased time on task and dependence in daily activities.[1] The interaction between sensory, cognitive and motor systems is very important in Parkinson's disease patients. The disease can disrupt all these systems and, consequently increase the risk of falls.[5] Individuals with Parkinson disease demonstrate impaired trunk stability. They tend to respond to instability with an abnormal pattern of muscle co-activation resulting in a rigid body, an inability to utilize normal postural synergies and difficulty in regulating feed-forward, anticipatory adjustments of postural muscles during voluntary movements.[1] Sensorimotor integration is impaired as evidenced by difficulty in adapting movement strategies to changing sensory conditions. Visuospatial impairment has been identified in patients with advanced Parkinson's disease and correlates with lowers cores in mobility.[1]

As the disease advances patients show axial rigidity. decreased muscle force production, loss of available ROM and muscle weakness[1] Extensor muscles of the trunk demonstrate greater weakness than the flexor group contributing to the adaptation of a flexed, stooped posture with increased flexion of the neck, trunk, hips, and knees.[1] This results in a significant change in the center-of-alignment position, placing the individual at the forward limits of stability.[1] Patients with Parkinson's disease often have difficulty turning around, not only while lying recumbent in bed, but also while standing upright.[5] Stooped posture is a destabilizing posture.[6] Subjects also demonstrate difficulty in maintaining feed forward anticipatory adjustments.

Recently, to improve the trunk balance the physiotherapists studied using the Swiss ball. These balls were originally used in the 1960 by Swiss physiotherapists (hence the name Swiss ball) to help the children with cerebral palsy improve their physical skills, including balance. Swiss ball is very much effective in the static and dynamic strengthening of the joint and spinal mobility, cardiovascular fitness through low impact aerobics, facilitating postural correction at an unconscious level increasing proprioception and kinesthesia, midline orientation and dynamic trunk control, neuro motor learning and coordination, to develop anti-gravity posture (tonic tone). [7]

In 1995 Berg K et al, found the reliability of Balance scale (0.98 (95% CI 0.97 to 0.99). Relative inter-rater reliability was also high (95% CI 0.96 to 0.98). In BBS, a subject is assessed with 5 point ordinal scale ranging from 0 to 4 with higher scores awarded on the basis of speed, stability or degree of assistance required for completion of the task. The task scores are summed to give a total BBS score out of a possible 56 points with higher scores representing better balance.[8]

The Mini-Mental State Examination (MMSE) was developed by Folstein et al. in 19758. Administration by a trained interviewer takes approximately 10 minutes. The test yields a total score of 30 and provides a picture of the subject's present cognitive performance based on direct observation of completion of test 10 items/tasks.[9]

Materials and Method

- Study Setting: Shri K.K Sheth Physiotherapy College, Rajkot
- Source of Data collection: Physiotherapy Center in and around Rajkot
- Study Population: Patients with Parkinson's Disease
- Sampling Method: Purposive random sampling
- Sample Size: 30 Parkinson's patients
- Study Duration: 3Week (4 sessions/week)
- Study Design: An Interventional Study

Inclusion Criteria

- Age: 50-80 Years[1]
- Male and Female Both[1]
- Patients are Clinical Diagnosed as Parkinson's Disease
- Berg Balance Scale Score >25[10]
- Willingness of the patients to participate in the study.
- Intake of Anti-Parkinsonian Medication
- Patients with normal cognitive function (MMSE > 23)[1]

Exclusion Criteria

- Wheel Chair or Bed -Ridden Patients
- History of Cardiovascular Diseases and Head Trauma or Other Neurological Problems e.g. stroke
- Patient with History of Recent Surgery and Musculoskeletal Injury
- Hemodynamically Unstable Patient

Materials used

Pen

Paper

Pillow

Swiss Ball

Mat

Watch

Chair

Plinth

Stool

Consent form

Berg balance scale

Trunk impairment scale

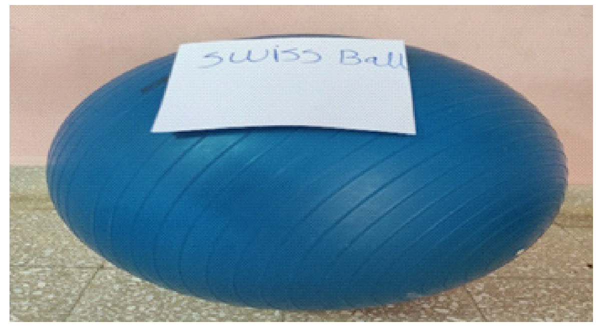

Figure 1. Materials Used

Outcome Measure

TRUNK IMPAIRMENT SCALE

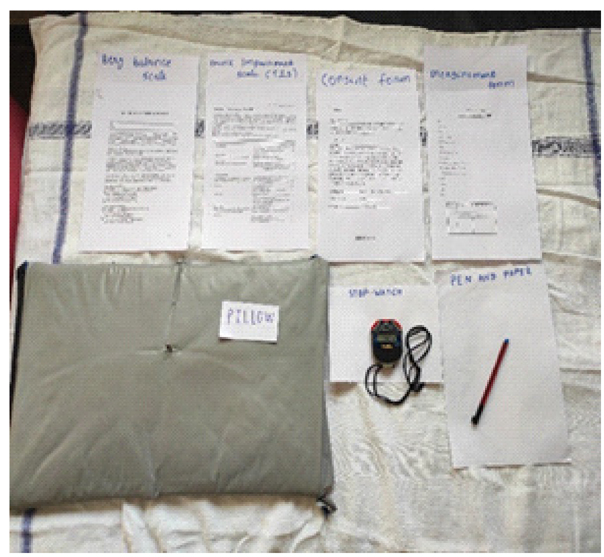

Figure 2. Swiss ball

The TIS was developed by verheyden et al. and aims to evaluate the trunk in patients who have suffered a stroke. The TIS assesses static and dynamic sitting balance and trunk coordination in a sitting position. For each item, a 2-, 3-or 4-point ordinal scale is used. The total score for TIS ranges between 0 for a minimal performance to 23 for a perfect performance. TIS Intra-observer and inter-observerreliability is high. Test/retest and inter-observer reliability for the TIS total score (ICC)-0.96 and 0.99, respectively[1]

Table 1: (GROUP A): Trunk Exercises on Swiss Ball with Conventional Therapy

EXERCISE	PROCEDURE
In supine lying 1. Pelvic bridging	In supine lying both the patient's legs were placed on a Swiss ball and asked to lift the pelvis off the support surface.
2. Unilateral bridging	It was performed by lifting the uninvolved leg off the Swiss ball while maintaining the pelvic bridge position
3. Trunk rotation	It was performed by placing the both legs on the Swiss ball and asked to move the Swiss ball to both the left and the right by rotating the pelvis.
In sitting 1. Static sitting balance	the patient was seated on the Swiss ball with hips and knee bent at 90 degrees and the feet kept flat on the support surface
2. Trunk flexion-extension	The patient flexes and extends the trunk on a Swiss ball.
3. Trunk lateral flexion	Upper trunk lateral flexion: It was executed by initiating movement from the shoulder girdle so as to bring the elbow towards the Swiss ball
4. Trunk rotation	It Was performed by moving each shoulder forwards and backwards on Swiss ball
5. Forward reach	It was performed by asking the patient to reach a fixed point at shoulder height by forward flexing the trunk at the hips on a Swiss ball.
6. Lateral reach	It was performed by asking the patient to reach out for a fixed point at shoulder height to elongate the trunk on the weight-bearing side and shorten the trunk on the non-weight-bearing side on a Swiss ball
7. Perturbations	The patient was in sitting position on the Swiss ball and the therapist gave perturbations in all directions

Group B: Trunk exercises on bed with conventional therapy

- Same Exercises as on Group A were performed in plinth.
- In both group conventional therapy was given.
- The intervention was performed for 45 min in 1 day for 4 days in a week, which was continued for subsequent 3 weeks.

Results and Discussion

Data was analysed by SPSS Software Version 20.0 And Microsoft Excel 2010. Prior To The Statistical Test, Data Was Screened for Normal Distribution by Shapiro-Wilk Test. According to Normal Distribution, Tests Were Applied for Within Group and Between Group Analysis. Here the difference of pre-test and post-test was taken and between group comparison of TIS showed statistically significant difference.

Table 2: Inter Group Comparision of TIS Score in Patients with Parkinson's Disease in Group a and Group B.

TIS Score	Mean	SD	Unpaired 't' test t value	P value	Result
Group A	3.7333	±0.96115	3.316	0.003	Significant
Group B	2.6000	±0.91026			

Here the difference of pre-test and post-test was taken and between group comparison of TIS showed statistically significant difference. Thus, the result of the present study rejects the null hypothesis and supports the experimental hypothesis which stated ($p<0.05$) that, there is an individually both trunk exercise on Swiss ball and trunk exercise on the bed was effective in improving trunk control. But when the comparison was done between them it was found that trunk exercise on a Swiss ball is more statistically effective in improvement of trunk control than bed exercise in Parkinson's patients. A study by **Nayak et al (2012) found the** better Trunk stabilization training on unstable surfaces activated the postural muscle around.

The first objective of the study was **S. Felix Renald, J. Raja Regan found** the group which performed trunk exercise on a bed which showed a change in dynamic sitting balance and not in coordination subscale, but trunk exercises on a Swiss ball showed significant change in both Dynamic Sitting balance and Coordination subscales in Trunk Impairment Scale. The change in trunk coordination subscale in the Swiss ball training group may be due to training on the unstable surface which may result in better recruitment of trunk muscles.

Trunk control improvement in Swiss ball group may be as the movement of Swiss ball under the patients provided a postural perturbation to which the trunk muscle responds reactively to maintain the desired postural stability.

In the biomechanical aspect the weight is shifted in any plane, the trunk responds with a movement to counteract the change in the centre of gravity training on Swiss ball as a change in the surface stability may influence trunk muscle activity and also influences anticipatory postural adjustment and trunk performance.[12]

Improved weight shifting ability through rotations also can enhance trunk muscle stability and balance. Improved lower trunk control effectively stabilizes the pelvis, which can lead to improved mobility and balance in the Swiss ball group. The bouncing and rocking movement on a Swiss ball increases alertness by connecting the vestibular system with reticular formation. The exercises on the Swiss ball restore the function of movement and equilibrium and it encourages the patient's participation and also makes the use of affected muscle easy. The unstable surface of the Swiss ball reduces the chances of repetitive stress on muscles. This could be a possible reason for better improvements found in the Swiss ball group.[10]

The current study supports that individually both trunk exercise on Swiss ball and trunk exercise on the bed was effective in improving trunk control. But when the comparison was done between them it was found that trunk exercise on a Swiss ball is more statistically effective in improvement of trunk control than bed exercise in Parkinson's patients.

Conclusion

From the result of the present study, it can be concluded that the Swiss ball trunk training exercise and trunk exercise on a bed had a significant effect on trunk control. Moreover, out of the two treatment Swiss ball trunk training had a more significant effect on improving trunk control.

Limitations of the study

- Gender inequality in this study.
- The duration of the disease was not homogenous
- Hoehn & Yahr Parkinson disease stage not consider.

Ethical Clearance: Ethical clearance was obtained from Shri k.ksheth Physiotherapy College, RAJKOT

Source of Funding: Self

Conflict of Interest: Nil

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Case Study

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Progress Monitoring Tool for Patient Suffering From OA Knee: Fitknees-Wearbale Sensor and Fitmust (Hand-Held Dynamometer): A Case Study

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Abstract

Background: OA risk rises significantly with age and is incredibly uncommon in anyone under the age of 30. Female sex, obesity, past joint damage (such as an ankle fracture or knee ligament rupture), atypical joint anatomy, and having family members with OA all raise the risk of getting the condition. It has now become necessary to monitor the progress of the individual with the treatment given.

Aim: To track the progression of the ailment using unique fitness and Fitmust devices.

Objective: To find out the percentage of progress the participant did in each of the parameters, to find any co-relation within the parameters.

Results: Wearables and a handheld dynamometer were used to calculate and significant findings were seen over the course of four months in addition to physiotherapy activities.

Conclusion: Wearables and artificial intelligence have made it simple for patients and therapists to monitor progress and recovery.

Keywords: OA knee, wearable sensors, artificial intelligence, progress monitoring

Introduction

Osteoarthritis is the most common degenerative disease, affecting About 16% of the global population. India has a higher prevalence of about 20-24%.[1](the definition of OA). OA risk rises significantly with age and is incredibly uncommon in anyone under the age of 30. Female sex, obesity, past joint damage (such as an ankle fracture or knee ligament rupture), atypical joint anatomy, and having family members with OA all raise the risk of getting the condition. Osteoarthritis (OA) has profound structural and functional implications for the affected joints. It involves cartilage degeneration, leading to increased friction, bone changes, and potential synovial membrane inflammation. Ligaments and tendons around the joint may also be affected[2]. Functionally, OA results in pain, stiffness, reduced range of motion, muscle weakness, and joint instability. These symptoms can significantly impair daily activities, such as walking and gripping objects, and may lead to

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secondary effects on other body parts, such as altered gait. Managing OA involves a multidisciplinary approach, combining medical treatments, physical therapy, lifestyle modifications, and assistive devices to alleviate pain, improve joint function, and enhance overall well-being, emphasizing early intervention for better outcomes.

Several tests are carried out to evaluate a patient's musculoskeletal health and functional capabilities thoroughly. First, the flexion and extension angles of the knee joint are measured, and if they fall within or surpass the normative range, the range of motion is deemed satisfactory. Setting a target angle that the patient can actively reach, closing their eyes, and assessing for any deviations from the target angle are the steps in the evaluation of proprioception. The acceptable error angle is within or below the normative range. With both eyes open and closed, static balance is assessed, and a longer time spent on a single leg suggests better health. The Timed Up and Go (TUG) test evaluates dynamic balance, and a longer period indicates a higher risk of falling. Gait is examined, and for it to be deemed normal, each measure must fall within the normative range. Muscle strength can also be assessed with a hand-held dynamometer; if it meets or surpasses normative levels, it is deemed satisfactory. When taken as a whole, these tests offer useful information on a patient's functional ability and musculoskeletal health.

Patient History and Observation

While walking, a 53-year-old woman, who had grappled with knee pain for the previous 16 years, experienced an unusual twist in her left leg, resulting in the onset of pain accompanied by swelling. Since the age of 25, she had also been enduring cervical pain. The cervical pain began mildly but eventually escalated to the point where she had to spend approximately 2.5 months in the hospital. The 20 kg of traction around her neck was secured. In a fall in 2012 that left her on her back, she suffered a broken tailbone. To address these issues, movement therapy was implemented. Her knee discomfort resurfaced in the current year and worsened. While walking up a slope, she injured her right foot, and upon seeking medical attention for the discomfort in her right knee, it was determined that she had torn her meniscus. Her agony had spread from knee to toe, and she was unable to stand for extended periods. She rated her pain as 4 on the NPRS. Descending stairs became more challenging for her. There was an ongoing throbbing ache and stiffness in the morning. She had recently received an osteopenia diagnosis and was undergoing physiotherapy treatment for the aforementioned issues.

Method

Knee testing with fitknees.

To monitor range of motion (flexion and extension),

Measuring flexion and extension angle of knee

The test is considered to be good if the range of motion is within the normative or more

To monitor proprioception

Initially setting the target angle the range till which the patient can perform it actively

Then asking to close eyes and to achieve the range set for the target angle and look for if there is any deviations.

The test to consider the error angle should be within the normative or less

The achieved angle should be near to the target angle.

To monitor static balance

Patient has to perform the test with eyes open and eyes closed and we have to look for the sway

With eyes open and closed the more time taken on single leg the condition is considered to be good

To monitor dynamic balance

Patient has to perform TUG test the more the time taken the more is the risk of fall

To monitor gait

All the parameters should be within in normative range if less than considerate to be abnormal. muscle strength testing withfitmust.

To monitor muscle strength with the help of hand-held dynamometer

The muscle strength should be within the normative or more.[3]

Monitor progress after every months.

- First report was monitored in month JANUARY
- Second report was monitored in month APRIL
- Third report was monitored in month May
- Fourth report was monitored in month AUGUST

INVESTIGATIONS:

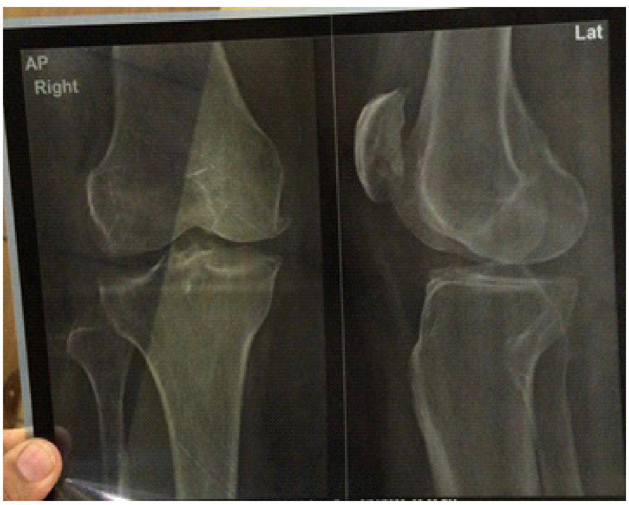

Fig 1: Right Knee X-Ray with Anterio-Posterior View & Lateral View

Fig 2: Bone Mineral Density Report

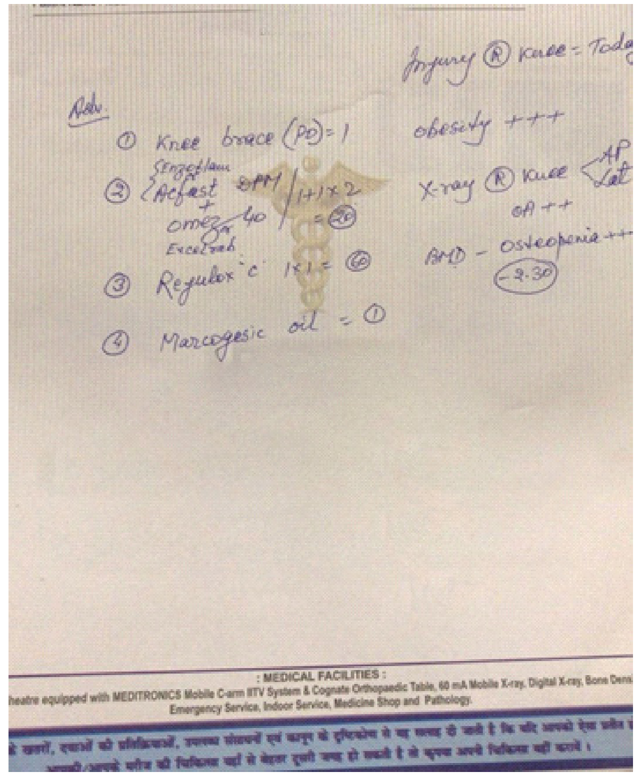

Fig 3: Drugs Investigations

PHYSIOTHERAPY TREATMENT

- Mobilization
- 180* Hip flexion with theraband - black theraband - right leg

  Red theraband - left leg

- Hip Abduction 10 reps 3 sets
- Cobra pose
- Bridging

Results

The chart shown below progress monitored by the wearable technology for particular months and also all the components that are calculated.

			FITKNEES			

Range of motion	**Normative**	**Report 1**		**Report 2**		**Report 3**		**Report 4**	
Active Flexion		**Left**	**Right**	**Left**	**Right**	**Left**	**Right**	**Left**	**Right**
	>= 125*	140	130	117	132	135	100	125	123
Active Extension	0*	23	4.1	9.8	12.1	4.4	10.8	5.6	3
Passive Extension	0*	4.9	2.9	0	0	4.4	6.7	0.9	0.3
Total of ROM	0-125*	4.9-140	2.9-130	0-117	0-132	4.4-135	6.7-100	4.7-125	2.7-123
Active proprioception	Error angle	-	-						
	5+-	-	-	1.3	-1	5.3	6.7	0.3	0.3
	target angle / achieved	-	-	53/61	50/54	4./55.5	48/57.6	48/5.6	47.7/5.4
Static balance	with eyes open								
	24.2+-9.3	6	8	-	-	4	0	9	5
Dynamic balance (TUG)	without support								
	7.9+-0.9	7.53		20.19		4.8		8.6	
Gait Analysis									
stride time (sec)	1.1+-0.09	1.2	1.3	1.08	1.37	1.31	1.27	1.2	1.1
stance time (sec)	0.65+-0.07	0.4	0.7	0.78	0.92	0.86	0.92	0.79	0.75
swing time (sec)	0.044+-0.05	0.8	0.6	0.3	0.45	0.45	0.35	0.42	0.35
stance phase (%)	58.98+-1.97	66.7	53.8	71.9	67.4	65.4	72.35	65.42	68.23
swing phase (%)	40.03+-3.56	33.3	46.2	28.1	32.6	34.6	27.65	34.58	31.78
stride length (meter)	1.35+-0.11	1.4	1.3	1.01	0.95	1.24	1.35	1.16	0.97
step length (meter)	80+-10	0.6	0.7	0.46	0.5	0.59	0.64	0.57	0.53
mean velocity (m/sec)	1.2+-0.2	1.1		0.8		1		1	
cadence (step/min)	114+-4.2	96		107		106.8		107	
Oxford pain score									
	48	29		21		--		27	
	<=20%	39.58		56.25		--		43.75	
			FITMUST						
			JANUARY		AUGUST				
MUSCLES	NORMATIVE		LEFT	RIGHT	LEFT				
	DOMINANT	NON-DOMINANT							
Quadriceps	33.4+-10.2	32.5+-10	14.1	14.1	10.67	27.2			
Hamstring	19.3+-5.6	18.9+-5.6	10.6	18.5	10.63	13.1			

A thorough evaluation of several elements pertaining to knee functionality and health may be found in the Fitknees table.

Range of Motion: For both the left and right legs, several reports are used to evaluate the active flexion and extension of the knees. The numbers indicate changes in the knees' range of motion and flexibility over time.

Active Proprioception: Target/achieved angles and error angles are used to assess proprioception, or the knowledge of one's own bodily position. The subject's ability to correctly detect where their knees are is measured, and differences between cases are noted.

Static and Dynamic Balance: Static balance refers to the capacity to remain stable in a still position and is measured with eyes open. Dynamic balance is measured using the Timed Up and Go (TUG) test, which reveals differences in performance by displaying how long a task takes to finish on its own.

Gait analysis :Metrics including stride time, stance time, swing time, stride length, step length, mean velocity, and cadence are included in the thorough gait analysis that is provided. These characteristics provide a thorough grasp of the person's gait and pace

Oxford Pain Score: The Oxford Pain Score is used to measure pain, and its values represent the level of discomfort felt. A person's pain management is shown by noting changes in their pain scores over time.

Fitmust (muscle strength):Strengthening your muscles, especially your hamstrings and quadriceps, is the main goal of the Fitmust segment. The subject's left and right limb strength assessments for both dominant and non-dominant limbs are compared to normative values at two distinct time points, January and August. This comparison aids in monitoring alterations in muscle strength over time and draws attention to any possible weak points or areas of concern in the knee-supporting muscles.

Discussion

In the evolving landscape of knee rehabilitation, the integration of wearables and handheld dynamometers has emerged as a transformative approach for progress monitoring. This enables healthcare professionals to assess gait patterns and joint angles, fostering personalized interventions and enhancing patient engagement through gamification features. Handheld dynamometers contribute to muscle strength assessment, functional testing, and tracking progress over time, allowing for targeted rehabilitation interventions and program optimization.6Challenges include addressing data security, integrating with electronic health records, standardizing protocols, and addressing cost and accessibility concerns. As these technologies advance, collaborative efforts between researchers, healthcare providers, and technology developers will further optimize the role of wearables and handheld dynamometers, ultimately improving outcomes for knee patients.

Ethical clearance: Ethical clearance obtained from ST. John's National Academy of Health sciences

Source of funding: self

Conflict of interest: nil

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Original Research

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Reliability of the Hand-Eye Coordination Test among Adults Using a Software: A Longitudinal Follow-up Study

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Abstract

This study aims to determine the reliability of the hand-eye coordination Software. The integrated control of hand and eye movements, as well as the processing of visual information to support attainment and acquisition and the use of hand proprioception to guide the eyes, are known as hand-eye coordination. Thus, this study aims to determine the reliability of the tests, so the research was conducted thrice with an interval of 6-7 days (test-retest). 28 Young Adults (18- 35 years of age) have participated in the study. The analysis includes finger-pointing tasks performed only with the use of Hand-eye coordination software prepared by the Software engineer. In this Software, Visual targets in the form of a ball then appeared on the screen on the left, on the right, or in the center in random order., and participants were asked to point an index finger of the leading hand as rapidly and precisely as possible at all targets on the screen. After touching the target (indicated by its disappearance), the participant immediately placed his/her hand back in the designated starting position (touchpad).Each participant was required to repeat this finger-pointing task. The accuracy value after 1 minute was recorded and the average accuracy value was calculated and used in the analysis A smaller value indicates greater touch accuracy. In addition, the average reaction time (in milliseconds) was also measured. Based on the data analysis, the reliability score is 0.806 (Cronbach's Alpha), which indicates a high level of internal Consistency.

Keywords: Hand-eye Coordination, Software, Reliability, Young Adults.

Introduction

Eye-hand coordination is an essential perceptual-motor capability that enables goal-directed motions in daily living, such as reaching for and handling items. "The ability to produce a controlled, accurate, and rapid movement" is the definition of motor coordination. Specifically, in many related ADLs, fluid motor coordination is a necessary precondition for sufficient UE performance. Proprioceptive information regarding the current angles of the head, neck, trunk, and arm joints as well as the corresponding muscular activity of these joints is also necessary for accurate arm movements in addition to visual data.[1]

Eye-hand coordination the coordinated use of the arms, hands, and fingers allows one to perform goal-

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directed hand movements. [2] Eye-hand coordination (EHC) is an important visual motor function that facilitates goal-directed use of the hand in daily life. for example, reaching for objects and grasping. It requires the integrated use of eyes (visual afference), arms, hands, and fingers to produce controlled, accurate, and rapid movements.[3]

Normal eye-hand coordination includes the synergistic capability of a few sensorimotor systems, including the visual systems, vestibular systems, proprioception, and the eye, head, and arm control systems, in addition to parts of cognition like attention and memory. Eye-hand coordination is the sum of its parts, this makes understanding the brain's basis of it quite challenging. However, eye-hand coordination is still more than this; it also raises combinatorial problems that do not appear when we examine the isolated instances of individual component systems. But ultimately, the goal of the system of eye-hand coordination is simple: using vision to direct hand movements (reaching, grasping, and manipulation). To maximize vision-for-action, this review will concentrate on the spatial aspects of how vision is converted into hand motion within the context of a system in which the eyes (and head) are also moving constantly. [4]

Eye-hand coordination Software was made by finger-pointing at stationary signals that occurcentrally and contralaterally to the pointing hand, indicating the degree of physical activity Also, while the visual target was moving, the practitioners; accuracy increased considerably.[1]. When combining the use of the hands and eyes to make motions, eye-hand coordination refers to a practical and effective movement in which the hand controls the applied force and the eyes serve as a sense of sight to perceive height, size, distance, andtargets.[5] Then according to[6], hand-eye coordination is important in the overall physical development of movements, such as throwing, and hitting, skills that require good hand-eye coordination. Coordination is atherapeutic center with experience to work effectively and everything that happens on the field during the game. Visual integration is a systematic process the process of processing information received visually is directed to guide to complete the given task. [7]

Material and Methodology

28 young healthy Adults between the age group 18-35 were randomly selected from the Physiotherapy department after taking informed Consent in this Longitudinal follow-up study. The objective of the study is to determine the reliability of the hand-eye coordination Software. To point as rapidly and precisely as possible, participants were instructed to use the index finger of their dominant hand. A visual signal that appears on a vertical display unit, from a fixed starting position on a desk.[1] A finger-pointing task was used to evaluate hand-eye coordination objectively. To ensure that the upper edge of the visual display unit was at eye level, eachparticipant sat in a chair.

