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Original Study

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The Relationship between Hand Dexterity with Hand Grip Strength in Young Males

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Abstract

Background: Hand dexterity a measure of hand flexibility and coordination can be affected by many factors including hand grip strength. However, there are limited studies and data about the association between hand dexterity and grip strength in Asian population. Hence, we aim to investigate the relationship between hand dexterity and hand grip strength in healthy males aged between 18 to 25 years old in Asian population.

Methods: Fiftyhealthy adult male participants between 18-25 years were recruited by advertisement.Hand grip strength and hand dexterity test by using a handheld dynamometer and Purdue pegboard test, respectively was measured. Purdue pegboard test consisted of two main parts: 1. Inserting pins into the pegboard holes using left, right, and both hands in 30 seconds. 2. Assembly using pins, collars, and washers in one minute. Pearson correlation coefficient and regression analysis was used to study the association between hand dexterity and hand grip strength.

Results: The results showed no correlation between left, right and combined hand dexterity with hand grip strength (p value = 0.481 and r = 0.099, p value = 0.181 and r value = 0.188, and p value= 0.945 and r value= 0.009) respectively. Moreover, the results also showed no statistically significant association between number of assemblies built and grip strength (p value = 0.430 and r value=0.111).

Conclusion: Our results suggest that there is no statistically significant relationship between hand dexterity and hand grip strength in young males aged between 18 to 25 years old. Thus, it can be concluded that hand grip strength is not a factor that affects hand dexterity in young adult males of Asian population.

Keywords: Dynamometer, Perdue Pegboard, hand dexterity and hand grip strength

Introduction

Hand is a group of complex joints which is considered the most interactive and active portion of the upper extremity. It is very important and useful in body and sign language. Besides, hand helps us to grasp, grip, and perform precise motions such as writing and sewing. Furthermore, a dexterous hand allows one to use their fingers and hands to perform

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daily tasks effectively. The central feature of effective functional performance of the upper limb relies on the synchronous interrelationship between sensory and motor components, which allows humans to control fingers independently regarding timing, kinetics, and force[1].

Hand grip strength is a screening tool that could be used to measure muscular strength generated by one's upper extremity. Hand grip strength is also a predictor of general fitness because it correlates to a person's nutritional, bone mineral, and muscle strength status[2,3]. Tsuji et al. proved that grip strength was a determinant of the mineral density of radial bones in young athletes' dominant forearms[4]. Besides, Ozdurak et al. also discovered that forearm muscular strength had a minimal relationship with bone mineral density in males. Moreover, the maximum muscle strength gained through grasping exercises could be a good predictor of bone mechanical characteristics due to muscles connected to the forearm create the majority of the voluntary load on the bones [5].

Additionally, several cross-sectional studies have suggested an association between hand dexterity or grip strength and overall cognitive function [6]. Between persons with mild cognitive impairment and healthy adults, clinical trials found significant disparities in motor dysfunction. For daily tasks requiring cognitive engagement, such as writing, cooking, crafting, and gardening, hand grip strength and coordination are necessary [6]. Motor speed skills, planning, attention allocation, and visual search are required for hand movements. Therefore, executive function, which is made up of the cognitive processes of attention, planning, judgement, working memory, inhibition, and task flexibility, has a significant impact on hand motor function levels [6].

Hand grip strength can influence one's hand dexterity. Hand dexterity is less predictable and most related to age, sex, and dominance [7]. A study by Omar et al. reported that hand dexterity and grip strength may be influenced by demographic characteristics [8]. Besides, one's hand dexterity may also decline with age due to neuromuscular function decline may affect one's performance on the daily task [9]. When age increases, the muscle strength decreases thus elderly may have poor force control. A more recent study reported that hand grip strength is associated with faster upper extremity mobility [10]. However, elderly data is not suitable to represent young males due to differences in age, muscles control, and lifestyle.

Therefore, the purpose of this study was to know how hand dexterity could influence one's handgrip strength in younger age group. This normative data helped further study hand dexterity and grip strength to predict general fitness and various diseases.

Methods

Fifty healthy male volunteers were recruited by advertisement and explained in detail about the study protocol. All participants signed a written informed consent form as proof of the agreement to participate in this study. The inclusion criteria of healthy males between 18 to 25 years with a normal BMI between 18.5 to 24.9kg/m2, having the right hand as the dominant hand, and without any medical illness was used in this study. This research study only tested the dominant right hand to standardize the data in this research. Participants who had recent hand injury or surgery, congenital or acquired hand deformities (unequal or uneven finger), and hand having pathological conditions the hand and cervical problems were excluded from this study.

The demographic data, including gender, age, weight, height, and dominant hand was collected from the participants. Their body weight was calculated using a digital scale to the nearest 0.1 kg, and their height was calculated using a measuring tape to the nearest 0.1 cm. This was used to calculate the participant's BMI. The participants' reported preference for using their dominant hand for activities including eating, writing, and opening and closing doors was used to determine hand dominance.

Hand dexterity performance:

The Purdue pegboard test was used to assess participants' hand dexterity. There were four sections to the hand dexterity test. Participants used one hand

individually for each segment in segments 1 and 2 to place pins into the board. Following that, in segment 3, participants simultaneously inserted the pins with both hands. In segment 4, participants used pins, collars, and washers to build miniature assemblies while utilizing both hands simultaneously. The outcomes were then computed and recorded. The test generates four different scores based on the entire test process. These tests were repeated three times, with the average findings calculated for each subject. In order to reduce measurement mistakes, the subjects' hand dexterity was evaluated using the same Purdue Pegboard and stopwatch.

Hand grip strength:

The hand grip strength of healthy male volunteers was measured using a hand grip dynamometer. The participants were told to sit straight with their left and right elbows flexed at right angles. For testing, a portable dynamometer was held in their dominant hands with their wrists in a neutral posture. Additionally, the control handle of the dynamometer was adjusted, and the results were recorded as a kilogram. The experiment's steps were repeated three times, and the average results were calculated for each subject. To reduce measurement mistakes, each participant utilized a handgrip dynamometer that was the same.

Statistical Analysis:

Pearson correlation coefficient was used to study the association between hand dexterity performance and hand grip strength in young males. The association between the two variables was ascertained using the regression analysis. Additionally, the hand grip strength and dexterity graphs were plotted. P values less than 0.05 were considered statistically significant.

Results

Physical Characteristics, Hand Dexterity and Hand Grip Strength measurements:

Table 1 provides the subjects' physical characteristics parameters, including age, body mass index (BMI), and hand grip strength. Table 2 shows the average subjects' hand dexterity performance which includes dexterity scores for left, right, both hands, and the number of assemblies built by subjects.

Table 1: Physical characteristics of study participants:

Physical Characteristics	Average	Standard deviation
Age	20.6 years	1.37
BMI	21.68kg/m^2	1.90
Hand grip strength	33.95 kg	8.11

Table 2: Hand dexterity scoring data of study participants:

Hand dexterity	Average	Standard deviation
Left hand	14.03	1.57
Right hand	15.27	1.42
Both hand	12.33	1.34
Assemblies built by subject	38.15	5.82

Association between hand dexterity and hand grip strength:

The association between the hand grip strength and the hand dexterity test of left hand, right hand, both hands and number of assemblies were examined using regression analysis and Pearson correlation coefficient (Figure 1). The regression analysis results indicated that there was no association exists between left, right and combined hand dexterity with hand grip strength (p value = 0.481 and r = 0.099, p value = 0.181 and r value = 0.188, and p value= 0.945 and r value= 0.009) respectively. The results also showed no statistically significant association between number of assemblies built and grip strength (p value = 0.430 and r value=0.111).

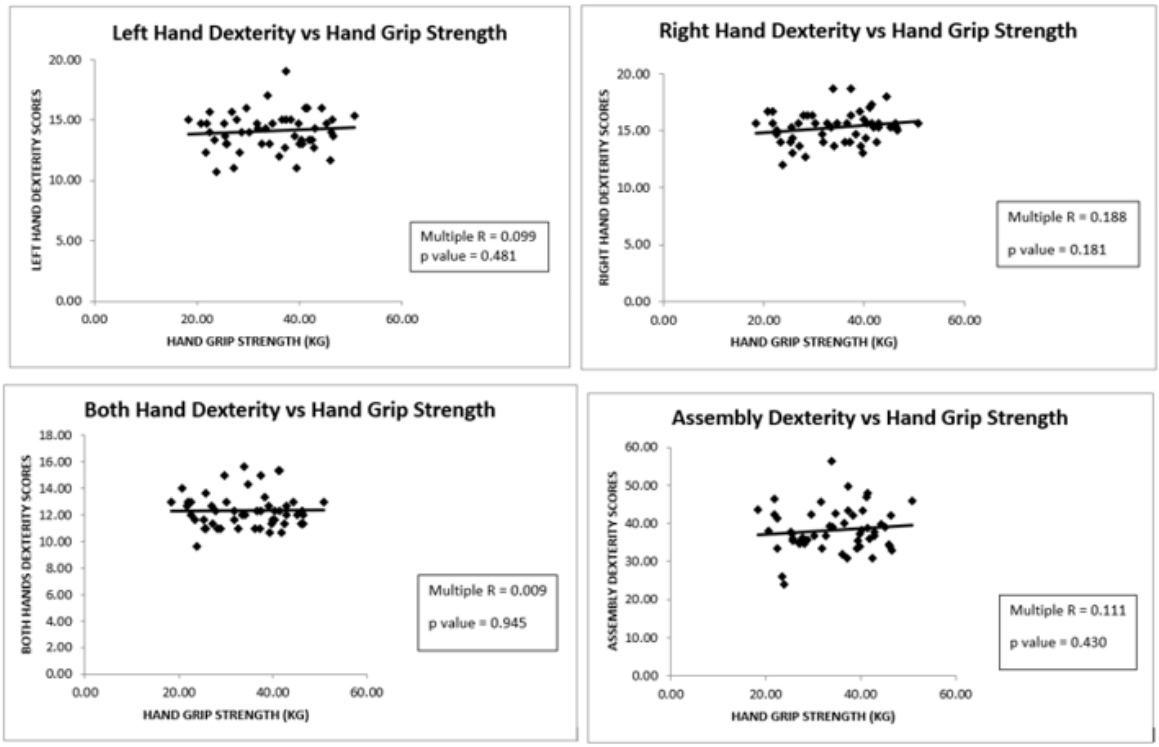

Figure 1: Correlation analysis of left, right both hand and assembly hand dexterity scores vs hand grip strength