The hips, knees, and ankles were at 90degreesof flexion with both feet flat on the floor or aplat form. The dominant hand of the participant had been placed on a touchpad that was approximately ten centimeters from the touch screen at the beginning of the test. Visual targets in the form of a ball then appeared on the screen on the left, on the right, or in the center in random order. Participants were asked to point an index finger of the leading hand as rapidly and precisely as possible at all targets on the screen. After touching the target (indicated by its disappearance), the participant immediately placed his/her hand back in the designated starting position (touchpad). Each participant was required to repeat this finger-pointing task Accuracy was defined as the absolute value of the deviation (linear distance) of the participant's touch location from the center of the visual target (a ball). The accuracy value was calculated and used in the analysis. A smaller value indicates greater touch accuracy. In addition, the average reaction time (in milliseconds).[3]The study was conducted thrice with an interval of 6-7 days (test-retest), and a total of 3 sessions (S1, S2, and S3) were conducted. S1 and S2 session was conducted by the same invigilator and S2 was conducted by a different Invigilator.

Result Analysis

Data was analysed by using SPSS Software. out of 28 adults, 15 were females and 13 were male with a mean age of 23±1.08 SD. From the data analysis, the result revealed that the correlation coefficient value is 0.810 as shown in Table 2 and $P < 0.0001$. so, it is statistically significant.

Table 1: Intraclass Correlation Coefficient

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.585[a]	.377	.760	5.267	27	54	.000
Average Measures	.809[c]	.645	.905	5.267	27	54	.000

Table 2: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.810	.808	3

Discussion

The purpose of this investigation was to determine the reliability of the tests and to provide acceptable reliability for the measurement of an eye-hand coordination task. The reliability test used a test-retest approach. Cronbach's Alpha Score was found to be 0.810 as shown in Table This shows that the reliability of the eye-hand coordination Software is included in the good category, so that the Software can be said to be reliable or can be used in data collection for Hand-eye coordination. A study has found that intraclass correlation coefficients range from 0.68 to 0.71 in adults.[9]

The results of research and development in the form of an eye-hand coordination test software have advantages: (1) Easy to Install and Use (2) it is Computer Friendly as it occupies< 1MB of Space. (3) can be used by coaches to analyse the abilities of Players. (4) this test software can be used at the beginning or before for assessment and improvement purposes.

The weaknesses and advantages of software cannot be avoided in a scientific study. Likewise, in the eye-hand coordination test that has been developed, some of the weaknesses of this software Include: (1) Report generation needs to be done every time after every test. (2) tests using computerized devices aren't practical for clinical scenarios without such equipment. (3) This study is been done among adults, so administering tests via computerized devices to older individuals with cognitive disorders needs to be further tested.

Conclusion

Based on the findings of this study, it can be concluded that the reliability of the hand-eye coordination Software to test Hand-Eye Coordination was 0.810(acceptable).This may provide athletes and practitioners with an effective tool for improving sports performance through increasing eye–hand coordination.

Also, there's a pressing need for further research to design devices that are portable, and mobile-based applications. Additionally, future research should elucidate the hand-eye coordination test responsiveness to clinical changes to establish its utility as a clinically valuable tool.

Conflict of Interest: None

Source of Funding: Self

Ethical Clearance: Yes (Ref No: BITSP/AO/IEC/2302/01)

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Simple Randomised Controlled Trial Comparison of Effect of Suspension Training and Plyometric Training on Dynamic Balance and Vertical Jump in Competitive Basketball Players

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Abstract

Objectives: To assess dynamic balance and vertical jump pre and post Suspension training and Plyometrictraining in competitive basketball players.

Methods: 24 basketball players aged 18-24 were selected and randomly assigned to three groups namely Suspension training, Plyometrics and the control group. Supervised sessions were held for 8 weeks, 2 times a week for 45 minutes. Pre and post assessment for dynamic balance and vertical jump was done.

Results: Suspension training and Plyometric training both have shown a positive effect on dynamic balance ($p < 0.007$) except for anterior direction and vertical jump ($p < 0.007$) in basketball players. The results of the control group have shown a lot of variability as no specific training was given for dynamic balance and vertical jump.

Conclusion: Suspension training and Plyometric training have positive effect on dynamic balance and vertical jump height. However, no training method is found to be more efficient than the other.

Key words: Basketball players, dynamic balance, plyometric training, suspension training, vertical jump height.

Introduction

Coordinative abilities rely on the movement control and regulation processes, which are fundamental in sports. One of the main components of coordinative abilities is balance. This ability is influenced by various factors that are sensory information (from somatosensory, visual and vestibular systems), joint range of motion, and strength (1)

Basketball is a multidirectional sport that involves explosive activities such as sprinting, rapid changes of direction, jumping, abrupt and intense change of direction, frequent commencement and stopping, and contact among players during offence and defence largely dependent on dynamic balance and agility. (2)

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Vertical jump is a functional movement required to basket the ball in the ring. Thus, training an athlete to improve the vertical jump is important along with training an athlete for good balance.

In order to improve athletic performance traditional training methods are being done on different platforms such as Bosu ball, Pilates ball and Thera-band or simple traditional exercises along with core exercises like Yoga, planks, crunches, kegels etc. More recently, the suspension training system Pro Suspension Training System (TRX) has been added to this group of materials(3)

The Suspension training provides foundational movement based training and the instability created through a single anchor point produces a proprioceptive-rich environment which requires a higher level of core activation than stable surfaces. Itenhances stability-endurance, hypertrophy, strength, power, balance, flexibility and coordination/ kinaesthetic awareness within each individual training session.(4)

Plyometrics is a high intensity training technique which uses stretch shortening cycle that utilises the energy stored during the eccentric loading phase and stimulation of the muscle spindles to facilitate maximum power production during the concentric phase of movement. Land based Plyometric programs can be used to achieve positive changes with regard to maximum jump velocity, maximum force, absolute and relative power as well as average power during counter movement jumps(5). Incorporating unilateral and bilateral Plyometric training improves the balance in young athletes. It is stated that balance ability is affected by explosive power.(6)

Need of the study

Balance and vertical jump are critical components in Basketball players. Suspension training and Plyometric training have both found to be effective. Hence, the need of the study is to compare efficacy of suspension training and Plyometric training on dynamic balance and vertical jump.

Methodology

Study design and setting

The trial was a three-group, simple randomised controlled trial in which basketball players playing at different levels were selected from the community, playing at different courts like (tar and synthetic) in Pune.

Participants

Inclusion Criteria:

1. Male, Female healthy Basketball players
2. Age :18-24
3. Playing basketball for at least 4 days/ week under a coach for 2-3 hours.
4. BMI : Ideal for height and weight (18.5-24.9)
5. Strength- Grade 5 by MMT for dynamic strength of Quadriceps, Gluteus maximus, Hamstrings, Gastrocnemius.
6. Good strength by Microfet 3 for static strength of Quadriceps, Gluteus maximus, Hamstrings, Gastrocnemius.

Exclusion Criteria:

1. Spinal problems /pain
2. Congenital problems of lower limb
3. Vestibular involvement
4. Any injury in lower limb

Procedure:

Around 75-80 basketball players were screened for inclusion and exclusion criteria and 24 players aged 18-24 were randomly assigned by simple randomisation with the help of random number generator on Stat trek after taking an informed consent from the participants. The subjects were assigned to 3 training groups namely Suspension training, Plyometric training and the control group respectively on taking a verbal consent and were assessed for dynamic balance by mSEBT and vertical jump by My Jump 2 pre and post training. mSEBT reach distance values were normalized by the limb length of the player. The results were calculated considering anterior, posteromedial and posterolateral reach distances as these directions have found to be reliable and to obtain a concise data. The app was found to be reliable however, reliability of test retest of the app was checked on 10 samples and was found to be 0.96 ICC. Strength was assessed by MMT and objective comparable static strength by Microfet 3. Supervised sessions were conducted for 8 weeks by qualified suspension and athletic trainer, twice a week for 45 minutes excluding warm up and cool down. 10 minutes of warm up prior to the training consisted of 5 minutes jogging, 5 minutes general exercises and stretching. Following training, 10 minutes of cool down was done. Statistical analysis was done using SPSS software version 16.0

Suspension training

TRX-Overhead squats, front squat, squat and hop, squat jump, single leg squat, split squat, step back lunge, balance lunge, crossing balance lunge, step side lunge, power pull, oblique lunge. 3 sets each with 30 seconds exercise time and with 30 seconds rest time.

TRX Over head squats

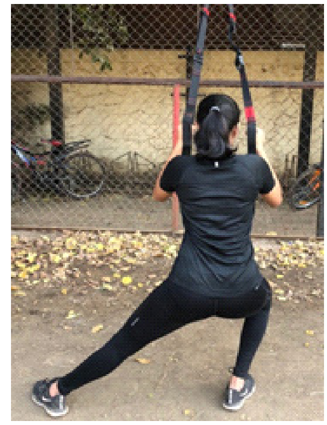
TRX crossing balance lunge

TRX power pull

TRX single leg squat

TRX step back lunge

TRX step side lunge

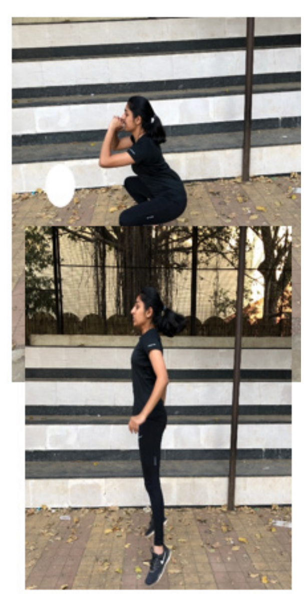


TRX front squat

Plyometric training

Squat jumps, Box jumps, Step lunge, Lunge and hop, German drill, Hop 45 degree and jump, Ice skater, Pogo hops, Tuck jumps, Paused jump squats, Lateral box over jumps, Box over jumps. 3 sets eachwith 30 seconds exercise time and 30 seconds rest time.

Squat jumps



Box jumps

German drill

Ice skater

Tuck jumps

Lunge and hop

Control group

Players in the control group underwent pre assessment and continued their usual exercise regime which consisted of weight training in the gym, regular fitness routine along with basketball training without being trained specifically for dynamic balance and vertical jump.

Outcome measures

In order to decrease the evaluation time, dynamic balance is checked by mSEBT which is consistent and reliable. It involves one leg standing with a highest aim achieved of the other feet in 3 different directions namely anterior, posteromedial and posterolateral(7)

My Jump 2

The CMJ is recorded by the recorder laying prone on the ground with the iphone facing the participant at approximately 1.5 m from the force platform and zooming in on the feet of the participant.

Descriptive statistics:	**AGE**	**BMI**	**GENDER**
Suspension training	20.25 ±2.48	20.32±8.44	4 males, 4 females
Plyometric training	19.87±2.42	20.81±2.23	6 males, 2 females
Control group	19.62±2.34	20.95±1.91	5 males, 3 females

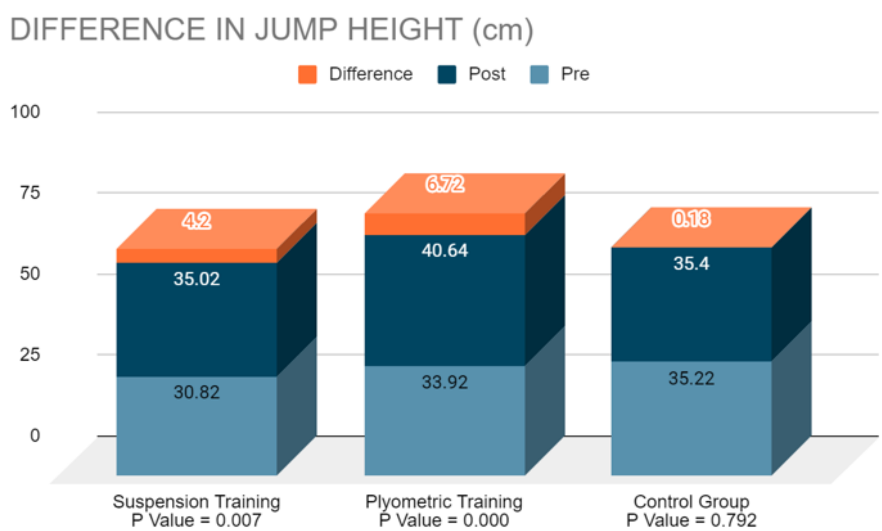
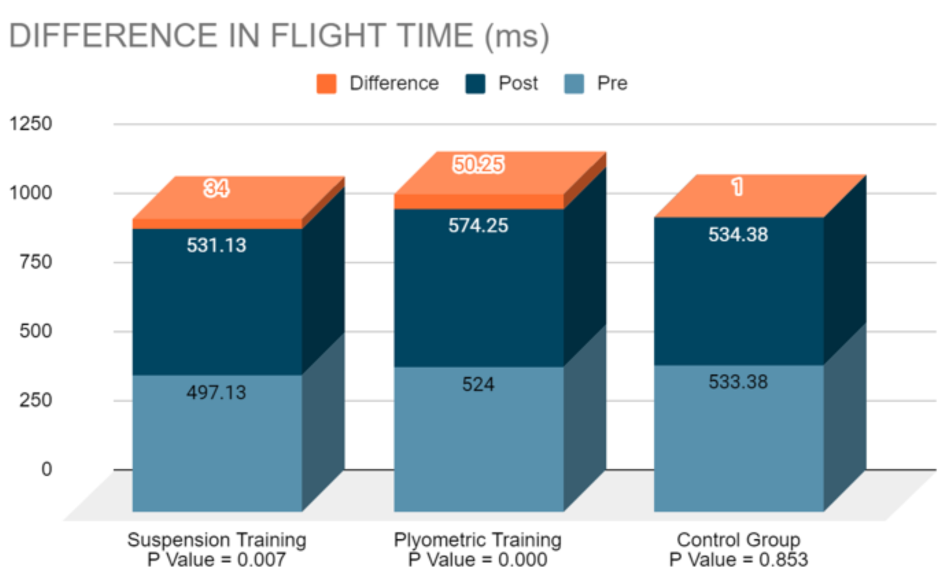


Figure no 1:



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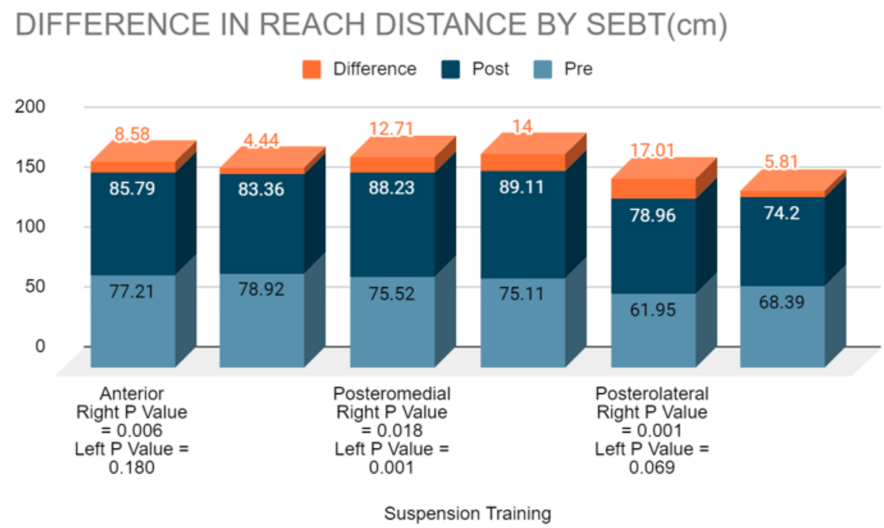

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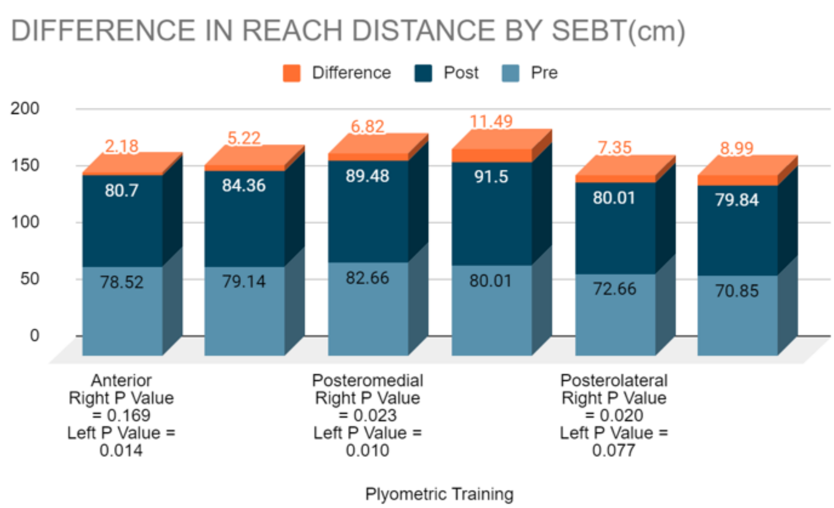

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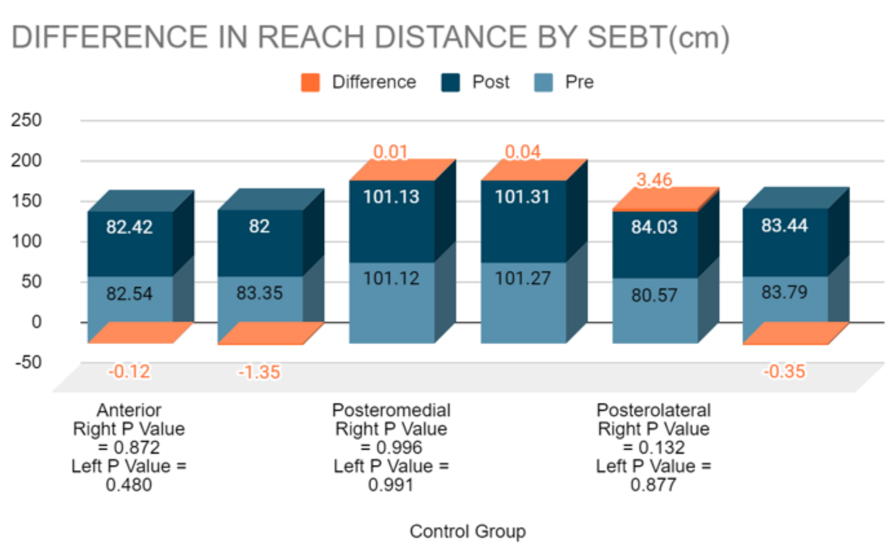

Figure no 5:

Discussion

The purpose of this study was to compare the effect of Suspension training and Plyometric training on dynamic balance and vertical jump in basketball players. 24 competitive basketball players aged 18-24 were included in the study as the pubertal age has passed by and growth changes have already taken place so there is no chance of further development which would affect the results.

The players falling in the normal range of BMI i.e 18.5-24.9 were included as obesity can affect balance and jump significantly.

Muscle strength of Quadriceps, Gluteus maximus, Hamstrings, Gastrocnemius was assessed bilaterally by MMT and MICROFET to have qualitative as well as the quantitative data.

The results of the study indicate that suspension training and Plyometric training both have been found to be effective compared to control group. However, the results of the anterior reach left side and posterolateral reach of left side of by Suspension training and anterior reach of right side and posterolateral of left side by Plyometric training showed difference but are not statistically significant. This result is likely as the study was done on competitive players playing at different levels and not on players playing at the same level so the level of training at each level differs from Elite players to recreational players. According to the study 'Balance ability and athletic performance' by CON HRYSOMALLIS (March, 2011) which was done to compare the balance ability of athletes from different sports; determine if there is a difference in balance ability of athletes at different levels of competition within the same sport; it was found out that balance ability was related to competition level for some sports with the more proficient athletes displaying greater balance ability.[(8)]

The Suspension trainer helps in providing foundational movement based training and the instability created by being partially suspended through a single anchor point produces a proprioceptive-rich environment which requires a higher level of core activation than stable surfaces. It forces the participant to engage the lumbopelvic musculature at all times to maintain proper body alignment and biomechanics which can translate into enhanced core stability both dynamically and statically.

A study by Özgür Nalbant says, Suspension training is also used in the treatment of trunk muscles that hold the spine and hip stable like in core exercises. All these muscles thus work together to keep the body in balance during movement. TRX suspension training studies are among the training priorities in basketball because of the importance of balance (Savaş 2013).

Study by Myer et al. (2006) who stated that the incorporating unilateral and bilateral Plyometric training (PT), improve the balance in young athletes. Salahzadeh et al. (2011) also indicated that using a combination plan (plyometric, technical, balance, and strength) can improve antrerior-posterior balance. It is stated that balance ability is affected by explosive power (Atilgan 2013).It was also stated that there is a significant relation between the given Plyometric training program, balance abilities and somatometric characteristics.

Another study by CON HRYSOMALLIS suggested that addition of balance training component to the activities of recreational active subjects increased vertical jump, agility and shuttle run. Balance training increased rectus femoris activation during jump landing. Greater muscle activation might optimize musculotendinous and joint stiffness reducing the amortization phase in the stretch shortening cycle and subsequently improve performance in eccentric-concentric action such as CMJ.

It has been suggested that peripheral and central neural adaptations and enhancement of neuromuscular factors were induced by Plyometric training, resulting in improved joint position sense and detection of joint motion. Peripheral adaptations that may have occurred because of Plyometric training likely resulted from the repetitive stimulation of the articular mechanoreceptors near the end range of motion (Grigg, 1994). Central adaptation resulting from Plyometric training may also improve proprioception. In conclusion of the study, ' Effects of In-season Plyometric training on sprint and balance performance in basketball players, by Abbas Asadi

,the results of this study highlights the potential of using plyometric training at in-season of competitive phase to improve sprint and dynamic balance.

Jump height and flight time have shown improvements with Plyometric training as well as Suspension training. Research done to compare effect of land and aquatic based plyometric training on jumping ability and agility of young basketball players suggests that this effect is a result of the stretch shortening cycle that utilises the energy stored during the eccentric loading phase and stimulation of the muscle spindles to facilitate maximum power production during the concentric phase of movement (Potach, 2004; Potach & Chu, 2008). Several research findings also show that land based plyometric programs can be used to significantly improve: explosive power (Fatouros et al., 2000; Luebbers et al., 2003); flight time (Fatouros et al.,2000). Thus, it is apparent that plyometric training is a useful training tool for athletes who participate in sport, which require dynamic, explosive types of movement such as basketball. This result was also supported by the study which suggested that a significant difference in standing long jump (SLJ) and vertical jump (VJ) after TRX training is parallel to the strength development of the core, back and leg muscles that contribute to jump performance. It is also an important factor in sports that require speed and explosive strength (Shaver, 1970; Muratlı, 2011).

The control group has shown a lot of variability in balance as well as the jump height and flight time. This variability could be because no training specific to balance and jump was given to the players in this group and were told to continue their regular exercise regime like weight training in the gym, regular fitness routine along with basketball training.

There is a positive effect of suspension training and plyometric training on dynamic balance and vertical jump in competitive basketball players. However, no training method is found to be more efficient than the other. The reason for this can be comparable activation of core muscles and leg as well as back muscles significantly improving explosive power and small sample size.

Clinical implication: To avoid injuries and to enhance athlete performance Suspension training and Plyometric training to improve dynamic balance and vertical jump have to be incorporated in the training.

Limitation: Small sample size.

Variation in training surfaces as the players train on different surfaces.

Future scope: The study can be carried out with larger sample size.

Minimal difference in heights of the samples and equal gender distribution per group would enhance the results in future.

There are a lot of multidirectional contact sports like football, handball, hockey, rugby, etc which involve dynamic balance and jumping so in future, studies can be done to check the effect of Suspension training and Plyometric training considering these sports.

The study can be carried out considering athletes playing at the same competitive level.

Conclusion

There is a positive effect of Suspension training and Plyometric training on dynamic balance and vertical jump in competitive basketball players. However, no training method is found to be more efficient than the other.

Ethical Clearance: Taken from departmental review board of Deccan Education Society's Brijlal Jindal College of Physiotherapy Taken from departmental review board of Deccan Education Society's Brijlal Jindal College of Physiotherapy dated 6th March 2020.

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Conflict of Interest: None

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Assessing POT Syndrome with Wearable Sensors and AI: A Case Study

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Abstract

Background: POTS affects younger people between the ages of 15 and 45, with a clear female predominance (80%). Dizziness, weakness, a quick heartbeat, and palpitations upon standing are the most frequent complaints. Additionally, patients frequently describe headaches, "brain fog," dyspnea, gastrointestinal problems, and musculoskeletal pain in addition to physical deconditioning and decreased exercise ability.

Objective:- fitnees assessment of neurological symptoms along with musculoskeletal symptoms.

Results - fitknees assessment shows significant changes in static balance, dynamic balance and gait parameter.

Key Words: wearable sensors, POTS

Introduction

According to extensive population-based studies, 15% to over 20% of people experience dizziness (including vertigo) on an annual basis. About one-fourth of complaints of dizziness are due to vestibular vertigo, which has a 5% 12-month prevalence and a 1.4% yearly incidence. It is two to three times more common in women than in men, and its incidence increases with age.[1] Vertigo is a common, painful, and disturbing condition that has drawn more and more interest from the medical and scientific fields. Because of how it affects people on a daily basis, it is crucial to comprehend its underlying causes, make a precise diagnosis, and employ efficient management techniques. In order to better understand the complicated balancing systems of the human body and to create more effective interventions and treatments for people who experience vertigo, scientists and medical experts are always trying to understand the complexities of the condition.[1]

POTS affects younger people between the ages of 15 and 45, with a clear female predominance (80%). In wealthy nations, the prevalence is between 0.2% and 1.0%. Immunological stressors such as viral infection, vaccination, trauma, pregnancy, surgery, or psychological stress are frequently responsible for the start of POTS.[2-4]

POTS is a condition characterized by an excessive increase in heart rate (tachycardia) when moving from a lying down to a standing position.