Discussion

This present study findings expand on previous research on grip strength and dexterity. In our study, we showed that there are no associations between hand grip strength and hand dexterity in young healthy adult males. Hawardet al. tested four groups of 18 subjects, two groups of volunteers were 18 to 25 years old, while two elder groupswere 45 to 55 years old [11]. The results showed that there was no discernible relationship between hand grip strength and dexterity function. It suggested that manual dexterity is not associated with musculoskeletal function. Therefore, a decline in hand dexterity might not indicate a decline in hand grip force.

However, some studies suggested a relationship between hand dexterity and hand grip strength in other groups of people, such as the elderly. Incelet al. tested 24 senior volunteer patients between 64- and 79 years old [12]. The study revealed a significant correlation between the Dreiser and Duruözindices – a functional disability score and the grip and pinch strengths in this geriatric group. These two indices had the strongest correlations with Lawton Instrumental Activities of Daily Living (IADL), which the study chose to measure activity limitation. Furthermore, the study also presented that the function of hand-muscle and functional dependency in older people are correlated [12]. Other than that, Shiffman et al. also reported that age-related declines in hand strength are positively correlated with reduced functional performance in activities requiring dexterity, strength, or both[13]. Indeed, another study also confirmed the relationship between dexterity and fine hand use (DFHU) task performance and grip strength in children aged between 3 to 13 yearsold[14]. This study suggests that potentially all these variables may reflect a construct called "children's upper limb motor performance". However, the relatedness of the motor performance measures was significantly diminished by partial correlations that took age into account [14].

In contrast, Martin et al. reported that grip strength accounted for more variation in aiming and tapping hand dexterity tasks than age [15]. The study shows that the hand dexterity tasks is declined significantly when the hand grip strength decreases. The research suggested that the adult with greater grip strength will have greater hand movements compared to adult with poor grip strength [15]. This

study also shows that hand strength appears to be closely related to dexterous activities that depend on the quick and exact coordinated movement control of the wrist, hand, shoulders and elbow such as that tapping and aiming [15]. Although this is the first time this argument has been raised, it is well recognized that well-controlled muscular forces, sensory information, and body plan are necessary for successful muscle coordination during movement execution. Muscle force changes during a movement affect the ability to execute the planned movement accurately, resulting in compensatory movements [15]. The thumb and index finger must pinch the stylus object while pointing and tapping with a minimum force more significant than the friction force necessary to prevent the object from slipping when raising it. The execution of the quick tapping and targeting actions then necessitates substantial muscle activations with quick movement accelerations in response to the job. The stylus must simultaneously coordinate force with movement accelerations and the target's impact while pinched between the thumb and index finger. Therefore, diminished strength will increase force capability variability, increasing movement trajectory variability and ultimate position accuracy [15]. Repeated executions of these effects will compound their effects. In repeated performances of a task such as the tapping task, these effects will be amplified because variations in muscle force during a voluntary contraction will increase the variance of movement kinematics from trial to trial [15].

Furthermore, the relationship between total number of assemblies built by subjects and hand grip strength was studied in our study. Our findings suggested that there is no relationship between number of assemblies built with hand grip strength. This suggests, unlike finger tapping and peg-placing activities, grip strength does not necessitate autonomous or precise finger control. For instance, in their seminal paper, Lawrence and Kuypers discovered that although monkeys lost their ability to move their fingers separately following a pyramidotomy, they were still able to strongly flex them together in a power grip [16]. It was also found that, whereas grip strength asymmetry was substantially connected with finger tapping asymmetry in right-handers, it was unrelated to finger tapping asymmetry in left-handers [16].

Conclusion

In conclusion, the present research study shows that there is no relationship between number of assemblies built, left, right, both hand dexterity scores and hand grip strength in young males aged between 18 to 25 years old.

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Conflict of Interest: There is no conflict of interest declared in this study.

Ethical Clearance: This study was cleared by the Joint Research and Ethics Committee of International Medical University, Kuala Lumpur, Malaysia.

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Original Research

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Effect of Body Mass Index on Foot Posture Types and Core Stability Among University Students

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Abstract

Background: Core Stability is the capacity to regulate the position and motion of the trunk over the pelvis for optimal force production, transmission, and motion control to the terminal segment during integrated sports activities. Obesity is linked to a number of debilitating musculoskeletal diseases in adults. The Foot Posture Index can be used to assess deviations in foot posture alignment, such as pronation and supination. Various studies were conducted to determine the impact of Body Mass Index on core stability and foot posture alignment in non-athletic males aged between 22 and 27 years. As a result, the current study is determining the impact of Body Mass Index on core stability and foot posture types in male and female participants of the age group (18 to 25 years).

Materials and Methods: In this Observational study A total 100 samples were taken based on the inclusion and exclusion criteria which were categorized into two groups. Group A -50 male subjects, Group B - 50 female subjects.

Foot Posture Index-6 was used to assess foot. Normal foot, Pronated and supinated foot type during static foot posture was obtained by Foot Posture index. Core Stability was checked by prone plank test.

Conclusion: According to this study, both Men and Women are more likely to acquire pronated feet when their weight increases. In females, the likelihood of having a flat foot and a pronated foot type increases as the weight increases, especially those who are belonging to overweight and obese category of Body Mass Index.

Keywords: Body Mass Index, Foot Posture Index, Plank Test.

Introduction

Obesity impairs quality of life with serious medical complications. It increases the mass of different body segments and modifies overall body geometry. The obese people are more prone to injury as it imposes functional limitations pertaining to the biomechanics of activities of daily living. The body mass index, which is calculated as a person's body weight divided by his or her height squared (kg/m^2), is a valuable tool for determining whether a person has an excess of body fat[1]. According to world health organization, a body mass index of 18.5 to 24.9 is considered normal, anything below is considered underweight while anything above is considered obese (WHO 1997). [2]

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Proximal stability for distal mobility is achieved by the core serving as an anatomical foundation for motion of the distal portions. Core stability is defined as the ability to control the position and motion of the trunk over the pelvis and leg to enable the best possible production, transfer, and control of force and motion to the terminal segment in integrated kinetic chain activities.[3] Both active and passive components contribute to the stability of the core; the active muscular components do so by increasing intra-abdominal pressure, compressive pressures on the spine, and the rigidity of the hip and trunk muscles.[4]

Any soft tissue having a proximal attachment origin on the axial skeleton is considered to be a part of the core's anatomical structure. Core instability is closely related to weak core muscles since studies have revealed that core muscles are crucial for stabilising the body, generating forces, rehabilitation, and building strength and stability of the core.[5]

Material and Methods

Research Setting

This study was performed between males and females of university students.

Ethical Consideration and Consent Taken

The Permission to conduct the study was taken from Departmental Committee, Physiotherapy Department, Guru Nanak dev university, Amritsar. Before the beginning of study, subjects/ participants were given detailed information about the purpose, aims, objectives, procedure of research in the language easily understood by the subjects and then the voluntary consent was obtained.

Sample Population

Both males and females, within the age group of 18-25 years are part of the study.

Sampling Method

Convenient sampling method was used.

Study Design:

The current research is observational design done with aim to find the effect of BMI on Foot Posture Type and Core Stability and in between male and female.

Sample Size

Study sample consists of 100 subjects including both males and females with 50 subjects each.

SELECTION CRITERIA

Inclusion Criteria

Age: 18 to 25 years

Normal, Overweight and Obese people

Exclusion Creteria:

Spinal deformity

Musculoskeletal problem

Talus fracture and calcaneum fracture

Foot pain

Reduced tactile and thermal sensibility

Peripheral neuropathy

Plantar fasciitis

Back pain

Limb length discrepancy

TOOLS FOR DATA COLLECTION

- Weighing machine

- Stadiometer

- Stopwatch
- Exercise mat

- Foot posture index sheet

Procedure

- Subjects (N=100) from population, both males and females (with 50 subjects each) meeting the inclusion criteria and willing to participate in present study were selected. After obtaining a written consent, information regarding the demographic profile, residential location, and occupation and education status from the subjects' data was recorded on the data collection form. Subjects were assured for Confidentiality of their response, then height and weight were measured and Body Mass Index (BMI) was calculated by putting values in formula weight/height square with weight calculated in kgs and height in cm, Then Foot Posture Index was checked and scoring was done accordingly while the participants were in standing position and the foot posture was Static Foot Posture. Further Core Stability was checked by doing Plank Test in a Prone bridge position.

Measurement of weight

Measurement of weight

Measurement of height

- **The Foot Posture Index (FPI):** The FPI is a system for observing and Rating static foot posture, incorporating six criteria with the participant standing in a relaxed bipedal position. These criteria include (i) talar head palpation, (if) observation of curves above and below the lateral malleoli, (iii) Frontal plane alignment of the calcaneus, (iv) Prominence of the talonavicular joint, (v) Congruence of the medial longitudinal arch, and (vi) Abduction/adduction of the forefoot on the rear foot. Each of these criteria are scored on a 5-point scale (ranging from -2 to +2) and the results combined, resulting in a summative score ranging from -12 (highly supinated) to +12 (highly pronated).

Congruence of the MLA (Female)

Congruence of the MLA (male)

- **Plank Test:** It was used to assess the core stability in a prone bridge position for as long as subject can hold the position, the time was recorded three times and then average of three readings was taken out.

Plank Test of (male)

Plank Test of (female)

- **Body Mass Index:** The formula of weight in kilograms divided by the height in meters squared was used to calculate BMI.

Results

Based on inclusion and exclusion criteria, a total of 100 subjects (50 male and 50 female subjects) were enrolled in this study. The mean and standard deviation of Body Mass Index (BMI) of males was 23.130±3.558 while the same for females was 23.088±3.154. Male core stability had a mean and standard deviation of 59.054±28.133 while female core stability had a mean and standard deviation of 28.931±14.940. Males' left feet had a mean and standard deviation of 3.640± 2.107 while their right feet had a mean and standard deviation of 3.500± 2.131 for the FPI-6. While the mean and standard deviation of the FPI-6 for a female's left foot was 3.580±2.129 and for her right foot was 3.240±2.308, respectively. Male Body Mass Index and left foot posture display a statistically significant pearson's correlation with P=0.000 and r = 0.680**. Males' right foot posture and body mass index demonstrate a statistically significant pearson's correlation of r=0.705**, where P=0.000. Female body mass index and left foot posture exhibit a statistically significant pearson's correlation (P=0.000, r=0.585**). Female Body Mass Index and right foot posture also have a statistically significant pearson's correlation (P=0.000, r=0.641**). There is significant correlation between body mass index and core stability in males (P=0.040, r=-0.292*) as compared to females (P=0.221, where r=-0.176).

Table 1: Table shows comparison between normal, obese and over weight

	Group (%)		Group (f)	
BMI	**Male**	**Female**	**Male**	**Female**
Normal	76.0%	82.0%	38	41
Obese	4.0%	4.0%	2	2
Over Weight	20.0%	14.0%	10	7

Table 2: Representation of Foot Posture Index (FPI) between males and females (left foot)

Variables	N	Mean FPI	S.D	p-value	r-value
Males	50	3.64	2.107	0.8877	1.98
Females	50	3.58	2.129		

Table 3: Representation of Foot Posture Index (FPI) between male and female (right foot)

Variables	N	Mean FPI	S.D	p-value	r-value
Male	50	3.50	2.131	0.5598	1.98
Female	50	3.24	2.308		

Table 4: Representation of Body Mass Index (BMI) between males and females.

Variables	N	Mean BMI	S.D	p-Value	r-Value
Males	50	23.13	3.558	0.9503	1.98
Females	50	23.09	3.154		

Table 5: Representation of Core Stability between males and females.

Variables	N	Mean-Core stability	S.D	p-Value	r-Value
Males	50	59.05	28.133	<0.001	1.98
Females	50	28.93	14.940		

Table 6: Shows correlation of Body mass Index (BMI) with foot posture index

Foot Posture Index	r-value	p-value
Right Foot	0.641**	0.000
Left Foot	0.585**	0.000

Table 7: Shows correlation of Body mass Index (BMI) with foot posture index

Males

Foot Posture Index	r-value	p-value
Right Foot	0.705**	0.000
Left Foot	0.680**	0.000

Discussion

The objective of this study was to determine how body mass index affected both core stability and the Foot Posture Index (FPI). The results are in line with a prior study that found obese males tends to have more pronated feet while obese women tend to have flatter feet.[6] Therefore, it is thought that obesity has an unusual impact on the structure of the foot. The study's objective was to determine how body mass index affected both core stability and the Foot Posture between males and females.

The foot is subjected to additional mechanical loading when the body weight is excessive. The outward appearance of a flat foot in obese people may be caused by fat accumulation.[7] According to this research, body weight has been found to be significantly linked to increased foot loading, particularly in the forefoot and midfoot. This finding suggests that obesity increases stress on the foot both directly through increased body weight and indirectly through the changes to the foot's structure, which results in a relatively pronated type of foot posture.[8]

The results of our study accounts for differences in Body Mass index (BMI) and Foot Posture Index (FPI) between males and females of participants aged 18 to 25. According to our biomechanical analysis of the foot posture index, people with an overweight BMI tended to have flat feet. Therefore, a higher prevalence of obesity has been noted in people with flat feet (wearing *et al*., 2006), which may be related to the earlier finding that people with flat feet have a more convex talonavicular prominence and forefoot abduction relative to the rear of the foot.[9]

My results are in conjunction with a previous study of Nisha Dhasal and zebabarodawala which showed that there is significant correlation between Body Mass Index and Foot Posture Index.[10] The increased amount of weight on foot has an impact on the overall limb kinetic chain. Therefore, the impact that obesity has on Foot Posture Index and function should be part of awareness about all the negative impacts on the affected individuals.

Zhao *et al*.,2020 study showed that arch structure bears the body weight and is greately influenced by factors such as gender and Body Mass Index strongly impacts arch height. The results of my study are in conjunction with this study which shows that women had low arched feet (flat foot) compared to men.[11]

According to (Redmond *et al*., 2008) the description of foot posture is based on the six criteria of Foot Posture Index (FPI-6) which divides the foot into three three categories i.e Normal, Pronated and Supinated foot. These are the broad terms which includes sub components as in pronated foot includes low arch height of foot.[12]

Sanchez and Rodriguez (2013) did a study to evaluate possible sex differences in the FPI and what are the factors that influence foot posture. In his study He took 400 individuals which included (201 men and 199 women) and in relaxed position and static bipedal stance, FPI (Foot Posture Index) was determined. The results for FPI between men and women were non-significant and he concluded that the posture which was most frequent was neutral with some degree of pronation, with no differences in FPI values between men and women and individuals with heavy or large foot size had higher FPI values that is they have a more pronated type of foot posture.[13]

A study by (Rasif and Wang, 2017) indicated a negative link between core muscle function and body composition factors; significant correlations were identified in men as compared to women. While evaluating the person, core muscular strength and stability should be taken into account, as well as being a part of therapy.[14]

Our findings are consistent with those of (Abdulwahab and Kachanathu, 2016), who tested the anterior core muscle endurance in 39 nonathletic subjects with BMIs ranging from 25 to 29.9 kg/ m2.[15] They discovered a substantial correlation between CS and BMI. It has been established that CS plays a part in the movement and transfer of muscular power from the torso to the extremities during functional and athletic activities. The result will be low force generation and inappropriate and restricted movement patterns of the extremities due to a loss in muscular energy from the core if the core muscles are weak and the extremities are strong. To maintain core stability, the body must use motor-processing, sensory, and biomechanical principles in combination with prior knowledge and the capacity for anticipatory reactions.[16] Therefore, in reaction to destabilising internal or external forces produced by extremities and expected or unforeseen challenges to stability, the body must govern the trunk.[17]

Study done by (Rasif and wang, 2017) there is significant differences in core muscle function between men and women.[18]The difference in trunk and lower limb muscle mass accounts for gender difference in core muscle and function (Marras and Colleagues, 2001) found that men have lower limb muscle cross- sectional area and had larger trunk than women by uses magnetic resonance imaging scan. Another reason for gender difference may be the more body mass in women. From these studies, the result of anatomy and function are indicative of differences in the core muscle function of young men and women. In overweight and obese subjects, the rectus abdominal muscle had the highest levels of fatty infiltration, while the lateral abdominal muscle and paraspinal muscle had lower levels.[19]

Conclusion

According to this study, both men and women are more likely to acquire pronated feet when their weight increases. In females, the likelihood of having a flat foot and a pronated foot type increases as the weight increases, especially those who are belonging to overweight and obese category of Body Mass Index. In this study Body Mass Index (BMI) and Core Stability are negatively correlated, meaning that as weight increases in both sexes, there is decrease in Core Strength. Compared to men, women displayed less stability in the Core Strength.

Conflict of Interest: None

Source of funding: Self

Ethical Clearance: The Permission to conduct the study was taken from Departmental Committee, Physiotherapy Department, Guru Nanak dev university, Amritsar. Before the beginning of study, subjects/ participants were given detailed information about the purpose, aims, objectives, procedure of research in the language easily understood by the subjects and then the voluntary consent was obtained.

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Research Article

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Effect Of 14 Days Physical Activity Walking Regime on Blood Pressure in Pre-Hypertensive Young Adults: A Randomised Controlled Trial

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Abstract

Background: Hypertension is a non-communicable disease characterised by chronic increase in blood pressure that results in cardiovascular illness including stroke, coronary artery disease and peripheral vascular disease. Recent literature suggests that increase in sedentary lifestyle is due to decline in physical activity and increases the rate of morbidity and mortality The incidence of prehypertension among young adults was found to be ranging approximately from 37.5 to 77.1%. Walking is a form of physical activity and a common ADL, that is feasible, low cost and has low risk and can be implemented into daily living. Here we describe the acute effect of walking regimen on blood pressure in pre-hypertensive young adults by using Harvard step test.