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It frequently causes symptoms including light-headedness, weariness, and occasionally muscle weakness. Although POTS predominantly affects the cardiovascular and autonomic nervous systems like Dizziness, weakness, a quick heartbeat, and palpitations upon standing are the most frequent complaints. Additionally, patients frequently describe headaches, "brain fog," dyspnea, gastrointestinal problems, and musculoskeletal pain in addition to physical deconditioning and decreased exercise ability.

Thus, when assessing some of these neurological conditions, it becomes difficult for the therapist to know exactly where the case is and how to quantify the measures. Some of the tests used in the clinic have limitations. This is where artificial intelligence comes into play. The test methods that are modified by the AI make it easy for the therapist to focus on the part that needs more focus.

PATIENT HISTORY AND OBSERVATION

An 38 year old female was complaining of giddiness, discomfort while traveling since five years She also started to experience nausea and discomfort. This episode she experienced only after traveling for a while. The symptoms started to occur even at home while performing daily activities like descending the stairs, even while cooking. The symptoms started to increase after a period of time. The symptoms were at their peak before the outbreak of the pandemic, She struggled when she was in the sunlight. She also had difficulty performing fast movements like fast walking, and turning activities.

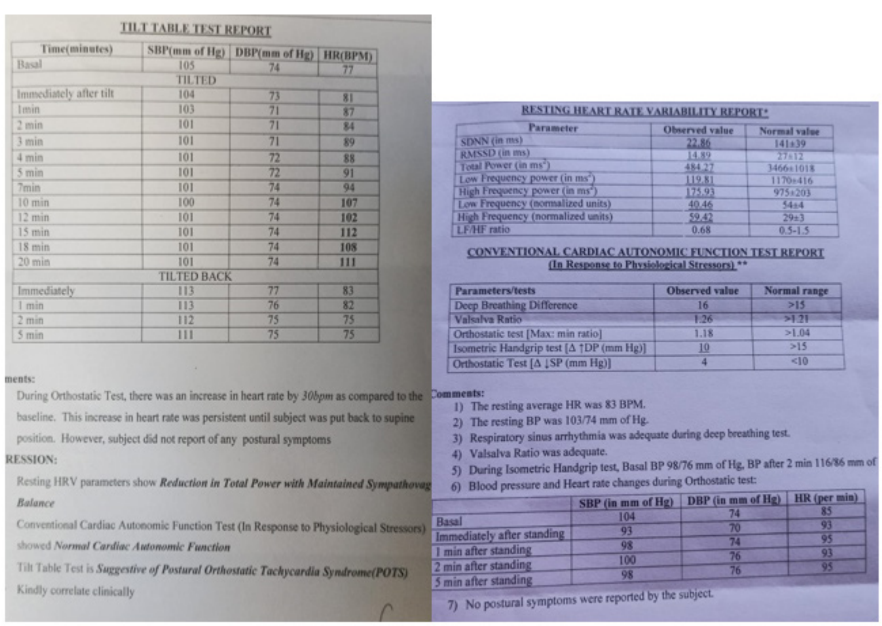
The feeling of sudden giddiness when forward bending and getting up suddenly from lying. She also had complaint of pain on the whole right side of her face. Considering it to be a migraine, she had undergone a lot of diagnostic tests. An increase in the rate was often seen. Symptoms of dysautonomia were also mentioned by her. Neurological tests were also carried out to confirm the same. For the atomic function testing, it showed that she was actually suffering from Postural Orthostatic Tachycardia Syndrome. The investigations done recently showed that she was suffering from vertigo, which causes the headaches for which she was taking medications as well. Along with the medications, the doctor also suggested she wear compression stockings.

On observation, she had rounded shoulders. Slightly slouched back posture.

MEDICAL DIAGNOSIS: Postural Orthostatic Tachycardia Syndrome

PHYSIOTHERPAY DIAGNOSIS: POTS is associated with lower limb muscular weakness, imbalance, and vertigo.

INVESTIGATIONS



TILT TABLE TEST REPORT

Time(minutes)	SBP(mm of Hg)	DBP(mm of Hg)	HR(BPM)
Basal	105	74	77
TILTED			
Immediately after tilt	104	73	81
1min	103	71	87
2 min	101	71	84
3 min	101	71	89
4 min	101	72	88
5 min	101	72	91
7min	101	74	94
10 min	100	74	107
12 min	101	74	102
15 min	101	74	112
18 min	101	74	108
20 min	101	74	111
TILTED BACK			
Immediately	113	77	83
1 min	113	76	82
2 min	112	75	75
5 min	111	75	75

ments:

During Orthostatic Test, there was an increase in heart rate by *30bpm* as compared to the baseline. This increase in heart rate was persistent until subject was put back to supine position. However, subject did not report of any postural symptoms

RESSION:

Resting HRV parameters show ***Reduction in Total Power with Maintained Sympathovag Balance***

Conventional Cardiac Autonomic Function Test (In Response to Physiological Stressors) showed ***Normal Cardiac Autonomic Function***

Tilt Table Test is ***Suggestive of Postural Orthostatic Tachycardia Syndrome(POTS)***

Kindly correlate clinically

RESTING HEART RATE VARIABILITY REPORT*

Parameter	Observed value	Normal value
SDNN (in ms)	22.86	141±39
RMSSD (in ms)	14.89	27±12
Total Power (in ms²)	484.27	3466±1018
Low Frequency power (in ms²)	119.81	1170±416
High Frequency power (in ms²)	175.93	975±203
Low Frequency (normalized units)	40.46	54±4
High Frequency (normalized units)	59.42	29±3
LF/HF ratio	0.68	0.5-1.5

CONVENTIONAL CARDIAC AUTONOMIC FUNCTION TEST REPORT
(In Response to Physiological Stressors) **

Parameters/tests	Observed value	Normal range
Deep Breathing Difference	16	>15
Valsalva Ratio	1.26	>1.21
Orthostatic test [Max: min ratio]	1.18	>1.04
Isometric Handgrip test [Δ ↑DP (mm Hg)]	10	>15
Orthostatic Test [Δ ↓SP (mm Hg)]	4	<10

Comments:

1) The resting average HR was 83 BPM.
2) The resting BP was 103/74 mm of Hg.
3) Respiratory sinus arrhythmia was adequate during deep breathing test.
4) Valsalva Ratio was adequate.
5) During Isometric Handgrip test, Basal BP 98/76 mm of Hg, BP after 2 min 116/86 mm of
6) Blood pressure and Heart rate changes during Orthostatic test:

	SBP (in mm of Hg)	DBP (in mm of Hg)	HR (per min)
Basal	104	74	85
Immediately after standing	93	70	93
1 min after standing	98	74	95
2 min after standing	100	76	93
5 min after standing	98	76	95

7) No postural symptoms were reported by the subject.

Fig 1 & 2

Fig 1- The tilt table test reports shows that during the orthostatic test the heart rate increased by 30bpm compared to the baseline. Resting heart rate variability showed reduction in total power with sympathovagal balance. The tilt table test is indicatory for postural orthostatic tachycardia syndrome.(POTS)

Fig 2- The reports mentioned in this test are resting heart rate variability and conventional cardiac autonomic function test. Resting heart rate and blood pressure was measured for the patient. All the parameters were measured accordingly.

PHYSIOTHERAPY TREATMENT

STRENGTH TRAINING **-** Both upper and lower limbs with therabands

NEUROMUSCULAR TRAINING

BALANCE TRAINING - single stand with eyes open and eyes closed

Progressing with bosu ball and wobble board

Result

Active proprioception test

To examine the patient's proprioception, an active proprioception test is carried out. to determine whether the patients' proprioception is affected by the disorder. The patient is instructed to flex their knee at a predetermined angle that has been specified; this angle is known as the target angle. The person is now required to reach the predetermined angle while completing the test three times with their eyes closed. The proprioception in this situation is unaffected if the person is able to achieve the established target angle.

Static balance

Fig 3 represents graph for static balance.

1. The test can be performed with both eyes open and eyes closed.
2. When the patient performs the test with with eyes open at ease then only proceed to eyes closed.
3. For this patient the test was performed with eyes closed.
4. The individual was asked to maintain balance on single leg at least was 30 secs.

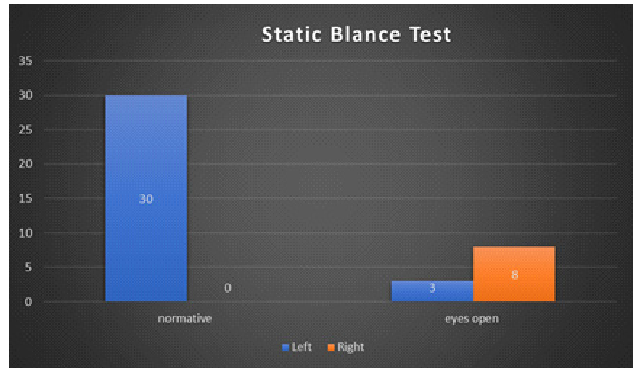


Fig. 3

DYNAMIC BALANCE

Fig 4 represents graph for dynamic balance.

The test was performed without any support

The longer it takes to complete the test, the greater the risk of falling.

For this individual the time taken to perform the test is more then normative so the chances of fall are more.

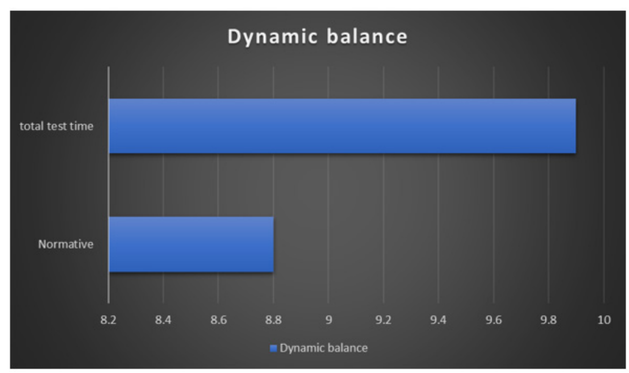


Fig. 4

Gait Analysis

Fig 5 represents graph for gait analysis.

No major difference in gait parameters were seen. The graph below represents only slight difference in cadence when compared to normative.

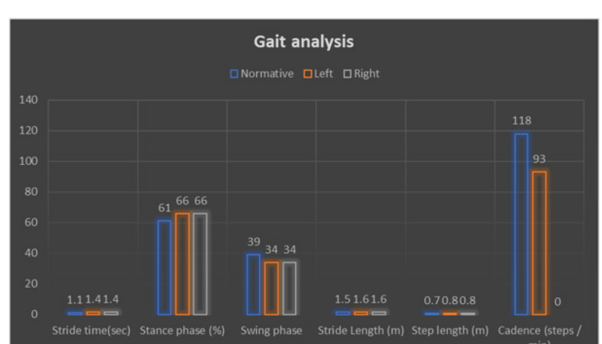


Fig. 5

Discussion

The use of artificial intelligence (AI) is revolutionising the treatment of postural orthostatic tachycardia syndrome (POTS). Beyond its diagnostic potential, AI is essential for remote patient monitoring via wearable technology. It continuously monitors vital indicators and gives people with post-traumatic stress disorder (POTS) real-time insights into their heart rate, blood pressure, and activity levels. AI algorithms improve the personalization of treatment regimens by evaluating patient data and selecting the best interventions based on unique reactions and features. By predicting POTS episodes through pattern identification in past patient data, predictive analytics helps to provide proactive therapy by enabling early intervention and better results.AI in rehabilitation customises workout plans and lifestyle suggestions based on personal health data, assisting in symptom management. AI also helps healthcare professionals make decisions by interpreting tests, recommending courses of action, and guaranteeing that they have access to the most recent findings and recommendations. The full integration of AI into POTS therapy offers the potential to provide individuals with this complex illness with proactive, individualised, and successful management options.

Significant promise exists in the application of AI sensors to the treatment of POTS (Postural Orthostatic Tachycardia Syndrome). AI sensors have the ability to identify and diagnose physiological changes related to POTS early on, enabling quicker management. Through the analysis of patient data and the optimization of therapy options, these sensors make it possible to develop personalized treatment programs. Continuous remote monitoring made possible by AI sensors enables prompt interventions, empowers patients with real-time feedback, and teaches them how to take care of themselves. Additionally, AI helps academics analyze huge amounts of information to better comprehend POTS and its causes. AI sensors lessen the need for frequent in-person visits, which results in cost savings. To achieve responsible adoption, however, ethical considerations and data privacy precautions must be in place.[5]

Informed consent was taken from the patient.

Ethical clearance: Ethical clearance obtained from ST. John's National Academy of Health sciences

Source of funding: self

Conflict of interest: nil

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Review Article

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Overuse Injury versus Training Load Error: A Systematic Narrative Review Comparing the Terminology Accuracy

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Abstract

Objective: The aim was to determine the research question which addresses the accuracy of the terms Overuse injury & Training load error in sports injuries.

Literature Search: Google scholar, PubMed & AJSM databases were searched from inception to 2nd September 2023.

Study Selection Criteria: The studies were included if the participants were athletes regardless of the type of sport & gender. Studies consisting overuse injuries, training load errors & comparison among the two were included.

Data Synthesis: The quality of studies was assessed using JBI Critical Appraisal Tool. The level of evidence was defined as strong & of high quality.

Results: 2672 studies were identified along with 5 articles from sources other than database search. 14 studies met the inclusion criteria & were added to the review. 11 studies concluded that increased training performance is directly proportional to the increased risk of injury. 3 studies directly call out for our field to replace the term Overuse injury with Training Load Errors. One of the studies specifies by stating that all overuse injuries are training load errors. 5 studies specifies that, even though there are negative effects of training errors, proper training prescription can act as a protective agent against injury.

Conclusion: This review emphasizes the field of Sports Sciences to avoid the term Overuse Injury & replace it with Training Load Error.

Key Words: and, athletes, overuse injuries, sports, training load errors.

Introduction

Overuse injuries occurs as a result of repetitive stress followed by inadequate resting period (Johnson, James H[4]). It is an injury which is a result of gradual process of repetitive microtrauma & increased load on the musculoskeletal system, which leads to tissue damage caused as a result of insufficient time of recovery (Franco et al[7]).

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An overuse injury, is by definition an error in training prescription (Gabbett et al 10). While it may be challenging to predict & prevent certain injuries, the majority of injuries typically stem from excessive loads & a history of overuse (Franco et al[7]).

The number of overuse injuries are increasing not only because of the increasing number of participants in sports, but also because of the increased training intensity & duration (Jayanthi et al[13]). There is arising evidence for an association between training load & risk of overuse injuries (Drew M K & Finch C F[5]).

Evidence highlights that increased hour of training per week, has a directly proportional relationship with increased overuse injuries (Sugimoto et al[17]).

The definition of training load was taken from a review by Drew M K & Finch C F[4]. It is stated as follows:

The cumulative amount of stress placed on an individual from multiple training sessions over a period of time, external workload performed or the internal workload to that response.

As previously stated, Training load can either be internal or external.

Internal workload can be defined as, The physiological response of the body to any external loading (ex: Exercise). It is the amount of stress that an exercise places on the body & can be measured using methods such as heart rate, perceived exertion.

Whereas, External workloads are the physical demands or quantification of the workloads external to the athlete. External factor mainly training errors may lead to muscular imbalance (Drew M K & Finch C F[5]).

Hence understanding the terminologies 'Overuse injuries' & 'Training load error' & using the more accurate among the two terms, is necessary to develop prevention strategies & early interventions.

The need for this study is to identify an accurate term in order to develop strategies for preventing the injuries, because there is a misconception among coaches & athletes that, increased training loads may lead to best competition results, which in turn is causing increased risk of overuse injuries. Evidence has been viewed for a more accurate terminology, but no systematic narrative review is available for the information regarding the accuracy of 'Overuse injury' or 'Training load errors'

Therefore, this study aims in bridging this research gap by conducting a review on the terminology accuracy.

The objective of this study is to define the research question which addresses the accuracy of the terms 'Overuse injury' & 'Training load error' in sprots injuries.

This study aims to interpret existing literature to analyze the accuracy & effectiveness of these terms in defining & describing sports injuries.

Methods

Following the guidelines of PRISMA 2020 checklist, the review was conducted.

Inclusion Criteria:

The studies included in this review followed the PICO framework (Population or patient, Intervention, Comparison, Outcome(s)) based on the PRISMA guidelines:

1. The population included should be athletes of any sports regardless of professional or amateur level & gender studies.
2. Studies that had overuse injury & training load error & studies that focus on intervention strategies of overuse injuries or training errors were included.
3. Studies that compare different terminologies, definitions for overuse injury or training load errors were included.
4. Studies that assist the accuracy, relationship, consistency, prevalence & other relevant outcomes were included.

Exclusion criteria:

1. Articles where the studies were related to surgical & pharmacological methods were excluded.
2. Studies conducted on animal population were excluded.
3. Studies that were based on non-primary research articles were excluded.

4. Language restrictions were applied & studies of languages other than English was excluded from the review.

Information Sources:

On 12th April 2023, a comprehensive literature review was conducted using multiple sources. Google scholar, PubMed & AJSM were explored to identify relevant studies published for the topic.

On 3rd May 2023, a more detailed study was conducted on literature review using NIH & Scopus. The keywords were chosen carefully to ensure broad coverage of the topic.

Snowball search technique was conducted to identify more studies by searching the reference lists, with the eligibility criteria of availability of full text reviews & using Google scholar, PubMed & Sci Hub to identify & screen the studies.

To identify any new articles found between the previous search date & the update & to ensure currency of the findings, an update of the database search was done on 22nd May 2023.

Once the exploration of the studies was completed, a detailed study of the articles was done starting from 3rd June 2023 up to 29th August 2023.

To ensure an update of the database, a second search was done on 2nd September 2023, to search for any new articles found between the previous search date & the update. The same search strategy was used including the 'snowball' technique.

Date of coverage of articles included in the study commenced from the time frame of 2014 up to 2023.

Search strategy:

Initially, an electronic search was conducted in the following databases:

Google scholar, PubMed & AJSM.

Databases were searched from 4th April 2023 to 30th May 2023 to develop the search strategy. Very important keywords were developed for the search. They are as follows:

and, athletes, overuse injuries, sports, training load errors.

Secondly, a search strategy was developed for the databases.

A detailed search strategy for the databases PubMed, AJSM & Google scholar are presented in Flowchart 1 & Flowchart 2.

After the initial selection, a snowball technique was used & search was conducted in the reference list to find more relevant studies.

At the end of the search strategy, literature review studies were cross checked to identify whether the study being conducted was included in any previous literature reviews.

The studies whose full text could not be obtained were downloaded from Sci Hub.

The data representing the dates of coverage & filters applied in search strategy is presented in Table 2.

Data selection & data collection process was conducted independently (DG).

Assessment of Risk of Bias:

The Risk of Bias for each included study was assessed using the Joanna Briggs Institute Critical Appraisal Tool (JBI). This tool consists of various questions designed for different study methods that assesses the Risk of Bias of a published article, including Cross sectional studies, systematic reviews, text & opinion & various other study designs.

To assess the Risk of Bias of a study, JBI tool was used to answer a series of questions about the study design, conduct & reporting.

Each question is rated with Yes, No, Unclear & Not applicable.

After the ratings of the individual questions were determined, the overall appraisal was obtained.

The detailed JBI Risk of Bias assessment of each study is given in Table 3.

Results

Article Identification:

A total of 2672 articles were retrieved through three database searches. After removing the duplicates of studies that did not meet the inclusion criteria, screening the titles & abstracts, a total of 23 articles met the inclusion criteria & were considered for a full – text review. Review of full text of these 23 articles resulted in the removal of 9 additional articles & 14 studies met the inclusion criteria in the review identified in the search strategy.

The summary of the included articles in the review is presented in Table 4 & Supplementary Appendix.

Description of the Included Articles:

The largest number of studies included, reviewed the relationship between overuse injuries, training load errors & debates about the terminology accuracy among the two.

Of the 14 articles included in the review, 11 studies [4,5,6,8, 9,10,11,12,13,14,17] concluded that increased training performance is directly proportional to the increased risk of injury.

3 studies [5,11,12] directly call out for our field to replace the term 'Overuse' injury with 'Training load errors'

This is because, the term 'Overuse' is causing confusion & fear among the coaches & athletes to reduce their training loads which in turn is leading the athlete to participate in competitions without adequate training or preparations [5,11]. This may expose the tissues to deconditioning, which in turn may increase the risk of injury [5,11].

Another study implies, more than 60% of running injuries could be attributed to training error & in fact all overuse injuries are training load errors [12].

Five studies [4,5,6,10,11] suggest that, despite the increased risk of injury associated with increased training performance, there is equal evidence to suggest that the proper prescription of training load can help in protecting against injury.

One of the studies highlighted a key factor stating that, external load only partially quantifies training load errors & can thus provide a partial quantification of the risk injury [4].

One of the articles specifies that, as the training load increases there is a high risk of overuse injury, but decreased training load should also be considered as one of the reasons for overuse injury [11].

Highly specialized athletes (i.e., athletes who had training experience of > 8 months) had greatest risk of injury, was the spotlight of one of the studies. A notable finding of this study was that, highly specialized athletes had a lower rate of acute injuries [13].

A contradicting study stated as follows,

Training load is just one factor among an array of factors that may contribute to overuse injury occurrence. Defining overuse injuries astraining load errors is a negation of their multifactorial nature [15].

Assessment of the Article Quality:

The Risk of Bias assessment was completed using the JBI Critical Appraisal Tool & the detailed quality of evidence is presented in Table 3.

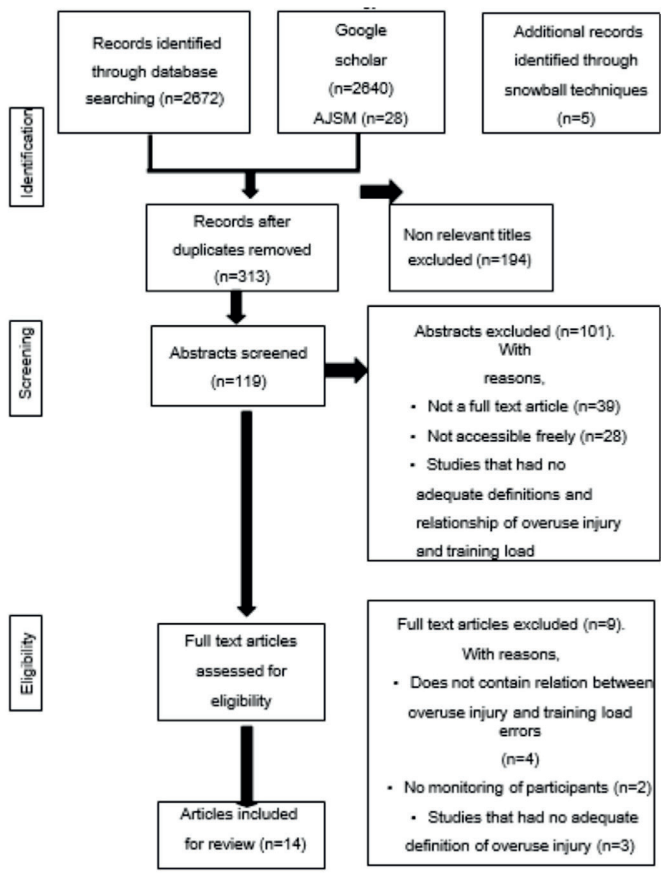
9 studies were of high score of evidence (>70% of criteria met).

3 studies reached moderate score (50-70% of criteria met).

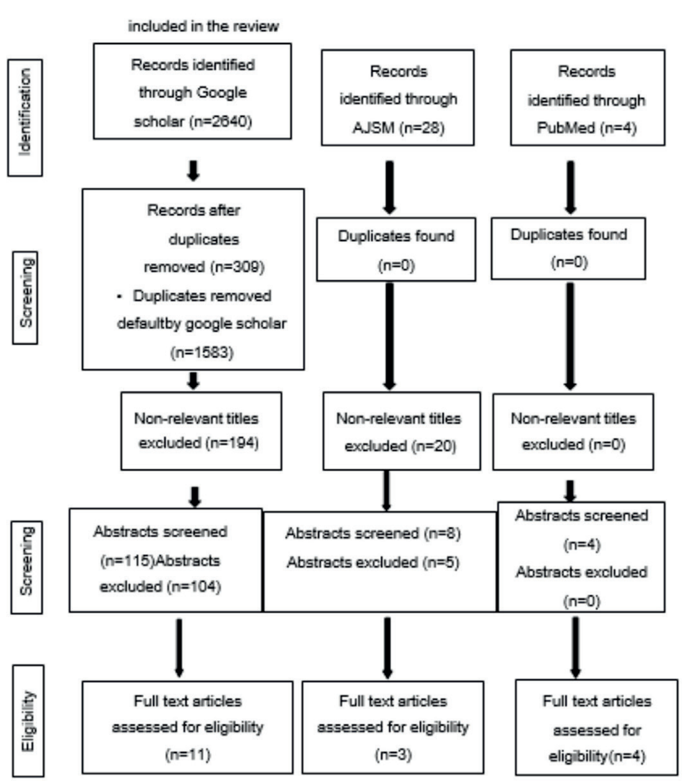
1 study demonstrated a low quality of evidence (≤50% of criteria met).

Table 1. Abbreviations

Abstract	Abbreviation
AJSM	American Journal of Sports Medicine
PICO	Population, Intervention, Comparison, outcome
NIH	National Institute of Health
JBI	Joanna Briggs Institute
PRISMA	Preferred reporting items of systematic reviews & meta-analysis
RoB	Risk of Bias
NOS	Newcastle Ottawa Scale
A : C	Acute: Chronic

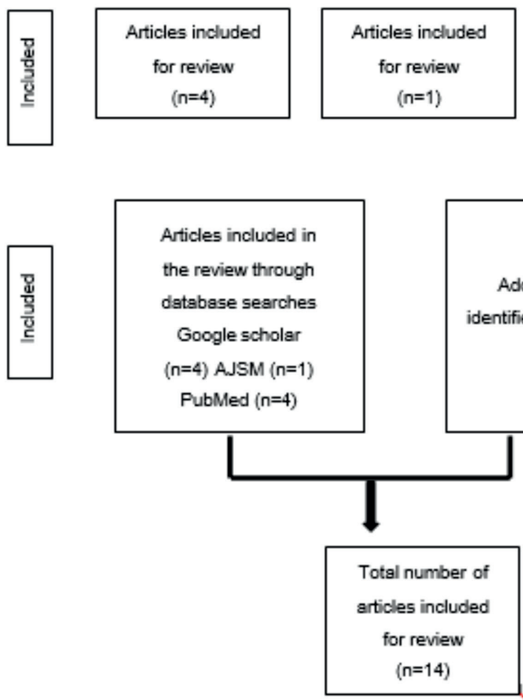


FLOWCHART 1. The detailed search strategy included in the review



FLOWCHART 2. The detailed search strategy for individual search engines

FLOWCHART 2. cont….