Methodology: Participants of either gender having pre-hypertensive state between the age 18-25 were recruited for the study. 34 subjects were selected and divided in two groups. Group A had to walk 10000 steps and group B walked to their maximum capacity. In pre-intervention both groups were assessed for blood pressure, Harvard test, and ideal body weight using brocca's index. Data was collected based on post intervention.

Conclusion: This study concluded that a short-term walking program of 10,000 steps per day can potentially lead to significant improvements in several health outcomes, including blood pressure, heart rate, Spo2 and physical fitness and have important implication for the prevention and management of hypertension in pre-hypertensive young adults.

Key Words: pre-hypertension, Blood pressure, Harvard step test, Walking

Introduction

Hypertension is a non-communicable disease characterised by chronic increase in blood pressure that results in cardiovascular illness including stroke, coronary artery disease and peripheral vascular disease. According to World Health Organization hypertension is pointed as the most important global risk factor responsible for increasing the rate of morbidity and mortality. There is a higher prevalence of hypertension in individuals living sedentary lifestyle and was found pre-dominantly in females of age group 20-44 years Recent literature suggests that increase in sedentary lifestyle is due to decline in physical activity and increases in the rate of morbidity and mortality[(1)] **(Ramakrishnan S. 2019)**

Physical activity is a non-pharmacological strategy for the treatment of hypertension. Aerobic exercises significantly lower blood pressure and

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oxidative stress in hypertensive individuals [2] **(Larsen MK 2016)** Due to its minimal side effects, physical activity is economically viable and alternative first line treatment for hypertension. [3] **(Noon C 2018)**

Prehypertensive young individuals having sedentary lifestyle are highly prone to developed hypertension in later stages of their life. The incidence of prehypertension among young adults was found to be ranging approximately from 37.5 to 77.1%.[4] **(Jun M 2020)** Also, association of prehypertension causes sub-clinical atherosclerosis and target- organ damage [5] **(Lyu QS 2018)**

According to classification system given by Tudor-Locke and Bassett on step count, an individual with more than 10000 steps per day is considered physically active.[6] **(Bassett DR 2017)** Walking is a form of physical activity and a common ADL, that is feasible, low cost and has low risk of injury and can be implemented into daily living. Walking increases the physical fitness and reduces the risk for cardiovascular disease by lowering the blood pressure and the risk of Non – communicable disease.[7]**(Lee LL 2019)**

Studies found that pedometer intervention in inactive adults are effective in increasing physical activity levels by creating awareness and motivating the patients[8] **(Consoli A 2020)** and Most of the smartphone pedometer application (pedometer lite) are free of cost shows more accuracy and live feedback which motivate people to achieve their daily level of physical activity. [9] **(Fong SS 2016)**

Various maximal and submaximal test are used to analysed cardiovascular response to stress. Test using lesser equipment and cost, increases the feasibility of the tester and the participants to perform the test and conclude the test. Harvard step test is one of the exercise tolerance tests, in which the participants step up and down on the platform until exhaustion by maintaining the stepping rate for 15 seconds. [10]

Methodology

- **Study design**: A Randomised controlled trial
- **Study duration**: 6 months (October 2022-March 2023)
- **Method of sampling randomisation:** Simple randomisation method
- **Study setting:** Participant's data was collected in latur in young adults
- **Sample size**: 34 (randomly divided into two groups)

Ethical clearance was obtained from the ethical department of Svss Latur College of Physiotherapy. Participants are screened on the basis of inclusion and exclusion criteria and Participants eligible were randomly divided into two groups by using random number generator to select the groups. Procedure was explained to the patients and required consent was taken from them. Data of all the participants was noted on day 1. The data include demographic data, blood pressure, co morbidities, medication in use, height, weight, pulse rate and Spo2.

Once the allocation was done participants in the group A received walking regimen of 10000 steps and group B up to their Maximum capacity for 14 days which was measured by pedometer. The blood pressure was assessed on day 1 and day 14. Data was collected based on post intervention of primary and secondary outcome measures.

According to the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7), prehypertension is defined as a systolic blood pressure reading of 120-139 mmhg or a diastolic blood pressure reading of 80-89 mmhg.

- Normal: < 120/80 mm Hg.
- Pre-hypertension: 120-139/80-90 mm Hg

Result

The study shows that the pre hypertensive ratio of male is more than the female, and a significant improvement in blood pressure levels in pre-hypertensive young adults following a 14-days physical activity walking regimen in Both Group A and Group B showed a significant reduction in blood pressure levels, with Group A demonstrating a larger improvement in blood pressure levels compared to Group B.

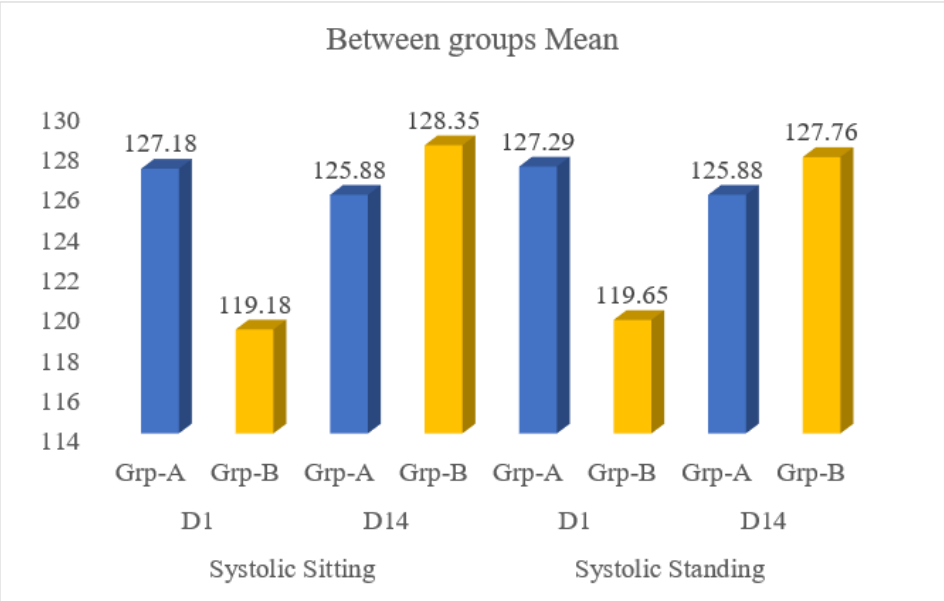
The mean systolic blood pressure decreased significantly from 127.29 ± 2.69 mmhg to 119.12 ± 2.78 mmhg in Group A ($p<0.001$), and from 127.41 ± 2.61 mmhg to 123.35 ± 2.74 mmhg in Group B ($p<0.05$). Similarly, the mean diastolic blood pressure decreased significantly from 85.82 ± 1.84

mmhg to 79.59 ± 2.13 mmhg in Group A ($p<0.001$), and from 86.00 ± 1.78 mmhg to 83.00 ± 1.93 mmhg in Group B ($p<0.05$).

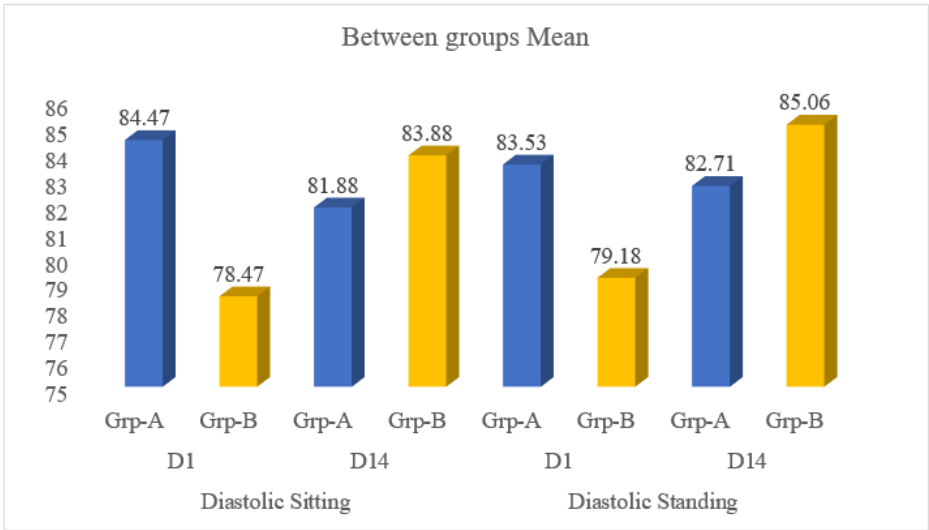
In terms of aerobic fitness, both Group A and Group B showed significant improvements as measured by the Harvard step test. The mean VO2 max increased significantly from 30.20 ± 0.94 ml/kg/min to 34.01 ± 1.01 ml/kg/min in Group A ($p<0.001$), and from 30.41 ± 0.91 ml/kg/min to 32.24 ± 0.97 ml/kg/min in Group B ($p<0.05$), In pre-hypertensive young adults following a 14-day physical activity walking regimen in Both Group A and Group B showed a significant reduction in blood pressure levels, with Group A demonstrating a larger improvement in blood pressure levels compared to Group B.

Table 1: summary statistics of Blood Pressure, Fitness index, Pulse Rate, SPO2

Variable	Time	Group	Mean	SD	T-value	P-value
Systolic Sitting	D1	Grp-A	127.18	4.00	8.120	0.001*
		Grp-B	119.18	2.24		
	D14	Grp-A	125.88	3.12	2.321	0.034*
		Grp-B	128.35	4.20		
Systolic Standing	D1	Grp-A	127.29	3.74	7.211	0.001*
		Grp-B	119.65	2.03		
	D14	Grp-A	125.88	3.28	2.369	0.031*
		Grp-B	127.76	3.80		
Diastolic Sitting	D1	Grp-A	84.47	4.72	6.185	0.001*
		Grp-B	78.47	4.03		
	D14	Grp-A	81.88	4.44	2.828	0.012*
		Grp-B	83.88	4.33		
Diastolic Standing	D1	Grp-A	83.53	5.45	.5.156	0.001
		Grp-B	79.18	3.94		
	D14	Grp-A	82.71	4.47	2.629	0.018*
		Grp-B	85.06	2.66		
Fitness Index	D1	Grp-A	57.24	13.44	3.039	0.008*
		Grp-B	55.59	13.27		
	D14	Grp-A	56.47	9.79	2.201	0.043*
		Grp-B	60.53	9.43		
Pulse Rate	D1	Grp-A	107.41	7.08	5.116	0.001*
		Grp-B	102.53	5.27		
	D14	Grp-A	107.76	5.37	2.637	0.018*
		Grp-B	110.76	2.39		
SPO2	D1	Grp-A	88.76	3.21	5.828	0.001*
		Grp-B	93.88	3.02		
	D14	Grp-A	89.82	3.73	3.771	0.002*
		Grp-B	90.29	3.90		



Graph 1: Group A shows a larger mean difference and effect size compared to Group B, suggesting that the intervention had a greater effect on Group A, indicating a larger improvement in Group A.



Graph 2: Both groups showed a significant difference in mean values between the two times, but Grp-A had a larger mean difference and effect size than Grp-B.

Disscussion

Hypertension is a significant risk factor for morbidity and mortality worldwide, and physical activity has been shown to be effective in preventing and managing hypertension. Therefore, the aim of this study was to investigate the effectiveness of a 14-day physical activity walking regimen on blood pressure in pre-hypertensive young adults.

The results of this study indicate that a 14-day physical activity walking regimen was effective in lowering blood pressure in pre-hypertensive young adults. The study used a randomized controlled trial design, with simple randomization used to assign participants to either a walking regimen of 10,000 steps per day (Group A) or walking to their maximum capacity (Group B).

The study found that Group A, which walked 10,000 steps per day, experienced a significant decrease in systolic and diastolic blood pressure after the intervention. However, the decrease in blood

pressure was less significant in Group B, which walked to their maximum capacity. These findings suggest that a walking regimen of 10,000 steps per day is effective in lowering blood pressure in pre-hypertensive young adults compared to walking to maximum capacity.

In addition, the study found a significant improvement in aerobic fitness in Group A, as measured by the Harvard step test. This suggests that a walking regimen of 10,000 steps per day for 14 days is effective in improving cardiovascular response.

Another unique aspect of the study was the use of a pedometer application in smartphones to measure walking regimen adherence and feasibility. The results showed that the use of the pedometer application was feasible and effective in measuring adherence to the walking regimen.

Overall, these findings have important implications for the prevention and management of hypertension in pre-hypertensive young adults. The study suggests that a walking regimen of 10,000 steps per day is an effective and feasible intervention for reducing blood pressure and improving cardiovascular response.

Conclusion

This study found that a 14-day walking regimen of 10,000 steps per day was effective in reducing blood pressure in pre-hypertensive young adults. It also improved their cardiovascular response as measured by the Harvard step test. The use of a pedometer application on smartphones was found to be feasible and effective in measuring adherence to the walking regimen. These findings highlight the potential of physical activity interventions, such as walking regimens, in the prevention and management of hypertension in young adults.

Ethical clearance: Taken from department of Svss Latur College of Physiotherapy

Source of funding: Self

Conflict of Interest: The author declares no conflict of interest related to this work. This research received no specific grant from any funding agency, commercial or not-for-profit sectors. Ethical clearance for this study was obtained from the Institutional Ethics Committee (IEC) and all participants provided written informed consent.

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Additional Effects of Medial Wedge Insole Coupled with Conventional Therapy in Patients with Bilateral Lateral Compartmental Knee Osteoarthritis: A Clinical Trial Study

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Abstract

Background: Osteoarthritis (OA) is the most prevalent disorder of the locomotor system, and involves the large weight bearing joints of the lower limb such as knee joint. The progression of OA knee is typically affected by mechanical stress created by varus and valgus malalignment, which in turn overloads the medial and lateral compartments, respectively. The rationale of wedged insoles is to transfer the load from the affected knee compartment to the joint contralateral compartment. So, the aim of the study was to compare the effectiveness of conventional therapy plus medial wedge insole in the footwear and conventional therapy alone on pain, physical function and alignment in lateral compartmental knee osteoarthritic patients.

Method: Study included 30 patients with bilateral lateral compartmental knee OA, aged 40-60 years and divided into 2 groups: Group A received conventional therapy plus medial wedge insole and Group B received conventional therapy alone for 6 weeks (3 sets of 10 repetitions daily). Inter-group analysis by unpaired t-test showed statistically significant improvement in Lequesne index score and tibiofemoral angle (P value ≤ 0.05).

Conclusion: In patients with lateral compartmental knee OA, conventional therapy plus medial wedge insole were more effective than conventional therapy alone in reducing pain, improving functional disability and tibiofemoral angle.

Key words: Medial wedge insole, Lateral compartmental knee OA

Introduction

Knee osteoarthritis (OA), also known as degenerative disorder of the knee joint, typically results from rupture and progressive loss of articular cartilage. It is a common joint disease with idiopathic causes.[1,2] Still, aging, obesity, knee injuries, and abnormal mechanical loads are considered to be its risk factors.[3]

The etiology of OA is not entirely clear, but its incidence increases with age and in women.[4,5] Obesity is a risk factor for the development and progression of OA knee.[4,6,7] The biomechanical theory concluded that obesity leads to repetitive application of increased axial loading at the knee joint with consequent degeneration of articular cartilage and sclerosis of subchondral bone.[8-10] The metabolic

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theory proposed that excess fat has a direct effect on cartilage over and above the effects of stress.[11]

Based on the global statistics, over 100 million people are suffering from osteoarthritis worldwide.[12] In western population, OA of the knee joint is the third in prevalence of this condition, following spine and hip, because knee receives high loading while standing and walking.[13] The prevalence rate of self-reported arthritis in the United States is projected to increase to 18.2% (59.4) million of the estimated population in 2020.[14] The main concern is the disability associated with arthritis, which is projected to increase from 2.8% of the 1990 population to 3.6% of the 2020 population.[15] In addition, arthritis limits daily activities in 11.6% of persons aged > 65 years. In India, prevalence of OA has been suggested to be 22 to 39%.[16-18]

In patients with lateral compartmental knee OA, joint space is lost in that compartment leading to knee valgus angulation. The angulation increases knee valgus torque which potentially leads to progressive joint space loss and angulation, then, becoming a vicious cycle. The wedge insole was postulated to be able to interrupt this vicious cycle and slow down the progression of this abnormality. It could also decrease knee valgus torque and knee pain.

Realignment of the femorotibial angle through corrective osteotomy for valgus malaligment and at the tibia for varus malalignment can slow down or retard progression of knee OA. However, the surgical approach has a number of difficulties and drawbacks, such as cost, insufficient correction, need for patient withdrawal from activities and complications in 15% of cases including conditions like thrombosis, thromboembolism and nerve injuries.[19,20]

The use of wedge insole represents an alternative to surgical approach. The rationale for use of wedge insoles is to transfer the load from affected joint compartment to the knee contralateral compartment. In this regard, the evidence based literature states that lateral wedge insoles help reduce pain associated with varus knee OA. Additionally, medial wedge insoles seem to be effective in decreasing lateral thrust and reducing pain while walking, particularly in people with early disease.[21]

Materials and Method

Study Design: A Clinical trial study

Study Population: Patients with bilateral lateral compartmental OA knee

Study Setting: Various Physiotherapy OPDs in Vadodara

Sampling Design: Convenience sampling method

Sample size: 30 patients

Inclusion criteria:

- Age 40-60 years
- Bilateral valgus deformity ≥ 8°
- Grade ≥ 2 lateral compartment involvement on Kellgren Lawrence Scale

Exclusion criteria:

- Body mass index ≥ 40kg/m^2
- Any history of trauma within one year to the knee joint
- Associated limb length discrepancy, congenital anomalies, neuromuscular disorders or any pathological conditions affecting knee joint.

Materials Used:

- Consent form
- Assessment form
- Lequesne Index Score for Osteoarthritis
- Examination table
- Medial wedge insole (8mm Height)
- Weight Cuffs, Sand bags and Pelvic strap
- Tracing Paper, Pencil, Scale
- Universal Goniometer
- Weighing machine
- Stadiometer
- Sony Cybershot 3x Zoom Digital Camera

Outcome Measures:

1) Lequesne Index:

It is a subjective scale used to measure pain/ discomfort, maximum distance walked and activities of daily living in patients with osteoarthritis and

degenerative arthritis of the knee. It is a valid, reliable and disease specific measurement scale.[25] It consists of total 11 items covering pain/discomfort (5 items), maximum distance walked (2 items) and activities of daily living (4 items).The total score for Lequesne Index for osteoarthritis is 24, the score for Lequesne pain/ discomfort subscale is 8, the score for Lequesne maximum distance walked subscale is 8 and the score for Lequesne activities of daily living subscale is 8.The highest score indicates worst symptoms.[22-24]

2) Tibiofemoral angle (TFA):

It has been described as the angle defined by the mechanical axis of the femur intersecting the mechanical axis of the tibia. Radiological, photographic, and clinical methods have been used to assess the normal limits of the TFA. However, very few studies have reported the normal limits of the TFA from the beginning of walking age to the end of the adolescent period.