Discussion

Relationship Between Overuse Injury & Training Load Errors:

The number of sports played, joint ROM, muscular strength, physical characteristics & overuse injuries are not associated with each other. This suggests that, training volume maybe a more important key factor in overuse injury risk than the number of sports played. Increased training hours may cause repetitive stress to developing body, which may lead to overuse injuries to various body regions (Sugimoto D et al[17]).

Goldilocks approach to training follows the principle of - Not too little, not too much (Gabbett T J et al[10]).

The term "Overuse" injury may cause a misconception among the athletes as well as coaches & trainers to reduce the training load, which may lead to tissue deconditioning. Thus, the athlete may participate in competitions unprepared. This in turn may lead to increased injury risk [5,11].

The increased training load among highly specialized athletes (i.e., training for > 8 months) are at a higher risk of overuse injury occurrence, as the tissue & structure of the body regions is exposed to repetitive stress & trauma [9,13].

Adverse events of exercise trainings are dose related (i.e., prescription of training load) by "experts", with the highest incidence of injury occurring when training loads were highest (Gabbett T J[9]).

During training, due to increased external workloads, Musculoskeletal structures must have exposed themselves to stress, because of which the stress-frequency combination slips into the injury region. This occurs only when an individual's training program is exceeded beyond their current limit (Hreljac A[12]).

Training Load as a Protective Agent Against Injury:

Many reviews focused on the negative impact of training load whereas, few studies also highlighted a very important factor of the protection of bodily structures via proper training prescription.

Four studies included in the review showed evidence for "Protectant against injury" principle [4,5,9,10,18].

Contemporary publication highlighted that; moderate chronic loads are protective whereas high & low loads are not [9,10].

Acute-Chronic Workload Ratio:

Acute workload is the amount of training performed in a short period of time, usually one week [i.e., Banister's fatigue].

Chronic workload is the amount of training / workload performed over a longer period of time, typically four weeks [i.e., Banister's fitness]

The ratio between acute workload to the chronic workload is defined as the Acute-Chronic workload ratio (9,10). These acute & chronic workloads can predict injury (Gabbett T J et al[10]).

If the A-C workload ratio is ≥ 1.5, it indicates the association of increased risk of injury (9,10).

If the acute workload is less & the chronic workload is high, then the athlete's sporting performance improves & the athlete is well prepared.

However, if the fatigue is greater than fitness, the A-C workload ratio may reverse, leading to overuse injury (Gabbett T J et al[10]). Thus, this ratio indicates both athlete's risk of injury & preparedness to perform (5,9,10,15).

The Acute-Chronic workload ratio is considered to be one of the 'Best practice' to monitor athlete's workload (5,10).

Prevention or Intervention Strategies:

One of the major strategies to prevent overuse injury is to perform cross training. Evidence states, athletes who are involved in multiple sports have increased benefits to reduce injury risk (Sugimoto D et al[17]).

Returning safely from injury is a crucial step in an athlete's career. Hence, it is highly advisable to the therapists & coaches to learn & understand about the previous history & the amount of training performed in the current week relative to the preceding four weeks.

Weekly increase in workloads by > 10% causes injury, hence in order to prepare for competition demands, an athlete needs to gradually increase their workloads, so that their fitness levels are greater than fatigue levels (Gabbett T J et al[10]).

Hulin *et al.*, illustrated that, the chronic workload of an athlete combined with the acute loads have a higher protective capacity.

To reduce injury risk, practitioners should aim within a range of approximately 0.8 – 1.3 A-C workload ratio.

Awareness Education on the Relationship between Overuse Injury & Training Load Errors:

Spike in training workloads leads to increased injury risk. Hence, the understanding among clinical staff, the coach, athlete & support staff about the spikes in training loads with the adequate management strategies is of greater importance.

Every staff must have knowledge regarding the association of overuse injury & training load errors, in order to prevent injury risk.

Multiple educational approaches should be used to teach the staff & athletes regarding the types of workloads, injury risk & proper training load prescription in order to avoid injuries (Drew M K & Finch C F[5]).

Strengths of the Review:

The research question is clearly identified & stated which provides a clear view of the review.

Five studies included in the review were searched through Snowball technique, leading to low risk of studies not being included & also low risk of bias.

Moreover, the studies were assessed for their quality of evidence, hence the Risk of Bias is low.

Using JBI tool for Risk of Bias assessment strengthens the review results.

The review was of high-quality, as it followed the PRISMA 2020 Checklist guidelines.

Most of the included studies met the criteria for the risk of bias assessment being considered as high-quality, hence the quality of level of evidence is high.

Limitations of the Review:

The search strategy was limited to articles in English, potentially eliminating some high-quality studies from the results.

One of the major limitations of the review was that, all the study data were reviewed by individual researcher, increasing the possibility of errors.

JBI Risk of Bias assessment has a major drawback, as the evaluation of evidence was performed by independent researcher.

Clinical Implications:

More research is needed to develop standardized definitions & measurement methods for training load errors.

Conclusion

This systematic review extends the studies conducted by M K Drew et al[5] & Tim J Gabbett et al[11] examining the relationship & terminology accuracy between Overuse injury & Training load errors.

Our results demonstrate that, evidence for relationship between Overuse injury & Training load errors in competitive athletes has been substantially strengthened in the past 8 years & continuous to grow stronger.

Overall, the term Training load error is more accurate & informative than the term Overuse Injury when describing injuries that occurs from repetitive stress.

As evidently stated by M K Drew & C Purdam[5], this review concludes by emphasizing the field of Sports Sciences to avoid the term Overuse Injury & replace it with Training Load Error.

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Conflict of interest and Source of Funding

The authors certify that they have no affiliations with or financial involvement in any organization in the subject matter or materials discussed in the article.

“We affirm that the authors have no financial affiliation (including research funding) or involvement with any commercial organization that has a direct financial interest in any matter included in this manuscript.

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Original Research

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Comparison Between Mirror Therapy and Mental Imagery in Improving Ankle Motor Recovery in Acute Stroke Patients: Experimental Study

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Abstract

Introduction: Stroke is the sudden loss of neurological function caused by an interruption of the blood flow to the brain. Initially, some 80% of all patients with stroke experience motor impairments of the contralateral limb, i.e hemiparesis. Mirror therapy is relatively new therapeutic intervention that focuses on moving the unimpaired limb. Likewise, another technique called Mental imagery is the cognitive rehearsal of a task in the absence of movement.

Aim and Objectives: To compare mirror therapy and mental imagery in improving ankle motor recovery in acute stroke patients.

Methodology: 30 stroke patients were selected in the study, and were randomly assigned into two groups. Group A i.e. Mirror Therapy group (n=15) or the Group B i.e. Mental Imagery group (n=15). Both the groups received 30 minutes of their respective therapy that ismirror therapy and mental imagery and in addition to 30 minutes of conventional therapy which included neuro developmental facilitation technique, stretching, gait training that is a total of 1 hour per day for 5 days a week for 4 weeks. Modified Ashworth Scale, 10 Meter Walk test (10MWT), Fugl-Meyer assessment Lower extremity (FMA-LE) scale were administered pre and post intervention to assess the ankle motor function.

Results: Only Fugl Meyer Assessment scores on comparison between Group A (Mirror Therapy) and Group B (Mental Imagery) revealed that statistically significant improvement was found in Group B (Mental Imagery) (t-value: 2.140; p-value: .041*).

Conclusion: The present study concluded that Mental Imagery proved to be more effective than Mirror Therapy in improving ankle motor recovery in acute stroke patients.

Key Words: Stroke, Mirror Therapy, Mental Imagery

Introduction

Stroke is the sudden loss of neurological function caused by an interruption of the blood flow to the brain. Ischemic stroke is the most common type affecting when a clot blocks or impairs blood flow, depriving the brain of essential oxygen and nutrients.

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Hemorrhagic stroke occurs when blood vessels rupture, causing leakage of blood in or around the brain.[1]

Ankle movement training is known to facilitate brain reorganization and the ankle paradigm may serve as an ongoing physiologic assay of the optimal type, duration and intensity of rehabilitative gait training. In the lower extremity, voluntary ankle dorsiflexion is a way of indicating the achievement of selective motor control.[5]

Mirror therapy is relatively new therapeutic intervention that focuses on moving the unimpaired limb. Mirror therapy in stroke patients involves performing movements of the unimpaired limb while watching its mirror reflection superimposed over the (unseen) impaired limb, thus creating a visual illusion of enhanced movement capability of the impaired limb.[5] Mirror therapy (MT) is the use of a mirror to create a reflective illusion of an affected limb in order to trick the brain into thinking movement has occurred without pain.

Mental imagery is the cognitive rehearsal of a task in the absence of movement. Numerous studies have been shown mental practice to be an effective training technique for enhancing the performance of motor skills when used in combination with physical practice and even when used in isolation.[7] Mental Imagery was initially developed to improve the performance of athletes and has been adopted in rehabilitation programs for persons with stroke to support motor recovery. Mental Imagery is a process in which a function, a behavior, or a performance is rehearsed mentally, as if the person is actually performing it.[4]

Methodology

a. Sampling criteria

Inclusion Criteria

1. Males and Females of age of 50-65 yrs[19]
2. MCA stroke[19]
3. First episode of unilateral stroke with hemiparesis & all the patients within 3-12 monthspost stroke[13,16]
4. Brunnstrom recovery stage 2 and above[15]

Exclusion Criteria

1. Patients with unilateral neglect.[19]
2. Patients with apraxia.[19]
3. Any diagnosed c/o of neurological, musculoskeletal, cardiopulmonary disorder whichmight affect the outcome of the study

b. PROCEDURE

A sample of 30 subjects who met the inclusion was selected. The procedure was explained to them, followed by signing of the consent form. They were randomly assigned to either the Group- A i.e Mirror group (N-15) or the Group-B i.e Mental imagery group (N-15) using chit method.

Modified Ashworth Scale[13], 10 Meter Walk test (10MWT)[13], Fugl-Meyer assessment Lower extremity (FMA-LE) scale[35] were administered pre and post intervention to assess the ankle motor function.

Both the groups received 30 minutes of their respective therapy that is mirror therapy and mental imagery and in addition to 30 minutes of conventional therapy which included neuro-developmental facilitation technique, stretching, gait training that is a total of 1 hour per day for 5 days a week for 4 weeks. Both the therapies consisted of ankle dorsiflexion and ankle eversion. During the mirror therapy practice the patients in Group-A was instructed to remain in sitting position with a mirror positioned between the two legs perpendicular to subject's midline.

The patients performed the movements while looking into the mirror, watching the image of their non involved leg, thus seeing the reflection of the leg movement projected over involved leg. During the Mental Imagery practice the patient in Group-B were asked to imagine the movements from an internal first person perspective, as if they were performing the tasks themselves, without actually executing them.

Data Analysis

The data was analyzed using SPSS software. Independent sample t test was used to compare the improvement between both the groups i.e Group A (Mirror Therapy) and Group B (Mental Imagery). Paired t test was used to compare pre and post intervention improvement within the respective groups. Gender (nominal variable) was calculated by Chi- square test.

Results

30 subjects were recruited in the study i.e 17 males and 13 females aged 50 to 65 years. They were randomly divided into two groups: Group A (Mirror Therapy) and Group B (Mental Imagery) with15 subjects in each group. The mean age of Group A (Mirror Therapy) and Group B (Mental Imagery) were 56.60 $\pm$ 3.757 years and 56.07 $\pm$ 5.092 years respectively (Table 8.1).

In Group A (Mirror Therapy) the mean pre and post intervention Fugl Meyer Assessmentscores were 19.27 and 21.33 (t value: 6.3; p-value: .000**) (Table 8.3) respectively. In 10 meter walk test, the mean pre and post intervention scores were .556 and .656 (t value: .17; p-value:

.000**) (Table 8.5) respectively. In Modified Ashworth Scale, the mean pre and post intervention scores were 1.40 and 1.20 (t-value: 1.32; p-value: .19^{NS}) (Table 8.7) respectively.

In Group B (Mental Imagery) the mean pre and post intervention Fugl Meyer assessment scores were 19.33 and 22.40 (t value: .563; p-value: .000**) (Table 8.4). In 10 meter walk test, the mean pre and post intervention scores were .559 and .690 (t value: 7.64; p-value: .000**) (Table 8.6). In Modified Ashworth Scale, the mean pre and post intervention scores were 1.60 and 1.33 (t value: 2.256; p-value: .041*) (Table 8.8) respectively.

Table 1: Comparison of pre and post intervention scores of Fugl Meyer Assessment of GroupA (Mirror Therapy)

VARIABLE	MEAN	SD	t-value	p-value
Pre Intervention	19.27	1.46	6.3	.000**
Post Intervention	21.33	2.024		

**=Significant at .01 level

Table 2: Comparison of pre and post intervention scores of Fugl Meyer Assessment of GroupB (Mental Imagery)

VARIABLE	MEAN	SD	t-value	p-value
Pre Intervention	19.33	1.799	.563	.000**
Post Intervention	22.40	2.197		

**= Significant at .01 level

Table 3: Comparison of pre and post intervention scores of 10 Meter Walk Test of Group A(Mirror Therapy)

VARIABLE	MEAN	SD	t-value	p-value
Pre Intervention	.556	.065	.17	.000**
Post Intervention	.656	.100		

**=Significant at .01 level

Table 4: Comparison of pre and post intervention scores of 10 Meter Walk Test of Group B(Mental Imagery)

VARIABLE	MEAN	SD	t-value	p-value
Pre Intervention	.559	.05	7.64	.000**
Post Intervention	.690	.113		

**= Significant at .01 level

Discussion

This study was designed to compare the effect of Mirror Therapy and Mental Imagery in improving ankle motor recovery in acute stroke patients. 30 subjects were recruited in the study & were randomly divided into two groups: Group A (Mirror Therapy) and Group B (Mental Imagery) with 15 subjects in each group. The Fugl Meyer Assessment, 10 Meter Walk Test and Modified Ashworth Scale scores were used to assess the motor performance of pre and post intervention. Post intervention Fugl Meyer assessment scores on comparison between Group A and Group B revealed that the mean for Group A was 21.33 and for Group B was 22.40 (t-value 1.33; p-value: .17^{NS}) respectively. Difference between pre and post score of Fugl Meyer test of Group A and Group B was separately calculated for each subject. The variable name to this difference has given as DIIFF-1.

In 10 meter walk test scores, post intervention mean between Group A (Mirror Therapy) and Group B (Mental Imagery) were .656 and .690 (t-value:.5; p-value: .34^{NS}) respectively. Difference between pre and post score of 10 Meter Walk test of Group A and Group B was separately calculated for each subject, the variable name to this difference has given as DIIFF-2.

In Modified Ashworth Scale, post intervention mean between Group A (Mirror Therapy) and Group B (Mental Imagery) were 1.20 and 1.33 (t-value: .521; p-value: .606^{NS}) respectively. Difference between pre and post score of Modified Ashworth test of Group A and Group B was separately calculated for each subject, the variable name to this difference has given as DIIFF-3. The t-test of difference shows that there was no significant difference between Group A and Group B (t-value: .357; p-value: .724^{NS}) (Table 8.11).

In Group A (Mirror Therapy) the mean pre and post intervention Fugl Meyer Assessmentscores were 19.27 and 21.33 (t value: 6.3; p-value: .000**) (Table 3). The results show that for Fugl Meyer Assessment and 10 Meter Walk Test showed significant improvement post intervention in GroupA.

In Group B (Mental Imagery) the mean pre and post intervention Fugl Meyer assessment scores were 19.33 and 22.40 (t-value: .563; p-value: .000**) (Table 4). The results show that for Fugl Meyer Assessment, 10 Meter Walk Test and Modified Ashworth Scale showed significant improvement post intervention in Group B.

The results showed that the post intervention performance of Group B (Mental Imagery) was better than Group A (Mirror Therapy) as Fugl Meyer Assessment scores on comparison between Group A (Mirror Therapy) and Group B (Mental Imagery) revealed that statistically significant improvement was found in Group B (Mental Imagery).

Sackett's Symbolic learning theory states that mental practice facilitates motor performance by allowing subjects to rehearse the cognitive components of task. This theory implies that movements are symbolically coded in the CNS, making them easier to execute.[73]

A study by Liu et al (2004) showed that different imagery training strategies can potentially improve different aspects in post stroke movement rehabilitation.[9]

A study by M. Bakker et al (2005) examined how corticospinal excitability was affectedby motor imagery of foot dorsiflexion and motor imagery of gait. Motor-evoked potentials were recorded from the Tibialis Anterior (TA) and first dorsal interossei (FDI). Motor-evoked potentials were recorded during motor imagery were compared to those recorded during a matched visual imagery task. Imagined foot dorsiflexion increased MEP areas in both TA and FDI.

In Group A (Mirror Therapy), Fugl Meyer Assessment score and 10 Meter Walk Test showed statistically significant improvement post intervention. The mechanisms by which mirror therapy acts to increase performance in motor learning could be that the activity of the central neutral networks appears to be modified by seeing the movement, and then the activity of the mirror neurons seemed to be modified by visual feedback.

Hence, with this study it is concluded that although Mirror Therapy has shown significant improvements, but Mental Imagery has proved to be a better treatment technique as compared to Mirror Therapy.

Conclusion

The present study concluded that Mental Imagery proved to be more effective than Mirror Therapy in improving ankle motor recovery in acute stroke patients. Hence, the alternative hypothesis has been partially accepted.

Ethical clearance: This study was approved by our institutional ethical committee.

Source of Funding: Self

Conflict of Interest: Nil

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Original Research

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Effect of Structured Cardio-Respiratory Fitness Protocol on Physical Function and Performance in Geriatric Patients: A Quasi Experimental Study

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Abstract

Background: Exercise interventions have emerged as a promising avenue for mitigating age-related declines, particularly in the context of physiological changes such as sarcopenia and muscle strength loss. A recent study utilizing the International Classification of Functioning, Disability, and Health (ICF) framework underscored declines in physical functioning among older adults. Geriatric individuals commonly undergo cardio-respiratory changes and experience a decrease in physical fitness. This study seeks to compare the effects of a structured cardio-respiratory fitness protocol with a conventional exercise program on physical function and performance in geriatric patients, with a specific focus on the impact of cardio-respiratory fitness on overall physical function.

Methods: Employing a quasi-experimental pre-test post-test design spanning six months, two groups of participants aged 50 to 70, encompassing both genders and with a BMI between 20 and 30, was included. The experimental group adhered to the structured cardio-respiratory fitness protocol, while the control group received conventional physiotherapy. Measured parameters included heart rate (HR), respiratory rate (RR), peak expiratory flow rate (PEFR), and Borg scale ratings. Pre and post-treatment data underwent statistical analysis.

Results: Both groups demonstrated improvements in HR, RR, PEFR, and Borg scale ratings post-intervention. Notably, the experimental group exhibited significantly greater improvements in these parameters compared to the control group ($p < 0.05$).

Conclusion: The structured cardio-respiratory fitness protocol yielded a significant enhancement in physical function and performance among geriatric patients. Recommendations for future research involve incorporating larger sample sizes, extended intervention durations, and personalized approaches to maximize effectiveness. This study contributes valuable insights into the potential benefits of structured cardio-respiratory fitness interventions for augmenting geriatric physical function and overall quality of life.

Keywords: Structured Cardiorespiratory Fitness Protocol, Physical Function, Geriatric Patients

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Introduction

The ageing population is a growing global concern; with an increasing number of individuals facing age-related declines in physical function and performance.[1] Maintaining or improving physical function is crucial for enhancing the quality of life and independence among geriatric patients. Exercise interventions have been widely recognized as a promising approach to mitigate age-related declines and improve overall health outcomes in this population.[2]A consequence of aging is degeneration in many physiological variables, with the most import being sarcopenia and subsequent loss of muscle strength. [2]

A recent study examining one-year changes in the physical functioning of older adults using the International classification of functioning, Disability and Health (ICF) framework suggested a significant decreased in muscle strength (both hip abductors & knee extensor) walking capacity, speed, mobility, sit-to-stand performance, upper extremity function and balance performance at the end of one year. Although there were no significant changes in the level of participation in activities of daily living.[3]

Aging is associated with decrease lung function and respiratory muscle strength during at a rate of 8% to 15% per decade of life after 50 years of age.[4,5] The deficit in respiratory muscle strength affects physical performance leading to diminish in exercise tolerance, deterioration of gait, and decrease of quality of life with advancing age.[6] The reduction of respiratory muscle function in the elderly thus makes this population vulnerable to disease and disability.[7]This reduction associated with aging occur after 50 years of age and can interfere with coughing efficiency.[8]

Geriatric population shows various cardio-respiratory changes like Degeneration of heart muscle, Decreased heart rate, Decreased myocardial contractility, Increased cardiac output during maximum exercise for cardiac system whereas Decreased total lung capacity & Increased residual volume, Decreased Forced Expiratory Volume. [FEV1], Decreased ciliary action to clear secretion, Decreased strength of respiratory muscle, Chest wall becomes rigid results in increased work of breathing for the respiratory system.[9] Cardio respiratory fitness[11], Physical fitness[12]and physiological components are considered to be more affected in geriatric patients.[10] Skilled components include agility, balance, co-ordination, speed, power and reaction time. Health components include cardio-respiratory endurance, muscular endurance, muscular strength, body composition & flexibility are the other factors that also affect this population.[11,12]

The conventional exercise program, which is commonly used in clinical setting, involves a more generalized approach to physical fitness training.[13]this program typically includes a combination of aerobic exercises, resistance training, and flexibility exercises without a specific focus on cardio-respiratory firness.[14] Previous researchers have stated that exercise can also help to reduce risk of many non-communicable diseases. Exercise has been shown to reduce the risk of coronary heart disease, stroke, certain types of cancers and diabetes, prevent post-menopausal osteoporosis and therefore reduce the risk of osteoporotic fractures, reduce the complications of immobility, reduce the risk of falls, improve mental/cognitive function, reduces stress/ anxiety and improve self- confidence.[15] An aerobic capacity is declined with combined effect of lowered maximum target heart rate, reduced myocardial contraction and consequently stroke volume, in addition to reduce maximum oxygen consumption.[16] An average respiratory rate for geriatric population is 12-28 breath/min.[17]

The optimal exercise protocols for maximizing physical function and performance in geriatric patients are still being explored.[18] Traditional exercise programs typically focus on general fitness training without specific attention to cardio-respiratory fitness, which plays a crucial role in overall physical function. In contrast, structured cardio-respiratory fitness protocols emphasize the development of cardiovascular strength specific to geriatric patient's need. To address this gap, the present study aims to find out the effect of a structured cardio-respiratory fitness protocol by comparing it with a conventional exercise program on physical function and performance in geriatric patients. After investigating the outcomes of these exercise interventions, this study aims to provide evidence-based recommendations to enhance the effectiveness of exercise programs for this population.

Methodology

The study design employed in this research is a quasi experimental study, specifically a pre-test post-test design with two groups. The study was conducted at Santosh college of physiotherapy in the outpatient department. Duration of the study was 6 months and a convenient sampling was used to select participants consisted of individuals residing in and around the Madurai district. A total of 60 based on G power test for sample size calculations, participants were selected in the study based on the inclusion criteria of age group 50 to 70 years both male and female with the BMI between 20 to 30, also those who have not undergone any cardiac surgery and who can walk at least with the stick. Whereas the patients with severe musculoskeletal, neurological, cardiovascular, psychological as well as who have received physiotherapy treatment in the last 6 months for improving lung function and those who were not willing to participate were excluded.

Later the nature of the study and interventions were explained to the subjects, and a written consent was obtained from those willing to participate. Pre-treatment outcome measures of physical function and performance, including variables such as respiratory rate, heart rate, systolic blood pressure, Borg scale and PEFR were recorded. The participants were allocated in two groups, Group A and Group B. Group A received the baseline treatment (conventional physiotherapy), while Group B received the structured cardio-respiratory fitness protocol. After 6 weeks, post-treatment assessments for physical function and performances were conducted using assessment tools, including respiratory and heart rate, systolic blood pressure, PEFR and Borg scale. Further both the pre and post treatment scores were used for statistical analysis.

Data Analysis:

For the analysis SPSS version 23.0 was used. Analysis was done by descriptive statistics. The Shapiro Wilk test was used for checking normality distribution of data. The data were normally distributed; demographic information was expressed in terms of mean ± standard deviation. Students paired sample t test was used for within group analysis for pre and post interventions in respective control and experimental groups, whereas independent t-test was used for compare the 2 groups. P<0.05 with 95% confidence interval was considered as significant.

Results

Table 1: Comparison of pre and post values of Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), and Rate of Perceived Exertion in Borg Scale in Control Group subjects.

No of Subjects	Values	HR		RR		PEFR		RPE in Borg Scale	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
30	Mean	76.4	82.3	9.9	12.2	339.1	426.7	6.1	3.6
	SD	7.16	1.34	2.32	1.51	802.32	2108.46	0.77	0.27
	T value	-6.4		3.71		-5.13		7.78	
	P value	0.00001		0.000793		0.000035		0.00001	

P<0.05[s***]

This table shows that the mean, standard deviation, t value and p value of Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), Rate of Perceived exertion in Borg scale in Control Group after the intervention of conventional physiotherapy guided by physiotherapists. There is statistically significant increase in Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), Rate of Perceived exertion in Borg scale after intervention of conventional physiotherapy in control group p<0.05***.

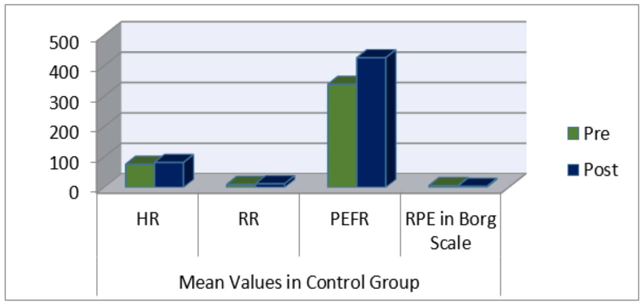

Fig 1: Pre and Post Mean Values of Parameters in Control Group

Table 2: Comparison of pre and post values of Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), and Rate of Perceived Exertion in Borg Scale in Experimental Group subjects.