The anatomic (longitudinal) axis of the femur is oblique, directed inferiorly and medially from its proximal to distal end. The anatomic axis of the tibia is directed almost vertically. Hence, the femoral and tibial longitudinal axes normally form an angle medially at the knee joint of 180° to 187° i.e. the femur is angled up to 7° off vertical, creating a slight physiologic (normal) valgus angle at the knee. If the medial tibiofemoral angle is greater than 187°, an abnormal condition called genu valgum "knock knees" exists. If the medial tibiofemoral angle is 175° or less, the resulting abnormality is called genu varum "bow legs."

Patients were requested to continue normal activities and avoid any other forms of treatment for the duration of the study, apart from routine physical management. Participants other than designated protocol were not permitted to administer any other forms of electrotherapy or other techniques (steroids, acupuncture, or taping) during the intervention period of the trial.[26-28]

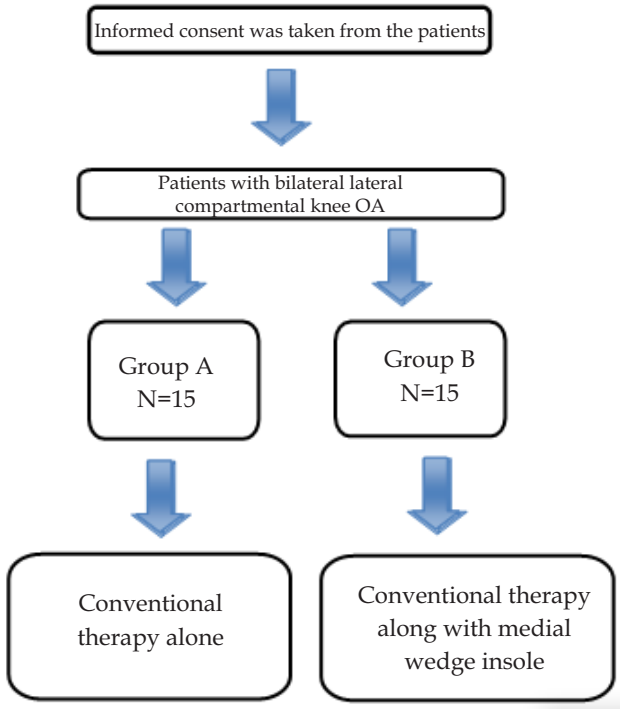

Figure 1: Consort Diagram

All the patients were informed in detail about the type and nature of the study. The subjects were divided into two groups; Group A and Group B; 15 participants in each group.

Group A: received only conventional therapy of knee osteoarthritis

Group B: received conventional therapy of knee osteoarthritis as well as medial wedge insole in the footwear.

Conventional therapy for both Group A and Group B:

Both Group A and Group B were educated about energy conservation and work simplification techniques and were given progressive muscular strengthening rehabilitation program, Frequency: 3 sets of 10 repetition daily for 6 weeks

(A) Quadriceps Setting exercise

(B) Short- Arc Terminal Knee Extension

(C) Straight- Leg Raise

(D) Hip Abductor strengthening in side lying

(E) Hamstring Curls in prone lying position

(F) Quadriceps Strengthening in high sitting position

(G) Tensor Fascia Lata Stretch

(H) Hamstring Muscle Stretch

(I) Calf Muscle Stretch

(J) Co-contraction of Quadriceps and Hamstring Muscles

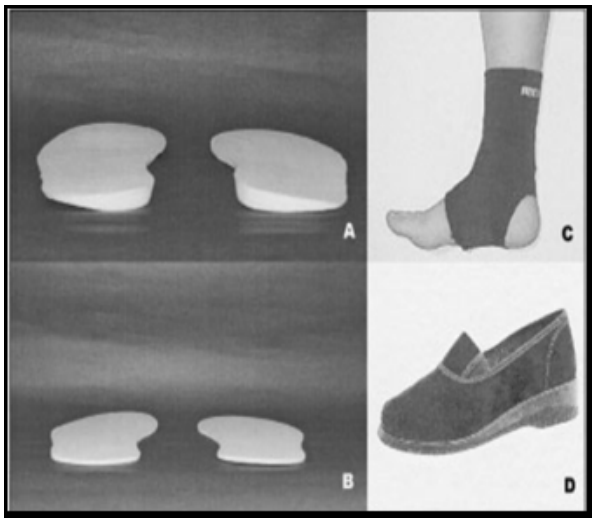

Figure 2: Medial wedge insole

Figure 3: Patient wearing medial wedge insole in the footwear

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 ShapiroWilk test. According to normal distribution, tests were applied for within group and between group analysis.

Table 1: Results of Unpaired t- test For Between Group Analysis (Between Group A & B)

Outcome Measures	Group A	Group B	P value	Remarks
Tibiofemoral Angle	2.066±0.7988	0.3333±0.4879	<0.001	Significant
Lequesne Index	4.333±1.0465	2.1333±1.1872	<0.001	Significant

Here, the difference of pre-intervention and post-intervention was taken and between group comparison of Tibiofemoral angle and Lequesne index showed statistically significant difference.

Hence, conventional therapy along with medial wedge insole were found to be more effective in reducing pain, improving functional disability and tibiofemoral angle in knee osteoarthritic patients.

In this study, additional effects of medial wedge insole along with conventional therapy in patients with bilateral lateral compartmental knee osteoarthritic patients were examined. Pain, physical function and alignment were assessed by Lequesne index and Tibiofemoral angle.

The first objective of the study was to find the effectiveness of conventional therapy on pain, physical function and alignment of knee osteoarthritic patients.

The second objective of the study was to find the effectiveness of conventional therapy plus medial wedge insole in the footwear on pain, physical function and alignment of knee osteoarthritic patients.

The third objective of the study was to compare the effectiveness of conventional therapy plus medial wedge insole in the footwear and conventional therapy alone on pain, physical function and alignment of knee osteoarthritic patients.

The results of this study showed statistically significant improvement in Lequesne index score and tibiofemoral angle with the use of conventional therapy along with medial wedge insole (within group comparison). However, in the inter-group comparison, conventional therapy along with medial wedge insole were found to be more effective than conventional therapy alone.

Thus, medial wedge insole along with conventional therapy can be further implemented in clinical practice for improving the pain, physical function and alignment in patients with bilateral lateral compartmental knee OA patients according to the availability of the clinical set up and the trained physiotherapists.

Conclusion

The results of this study support the alternative hypothesis and showed statistically significant improvement in Lequesne index score and tibiofemoral angle for pain, physical function and alignment with the use of conventional therapy along with medial wedge insole (within group comparison). However, in the inter-group comparison, conventional therapy along with medial wedge insole were found to be predominant than conventional therapy alone. All findings support the idea and concluded that conventional therapy plus medial wedge insole proved to be more effective than conventional therapy alone in patients with lateral compartmental knee OA.

Limitations

- The study consisted of only a small quantity of patients, which should be revised to a large number of patients and for longer duration of time.
- This was a short term study of 6 weeks and further follow up of patients were not carried out.
- The patients in this study were recruited without clinical diagnosis of OA knee, they were taken on the basis of radiological diagnosis of lateral compartmental OA knee.

Ethical clearance: Ethical clearance was obtained from The Institutional Review Board from Pioneer Physiotherapy College, Vadodara.

Source of funding: Self

Conflict of interest: Nil

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Original Article

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Effect of Muscle Energy Technique Versus Static Stretching on Calf Flexibility in Females

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Abstract

Introduction: Flexibility is an important physiological component of physical fitness. The length of the muscle tissue is thought to play an important role in the effectiveness and efficacy of human movement. Calf is one of the commonest muscle prone to tightness. Most of the forefoot and ankle problems arise due to gastrocnemius and soleus tightness and contractures. To manage such a condition, stretching of the calf muscles are commonly prescribed to increase available dorsiflexion of the ankle joint. Though there are several effective physiotherapeutic exercises available to resolve this problem, but it's still in dilemma about the immediate effects. Muscle Energy Technique (MET) and Static Stretching (SS) are the techniques which can efficiently improve the flexibility of muscles and also very scarce literature is present on comparing the effect of these techniques for increasing ankle dorsiflexion for improving calf tightness. So, this study aimed to evaluate and compare the immediate effect of Muscle Energy Technique and Static Stretching on calf flexibility in females.

Methodology: An experimental study in which 30 female subjects aged between 18 to 25 years were divided into two groups.GroupA (n= 15) and Group B (n=15) were given MET and Static Stretching (SS) respectively. Ankle Dorsiflexion ROM was assessed pre- intervention and post- intervention. The data collected were analyzed by SPSS (version 26).

Result and Conclusion: Group A (MET) and Group B (SS) were given suitable intervention for calf muscle tightness, and bothgroups showed that the mean ROM during post-test was higher than pre-test. After the comparison of both groups, no significant difference was seen in the mean scores ($p \geq 0.05$). Equal number of repetitions of both techniques were given, however, still MET showed slightly greater effect. Therefore, the study concluded that fewer repetitions of MET could have greater or equal effect as Static Stretching. Further studies with large sample size and follow up are recommended.

Keywords: Muscle Energy Technique, Static Stretching, Flexibility, Calf muscle

Introduction

Flexibility is an important physiological component of physical fitness[1]. Limited extensibility is a common problem that affects various patient population as well as healthy able-bodied individuals[2]. Flexibility is the ability of the joint or group of joints and muscles to effectively move through an unrestricted and pain free range of

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motion[3]. Decreased flexibility can cause inefficiency in the workplace and is also a risk factor for conditions such as low back pain, plantar fasciitis, any muscle imbalances, muscle tightness, more prone to injuries, affects the health of cartilage around the joints etc. which will affect's a person's static and dynamic balance[4].

Calf muscle is one of the common postural muscles which is more to shortness. Many people suffer from calf muscle tightness[5].It is reported that about 88% of forefoot and ankle problems arise due to gastrocnemius tightness and contractures[6].

The calf complex is an important part of locomotion activity and weight bearing. The calf muscle is mainly composed of two muscles, gastrocnemius and soleus muscle. The gastrocnemius muscle is the muscle of the back. Part of the lower leg. The soleus is flat muscle below the gastrocnemius muscle [7].

There are a variety of techniques used in physiotherapy for improving joint muscle flexibility in different set ups. Some of them include- Muscle Energy Technique and Static Stretching [6].

Muscle Energy Technique (MET) is a manual technique developed by osteopaths that is now used in many different manual therapy professions[8]. Dr. Fred Mitchell has been titled the father of Muscle Energy Technique[9]. Muscle Energy Technique is a procedure in which there is voluntary contraction of a patient's muscle in a precisely controlled direction with different levels of intensity, against a distinctly executed counter force applied by the therapist[10]. It is effective in lengthening a shortened muscle or muscles contracture, strengthening muscles, as a lymphatic or venous pump to aid drainage of fluid or blood, and increasing range of motion of a restricted joint [11]. Muscle Energy Technique works on two principles i.e., post isometric relaxation and reciprocal inhibition[12].

Static Stretching is the most common term used to describe a method by which soft tissue are lengthened just past the point of tissue resistance and then held in lengthened position for an extended period of time with a sustained stretch either in predetermined prior to stretching or based on the person's response during the stretching procedure [3]. A session of 3 repetitions each of 30 seconds increase the muscle length sufficiently [13].

Aim of The Study

The aim of the study was to evaluate and compare the immediate effectof Muscle Energy Technique and Static Stretching on calf flexibility in normal females.

Objectives of The Study

To find out the effect of Muscle Energy Technique on thecalf muscle flexibility.

To find out the effect of Static Stretching on the calf muscle flexibility.

To compare the effectiveness of Muscle Energy Technique and Static Stretching on thecalf muscle flexibility.

Need of The Study

The calf muscle is one of the most common postural muscles that are often prone of getting short. Many females suffer from calf muscle tightness. Females those who participate in sports or those who wear high heels (which force the ankle into plantarflexion). Females whose occupation requires sitting for long period of time may also experience shortening of the tissues in this compartment because gastrocnemius and fascia associated with this part of lower extremity are held in shortened position. Shortness of calf muscles results in limited dorsiflexion range of motion which lead to excessive pronation at subtalar joint and is associated with midfoot and forefoot pain[5]. This can be prevented by stretching the muscles. Muscle Energy Technique and Static Stretching are the techniques which can efficiently improve the flexibility of muscles. But there are a few studies comparing both these techniques. So, this study was done to compare the immediate effect of both techniques on flexibility.

Methodology of The Study

Study Design: This study was an experimental design involving the comparative analysis of Muscle energy technique and Static stretching on calf muscle flexibility. In this study the subjects were analyzed with the parameter of calf muscle flexibility assessed using Universal Goniometer.

Study Setting

This study was done in the Bebe Nanki Girls Hostel, Sri Guru Granth Sahib World University, Sri Fatehgarh Sahib (Punjab).

Informed consent

A written informed consent for participation in the study was obtained from each subject.

Method of Sampling: Convenience sampling

Sample Size: 30 subjects

Study Duration: Jan 2023-May 2023

Selection Criteria

Inclusion Criteria

Females of age group 18-25 years with ankle dorsiflexion range <20 degrees were included.

Exclusion Criteria

Subjects having history of calf/ ankle joint injury within one year and, having any type of congenital/ acquired deformity of lower extremity were excluded.

Measurement Tools

Goniometry of the calf muscle was done using a Universal Goniometer, and three measurements were made for each movement. The result was obtained from the calculation of the mean values.

Dorsiflexion

The motion occurs in the sagittal plane around a medial- lateral axis. Normal dorsiflexion ROM, in non-weight bearing is 15 to 20 degrees[14].

Goniometry of the Gastrocnemius muscle

Testing position: The individual was asked to be in supine position with legs off the couch and the knee in extension. The foot should be in 0 degrees of inversion and eversion[14].

Goniometer Alignment

Central fulcrum of the goniometer over the lateral aspect of the lateral malleolus.

Align proximal arm with the lateral midline of the lower leg; use head of fibula for reference.

Align distal arm parallel to the lateral aspect of the fifth metatarsal.

Testing motion: The individual was instructed to move ankle into dorsiflexion until a mild stretch sensation is felt then the range of dorsiflexion was measured[14].

Fig. 1: Goniometry for Gastrocnemius Muscle

Goniometry of the Soleus muscle:

Testing position: The individual was asked to be in supine position with legs off the couch, and the knee flexed to 30degrees and supported by a pillow. The foot should be in 0degree of inversion and eversion[14].

Goniometer Alignment

Central fulcrum of the goniometer over the lateral aspect of the lateral malleolus.

Align proximal arm with the lateral midline of the lower leg; use head of fibula for reference.

Align distal arm parallel to the lateral aspect of the fifth metatarsal.

Testing motion: The individual was instructed to move the ankle into dorsiflexion until a mild stretch sensation was felt then the range of dorsiflexion was measured[14].

Fig. 2: Goniometry for Soleus muscle

Procedure

Thirty female subjects were selected for this study based on inclusion and exclusion criteria and were

equally divided into two groups; namely, Group-A (Muscle Energy Technique) and Group-B (Static Stretching). The baseline measurements of ankle flexibility were assessed using Universal Goniometer before the intervention.

Group A: 15 subjects were given Muscle Energy Technique (post isometric relaxation) to the gastrocnemius and soleus muscles bilaterally.

Position: The subject was in supine with feet extending over the edge of the table, with the knee flexed over a rolled towel for soleus and the knee straight for gastrocnemius8.

Starting from the restriction barrier or just short of it, the subject was asked to exert a small effort (no more than 20% of available strength) towards plantar flexion, against unyielding resistance, with appropriate breathing. The contraction was held for 7-10 seconds together with a held breath. On slow release, on an exhalation, the ankle was dorsiflexed slightly and painlessly beyond the new barrier, with the subject's assistance, (and the tissues were held in slight stretch for at least 10 seconds to allow a slow lengthening of tissues). This cycle was repeated for 5 times in each session[8].

Fig. 3: MET for Gastrocnemius Muscle

Fig. 4: MET for Soleus Muscle

Group B:

Position: The subject was in supine with feet extending over the edge of the table, with the knee flexed over a rolled towel for soleus and the knee straight for the gastrocnemius.

In this, ankle was dorsiflexed and the soft tissues were lengthened just past the point of tissue resistance and then held in the lengthened position for 30 seconds, and then slowly released. This cycle was repeated for 5 times in each session[3].

After the treatment, reassessment was done to check the calf muscle flexibility by assessing the dorsiflexion Range of Motion (ROM) and changes was recorded.

Fig. 5: Static Stretching for Gastrocnemius Muscle

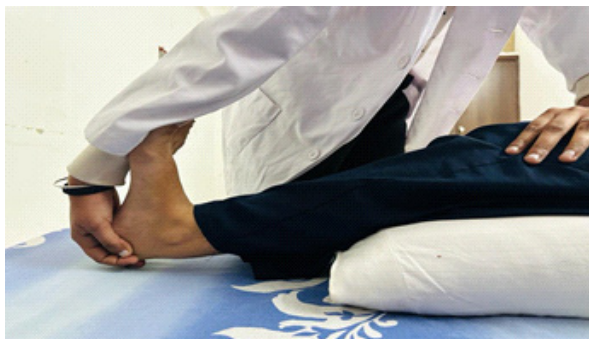

Fig.6: Static Stretching for Soleus Muscle

Statistical Analysis

The data was analyzed and interpreted statistically using version 26 of the SPSS (Statistical Package for Social Sciences). Descriptive statistics were reported as means, standard deviation and standard error mean. A repeated measurement test was used to compare the clinical test measurements in each group three times. Besides, one-way Analysis of Variance (ANOVA) was applied to determine the differences among the study groups. In case of significant differences, A Paired T-test was used in each group to compare the pre-post. An independent t-test was used to compare the changes after the interventions in ROM between two groups.