No of Subjects	Values	HR		RR		PEFR		RPE in Borg Scale	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
30	Mean	74.8	85.5	10.4	16.3	379.9	480.3	6.5	2.5
	SD	8.18	3.39	0.93	0.9	2555.21	1214.46	0.28	0.28
	T value	-9.95		-13.78		-5.17		16.97	
	P value	0.00001		0.00001		0.000032		0.00001	

$P<0.05^{s***}$

This table shows that the mean, standard deviation, t value and p value of Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), Rate of Perceived exertion in Borg scale in Experimental Group after the intervention of Structure Cardio Respiratory Fitness Protocol guided by physiotherapists. There is statistically significant increase in Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), Rate of Perceived exertion in Borg scale after intervention of Structure Cardio Respiratory Fitness Protocol guided by physiotherapists in Experimental Group with $p<0.05^{***}$.

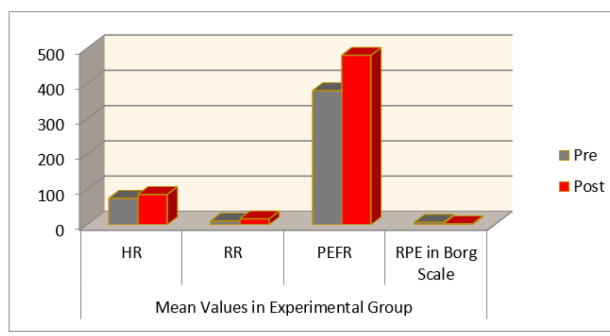

Fig 2: Pre and Post Mean Values of Parameters in Control Group

Table 3: Comparison of pre values of Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), and Rate of Perceived Exertion in Borg Scale between Control and Experimental Group to check homogeneity among groups.

No of Subjects	Values	HR		RR		PEFR		RPE in Borg Scale	
60	Group	Con	Exp	Con	Exp	Con	Exp	Con	Exp
	Pre Mean	76.4	74.8	9.9	10.4	339.1	379.9	6.1	6.5
	SD	7.16	8.18	2.32	0.93	802.32	2555.21	0.77	0.28
	T value	1.292		0.8763		-2.2269		-1.23771	
	P Value	0.10633		0.1962		0.019		0.115864	

$P>0.05^{Ns}$

This table shows that the pre mean, standard deviation, t value and p value of Heart Rate (HR), Respiratory Rate (RR), Systolic Blood Pressure (SBP), Peak Expiratory Flow Rate (PEFR), Rate of Perceived exertion in Borg scale between Control and Experimental Group before intervention. There is no statistically significant difference Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR)*** (Homogeneity is not maintained), Rate of Perceived exertion in Borg scale before intervention of conventional physiotherapy in control group $p>0.05^{NS}$. Thus homogeneity of values maintained between groups which is important prerequisite for experimental study.

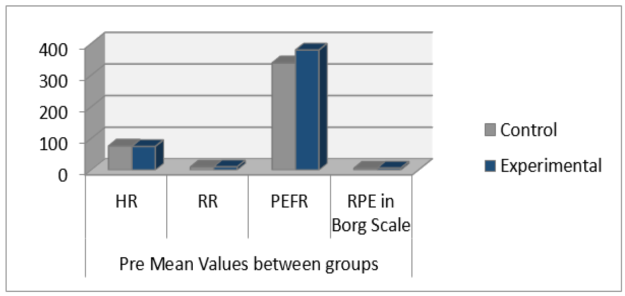

Fig 3: Pre-Mean Values of Parameters between Control and Experimental Group

Table 4: Comparison of post values of Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), and Rate of Perceived Exertion in Borg Scale between Control and Experimental Group to check significance between groups.

No of Subjects	Values	HR		RR		PEFR		RPE in Borg Scale	
60	Group	Con	Exp	Con	Exp	Con	Exp	Con	Exp
	Post Mean	82.3	85.5	12.2	16.3	426.7	480.3	3.6	2.5
	SD	1.34	3.39	1.51	0.9	2108.46	1214.6	0.27	0.28
	T value	-4.65122		-8.34978		-2.94039		4.71429	
	P Value	0.000099		0.00001		0.004373		0.000086	

$P<0.05^{***}$

This table shows that the post values of mean, standard deviation, t value and p value of Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), Rate of Perceived exertion in Borg scale in Experimental Group after the intervention of Structure Cardio Respiratory Fitness Protocol guided by physiotherapists. There is statistically significant increase in Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), Rate of Perceived exertion in Borg scale after intervention of Structure Cardio Respiratory Fitness Protocol guided by physiotherapists in Experimental Group when compared to control group post values with $p<0.05^{***}$.

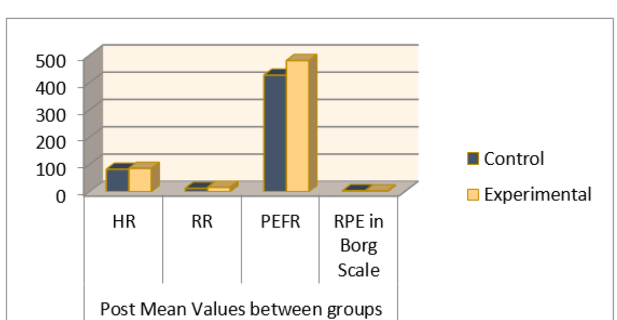

Fig 4: Post Mean Values of Parameters between Control and Experimental Group

Discussion

The findings of this study demonstrate a significant improvement in various variables before and after the intervention in both the control and experimental groups (refer to Table 1 and Table 2). The pre-intervention values of heart rate (HR), respiratory rate (RR), peak expiratory flow rate, and rate of Perceived exertion in Borg's scale were similar between the control and experimental groups, indicating homogeneity (refer to Table 3). However, the post-intervention Mean values of HR, RR, peak expiratory flow rate, and Borg scale in the experimental group showed statistically significant improvement compared to the control group, with p-values less than 0.05 (refer to Table 4). Therefore, the null hypothesis has been rejected, and the alternative hypothesis has been accepted in this study. These improvements in the variables suggest that the structured cardiorespiratory fitness protocol training provided to the geriatric subjects during the study intervention period contributed o enhanced physical function and performance.

In the geriatric population, cardiorespiratory changes such as decreased lung function, lung capacity, and strength of respiratory muscles can adversely affect normal physical function. However, when cardiorespiratory fitness improves, it directly enhances physical function among geriatric patients. This study aligns with the research work conducted by Sarawut J. et al., which highlights the effects of pursed-lip breathing exercise using a windmill on lung function and respiratory muscle strength in the elderly. Ageing leads to a decline in lung function and a reduction in respiratory muscle strength.[19]

Another study by Jin-Seop Kim et al. investigated the impact of balloon blowing exercise on lung function in young adult smokers. The study aimed to determine the lung capacity improvements when using a balloon blowing exercise to enhance patients' ling function. Same concept was used in the current study which showed the balloon blowing exercise was found to improve physical functions in geriatric patients. Recent study reinforces the notion that the geriatric population experiences reduced physical function and performance due to the aging process. However, administering a structured cardiorespiratory fitness protocol can significantly improve these factors among geriatric individuals.[20]

This study had several limitations that need to be considered. Firstly, the sample size was less. Additionally, the study suffered from limited supervision, potentially affecting the quality and effectiveness of the treatment. Another constrain was the smaller number of sessions. Finally, the program focuses exclusively on geriatric patients, which excludes other age groups who may also benefit from the treatment. These limitations highlight the need for further considerations and potential modifications to enhance he inclusivity and effectiveness of the program.

Conclusion

It is concluded that the structured cardio-respiratory fitness protocol training has a statistically significant improvement on physical function and performance in the geriatric population, and the structured cardio-respiratory fitness protocol has a statistically significant improvement in heart rate (HR), respiratory rate (RR), peak expiratory flow rate (PEFR), and the Borg-RPE scale, which reflect physical function and performance in geriatric patients.

Several recommendations and suggestions can be considered such as increasing the sample size, extending the intervention sessions, applying treatment with greater precision and tailored approaches can enhance its effectiveness and address individual needs more effectively. Follow up can be implemented in order to enhance the inclusivity, effectiveness, and long-term outcomes of the treatment program.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT:

Author a: Conceptualization, Formal Analysis, Methodology, Writing – Original Draft, Project Administration.

Author b: Conceptualization, Investigation, Writing – Original Draft, Writing – Review and Editing, Investigation, Project Supervision.

Author c: Formal Analysis, Data Collection, Methodology, Investigation.

Author d: Formal Analysis, Data Collection, Methodology, Investigation.

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The Effectiveness of Virtual Reality Along with Task Specific Training on Quality of Life of C6-C7 Level- Incomplete Spinal Cord Injury Patients.

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Abstract

Background: Spinal cord injury is a devastating condition. In recent years, traumatic spinal cord injury has become one of the major disabling conditions in young males. These chronic complications negatively impact patients' functional independence and thus affect the quality of life.

Methods: Thirty-seven spinal cord injury patientsC6-C7 with American Spinal Cord Injury Association (C, D) who full-filled the inclusion criteria were recruited, out of which 7 discontinued the therapy program, 15 spinal cord injury patients in Group I (Virtual Reality with Task Specific Training) and 15 spinal cord injury patients in the Group II (only task specific) completed the study. Virtual Reality training was given as an intervention using NIRVANA which is a semi-immersive Virtual Reality training.

Results: Group I, which received only Task Specific Training, revealed a statistically significantly positive change in Quality of life ($Z = -2.671$, $p = 0.008$) with a medium effect size of ($r = 0.48$). For Group II, which received Virtual Reality along with Task Specific Training, revealed a statistically significantly positive change in Quality of life ($Z = -3.415$ $p = 0.001$) with a large effect size of ($r = 0.62$)

Conclusion: Both the groups showed significant positive improvements in quality of life in spinal cord injury patients, indicating that both task-oriented training and the use of Virtual Reality as treatment modalities have a direct impact on QoL. However, more significant improvement was seen in Group 2 where Virtual Reality was combined with Task Specific Training.

Key words: Virtual Reality Training, Spinal Cord Injury, Task Specific Training, Quality of Life

Introduction

Spinal cord injury is a devastating condition. In recent years, traumatic spinal cord injury has become one of the major disabling conditions in young males.[1]India is a developing country with men being the bread winners of the family. Hence, these young males who are the sole bread winners of the family when they become physically challenged due to spinal cord injury, not only the client but also

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the whole of the family gets affected.[2] Spinal Cord Injury can cause an impact on the psychology of the client, can lead to family breakdown, lead to delay or no return to work, difficulty in maneuvering in the physical environment, which presents itself as a barrier, the client develops negative attitudes.[3]

According to WHO, spinal cord injury may result in temporary or permanent changes in an individual's motor, sensory and automatic functions. Every year, 250000 and 500000 people around the world suffer from spinal cord injury.[4]

The World Health Organization defines QOL as an individual's perception of their position in life in the context of the cultural system and values where the person lives, taking into account goals, expectations, standards and concerns.[5] Cervical level injuries have chronic long-term complications including respiratory, cardiovascular, urinary and bowel complications, spasticity pain syndromes and bone fractures are also common. These chronic complications negatively impact patients' functional independence and thus affect quality of life.[6] Bernard et al in a study reported that the quality of life in patients with SCI is decreased.[7]

When the injury is at the cervical level, the impairment of arm and hand function is evident. This, in turn, can render the SCI patient visibly dependent on the caregiver, thus increasing the caretakers' burden, and loss of client' independence leading, to poor quality of life. VR based therapies to reduce disability and enhance quality of life have been used successfully in other neurological conditions.[8]

Virtual Reality (VR) is "the use of interactive simulations created with computer hardware and software to present users with opportunities to engage in environments that appear and feel similar to real world objects and events".[9,10] Participants interact with projected images, maneuver virtual objects and perform activities programmed into the task, giving the user a sense of immersion in the simulated environment. VR training aims to improve neural plasticity by providing a safe and enriched environment to perform functional task-specific activities with increased repetitions, intensity of practice, and motivation to comply with the intervention.

Motor learning is acquisition and /or modification of movement and the motor control is movement already required. In motor learning, feedback is very important. VR provides real time feedback to the clients. It uses equipment to show internal physiological events in the form of visual and auditory signals. Feedback provided by VR through repetitive and intense and challenging impairment- oriented training through augmented feedback. There are broadly three types of VR, they are Immersive, Semi-immersive and non-immersive VR. Semi-immersive VR uses 2D displays with a limited field of view, computer augmented visual environment (CAVE) or a large screen.

Amanda Vitória Lacerda de Araújo , Jaqueline Freitas de Oliveira Neiva , Carlos Bandeira de Mello Monteiro , Fernando Henrique Magalhaesin their metanalysis of 25 articles on VR in rehabilitation of SCI, reported that VR-based rehabilitation in subjects with SCI may lead to positive effects on aerobic function, balance, pain level, and motor function recovery besides improving psychological/ motivational aspects. Further high-quality studies are needed to provide a guideline to clinical practice and to draw robust conclusions about the potential benefits of VR therapy for SCI patients.

In the present study, a trial was made to find out the effect of Virtual Reality along with Task Specific Training in C6-C7 incomplete Spinal Cord Injury clients.

Methods

Thirty-seven SCI patients who full-filled the inclusion criteria were recruited from the Department of Occupational Therapy, Swami Vivekananda National Institute of Rehabilitation Training and Research, Cuttack, Odisha, between June 2020-December 2022. Out of 37 patients recruited, 5 patients discontinued the therapy program due to some problem at their home front and 2 clients opted out of the study. Finally, 15 SCI patients in Group I VR with Task Specific Training (TST) and 15 SCI patients in the Group II only Task Specific Training (TST) completed the study. Written informed consent was taken from all the participants.

Inclusion criteria

a) C6-C7 Incomplete Spinal Cord Injury with ASIA (C, D)

b) Traumatic SCI cases;

c) Individuals with poor performance in activities of daily living (eating, dressing, grooming etc).

Exclusion criteria

a) Contracture of hand;

b) Orthopedic disorder;

c) Documented- psychiatric illness, visual problems

d) mini-mental state examination (score less than 24)

Intervention

VR training was given using NIRVANA which is a semi-immersive VR, based on the principle of creating a relationship between the user and a virtual environment. In this VR the client moves the hand to manipulate the virtual environment. The task can be customized to allow the patient to perform active movement of the shoulder, elbow, wrist and hand. The exercises can be tailored to train the muscles of the upper limb. As gaming was incorporated and real time feedback is received both through audio & visual feedback, the clients get engaged actively and focus on the task rather than the movements.

Two tasks were given to patients- airhockey and painting the landscape. The clients also received the following task specific repetitive training.

Table 1:

Activity	**Time**	**Progression and Adaptation**
Open covered pots of different sizes and transfer flour to a cup with a spoon, then close the pot	5 min	Progression: Increase the speed and the number of repetitions
Pick up coins and cards from the table and put the coins in a pot and gather the cards	5 min	Progression: Increase both the speed and the number of coins and cards on the table
Write and/or draw pictures on a piece of paper	5 min	Progression: Increase the number of words or pictures as well as the degree of difficulty of the pictures to be drawn
Open a safe box, pick up small objects inside the box, and transfer them to a pot, then lock the safe box.	5 min	Progression: Increase both the speed and the number of objects inside the box
Pick up and transfer jars, bottles, and glasses of different sizes and weights located on a table. Transfer the liquid contents from jars and bottles to glasses	5 min	Progression: Increase the speed as well as the distance from the object to be reached
Throw and catch balls (in pairs)	5 min	Progression: Increase both the speed and the distance from the players

Results

A total of 37 clients were enrolled in this study. Out of 37 patients recruited, 5 patients discontinued the therapy program due to some problem at their home front and 2 clients opted out of the study. A total of 30 patients were included in the study (26 Males and 4 Females) They were further divided into two groups having 15 participants each- Group 1 (12 Males and 3 Females) had an age range of 40.73 $\pm$ 12.16 & Group 2 (14 Males and 1 Female) had an age range of 33.93 $\pm$12.59. Group 1 was administered with only TST and Group 2 was given TST along with VR as a mode of intervention.

In order to evaluate changes after intervention for Group I, which received only TST, Wilcoxon Signed Rank Test revealed a statistically significantly positive change in Quality of life ($Z = -2.671$, $p = 0.008$) with a medium effect size of ($r = 0.48$)

Group 1 (TST) within group analysis.			
PRE-TEST MEAN	**POST-TEST MEAN**	**Asymptotic Sig. (p)**	**Test statistic (Z)**
42 ±11.28	47.48 ± 10.74	0.008	-2.671

Table 2 shows the pretest- posttest within group analysis of Group 1. It is observed that there is a statistically significant improvement in QoL after intervention.

For Group II, which received VR along with TST, Wilcoxon Signed Rank Test revealed a statistically significantly positive change in Quality of life (Z = -3.415 p = 0.001) with a large effect size of (r = 0.62).

Group 2 (TST + VR) within group analysis.			
PRE-TEST MEAN	**POST-TEST MEAN**	**Asymptotic Sig. (p)**	**Test statistic (Z)**
37.51 ± 8.3	46.45 ± 8.8	0.001	-3.415

Table 3 shows the pretest- post-test within group analysis of Group 2. It is observed that there is a statistically significant improvement in QoL after intervention.

To evaluate the difference between the improvements in quality of life for the two groups, Man Whitney U Test was utilized. The test revealed a significant difference between Group I, which received TST, and Group II, which received both VR and TST as a form of intervention. The test revealed significant differences between Group I

(Median = 6.25 , N= 15) and Group II (Median = 9.00 , N = 15) , p = 0.011.

IMPROVEMENT IN QoL (Between group analysis)			
TREATMENT	**N**	**Mean± SD**	**Asymptotic Sig. (p)**
TST	15	6.3 + 3.97	0.011
VR + TST	15	8.9 ± 2.67	

Table 4 shows between group analysis of improvements in Quality of life scores. It is observed that there is a statistically significant difference in improvement of QoL between both groups. Group II was found to have better effectiveness.

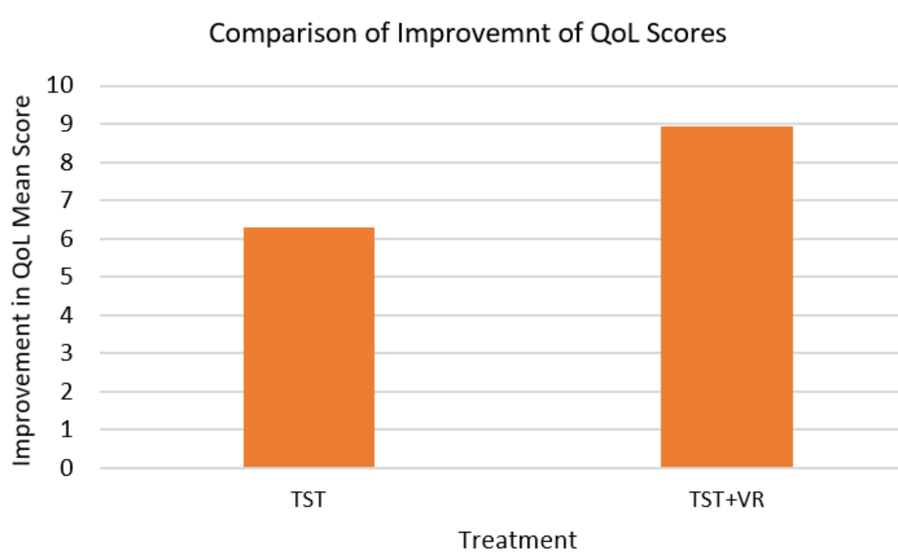

Fig 1 shows the comparison of improvement in QoL scores between the groups.

Furthermore, Mann Whitney U test was utilized to compare the improvement between the domains of the WHOQOL-BREF scale (Physical Domain, Psychological Domain, Social Domain and Environmental Domain) between the two groups.

SL.NO.	DOMAINS	TREATMENT	N	MEAN±SD	Asymptotic Sig. (p)
	Physical Domain	TST	15	14.6 ± 14.5	
		VR + TST	15	10.33 ± 8.6	0.624
2.	Psychological Domain	TST	15	4.3 ± 3.4	
		VR + TST	15	5.0 ± 2.6	0.267
3.	Social Domain	TST	15	5.4 ± 5.3	
		VR + TST	15	8.8 ± 6.3	0.148
4.	Environmental Domain	TST	15	3.3 ± 3.9	
		VR + TST	15	11.5 ± 3.0	0.00

Table 5: shows the between group analysis of improvements in the physical, psychological, social and environmental domains of Quality of life scores. It is observed that there is no significant difference between both groups of physical, psychological, and social domains. However, it is observed that there is a statistically significant difference in improvement in the environmental domain between both the groups. Group II showed to have performed better.

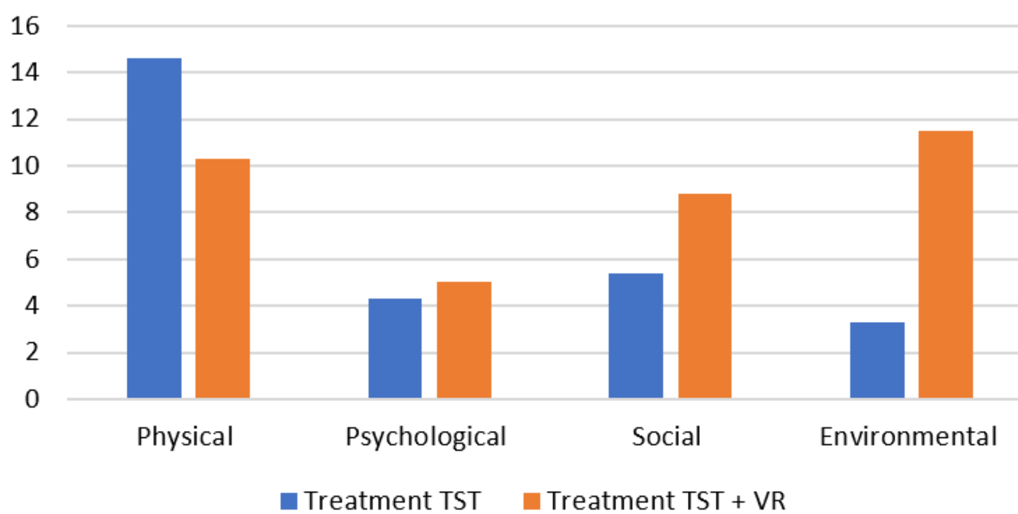

Fig. 2 shows the comparison of improvement in physical, psychological, social and environmental domain scores between the groups.

Discussion

VR systems are being widely used for neuro-rehabilitation and improving the quality of life. Iulia et. al in a 2020 study commented that in VR complex movement tasks for both upper and lower extremities are practiced in a gamified setting, encouraging self-improvement and competition. The VR training shows promising results in terms of accuracy and feedback, thus proving as an effective tool for enhancing the overall quality of life of a patient.[11] The results of the study revealed that both the groups showed significant positive improvements in quality of life in SCI patients, indicating that both TST and the use of VR as treatment modalities have a direct impact on QoL. However, more significant improvement was seen in Group 2 where VR was combined with TST.

It was interesting that in the individual domains of the WHOQOL-BREF scale, it was only the environmental domain that showed a significant difference in improvement between the two groups. The other 3 domains, namely- Physical, Psychological and Social Domains, showed improvements in mean scores were the same across the two groups. The improvement in Psychological, Social and

Environmental Domains was better in the group that received VR as intervention; the opposite was witnessed for the physical domain.

In a similar study as the present one was carried out by Arshad et al on Stroke patients in 2020 where the first group was subjected to VR along with task oriented training and the second group was subjected to only task oriented training, to improve mobility, physical performance and balance, the results showed that better improvement in the first group where VR was used.[12]VR helps in health improvement with positive effects on motivation, self-confidence, commitment, active participation in Spinal Cord injury patients as found in a systematic review by Orsatti et.al., in 2021. It also concluded that VR technology is an effective tool of neurorehabilitation complementary to conventional therapies and promotes functional improvement in SCI patients in all types of settings.[13]Biofeedback enables motor control during activities and thus mediates use-dependent plasticity in trained neuromotor systems.

Augmented biofeedback is a task- oriented paradigm. Feedback given to clients is knowledge of performance and knowledge of result as the client is able to receive the information of his/her training during and after the exercise.

Feedback received is important in motor learning. Hence, motor learning emerges from a complex perception, cognition and action process that is similar to motor control. The results reveal that the physical health domain of the Quality-of-life scale improved the most followed by social relationship domain, psychological and environmental domain, thus suggesting that SCI patients have poor quality of life pertaining to physical and functional limitations and with the use of VR there is a significant improvement in the mentioned domains. However, a recent systematic review (Catalin et al, 2022) showed that there were no beneficial effects of VR Based Therapy on functional performance or quality of life in Spinal Cord Injury patients, however when taken together with conventional therapy it acted like a complementary package and results achieved were positive. [14] The present study concludes that VR is an effective mode of therapy. When combined with TST, higher level Spinal Cord Injury patients receive benefits in improving their quality of life. Future research for all levels and types of SCI must be carried out to generalize the conclusion.

Ethical Clearance was taken from the departmental ethical committee.

Source of Funding: Self.

Conflict of Interest: Nil.

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Appendix

Declaration of Helsinki

We, Mrs. Pragyan Singh and Dr. Amitabh Dwivedi the authors of the research paper titled "The effectiveness of virtual reality along with task specific training on quality of life of C6-C7 level-incomplete spinal cord injury patients." submitted to the Indian Journal of Physiotherapy & Occupational Therapy on 19th December 2023 for the purpose of publication solemnly declare that we have abided by the guidelines mentioned below to the truest of our abilities.

We declare that:

1. "The health of my patient will be my first consideration," and in accordance with the International Code of Medical Ethics we declare that, "We have acted in the patient's best interest when providing medical care."
2. It is our duty to promote and safeguard the health, well-being and rights of patients, including those who are involved in medical research. Our knowledge and conscience are dedicated to the fulfillment of this duty.
3. We acknowledge that- Medical progress is based on research that ultimately must include studies involving human subjects.
4. We consider that- The primary purpose of medical research involving human subjects is to understand the causes, development and effects of diseases and improve preventive, diagnostic and therapeutic interventions (methods, procedures and treatments). Even the best proven interventions must be evaluated continually through research for their safety, effectiveness, efficiency, accessibility and quality.
5. Medical research is subject to ethical standards that promote and ensure respect for all human subjects and protect their health and rights.
6. While the primary purpose of medical research is to generate new knowledge, this goal can never take precedence over the rights and interests of individual research subjects.
7. It is our duty to protect the life, health, dignity, integrity, right to self-determination, privacy, and confidentiality of personal information of research subjects. The responsibility for the protection of research subjects must always rests with us and never with the research subjects, even though they have given consent.
8. We have considered the ethical, legal and regulatory norms and standards for research involving human subjects in their own countries as well as applicable international norms and standards. No national or international ethical, legal or regulatory requirement has been violated in any way.
9. We have combined medical research with medical care and involved patients in research only to the extent that this is justified by its potential preventive, diagnostic or therapeutic value and we have good reason to believe that participation in the research study will not adversely affect the health of the patients who serve as research subjects.
10. All medical research involving human subjects is preceded by careful assessment of predictable risks and burdens to the individuals and groups involved in the research in comparison with foreseeable benefits to them and to other individuals or groups affected by the condition under investigation. Measures to minimize the risks were implemented.
11. We acknowledge that- Medical research involving human subjects conforms to generally accept scientific principles and is based on a thorough knowledge of the scientific literature, other relevant sources of information, and adequate laboratory.
12. The design and performance of each research study involving human subjects has been clearly described and justified in a research protocol. The protocol contains a statement of the ethical considerations involved and indicates how the principles in this Declaration have been addressed. The protocol includes information regarding funding, sponsors, institutional affiliations, potential conflicts of interest, incentives for subjects and information regarding provisions for treating and/or compensating subjects who are harmed as a consequence of participation in the research study.
13. Every precaution has been taken to protect the privacy of research subjects and the confidentiality of their personal information.
14. Participation by individuals capable of giving informed consent as subjects in medical research was voluntary.
15. Each potential subject has been adequately informed of the aims, methods, sources of funding, any possible conflicts of interest, institutional affiliations of the researcher, the anticipated benefits and potential risks of the study and the discomfort it may entail, post-study provisions and any other relevant aspects of the study.
16. Researchers, authors, sponsors, editors and publishers all have ethical obligations with regard to the publication and dissemination of the results of research. Researchers have a duty to make publicly available the results of their research on human subjects and are accountable for the completeness and accuracy of their reports. All parties should adhere to accepted guidelines for ethical reporting. Negative and inconclusive as well as positive results must be published or otherwise made publicly available. We will abide by the same.

Signature

Principal Investigator:
Mrs. Pragyan Singh

Co-PI
Dr. Amitabh Dwivedi

Original Research Article

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Physical Activity of Undergraduate Students in Medicine and Physiotherapy Programmes in a Nigerian Medical University

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Abstract

Background: There appears to be dearth of empirical data to ascertain the physical activity level of Nigerian undergraduate students, especially among medical students. Hence, there would be need to investigate the physical activity level of students in a Nigeria university community.

Aim: The aims of the study were to assess and compare the physical activity of undergraduate students studying Medicine and Physiotherapy.

Methods: Two hundred and sixteen undergraduate students studying Medicine and Physiotherapy were recruited using Stratified sampling technique. The International Physical Activity Questionnaire was administered to each student and the data generated was used to compute the Physical activity scores of each participant. Descriptive statistics and Inferential statistics of ANOVA and Independent t-test (student) were used to compare physical activity of the students.

Results: The results obtained from this study showed skewness in the mean Physical Activity of students at different studying levels due to some that are physically hyperactive. There was no significant difference in the overall Physical Activity of students studying medicine and physiotherapy. However, there were significant differences in the vigorous physical activity of the students ($F= 2.54$, $p = 0.04$). The mean vigorous physical activity of 500 level students studying physiotherapy was significantly higher than that of the 400 level students studying in both programmes ($p=0.003$ and $p = 0.032$ respectively). There were no significant differences between in the vigorous activity of the final year students in physiotherapy and medicines; and between male and female, although, the sitting PA of female undergraduate students was significantly higher that of male.

Conclusion: There was no significant difference in the total physical activity of students studying medicine and physiotherapy. Similarly, there was no significant difference in the physical activity of male and female students, excluding that of sitting component of physical activity score which was higher for the later.

Keywords: Comparative analyses, Physical activity, Medicine, Physiotherapy.

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Introduction

Physical activity (PA) is a non-pharmacological therapy that has significant positive physiological and psychological effects coupled with improved academic achievement and mental health in young adults[1234]. The PA has become a healthy behavior that must be considered in all public health policy system in both developing and developed countries[5].

There is a documentation that over 80% of the global populations of young people in schools fell below the standard recommendations of 60 minutes of moderate-to vigorous physical activity per day[6,7]. The level of structured exposure of students to PA in university is not as high as that of those in the junior schools, and despite this, the emergence of new social networks is promoting sedentary lifestyle which subsequently leads to stress and alteration in the psychological well-being of university students[8]. Most universities have environment and facilities for physical activity but these are underutilized[9]. In a study conducted in Poland, most medical students did not engage in any form of Physical activity, attributing it to lack of time as they are mostly struggling to meet up with academic obligations[10]. In India, physiotherapy students were found to have low to moderate level of physical activity[11]. However, the physical activities of Nigeria medicine and physiotherapy students are relatively unknown. Also, it's generally believed that students studying medicine are involved in more sedentariness than other students but this is a speculation without empirical support.

Materials and Methods

Participants

The participants in this study were 216 undergraduate students of Medicine and Physiotherapy Departments at the University of Medical Sciences, Ondo, Ondo State, Nigeria. The study period was (Feb 2023 to October 2023).

Inclusion and Exclusion Criteria

Included in the study were students in the clinical years, studying Physiotherapy (400 and 500 levels) and Medicine (400 to 600 levels). They were students who formally registered for required courses and excluded are those who didn't consent to participate or had chronic medical illness and musculoskeletal disease or disability that may impair physical functions. The sites of study were at lecture rooms of the University of Medical Sciences, Ondo.

Sampling Technique

Stratified sampling technique was used to recruit students from the department of Medicine and Physiotherapy. The total number of students in each level and departments were collated according to Matriculation numbers. The lists of male and female students in each level were separated and all students who fell on odd serial numbers in each list were recruited for the study.

Research Design

The design was a mixture of cross-sectional survey and comparative study.

The sample size that was used for this study was computed to be 150 using the Smith's formula[12]. However, 216 students were recruited for this study in other to give room for attrition.

Instruments

A proforma questionnaire was used to collect data on age, gender, level of study, department and other sociodemographic information of each student while International Physical Activity Questionnaire (IPAQ) was used to determine the Physical Activity Level of each participant. The Scoring was based on a metric called METs, which are multiples of the resting metabolic rates. MET levels: Light-3.3METs, Moderate-4.0METs, Vigorous-8.0 METs. The scoring was categorized into low, moderate and high physical activity level.

Category 1: Low - This is the lowest level of physical activity. Those individuals who do not meet the criteria for categories 2 or 3 are considered to have low physical activity level

Category 2: Moderate- Any one of the following three criteria:

1. 3 or more days of vigorous activity of at least 20 minutes per day or
2. 5 or more days of moderate -intensity activity or walking of at least30 minutes per day
3. 5 or more days of any combination of walking, moderate -intensity or vigorous intensity activities achieving a minimum of at least 600 MET-min/week

Category 3: High – Any one of the following two criteria:

1. Vigorous -intensity activity on at least 3 days and accumulating at least 1500 MET-minutes/week
2. 7 or more days of any combination of walking, moderate -intensity or vigorous intensity activities achieving a minimum of at least 3000MET-minutes/week. Physical activity level is a standardized categorical variable describes as low, moderate and high/vigorous[13]. (Craig et al, 2003).

Procedure

Ethical approval was obtained from the Research and Ethics Committee of the University of Medical Sciences, Ondo (NHREC/TR/UNIMED-HREC-Ondo.St/22/06/21). The purpose of the research work was explained to the participants. The IPAQ questionnaire was administered to physiotherapy and medicine students, and in order to maintain anonymity, participants' name and address were not required to be filled in the questionnaire. The students who consented to participate were given the copy of the questionnaire which were filled and returned immediately. The data generated from the IPAQ questionnaire was used to compute the Physical activity and the scores to be obtained were used to classify the participants to categories, Low Physical activity, Moderate Physical activity and Vigorous Physical activity

Analyses

Descriptive statistics of mean and standard deviation were used to analyze the data generated. The Inferential statistics of independent t-test (student) was used to compare physical activity of male and female students in Medicine and Physiotherapy based on level of study and gender. The ANOVA was used to compare selected anthropometric parameters and physical activity of students at different levels. Level of statistical significance, P, is set at 0.05. Level of confidence is 95%. Data was analyzed using Statistical package for social sciences (SPSS 21).

Results

The result showed that among 400 level students in physiotherapy, there are 23(48.9%) male while there are 24(51.1%) female. Forty-six (95.8%) are single while only two (4.2%) are married. The result showed that there are 21(55.3%) male while they are 17(44.7%) female. Thirty-seven (94.9%) are single while only two (5.1%) are married. There are 21(46.7%) male and 24(53.3%) female. Forty-five (97.8%) are single while only one (2.2%) is married. The other student's level, gender, anthropometrics parameters and marital status are presented in table 1 while age classifications are in table 2. The result of analysis of variance (ANOVA) showed that there were no significant differences in the height, weight and BMI of all the students (Table 3).

Table 1: Selected Anthropometrics Parameters of all the Students

Variables		Height Mean ± SD	Weight Mean ± SD	BMI Mean ± SD
400L	Medicine	1.68 ± 0.12	62.23 ± 12.53	22.17 ± 5.11
	Physiotherapy	1.74 ± 0.09	65.56 ± 10.09	21.89 ± 2.99
500L	Medicine	1.70 ± 0.13	65.89 ±10.54	23.06 ± 4.24
	Physiotherapy	1.70 ± 0.11	64.29 ± 12.06	22.78 ± 4.44
600L	Medicine	1.69 ± 0.11	61.79 ± 12.33	22.14 ± 5.22

Table 2: Age Classifications of all the Students

Variables		Age Classification	Frequency	Valid Percentage%
400L	Medicine	15- 20	16	33.3
		21-25	27	56.3
		26-30	5	10.4
	Physiotherapy	15-20	11	26.8
		21-25	30	73.2
500L	Medicine	15-20	16	34.8
		21-25	25	54. 3
		26-30	5	10.9
	Physiotherapy	15-20	9	17.0
		21-25	40	75.5
		26-30	4	7.5
600L	Medicine	21-25	18	64.3
		26-30	9	32.1
		>30	1	3.6

Table 3: Comparison of the anthropometrics parameters of the students

Variables		**Sum of squares**	**Df**	**Mean Square**	**F**	**p**
Height	Between groups	0.088	4	0.22	1.803	0.130
	Within groups	2.414	198	0.12		
	Total	2.502	202			
Weight	Between groups	557.954	4	139.488	1.017	0.399
	Within groups	28654.236	209	209	137.102	
	Total	29212.190	213			
BMI	Between groups	33.112	4	8.278	0.398	0.810
	Within groups	4116.537	198	20.791		
	Total	4149.649	202			

The result showed that the total mean physical activity level of 400 level students studying medicine was 8090.44 ± 12662.82MET minutes/week with skewness of 2.124. The mean vigorous activity level was 762.33 ± 1273.93 MET minutes/week with skewness of 1.578 while the moderate physical activity level was 1978.67 ± 6138.48 MET minutes/ week with skewness of 4.340. The Physical activity of 400 level students studying physiotherapy was 3216.52 ± 3440.65 MET minutes/week with skewness of 2.621. The mean vigorous activity level was 270.24 ±982.03 MET minutes/week with skewness of 3.947 while the moderate physical activity level was 945.27 ±2124.60 MET minutes/week with skewness of 3.880. The results of that PA Levels are presented in table 4.

Table 4: The Vigorous, Moderate and Walk Physical Activity of all the Students

	Variables	**Vig.P. A Mean* ± S. D**	**Mod.P. A Mean* ± S. D**	**Walk MET Mean* ± S. D**
400 Level	Medicine	762.33±1273.93	1978.67±6138.48	4177.53±11035.30
	Physiotherapy	270.24 ±982.03	945.27 ±2124.60	858.81±1335.06
500 Level	Medicine	739.13 ±1267.74	2052.17 ±6262.67	4359.16±11241.92
	Physiotherapy	1892.83 ±4494.34	1438.11 ±2539.10	1455.11±2459.04
600 Level	Medicine	1687.14 ±3089.08	1411.59 ±4002.49	1177.76 ±1681.70

* MET minutes/week

Table 5: The Sitting Component and Total Mean Physical Activity of all the Students

	Variables	Sitting PA Mean* ± S. D	Total PA Mean* ± S. D
400 Level	Medicine	1171.91±995.17	8090.44±12662.82
	Physiotherapy	1142.20±646.81	3216.52 ± 3440.65
500 Level	Medicine	1162.60±1008.25	8313.07±12892.6
	Physiotherapy	826.68±527.57	5612.74 ± 6490.38
600 Level	Medicine	1366.20 ±1117.25	42222.00± 5584.51

*MET minutes/week

Table 6: The Skewness in the data for Physical Activity (Walk and Sitting Components)

	Variables	Walk PA Skewness	Sitting PA Skewness
400 Level	Medicine	2.931	0.852
	Physiotherapy	2.615	0.780
500 Level	Medicine	2.853	0.876
	Physiotherapy	2.835	-0.100
600 Level	Medicine	1.735	1.295

Table 7: Vigorous, Moderate, Walk, Sitting and Total Mean Physical Activity of Male and Female Gender

Physical activity	Gender	Mean ± S.D (MET min/week)	T	p
Vigorous	Male	1019.50 ± 2604.88	-0.314	0.360
	Female	1140.74 ± 2910.07		
Moderate	Male	938.10 ± 2007.01	-1.970	0.001
	Female	2160.30 ± 6089.69		
Walk	Male	2282.55 ± 6428.09	-0.670	0.156
	Female	3000.10 ± 8820.46		
Sitting	Male	875.79 ± 722.07	-3.666	0.013
	Female	1312.76 ± 976.62		
Total PA	Male	5105.43 ± 7652.82	-1.848	0.008
	Female	7613.89 ± 11563.350		

The result of the Analysis of Variance (ANOVA) showed that there were no significant differences in the total mean physical activity of students studying medicine and physiotherapy. However, there were significant differences in the vigorous physical activity of the students (F= 2.54, p = 0.04). The result of the Post hoc analysis (LSD) showed that the mean vigorous physical activity of 500 level students studying physiotherapy was significantly higher than that of the 400-level student of studying physiotherapy (p=0.003) and that of the 400 level students studying medicine (p= 0.032). There was no significant difference between in the vigorous activity of 500 level physiotherapy and 600 level medicine students. The result of the analysis of variance (ANOVA) of the vigorous, moderate, walk, sitting and total MET are presented in table8 and table 9 and the post hoc of the vigorous physical activity of all the students are presented in table 10.

Table 8: comparison of the vigorous, moderate and walk physical activity

	Physical Activity	Sum of square	Df	Mean square	f	p
Vigorous	Between groups	70433816.23	4	17608454.06	2.543	0.041
	Within groups	1364132901	1364132901	197	6924532.492	
	Total	1434566717	201			
Moderate	Between groups	35576377.87	4	8894094.468	0.396	0.812
	Within groups	4449333760	198	22471382.63		
	Total	4484910138	202			
Walk	Between groups	490715329.5	4	122678832.4	2.053	0.088
	Within groups	11831556021	198	59755333.44		
	Total	12322271350	202			

Table 9: Comparison of Sitting and Total Physical Activity

Physical Activity		Sum of squares	Df	Mean square	F	p
Sitting	Between groups	4453143.757	4	1113285.939	1.603	0.175
	Within groups	137495617.8	198	694422.312		
	Total	141948761.6	202			
Total	Between groups	774447563.8	4	193611891.0	1.994	0.097
	Within groups	19224810218	198	97095001.10		
	Total	19999257782	202			

Table 10: Results of Post Hoc Analyses of the Vigorous Physical Activity

Physical Activity	Level (i)	Level (j)	Mean Difference (i-j)	P
Vigorous	500 Level Physiotherapy	400L Physiotherapy	1662.59	0.003
		400L Medicine	1130.50	0.032
		500L Medicine	1153.70	0.31
		600L Medicine	692.83	0.382
	400 Level Medicine	500L Medicine	-23.20290	0.966
		600L Medicine	-437.66667	0.585
	500 Level Medicine	600L Medicine	-460.86957	0.567

Discussion

Physical inactivity is the fourth leading risk factor for global mortality (6% of death globally) according to WHO on Global Recommendation on Physical Activity for Health. Physical inactivity has become the major implication for the prevalence of cardiovascular disease, hypertension, type II diabetes, stroke, osteoporosis, anxiety, depression, lipid disorder. Worldwide, 31% of adults are estimated to be physically inactive and these levels are rising with major public health implications[14].

The mean Physical Activity levels obtained in this study ranged from 3216.52 to 8,313.07 MET among the students. The PA observed in this current study is similar to that of Adenle[15] which was among health professionals. Although, Adenle[15] reported abysmally very low physical activity level of 235.88 ± 211.82 MET in some health professionals. Considering the high level of PA observed in this study, there is likelihood that the students will have good academic performance because physical activity has been proven to improve academic performance in schools[16]. The findings of this current study also showed that most of these students have moderate to high PA. Some factors have been attributed to contributing to low levels of physical activity and this included lack of time, access to safe and convenient places to be active and personal beliefs and attitudes towards physical activity[17]. The standard recommendations for adults aged 18-64 years are that individual should engage in at least 150 minutes of moderate intensity aerobic physical activity throughout the week or do at least 75 minutes of vigorous intensity aerobic physical activity throughout the week or an equivalent combination of moderate and vigorous intensity activity.

The result obtained from this study showed skewness in the mean Physical Activity (PA) of students at different studying levels. This implied that the data were not evenly distributed due the fact that some students had extremely high PA. However, the mean vigorous physical activity of 500 level students studying physiotherapy was significantly higher than that of the 400 level students in physiotherapy and medicine; and that of 500 level students in medicine. Although, there was no significant difference between in the vigorous activity of students in the final year of medicine and physiotherapy (500 level physiotherapy and 600 level medicine students). This may be attributed to the likelihood that student in both levels were in the final year and there was similarity in the academic engagements and were also involved similar day to day activity of attending clinical postings and collating data of research work. Angyan[18] reported that medical students had low physical activity levels, attributing it high workload and less free time while Kochanowicz[19] observed that physiotherapy students were found to have a high level of physical activity as a result of their university modules involving sports as well as their free-time activities such as volleyball, swimming, or cycling. It is noteworthy that the studies of Angyan and Kochanowicz[18,19] did not compare the physical activity of students in physiotherapy and medicine. Furthermore, a similar study by Adenle[15] found no significant difference in the PA of healthcare professionals and this was attributed to similarity in activities within the hospital work settings.

The results showed that there was no significant difference in the mean total Physical Activity of male and female undergraduate. Sex was considered as one of the most important predictors of physical activity in some previous studies[20]. The sitting PA of female undergraduate students, however, was significantly higher that of male in this current study. This current finding corroborated that of Caspersen[21] which reported that among adults, levels of physical inactivity in women were moderately greater (5.5% points) than for men. Among adolescents, Caspersen[21] also found differences between female and male respondents to be larger for regular, vigorous activity (11.3% points greater for male respondents).

Conclusion

In conclusion, this study found that there was no significant difference in the Physical Activity of students studying medicine and physiotherapy but the mean of a sub-component (vigorous physical activity) of 500 level students studying physiotherapy was significantly higher than that of the 400 level students in physiotherapy and medicine; and that of 500 level students in medicine. It was also concluded that there was no significant difference in the physical activity of male and female students, excluding that of sitting component of physical activity score which was higher for the later.

Conflicts of Interest: There is no conflict of interest regarding the publication of this article.

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Original Research

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Prevalence of Forward Head Posture in Goldsmith Workers

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Abstract

Background: It was found that goldsmiths were highly affected by improper body posture and workload. Twisting, bending over, and over-reaching are the results of poorly designed workstations; this will cause postural abnormality, and later on, this can lead to musculoskeletal-related disorders, in which forward head posture (FHP) is the most common postural abnormality. Therefore, to aware the workers about their musculoskeletal disorder as well as the analysis of the worker suffering from forward head posture (FHP).

Materials and Methods: The study took place at the workplace of goldsmith workers in Nagpur, Maharashtra, for 1.5 years. With the confidence interval of 95%, an absolute precision of 15and based on a pilot study and literature reviews, the sample size was estimated to be 35.AGoniometer, camera(for photographic Images), laptop and two-sided tape were used to determine the cranio-vertebral angle. Thirty-five goldsmiths participated in the study. The photographic method was used to evaluate cranio-vertebral angle, which helps to determine forward head posture.

Result: In this study 35 goldsmith workers were evaluated with a mean age of 37±10 years, a mean working hour of 11±10 hours and a work experience of 18±9.8 years. Out of 35 goldsmiths 25 showed the prevalence of forward head posture, or 71.42% of them had forward head posture.

Conclusion: Based on the results the present study which was conducted on goldsmith workers concluded that prevalence of forward head posture was 71.42% among the population.

Keywords: Forward Head Posture (FHP), Cranio-vertebral Angle (CVA).

Introduction

The posture is defined as the attitude assumed by the body either with support during the course of muscular activity or as a result of the coordinated action performed by a group of muscles working to maintain the stability [1]. Any changes in the attitude of the body results in deformity.

Forward head posture (FHP) is also one such alteration which is hyperextension of the upper cervical vertebrae and forward translation of the cervical vertebrae [2], this is a poor habitual neck posture.

Forward head posture (FHP) is usually caused by prolonged sitting in an improper posture or working

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in the same posture with the cervical protracted. Some studies have shown that there is no correlation between forward head posture and neck pain in the cervical region but some studies say that FHP changes the biomechanical stress of the cervical spine and leads to musculoskeletal disorders such as cervical pain, headaches and temporomandibular joint dysfunction and muscle dysfunction[3,4,5].

A group of people are engaged in making different types of ornaments with gold, known as goldsmith workers. Forward head posture is usually seen in all occupational disorders that demand prolonged sitting or standing work with the head flexed. As the goldsmiths usually do prolonged sitting work with altered biomechanics such as a cervical spine flexed, forward translated, shoulder protracted and elbow flexed for doing precise work so they have chances of forward head posture. It was found that goldsmiths were highly affected by improper body posture and workload. Twisting, bending over, and over-reaching are the results of poorly designed workstations. Moreover, lack of proper radiance at the work site also exerts an additional adverse effect on the health of the goldsmiths [6]. Stress on certain groups of muscles and joints by monotonous or repetitive movements, especially in upper spinal area, shoulder area, and upper thorax area and manual handling of heavy work for prolonged period of time, this will cause postural abnormalities and later on this will cause musculoskeletal- related disorders, of which forward head posture (FHP) is the most common postural abnormality.

Head and shoulder postural mal-alignments are causes of muscular imbalances surrounding the shoulder and upper thorax area. Like shortening of the upper trapezius, the splenius capitis, the cervices and the semispinalis capitis, cervical erector spinae and the levator scapulae musculature [7]. This posture can change the position of the scapula on the thoracic wall and decrease the ability of the scapula to rotate upwardly [8].

To prevent these postural malalignments, it is necessary to find out the postural abnormality. Clinical assessment of forward head posture (FHP) is based on visual observation, but this will only qualitative measurement, which is not reliable method. To find out quantitative measurement, multiple objective methods have been used for measurement of the FHP [9].

Finding out the prevalence in a specific population is important so that further progression can be prevented, and treatment should begin as early as possible [6].

Material and Method

With a confidence interval of 95%, an absolute precision of 15 and based on pilot studies and literature reviews, the sample size was estimated to be 35. The participants included were between the ages of 20 and 55, which are goldsmith workers who work a minimum of 6–8 hours a day, have work experience of at least 5 years, and make ornaments manually. The participants who were excluded are industrial workers who use modern technical gadgets for ornament making, have less than 5 years of working experience, and have any pathology related to the spine, such as fracture, tuberculosis, or rheumatoid arthritis of the spine. They were collected from August 2022 to April 2023 at the workplace of goldsmith workers in Nagpur, Maharashtra.

Procedure of data collection:

1] Subject:

A detailed history of the subject was taken. The subject was within the age group of 20–55 years and participated in this study. The subject was recruited from the goldsmith worker community at their work site. The participants had been excluded because of their history of neck pain, cervical spine injuries (fracture, sprain, strain, whiplash), cervical spondylosis, obvious spinal deformities, neurological and neuromuscular disorders, chronic headaches, TMJ dysfunction, cervicothoracic and lumbar kyphoscoliosis, rheumatic disease, torticollis, and balance disorders.

The informed consent was obtained from each participant after giving verbal information about the nature of the study. The patient was seated in a relaxed position on a stool, and then the following photography procedure was started:

2] Photography procedure [10]:

A picture of the lateral view of each subject was taken to objectively assess the FHP. A mobile phone was placed at a distance of 1.5 m on a fixed base without rotation or tilt in the hands of the person taking a picture. The height of the mobile camera was adjusted to the level of the subject's shoulder, and a self-balanced position was chosen to standardize the head and neck posture of subjects. To achieve this position, subjects moved their head and neck into flexion and extension in the full range and gradually reduced their range until they eventually stopped moving and maintained the head and neck in a neutral position. The necessity of maintaining a neutral position before the photography was explained to the subjects. The tragus of the ear was clearly marked, and a plastic pointer was taped to the skin overlying the spinous process of the cervical-7(C7). Once the picture was obtained, it was used for measuring the craniovertebral angle. The line that is required for measurement is to be drawn in Microsoft Paint. In order to measure the craniovertebral angle(CVA), the angle between the horizontal line passing through C7 and a line extending from the tragus of the ear to C7 was calculated (Fig. 1). The CVA was measured using a Goniometer.

A smaller CVA indicates a greater FHP, and a CVA less than 48–50 is defined as FHP. The cut-off point for the CVA in this study was 48; subjects with a CVA below 48 were defined as FHP, and those with a CVA above 48 were defined as healthy. The reliability of this procedure is reported as high (ICC = 0.88)[7].

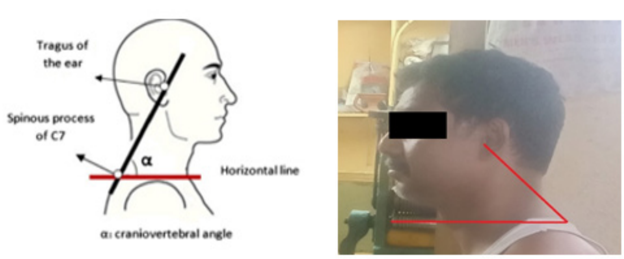

Fig-1 Photography method to evaluate the Forward Head Posture (FHP)

In each examination, the FHP was assessed in a relaxed sitting position in accordance with standard protocol. A picture of the lateral view of each subject was taken in a sitting position.

Finding:

In this study, 35 goldsmith workers were evaluated with a mean age of 37±10 years, mean working hours of 11±10 hours, and work experience of 18±9.8 years. Out of 35 goldsmiths, 25 had a prevalence of forward head posture, that is, 71.42% of them had forward head posture. The analysis was carried out with the statistical software GRAPH PAD PRISM version 5.0. Frequency distribution was done amongst the goldsmith workers based on craniovertebral angle. The continuous variables that were utilised for the study were as follows: age, work experience, working hours, and cranial-overtebral angle. The frequency distribution was carried out so as to identify the prevalence of forward head posture.

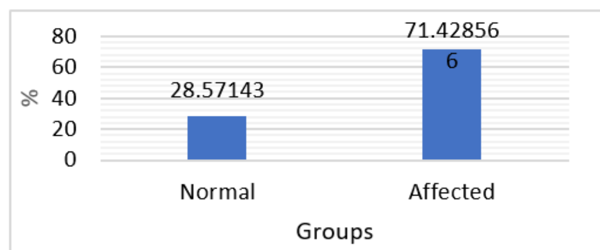

Fig 2 Percent prevalence of FHP amongst goldsmiths

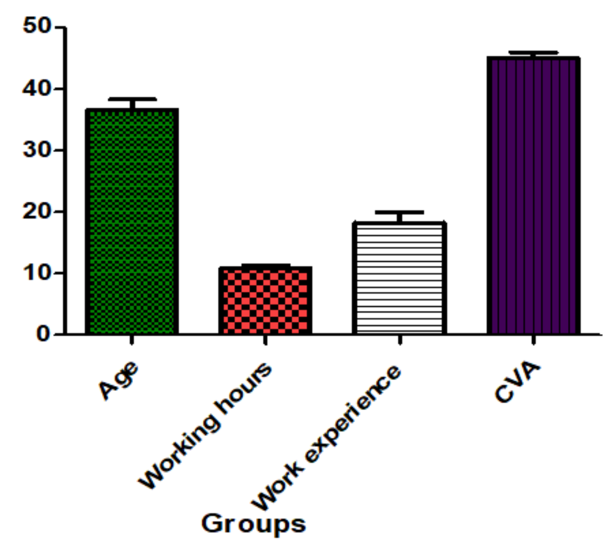

Fig. 3 graphical analysis of goldsmiths based on outcome measures

Table 2 statistical data of whole group based on outcome measures

Statistical Data of Whole groups				
	Age	**Working hours**	**Work experience**	**CVA**
Number of values	35	35	35	35
Minimum	21	6.0	2.0	35
25% Percentile	26	10	10	40
Median	39	12	20	45
75% Percentile	42	12	30	50
Maximum	54	16	33	57
Mean	37	11	18	45
Std. Deviation	10	2.1	9.8	5.2
Std. Error	1.8	0.35	1.7	0.88

Discussion

In this study, it was found that the prevalence of forward head posture is higher in those goldsmiths who are sitting in bad posture and doing their work for a prolonged period of time in the same posture. The high prevalence of FHP is seen in different occupations with similar postures, such as school-going students, housewives, office workers, and dentists, even though they are physiotherapists, as per the studies in some articles. A study by Goswami et al. shows that 70% of physiotherapists have forward head posture[9]. A study by Vakili et al. shows that the prevalence of FHP among dentists is 85.5% [11]. There is no significant study conducted on goldsmith workers, as the study shows the prevalence of FHP in goldsmiths is 71.42%, which is very high due to their work habits and working environment.

The study was projected to find the prevalence of forward head posture (FHP) in goldsmith workers. As per the findings of the present study, out of 35 subjects, 25 were found to have forward head posture, which is 71.42% of the total population.

During the study, it was found that the participants are more into precise work, such as making designs of several ornaments such as rings, bangles, bracelets, and other miniatures, which usually demands more focus and work in a position in which the cervical spine is in flexion and protraction. An ergonomically incorrect posture for a prolonged period of time results in shearing and repetitive stress on the body, in which the neck is more involved, which causes an imbalance of muscles and leads to forward head posture. Holding the head in a flexed position for long periods of time can lead to musculoskeletal disorders such as 'upper-crossed syndrome' involving obliteration cervicallordosis in combination with upper thoracic vertebrae kyphosis[12,13].

Many studies show that FHP leads to several pathologies, such as myofascial trigger points, cervicogenic headaches, neck pain, and reduced lung capacity [14], severe FHP will also affect the dynamic posture.To prevent this and further musculoskeletal disorders, it is necessary to find out the prevalence of FHP among the population so we can treat it as soon as possible.

Conclusion

Based on the results, the present study, which was conducted on goldsmith workers, concluded that the prevalence of forward head posture was 71.42% among the population.

Conflict of interest: None

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Ethical Clearance: Taken from the ethics committee of our institution (Shri K. R. Pandav College of Physiotherapy) on 23rd November 2021.

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Original Study

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The role of Respiratory Physiotherapy in reductionof Chronic Pulmonary Infection Score (CPIS) in Acquired Brain Injury Patients admitted in Intensive Care Unit: A Comparative Study

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Abstract

It was accounted for ABI as damage to the brain which brings about disintegration in subjective, physical, enthusiastic and autonomous working. Acquired brain injury can occur due to injury, hypoxia, contamination, tumor, substance manhandle, degenerative neurological sickness and stroke1,2. Serious ABI is characterized as a GCS of 3-8 after cardiopulmonary revival in a patient with an irregular computer tomography (CT) output of the head which shows haematomas, wounds, oedema, and compacted basal cisterns3,4. The definitions gave in this passage were embraced for use in this ABI investigation. CPIS was used to diagnose and determine the incidence of VAP.

Clinical pulmonary infection score(CPIS)-

Temperature(°C)

≥36.5and≤38.4=0point

≥38.5and≤38.9=1point

≥39or≤36=2points

Blood leukocytecount (cells/mm^3)

≥4,000and≤11,000=0point

<4,000or>11,000=1point+bandforms

≥500=+1point

Trachealsecretions

Scanty=0point

Moderate/profuse but not purulent = 1 point

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Moderate/profuseandpurulent=2point

Oxygenation: PaO2/FiO2

>240orARDS=0point

≤240andnoevidenceofARDS=2points

Pulmonaryradiography

Noinfiltrate=0point

Patchy/diffuse in filtrates=1point

Local is edinfiltrate=2points

Culture of tracheal aspirate (semi-quantitative)

Pathogenic bacteria cultured ≤ 1+ or no growth=0point

Pathogenic bacteriacultured>1+ornogrowth=1point

Same pathogenicbacteriaseen on Gramstain >1+=2points

Totalscore = CPIS (possible range=0to12)

Methods: Respiratory physiotherapy procedures assists to expand lung volumes, enhance gas diffusion, reduce work of breathing, reduce MV stay of patients and induce optimum recovery. In this the respiratory physiotherapy applications involved a regimen of Positioning, Manual Hyperinflation (MH), Airway Suctioning, PNF for Respiration, Passive Limb Movement protocol and Early Mobilisation protocol.

Results: The results shows that the Chronic Pulmonary Infection Score (CPIS) reduced from at the time of admission to at the time of discharge, the significance of P<.005

Conclusion: Respiratory physiotherapy managed Chronic Pulmonary Infection Score (CPIS) reduction from at the time of admission to at the time of discharge and improved the outcome of the ABI patients.

Keywords: Acquired Brain Injury, Moderate to Severe Head Injury, Respiratory Physiotherapy, Chronic Pulmonary Infection Score, Intensive Care Unit, Cognition, Conscious.

Introduction

Acquired brain injury patients treated with mechanical ventilation (MV) usually develop Ventilator-associated pneumonia (VAP) that is aserious & complex health hazard. Pneumonia occurs due to microbial attack of the ordinarily sterile lower respiratory tract. The dominant part of pneumonia is that, this disease occurs due to potential pathogens that have colonized the oropharyngeal airway route. When VAP occurs the stay of patient on MV, the stay of patient in ICU and the stay of patient in hospital increases. There is a significant finding of ABI patients admitted in ICU may develop VAP, which could effect on ICU results. It has been generally shown that VAP in ABI patients induces huge, expanded expenses to the social insurance framework, an expanded danger of horribleness and mortality emerging.[5,6]

Respiratory physiotherapy interventions are a generally reasonable and broadly accessible administration technique that may profit patients in the ICU by reducing the rate of VAP and its related outcomes. Hypothetically respiratory physiotherapy reduce the stay on MV and improve ventilation which may decrease the frequency of VAP. In this way, respiratory physiotherapy may reduce the stay on MV, requirement of tracheostomy, expenses and hospital stay.[7]

AIMS

This study aimed to provide the first comprehensive objective evaluation of the effectiveness of respiratory physiotherapy services for patients admitted to the ICU with ABI by:

- Investigating the clinical effectiveness and cost effectiveness of respiratory physiotherapy interventions in reduction in CPIS, altering the incidence of VAP and other important clinical outcomes such as duration of MV and length of ICU stay.

- Providing justification of respiratory physiotherapy service provision to the ICU in terms of clinical effectiveness and cost effectiveness for patients with VAP following ABI.
- Providing validation of the required level of respiratory physiotherapy services and staffing in the ICU based on clinical outcomes

Material and Methods

A prospective randomized study was done to assess the effects of respiratory physiotherapy on the incidence and resolution of VAP in patients admitted with ABI to the ICU at SH. The aim of Part A of the study was that the provision of regular prophylactic respiratory physiotherapy interventions along with routine medical and nursing care reduce the incidence of VAP. In part A of this study subjects were randomised.

In part A of this study male and female patients according to inclusion criteria received 24-hourrespiratory physiotherapy service (six interventions approximately every four hours throughout the day and night) along with routine medical and nursing care, passive movements and early mobilisation.

The aim of part B of this study was that the provision of regular respiratory physiotherapy interventions along with routine medical and nursing care influenced the progression and/or resolution of VAP.

Subjects from part A who developed VAP were transferred to Part B of the study based on inclusion criteria as outlined in dependent variable.

In part B of this study male and female patients according to inclusion criteria received 24-hour respiratory physiotherapy service (six interventions approximately every four hours throughout the day and night) along with routine medical and nursing care, passive movements and early mobilisation.

Subjects

ABI patients admitted to the ICU at SH who satisfied the inclusion criteria were eligible for participation in the study.

Inclusion Criteria

Inclusion criteria comprised of the following:

- Age between 16-85years[8]
- GCS less than or equal to nine (≤) 9 on admission to the SH ICU
- Presence of an ICP monitor or drain
- Invasive mechanical ventilator support for greater than twenty four hours (>) 24 hours
- Eligible subjects were prospectively randomised to a study group on admission to the SH ICU

Exclusion Criteria

Exclusion criteria comprised of the following:

- Patients on active therapy
- Patients with excessive respiratory support as:

Nitric oxide ventilation, Fraction of inspired oxygen [FiO2] > 0.8, Positive end expiratory Pressure [PEEP] >10 centimetres of water [cmH2O].

- Patients with excessive oxygen consumption they would not receive MH, Positioning and Airway suctioning according to SH ICU standard operating policy.
- Patients with unstable haemodynamic status as:
  - ⇒ MAP [in millimetres of Mercury (mmHg)] > 120 or <60
  - ⇒ HR (in beats per minute) > 120 or < 60
  - ⇒ Labile MAP or HR
  - ⇒ Presence of new cardiac arrhythmias
  - ⇒ Excessive inotropic support as Noradrenaline or Adrenaline infusion at > 30 milligrams per hour

These MAP and HR criteria are based on greater than 10 percent change from the normal range[9]. In the ABI patients optimization of tissue perfusion and cerebral oxygenation level may be a special issue if significant change occur from the normal level. Exclusion criteria based on the clinician's clinical experience, the dosage of vasoactive drugs titrated according to patient's body weight and clinical effects.

Patients with unstable neurological status as:

- Labile ICP or CPP,
- Sustained ICP > 25 mmHg,
- Sustained CPP <70 mmHg.

The primary focus of ICU management of ABI patients is to prevent secondary cerebral damage characterised by a reduction in cerebral perfusion pressure due to hypotension and hypoxia[10]. The above neurological criteria are from the Brain Trauma Foundation management guidelines[11].

For the purpose of this study 'labile' was considered as a clinically significant changes in any of: MAP, HR, ICP and CPP of 20 per cent or more of normal values required definitive intervention. MacIntyredescribed an acute increase or decrease in blood pressure at least 20 percent is indication of haemodynamicinstability[12].

Results and Discussion

Table 1: Demographic and clinical characteristics of the study subjects

Age (in years)	
Mean ± SD	45.54 ±11.56
Median (Range)	47 (21 – 78)
Gender	
Male	82 (71.9%)
Female	32 (28.1%)
Residence	
Urban	67 (58.8%)
Countryside	47 (41.2%)
BMI	
<25 Kg/m²	28 (24.6%)
25 – 29 Kg/m²	60 (52.6%)
≥30 Kg/m²	26 (22.8%)
Reason for admission	
Assault	5 (4.4%)
ICH	29 (25.4%)
MBA	27 (23.7%)
MVA	27 (23.7%)
SAH	26 (22.8%)
Comorbidity	
H/O COPD	70 (61.4%)
Smoking	53 (46.5%)
Chronic sputum production	49 (43%)

Table 1. shows demographic and clinical characteristics of the study subjects

According to the objectives of this study the comparison of the groups determines that the randomization process was followed on the basis of inclusion criteria. In the treatment there were significantly more males than females. Results of the Levene's test defined that equality of changes between the groups based on demographic variables. The Levene test checks whether several groups have the same variance in the population. Levene test is therefore used to test the null hypothesis that the samples to be compared come from a population with the same variance.

Table 2: Comparison of CPIS among study subjects

Time	CPIS	Mean difference	Test of significance
At admission	4.15±0.50	1.85±1.45	t=13.61 at 113 df, **P<0.001 (S)**
At discharge	3.30±1.33		

Table 2 shows that CPIS score reduced from at the time of admission to at the time of discharge among study subjects. Thus level of significance p 0.005.

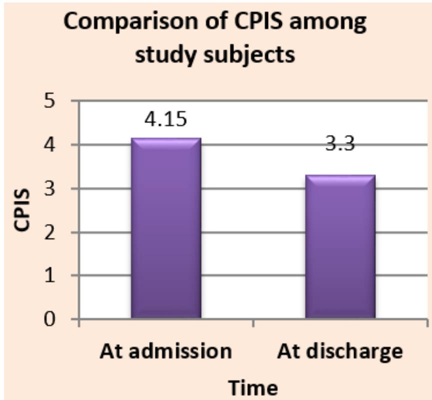

Fig 1: Comparison of CPIS of study subjects at the time of admission and at the time of discharge

Discussion

This segment of the Discussion defines the occurrence of VAP in form of CPIS score, term of stay on MV and length of ICU stay. The numbers of patients of ABI was 114 who satisfied inclusion criteria assessment. Respiratory physiotherapy particularly focus on the distinguished causes of VAP. Various elements and occasions are responsible for course of pathogenesis of VAP. In ICU the arrangement of Respiratory physiotherapy required where premorbid factors like age, smoking and seriousness of ABI induces endotracheal intubation of patients.[13]

Physiologically the prophylactic respiratory physiotherapy helped to change the rate of VAP with clearance of airway route, enhancing oxygenation and lung consistence, that's why lower respiratory tract has not been imperiled with microscopic organisms.

Conclusions

The impact of prophylactic respiratory physiotherapy reduced CPIS score in acquired brain injury patients from at the time of admission to at the time of discharge[14,15]. The fundamental conclusion from this study was that the utilization of 24-hourrespiratory physiotherapy service (six interventions approximately every four hours throughout the day and night) along with routine medical and nursing care, passive movements and early mobilization reduced occurrence of VAP, stay on MV and stayof ICU of ABI patients in ICU at SH. When criticalillness ICU parameters were assessed with clinical factors the arrangement of a prophylactic respiratory physiotherapy regimen is recommended intentional to avoid VAP in ABI patients. The study provides comparison between subject's CPIS score at the time of admission and at the time of discharge. Subjects those developed VAP were significantly male and admitted with a lower GCS. Duration of MV, length of ICU stay and length of hospital stay were significantly increased in subjects with VAP.[16,17,18]

Conflict of interest- Nil

Source of Funding- Self

Ethical clearance- Ref no.06/ EC/RENEW/ INST/2021/12208

SOLANKI HOSPITAL INSTITUTIONAL ETHICS COMMITTEE

Consent: Informed consent was taken from all participants in the study for publication work in the journal. If patient was conscious then consent was read and signed by himself or herself. If patient was not conscious then his/ her LAR read and signed the Informed consent.

Abbreviations

ABI	Acquired Brain Injury
GCS	Glasgow Coma Scale
RLA-R	Rancho Los Amigos revised Scale
CT	Computer Tomography
PNF	Proprioceptive Neuromuscular Facilitation
ICU	Intensive Care Unit
VAP	Ventilator Associated Pneumonia
SH	Solanki Hospital
ICP	Intracranial Pressure
MAP	Mean Arterial Pressure
HR	Heart Rate
CPP	Cerebral Perfusion Pressure
ETT	Endotracheal Tube

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Original Article

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Comparison of Ladder Training Versus Plyometric Training on Agility & Speed among Vadodara Cricket Players: An Experimental Study

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Abstract

Background: Cricket is the second most popular sport in the world, right behind football, and it is played between 105 nations that are members of the ICC. In cricket, speed plays an essential role as the faster the speed generation the more the number of singles taken & saved during fielding. Agility is required in the infield of cricket because fielders are closer to the batsmen and have less time to react. Ladder drills improve footwork & coordination in players performance level which makes players easy to catch, strike or block or tackle. In Agility Ladder, jumps are performed without obstacles & in multidirectional ways with fast ground contact time.

Aim: To compare the effect of Ladder Training versus Plyometric Training on agility & speed among cricket players.

Method: 38 male cricket players (under -19) were selected by convenient sampling. Participants who met the inclusion criteria were randomly allocated into two equal groups: Ladder Training group and Plyometric Training group. Baseline data was collected by Illinois agility test & 40m Sprint test. The training duration was 3 sessions/week for 6 weeks.

Results: The data was analyzed using paired – t test for within group and Unpaired – t test for between group. Results showed that both the training methods produced significant improvement in agility & speed performance but ladder training method showed statistically significant difference in agility ($p<0.0001$) & speed ($p<0.0002$) than plyometric training.

Conclusion: The present study concludes that Ladder training has an added advantageous effect for improving speed and agility in cricket players over plyometric training.

Keywords: Ladder training, Plyometric training, Speed, Agility, Cricket.

Introduction

Cricket is the second most popular sport in the world, right behind football, and it is played between 105 nations that are members of the International Cricket Council. It has entertained spectators of all ages and genders. Athleticism, talent, and strategy are all required for the bat-and-ball game of cricket.[1]

Cricket is most prominently played in England,

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India, Australia, New Zealand, and South Africa. Cricket is played in three formats: test, one-day, and twenty-twenty (T20).[2] When compared to Test cricket, T20 and one day cricket players require approximately 50-100% more maximal sprints per hour.[2] As a result, speed in cricket is frequently focused on critical match situations such as running between the wickets for batsmen and delivery during fast bowling, so fielder speed is most important.[3] Agility, like flexibility, is required in the infield of cricket because fielders are closer to the batsmen and have less time to react, whereas outfielders require a strong fielding the balls back to the infield with a throwing arm.[3]

In cricket, prominent sites of injury are shoulder (22.85%), lumbar spine (17.14%), knee (11.42%), thigh (8.57%), out of which muscle injuries are 40%, fracture 28.6%, & ligament 11.42%. Injuries during fielding are 42.85% while bowling 40%. At age of 18-24 years injuries are more prone to occur such as 37.14% overuse injuries & 71.42% lumbar spine injury.[4]

In cricket, speed plays an essential role as the faster the speed generation the more the number of singles taken & saved during fielding.[5] Speed ladder drills can be used by all sports as they help to improve speed, agility, leg explosive strength & aerobic capacity.[6] Apart from this, plyometric training drills combined with resistance training also improve speed.[19]

Agility is defined as the ability to change directions while maintaining body control, balance, and speed.[7] Benefits of agility improvement is increase in body stability during quick moments, improved intramuscular control, reduce injury & re-injury risk.[8]According to Barnes & Attaway, (1996); Craig, (2004); Patteiger et al., (1999); Agility training works on motor programming re- enforcement which has effect on neuromuscular conditioning, muscle spindles neural adaptation, golgi tendon organs & proprioceptors in joints.[22-24]

In order to maximize athletic performance, ladder drills are used to improve footwork. It aids in enhancing foot speed, mobility, balance & coordination, agility, power, core and joint stability, strength, proprioception and reaction time.[9] Ladder drill training sessions are engaging when they are carried out rhythmically since this teaches the body and mind how to coordinate different foot movements.[10] A Ladder is composed of two nylon straps and plastic rungs spaced 15-18 inches apart, depending on the training objective. Rope and PVC pipe can be used for making a ladder at home and taping it to ground, just like an agility ladder. Ladder drills improves footwork & coordination in players performance level which makes players easy to catch, strike or block or tackle.[11] In Agility Ladder, jumps are performed without obstacles & in multidirectional ways with fast ground contact time.[12]Basic skills of ladder training are of 4 types: running through ladder, skips, shuffles & jumps/hops also linear & lateral movements.[6]

Plyometric Training (PT) is characterized by rapid muscle stretching (eccentric action) followed by short amortization phase, lastly explosive concentric movement, which enables the synergistic muscles to engage the myotatic – stretch reflex during stretch – shortening cycle. The three phases of plyometric movement are known as the stretch- shorten cycle of muscle work, and they are characterized by two patterns. The first phase of plyometric movement is primarily stretching or eccentric muscle activity, which is marked by a high concentration of elastic muscle energy. The second phase is called the amortization phase and starts at the end of the first phase and ends with the beginning of the concentric muscle action. Finally, the third phase is the final phase of muscle contraction, which is primarily manifested as the jump, hit or throw. These phases of plyometric movement are referred to as the stretch-shorten cycle of muscle work.[13] PT improves agility, stability, balance, speed as athletes aid to increase speed strength ratio which generates more force during quick start & faster propelling off ground.[5]

Although cricket is the most popular sport in India, young players at national level lack a sense of fitness. While skill- related fitness alone is insufficient to perform at a high level as every cricket player concentrates on it. Due to this lack in skills or expertise, Indian trainers continue to use traditional training programs. While globally, ladder training and plyometric training are crucial training techniques of games to improve players speed and agility. However, ladder training and plyometric training among young cricket players has not been the subject of any research. Thus, the aim of the present study was to compare the effect of ladder training and plyometric training on agility and speed among cricket players of Vadodara.

Materials and Methodology

The 38 players were recruited from Youth Service Center Academy, Vadodara for the study. Convenient & Purposive sampling technique method was adopted. Players were selected based on inclusion and exclusion criteria. Ethical approval was obtained from the Institutional Ethical Committee of KPGU(Reference no. KPGU/KSPR/EC/23/03/27.16, 04/03/2023) and permission was taken from Youth Service Center Academy, Vadodara for the study. Prior to the study, written informed consent signed by participants with their voluntary acceptance & interest. Participants were allocated randomly by chit method in 1:1 ratio either to Ladder Training group or Plyometric Training group. Baseline data was collected and each participant was tested by Illinois Agility Test and the 40-meter Sprint Test prior to the beginning of training and at the end of six weeks with the results recorded in a sheet. Both groups were given Intervention for 18 sessions for 6 weeks. (3 days/week)

Inclusion criteria was under 19-year players, Semi Professional, Male, who were practicing every week for at least 8-10 hours, not enrolled in any kind of research project & fitness program for 6 months and the participants who were willing to participate. While participants who had any history of previous or recent surgery or injuries, any orthopedic deformity, any neurological disorders, recent infection and cancer/ malignant condition were excluded from the study.

Intervention:[2,14-18]

Group A: Participants received Ladder Training

Group B: Participants received Plyometric Training

In Ladder training, the length of the ladder was 520 cm & width 50 cm, distance between blades was 50 cm & number of blades 15.

In Plyometric Training, Cones of 20 cm height were used& the spacing between the cones was 50 cm, number of cones- 15 pieces.

Both the groups carried out 10 minutes warm up & 10 minutes cool down exercises, 20 minutes of Ladder Training or Plyometric Training respectively.

Warm up[2]

Muscles stretched were - gastrocnemius, hamstrings, hip flexor, hip extensor, quadriceps, adductors.

General warm-up consisted of 5 minutes of jogging at a normal pace, followed by a combination of static and dynamic stretching of the subject. The above muscles were given static stretches for 30 seconds and then dynamic stretches for 30 seconds 5 times & 1 set each with a 20-second interval rest for 5 minutes in total.

Cool Down [18]

5 minutes slow jogging followed by static stretching of above muscles for 5 minutes with 5 repetition each 1 set.

The following table shows the exercise intervention for 6 weeks of both Group A and Group B as follows:

Table 1. Exercise Intervention. Group A – Ladder training, Group B- Plyometric training.

Number of weeks	Group A	Group B	No. of repetition
Week 1 & 2	Straight run Hopscotch Single foot hops zigzag pattern Linear hops 90 rotations	Side jump Jump & squat Single leg hop Single leg slalom Ankle hop	6 repetition × 2 sets 30 second recovery between repetition 60 second recovery between sets

Continue...........

Week 3 & 4	Two-foot run Backward Hopscotch Single foot lateral in & out hops Front to back Serpentine	Double leg lateral cone jump (35 cm) Single leg lateral cone jump (25cm) Scissor jump Front jump Alternate lunges jump	6 repetition × 2 sets 30 second recovery between repetition 60 second recovery between sets
Week 5 & 6	Bunny hops Hopscotch variation Two -foot hops zigzag pattern V pattern 2 in, 2 out lateral run	Double leg hurdle jump (50cm) Single leg hurdle jump (25cm) Single leg forward hop Single leg 2 forward & 1 back Single 90 degree	6 repetition × 2 sets 30 second recovery between repetition 60 second recovery between sets

Outcome Measures

- ILLINOIS AGILITY TEST
- 40 M SPRINT TEST

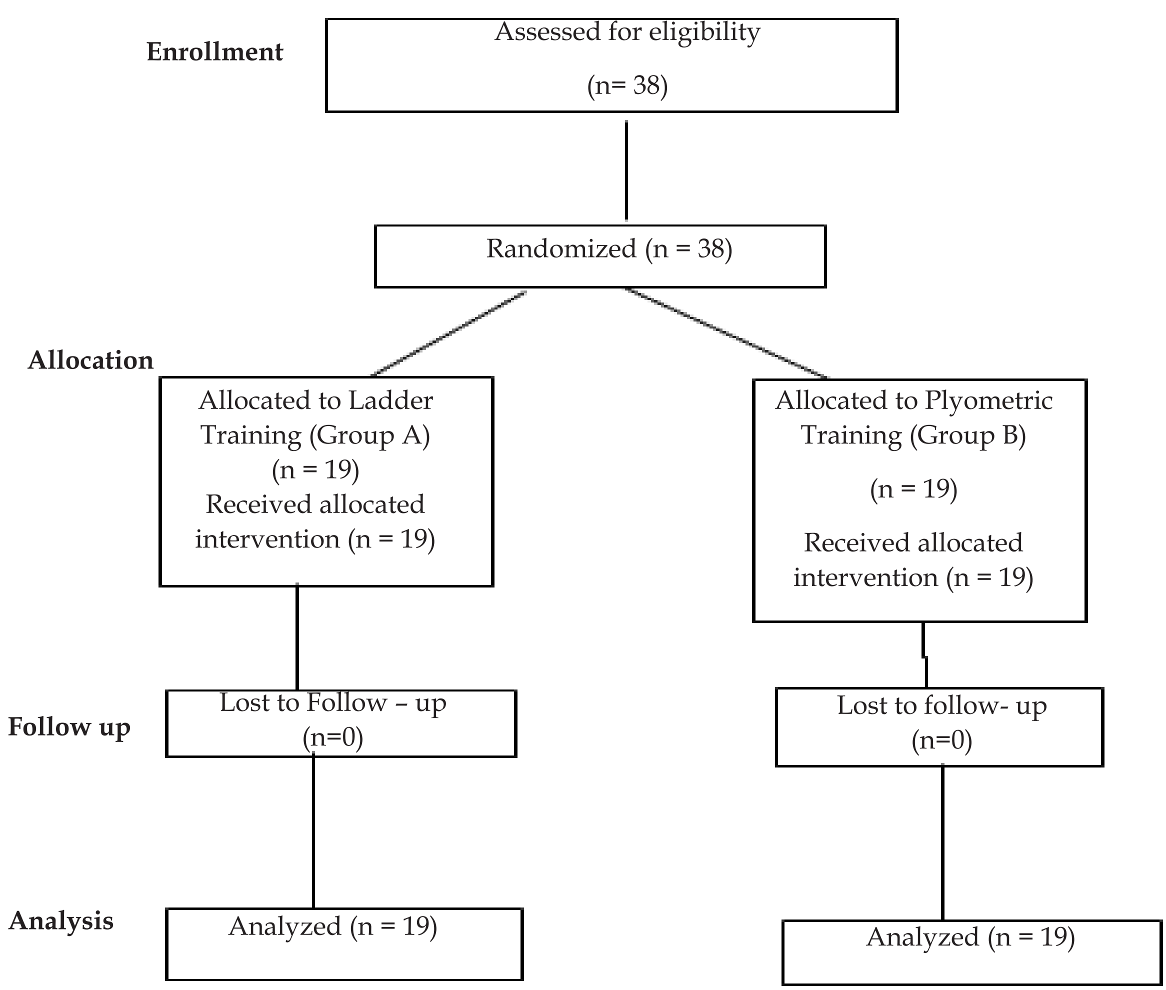

Figure 2: CONSORT Flowchart of the methodology.

Statistical Analysis

Descriptive statistical analysis obtained by using frequency, percentage, mean, SD, median and IQR. Paired t – test was used for the comparison of pre and post data within the group. Unpaired t – test was used for the comparison of data between group A and group B. All the statistical analysis was performed by using IBM SPSS version 29.0.0.

Result

The Group A pre mean value of Speed was 10.53± 1.20 and post mean value 8.97± 0.95 where $p< 0.0001$, pre mean value of Agility was 13.8± 1.39 and post mean value 11.25± 1.34 where $p<0.0001$. The Group B pre mean value of Speed was 11.02± 1.16 and post mean value 10.24± 0.93 where $p< 0.0001$, pre mean value Agility was 14.64± 0.62 and post mean value 13.13± 0.83 where $p< 0.0001$

Post – intervention, the average Speed in Group A was 8.97 ± 0.95, while the average Speed in Group B was 10.24 ± 0.93. The average Agility in Group A was 11.25 ± 1.34, while in Group B was 13.13 ± 0.83 as per Table 2. The unpaired 't' test showed statistically significant difference in between group analysis.

Table 2: Data represents comparison of post intervention parameters of the Group A and Group B after 6 weeks.

PARAMETERS	Group A Mean & SD	Group B Mean & SD	t – value	p – value
Speed	8.97 ± 0.95	10.24 ± 0.93	4.15	0.0002
Agility	11.25 ± 1.34	13.13 ± 0.83	5.17	0.0001

Discussion

The study was aimed to compare the effectiveness of ladder training and plyometric training on agility & speed among cricket players.

38 male cricket players (under -19) were allocated into two equal groups randomly. Group A were given Ladder Training and Group B was given Plyometric Training.

When compared to both the groups, group A showed significant improvement in improving Agility than group B. In group A, the post mean Agility value was 11.25 ± 1.34, & In group B, the post mean Agility value was 13.13 ± 0.83. Improved Agility in group A could be possible due to several factors i.e during exercise, the muscle becomes more elastic and improves joint mobility which allows leg to swing in the steps. Muscle flexibility also enhances muscle extension, allows stronger and faster muscle contraction which helps to complete the steps quickly. Including dynamic balance in training aids body control during movements and improves agility. The way the body adjusts to training and how the brain processes movement both contribute to gains in agility enhancement. The speed at which muscles contract increases due to changes in muscle fiber or quick twitch. The muscle fibers enhance the muscular contraction speed leading to rise in agility level.[20]

Our study's findings were confirmed to be in line with those of K Venkata Surya Prakash et al. (2021). An experimental and control group of sixty kabaddi players participated in the research. Performance, speed, and agility were the main training objectives for both groups. Comparing ladder training to other regular training methods like plyometric training, they suggested that ladder training can be beneficial, efficient, and performance-oriented.[9]

When compared to both the groups, group A showed significant improvement in improving Speed than group B. In group A, the post mean Speed value was 8.97 ± 0.95, & in group B, the post mean Speed value was 10.24 ± 0.93 had shown statistically improvement. Improved Speed in group A could be possible due to several factors i.e there is an innervation adaptation which is based on the extent to which the muscles can be recruited by the CNS and the pace at which the muscles can be excited by motion.[19]

Increased neural drive to agonist recruitment, better neuronal firing rates and more synchronization in the timing of neural discharge (intermuscular coordination, reduction in inhibitory processes) are the ways in which the neurological system can produce more force. Potential neural adaptation locations that may lead to an enhanced neural drive, neuronal firing rate or synchronization include: the motor cortex, descending corticospinal tract, golgi tendon organ and the neuromuscular junction. Both learning new motor skills and aiming to exert maximum force cause an increase in motor cortex activity. The agonist and antagonist may be more synchronized as a result of motor learning via ladder training (LT), which would ultimately improve performance.LT workouts mimic sprint and change of direction (COD) performance motions, which could have improved change of direction (COD) and sprint performance. The descending corticospinal tract adjusts by myelinating neurons to speed up neural input. The rate of force development (RFD) may increase if the information from the motor cortex reaches the targeted muscle more quickly. The acetylcholine receptors, perimeter length and total length of nerve terminal branching all increase as the neuromuscular junction adapts. This adaptation might speed up and increase the amount of neuronal input which would result in a contraction with more force and higher RFD.[21]

Hence, the study concluded that Group A is more effective than Group B, as during ladder training exercises may have produced more applicable and useful motor programs that manage the complex intramuscular coordination needed for the speed and agility.

Conclusion

The Objective of the study was to compare the effectiveness of Ladder training versus Plyometric training on agility & speed in cricket players. Study concludes that Ladder Training was more effective than Plyometric training in improving agility & speed in cricket players. Hence, the alternate hypothesis was accepted and the null hypothesis was rejected. Both the techniques are almost equal in their clinical effectiveness for improving agility & speed and that either of the techniques may be used in clinical practice for improving agility & speed.

The limitation of the present study was sample size was small so couldn't be generalized to the whole cricket players population, smaller geographical area was covered, smaller age group was taken, only male cricket players were included and no long term follow up was taken.

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Conflict of interest: None

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Original Research Article

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Effects of Instrument Assisted Soft Tissue Mobilization and Foot Strengthening Exercise on Navicular Height and Ankle Range of Motion in College Students with Flexible Flat Feet: A Comparative Study

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Abstract

Background: The medial longitudinal arch (MLA) plays a major role in maintaining the biomechanics of the foot and is maintained with the help of active and passive systems. Dysfunction of active and passive support system can lead to a reduction of navicular height, leading to excessive pronation of the foot known as pes planus. Pes planus is caused by injury, prolonged stress on the foot, obesity, and faulty biomechanics which will result in posterior tibial tendon dysfunction, collapse of the foot archand flat foot. The patients with posterior tibial tendon dysfunction and pesplanus have reduced dorsiflexion and increased eversion. So, the aim was to study the effects of instrument assisted soft tissue mobilization and foot strengthening exercise on navicular height and ankle range of motion in college students with flexible flat feet.

Method: Total 40 students were recruited for the study as per selection criteria and were divided into two groups (20 in each group). Group A was treated with Instrument Assisted Soft Tissue Mobilization (IASTM)and group B was treated with Foot Strengthening Exercise for five days a week for 4 weeks. Inter-group analysis by Mann Whitney U-test showed statistically significant improvement in navicular height and ankle range of motion (P value ≤ 0.001).

Conclusion: This study showed statistically significant improvement in navicular height and ankle ROM with the use of IASTM and foot strengthening exercise. However, IASTM was found to be more effective in improving ankle ROM and foot strengthening exercise was found to be more effective in increasing navicular height.

Keywords: Instrument Assisted Soft Tissue Mobilization, Navicular Height, Flexible Flat Feet

Introduction

McKeon et al.[1], in 2015 stated that the human foot is a flexible but complex structure that plays a major role in both static and dynamic postures. The medial longitudinal arch (MLA) is responsible for maintaining the structure of the foot and is maintained with the help of active and passive systems.

The passive support system of the foot involves the bony arch, which includes the talus, calcaneum, navicular, medial cuneiform and the first metatarsal

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bone, along with the ligamentous support, which consists of plantar aponeurosis, long and short plantar ligaments and the spring ligament.

Active support system of the MLA comes from both intrinsic and extrinsic musculature including the anterior and posterior tibialis, fibularislongus and the plantar foot intrinsic muscles. Of the intrinsic muscles, abductor hallucis, flexor digitorumbrevis and quadratus plantar are the three muscles thought to contribute the most support.[2]

Dysfunction of active and passive support system results in reduction of MLA height, leading to excessive pronation of the foot. The MLA has two extremes of structural position, high arch or pescavus and low arch or pes planus.[3]

Extrinsic muscles of the foot have been thought to have a substantial effect on supporting MLA during dynamic movements.[4-5] One specific muscle that receives a lot of attention is the tibialis posterior (TP) which has multiple insertions once it passes the medial malleolus and enters into the foot.[6] The TP is the primary extrinsic muscle of the foot that is thought to support the medial longitudinal arch.[5-9] The complex anatomy of the TP insertion sites serve to support the MLA and dysfunction of this muscle can lead to decreased stability of the MLA and an increase in likelihood of flat foot deformity.[10]

The intrinsic muscles of the foot are also often cited as providing the primary support for the MLA.[11] These musclesoriginate and insert within the foot and have small moment arms, thus generating only a small amount of force.[12] Intrinsic muscles of the foot act as the stable base for prime extrinsic muscles such as the TP to perform the gross movements of the ankle. Activation of intrinsic muscles is shown to increase as postural demand increases such as when an individual is in full weight bearing.[13]Active muscles will contract and pull the metatarsal heads posterior towards the calcaneum which will increase the MLA height. When the intrinsic musclesget fatigued, this causes a significant decrease in the MLA height.[14]

Snyder et al.[15] in 2009 and Panichawit et al.[16]in 2015 suggested that to correct foot pronation including MLA flattening, increasing the strength of the intrinsic and extrinsic muscles is the most effective method. Currently, exercise intervention that combines both foot intrinsic muscles and foot extrinsic muscles are rare.

Pesplanus is defined as the syndrome of many static and dynamic deformities with collapse of medial arch.[17] Kuhn et al.[18] in 1999 stated that pesplanus (or flat foot) develops as the MLA decreases and is largely divided into rigid and flexible type. Rigid type include states in which the MLA has dropped regardless of bearing weight, flexible type occurs when MLA is formed without bearing weight but disappear during weight bearing. Chougala et al.[19] in 2015 stated that previous studies were done using Denis grading which reported that 44% of young adults are exposed to the risk of developing pesplanus.

Range of motion in flatfoot patients have always been affected due to structural and functional limitations.[20] In flat foot individuals, myofascial adhesions develop over time, resulting in reduced ROM.[21]According to a study conducted on foot and ankle kinematics, patients with posterior tibial tendon dysfunction and pesplanus have reduced dorsiflexion and increased eversion.

Restriction within the myofascial system may occur due to injury, poor posture, or lack of full range of joint motion.[22] Instrument assisted soft tissue mobilization (IASTM) is a technique used for relieving such restrictions and involves using instruments to address musculoskeletal pathologyrelated impairments and help heal soft tissues.[23] Advocates of IASTM proport that it is able to decrease fascial adhesions, thus refining ROM. Secondly, modifications in blood flow and vascularization in the fascia are exposed to modification as a result of IASTM, which may lead to compact neural inhibition.[24] Finally, there is a projected neurological mechanism that involves the facilitation of muscle relaxation/inhibition.[25] Thus, reduction of myofascial adhesions, modification in blood flow and vascularity, or facilitation of muscle relaxation/inhibition may be the primary reason for the increase in range of motion.

Navicular Drop Test (NDT): Navicular drop defined as the distance between the original height of the navicular from the floor, with the foot on the floor in sitting in the subtalar neutral position, and the final weight-bearing position of the navicular in relaxed stance. The navicular drop test is used as an indicator of foot pronation. Navicular drop test addresses the plantar flexion component of talar motion and is used to assess the amount of subtalar pronation.[26]

Materials and Method

Study design: An Experimental study

Study population: College students with flexible flat feet

Study setting: Various colleges in Vadodara city

Study period: 4 weeks

Study duration: 8 months (October 2022 – May 2023)

Sampling design: Purposive sampling method

Sample size: 40 students

Inclusion criteria:

- Age group: 18 to 25 years
- Gender: Both male and female
- College students with bilateral flexible flat feet (Staheli's arch index > 0.7 and Jack test positive)
- Students with reduced ankle dorsiflexion
- Students willing to participate in the study.

Exclusion criteria:

- History of any foot surgery
- Congenital foot deformities
- Trauma around ankle and foot in the last 6 months
- Impaired sensation over ankle and foot
- Hypersensitive skin
- Any neurological conditions which affected the outcome and treatment protocol of the study.
- Any cardiopulmonary conditions which affected the outcome and treatment protocol of the study.
- Any musculoskeletal conditions which affected the outcome and treatment protocol of the study.

Materials used:

- Treatment table
- IASTMtool (myoblaster)
- Petroleum jelly
- 360^0goniometer
- (ICC-0.94 to 0.98)
- White paper
- Ink pad
- Pen and Pencil
- 1 kg dumbell
- Theraband
- Towel
- Calculator
- Ruler

Figure 1: Materials used

Outcome Measures:

1. Navicular Drop Test: (ICC= 0.83 to 0.95)

- To measure the navicular height, navicular drop test was performed with the help of a thick white index card. It was placed parallel to the subject's feet (maintained in a subtalar neutral position) inner aspect of the hindfoot, with the card placed from the floor in a vertical position passing the navicular bone. The level of the most prominent point of the navicular tubercle was marked on the card and the floor was measured during sitting and standing. If navicular height is more than 10 mm in standing when compared to sitting position, then individual is having functional flat feet and was included in the study.

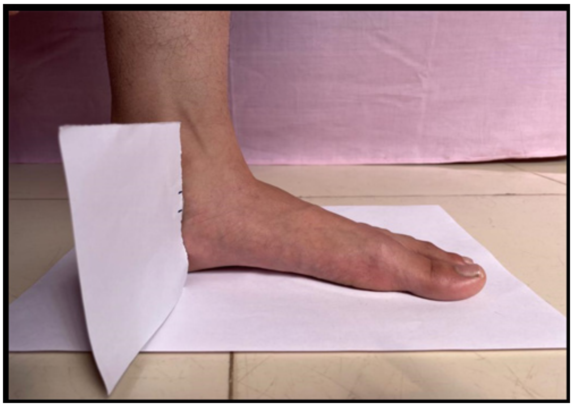


Figure 2: Navicular drop test

2. Ankle Range Of Motion : (ICC= 0.94 to 0.98)

- The range of motion of ankle was measured by universal goniometer for the range of dorsiflexion.

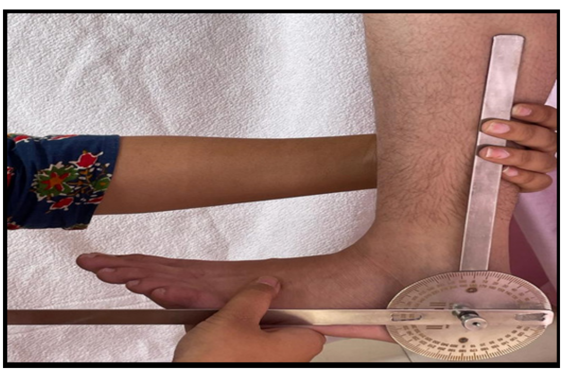
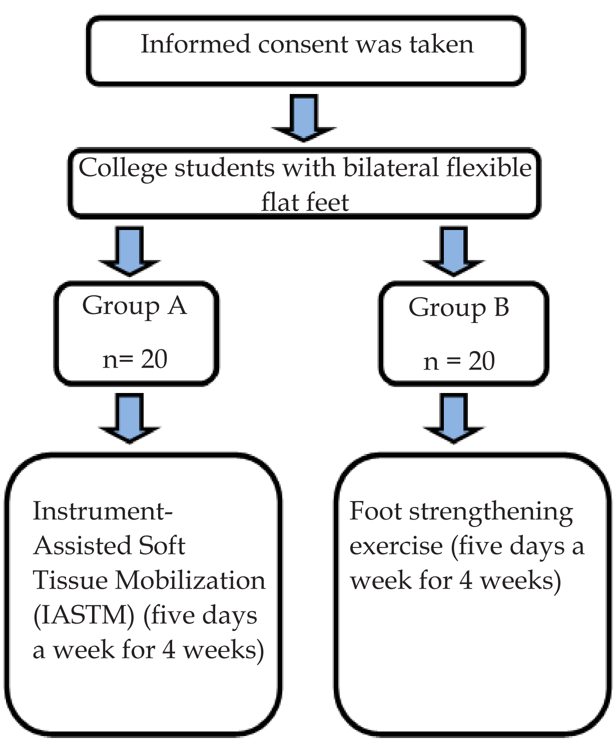


Figure 3: Ankle range of motion



Group A:20 students received conventional physiotherapy treatment along with IASTM. For conventional physiotherapy treatment, students were positioned in supine lying on the treatment table. Plantar fascia release was given by the therapist's knuckles for 2 minutes over the sole of the foot. Plantar fascia stretch was given in the sitting position in the form of self stretching and was maintained for 30 seconds and was repeated for 3 times.

For IASTM treatment, students were instructed to lie in prone position with their feet off the table. Small amount of petroleum jelly was applied to the sole of the foot followed by scanning the fascia using the sweep strokes to identify areas of restriction. For scanning stroke, mainly 3 strokes were used:

1. First stroke from heel to little finger of foot
2. Second stroke from middle heel region to middle finger of foot
3. Third stroke from heel to greater toe of foot

Areas of restriction were treated with the IASTM tool (myoblaster) for 30-60 seconds per lesion. The tool was moved parallel to the fibers in alternating proximal and distal direction. Each student received treatment for 2 minutes.

Figure 4: Sweeping technique of IASTM

Group B: 20 students received conventional physiotherapy treatment along with foot strengthening exercise. For conventional physiotherapy treatment, students were positioned in supine lying on the treatment table. Plantar fascia release was given by the therapist's knuckles for 2 minutes over the sole of the foot. Plantar fascia stretch was given in the sitting position in the form of self stretching and was maintained for 30 seconds and was repeated for 3 times.

Foot strengthening protocol:

1. Foot adduction resisted exercise - 10 repetitions
2. Bilateral heel raise in standing position - 10 repetitions 5 sec hold
3. Foot inversion and eversion resisted exercises- 10repetitions
4. Great toe extension - 10 repetitions 5 sec hold
5. Toesextension - 10 repetitions 5 sec hold
6. Toe spreading exercise - 20 repetitions
7. Short foot exercise in non-weight bearing - 20 repetitions
8. Short foot exercise in weight bearing - 20 repetitions
9. Towel curl exercise in sitting position without weight - 10 repetitions
10. Towel curl exercise in sitting position with weight - 10 repetitions

Results and Discussion

Data was analysed by IBM SPSS 29 software and Microsoft Excel 2019. Prior to the statistical analysis test, data was screened for normal distribution by Shapiro-Wilk test. According to normal distribution, tests were applied for within group and between group analysis.

Table 1: Baseline Data

GROUPS	GROUP A	GROUP B
NO. OF SUBJECTS	20	20
	MEAN ± SD	MEAN ± SD
AGE	21.25±1.97	21.45±1.31
GENDER	FEMALE :14	FEMALE :14
	MALE :6	MALE :6

Table 2: Results of Mann Whitney-U Test for IASTM and Foot Strengthening Analysis (Between Groups A & B)

Outcome Measures	IASTM (Mean ± SD)	Foot Strengthening Exercise (Mean ± SD)	U Value	P Value	Remarks
NDT(right)	2.00±0.5619	4.65±1.0894	4.500	<.001	Significant
NDT(left)	2.20±0.5231	5.20±0.9514	<1.00	<.001	Significant
ADF(right)	5.20±0.6958	3.65±1.3484	81.00	<.001	Significant
ADF (left)	5.10±0.4472	3.75±1.3717	95.00	<.001	Significant

Here, the absolute difference of pre intervention and post intervention was measured by Mann Whitney U-test and inter-group comparison of NDT (right), NDT (left), ADF (right), ADF (left) showed statistically significant difference as shown in the Fig5. Hence, IASTM was more effective in increasing ankle dorsiflexion range of motion and foot strengthening exercise was more effective in increasing navicular height.

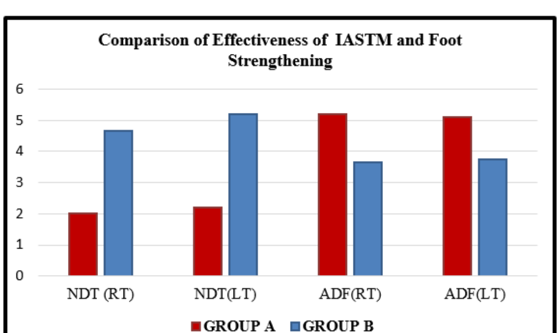


Fig 5: Mean difference between Groups A and B (Pre v/s Post)

In this study, effects of instrument assisted soft tissue mobilization and foot strengthening exercise on navicular height and ankle range of motion in college students with flexible flat were examined. Navicular height was assessed by Navicular Drop Test (NDT) and ankle dorsiflexion (ADF) was measured by 360^0goniometer.

First objectivee of this study was to determine the effects of instrument assisted soft tissue mobilization on navicular height (NDT) and ankle range of motion in college students with flexible flat feet.

The IASTM treatment is thought to stimulate connective tissue remodelling through resorption of excessive fibrosis, along with inducing repair and regeneration of collagen secondary to fibroblast recruitment. In turn, this will result in the release and breakdown of scar tissue, adhesions, and fascial restrictions.[27]

Tanaji Darshanaet al in 2020 conducted a study named "A comparative study of Instrument Assisted Soft Tissue Mobilization with conventional physiotherapy treatment in patients with flexible flat foot on ankle range of motion and foot posture index". In this study, 32 participants both male and female (aged- 18 to 22) were included. They were divided into two groups; Group A and Group B were assessed with two outcome measures; foot posture index and ankle range of motion. Group A received conventional exercise along with IASTM and Group B received conventional therapy along with strengthening exercise for 4 weeks. The study concluded that 4 weeks of IASTM technique improved foot posture index (FPI) and ankle range of motion in young individuals.[28]

Second objective of this study was to determine the effects of foot strengthening exercise on navicular height (NDT) and ankle range of motion in college students with flexible flat feet.

Among prior studies, Hyong et al.[29](2009) reported that when extrinsic foot muscle strengthening exercises were implemented with subtalar joint treatment, dynamic balance significantly increased, and Panichawit et al.[16] (2015) implemented intrinsic and extrinsic muscle strengthening exercises for flexible pesplanus patients and reported that foot functions got improved. Neumann et al.[30](2011) stated that the foot intrinsic muscle and tibialis posterior muscle strengthening training allowed for longer gaits compared to other supination muscles that are used during the propulsion stage.

Third objective of this study was to compare the effects of instrument assisted soft tissue mobilization and foot strengthening exercise on navicular height (NDT) and ankle range of motion in college students with flexible flat feet.

In the current study, students were assessed at baseline and after 4 weeks of therapy with IASTM and Foot strengthening exercise. The results showed statistically significant improvement in navicular height and ankle dorsiflexion range of motion(ADF) with the use of IASTM and foot strengthening exercise (within group comparison). But, in between group comparison, IASTM was found to be more effective in improving ankle dorsiflexion range of motion and foot strengthening exercise was more effective in increasing navicular height.

Thus, both techniques (IASTM as well as foot strengthening exercise) can be further implemented in clinical practice for increasing navicular height and improving ankle dorsiflexion ROM related to the flexible flat feet according to the availability of clinical set up and the trained physiotherapists.

Conclusion

The results of this study supported the null hypothesis and showed statistically significant improvement in navicular height and ankle ROM with the use of Instrument Assisted Soft Tissue Mobilisation(IASTM) and foot strengthening exercise (within group comparison) by Wilcoxon Signed Rank test. But, in between group comparison by Mann Whitney U-Test, IASTM was found to be more effective in improving ankle ROM and foot strengthening exercise was found to be more effective in increasing navicular height.

Limitations

- As study was a comparative study, it did not include a control group.
- This study used a 4 week intervention to investigate the effects of IASTM and strengthening protocols on changes in navicular height but, 6 or 8 weeks intervention may produce more significant results.
- No electrical modalities were used in this study for improving strength of the foot muscles.

Ethical clearance: Ethical clearance was obtained from The Institutional Review Board(PPC/OW/4020A/2022) from Pioneer Physiotherapy College, Vadodara.

Source of funding: Self

Conflict of interest: Nil

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