Flow Chart of Enrolment and Testing Procedure

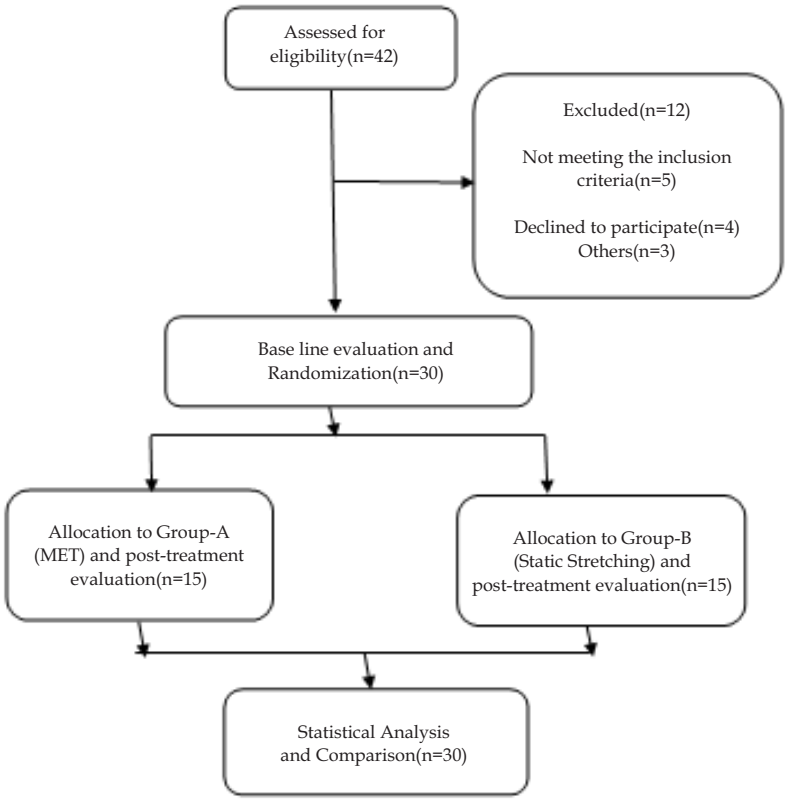

Fig. 6: Flow Chart of Enrolment and Testing Procedure

Results

Table 1: Baseline characteristics and demographic detail of subjects

S. No.	Demographic details	Group A (MET) (n=15)	Group B (SS) (n=15)
1	Age (Years)	25.2 2.89	25.22.81
2	Height (Centimeters)	160.65.46	160.37.89
3	Weight (Kilograms)	65.87.35	63.99.31

Table 2: Baseline Measures and post-intervention measures of Group A (Muscle Energy Technique)

Outcome Measures Ankle Dorsiflexion (ROM)		Baseline Measures MeanSD	After Intervention MeansSD	p-value
Gastrocnemius	Right	9.333.77	13.664.58	.003
	Left	9.16 4.57	13.54.63	.001
Soleus	Right	16.16 7.75	23.165.41	.015
	Left	13.834.44	20.663.26	.016

Table 3: Baseline measures and post-intervention measures of Group B (Static Stretching)

Outcome Measures Ankle Dorsiflexion (ROM)		Baseline Measures Mean SD	After intervention Mean SD	p-value
Gastrocnemius	Right	8.831.47	12.163.37	.015
	Left	9.331.96	13.333.32	.009
Soleus	Right	18.332.06	23.332.65	.010
	Left	19.503.50	24.164.21	.011

Table 4: Between the group comparison of before-intervention and after-intervention measures and their p-value

Outcome Measures		Group-A (Muscle Energy Technique)		p-value	Group-B (Static stretching)		p-value
		Before intervention Mean SD	After intervention Mean SD		Before intervention Mean SD	After intervention Mean SD	
Gastrocnemius	Right	9.33 3.77	13.664.58	.003	8.831.47	12.163.37	.015
	Left	9.164.57	13.504.63	.001	9.33 1.96	13.333.32	.009
Soleus	Right	16.167.75	23.165.41	.015	18.332.06	23.332.65	.010
	Left	13.834.44	20.663.26	.016	19.503.50	24.164.21	.011

Discussion

This study was done to analyze the immediate effect of MET and Static Stretching for the calf muscle flexibility. Calf muscles (plantar flexors) are prone for tightness because of prolonged periods of sitting in this modern sedentary lifestyle. Tightness may vary the length tension of the muscle and alter the limbs shock absorbing properties. This can be prevented by stretching the relevant muscle or muscle group. Proper flexibility reduces the risk of injuries and restores the normal function of the shortened muscles [15].

Subjects under Group-A showed overall significant post-intervention results which shows that the application of MET on a muscle group or group of muscles significantly increased the flexibility of muscles. During MET, a muscle elongation is maintained for a duration of 30 seconds thus leading to increased muscle length with a combined effect of creep and plastic changes occurring in the connective tissue [16].

Subjects under Group-B showed significant results, there was an increase in post-intervention Ankle Dorsiflexion ROM. There was an increase in muscle length and a decrease in muscular and connective tissue stiffness that results in improved muscular extensibility [17]. Static Stretching leading to increased ROM might be due to increased number of sarcomeres in series (muscle length) due to prolonged exposure to stress and also due to viscoelastic behaviour of muscle and short-term changes in muscle extensibility [18].

On comparing Group-A (MET) and Group-B (Static Stretching) it appears that there was a significant improvement in ROM of ankle joint, i.e., dorsiflexion, for both the right and left sides, after the intervention. The mean value for the ROM of the ankle joint was increased from baseline to after intervention and was statistically significant (p-value<0.05 for all measures), indicating that the intervention had a significant effect on improving the ROM and functional ability of the ankle joint. Ramesh et al., 2021 stated that MET and Static Stretching both tend to improve muscle flexibility but MET was more effective as compared to Static Stretching.Fryer, 2011 in their study have explained that the reasons of increased flexibility after MET may be the result of biomechanical or neurophysiological changes or increased stretch tolerance[11]. Thus, the results of our study corroborate the previous findings about a significant immediate effect of single session of MET and Static Stretching (5 repetitions each) on improving the flexibility of calf.

This study implies that MET and Static Stretching both can be equally preferred for relieving the tightness developed in the muscles but the MET is slightly more effective.The scope of the study is limited due to shorter duration of treatment course, only female subjects are included.

Conclusion

This study states both Muscle energy Technique and Static Stretching have an immediate effect on reducing calf muscle tightness. The two interventions were performed on two groups; Group-A (MET), Group-B (Static Stretching). Equal number of

repetitions of both techniques were given, however, still MET showed slightly greater effect. Therefore, the study concluded that fewer repetitions of MET could have greater or equal effect as Static Stretching. Further studies with large sample size and follow up are recommended.

Conflict of Interest: Nil.

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Upper Extremity Electromyography During Bouldering: Research Report

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Abstract

Background: Despite the growing popularity of bouldering, little is known about the degree and variability of muscle activation that occurs while solving bouldering problems. The purpose of this study was to explore the electromyography of eight upper extremity and trunk muscles during a session of indoor bouldering while completing four different problems.

Methods: Eleven climbers with self-reported ability to climb a V-scale V4 problem grade or higher and regularly boulder at least two days/week for at least six months participated in this study. Electromyography was used to record muscle activity of the flexor digitorum superficialis, extensor carpi radialis longus, biceps brachii, triceps brachii, anterior deltoid, middle deltoid, posterior deltoid, and latissimus dorsi.

Conclusion: The highest average EMG across all four climbs occurred in the flexor digitorum superficialis, latissimus dorsi, and extensor carpi radialis brevis. Significant differences in muscle activity were noted between the anterior deltoid and latissimus dorsi, flexor digitorum superficialis and biceps brachii, triceps brachii and flexor digitorum superficialis, posterior deltoid and latissimus dorsi, and triceps brachii and latissimus dorsi. This information may be useful in developing a strength and conditioning program for climber and to help guide rehabilitation and return to climbing decisions for climbers who have been injured.

Keywords: Bouldering, EMG, Physiotherapy, Upper extremity

Introduction

Competition climbing was recognized as an Olympic sport in 2020 and debuted in the 2021 summer games in Tokyo, increasing its popularity as both a competitive and recreational sport.[1] The competitive discipline of climbing includes bouldering, which involves movement sequences performed on a pre-determined direction of travel, without a rope, and at about 10-20 feet in height, requiring power and strength[2] as compared to endurance. Due to the lack of rope and harness, safety mats are positioned under the climber to protect them in the event of a fall. The increased popularity of bouldering has led to an increase in climbing related injuries.[3] The most frequently injured body parts sustained during

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climbing are the hands and wrists[3], likely due to the strength requirements of the forearm flexors and grip to successfully complete a climb.[4-6]

A bouldering problem is the specific route the climber takes when moving up the bouldering wall. A bouldering route is called a problem because it takes some figuring out before physically starting the climb; the climber studies the route and finds the best way to successfully ascend the wall. The sport of bouldering requires the athlete to move their body mass vertically, with a varying degree of support, through a variety of movements and body positions, to solve a bouldering problem. The ability to produce adequate muscle force when solving a problem may prevent falls, reduce climbing-related injuries, and improve climbing skill.[5]

It has been demonstrated in the climbing population that grip strength and forearm flexorsare associated with climbing ability.[4-6] However, the degree and variability of other muscle activation that are employed while solving bouldering problems is unknown. The purpose of this study was to explore muscle activation through electromyography (EMG) of eight upper extremity and trunk muscles during a session of indoor boulderingwhile completing four different problems. It was hypothesized that the level of muscle activity would vary between muscles. Insight into muscle activity may help climbers focus their trainingefforts to improve climbing ability and to assist with rehabilitation decisions if an injury occurs.

Materials and Methods

Participants

Eleven experienced climbers volunteered to participate in the study. See **Table 1** for descriptive characteristics. To be eligible to participate, all participantshad to be 18-45 years of age, have a self-reported ability to climb a bouldering problem of at least a V-scale V4 (Fontainebleau 6A), and regularly boulder at least 2 days/week for at least 6 months. Additionally, participants were excluded if they had any current upper or lower extremity injuries which may limit ability to climb. Prior to testing, participants were asked to refrain from strenuous activity 24 hours prior and caffeine, nicotine, and pre/post-workout supplements 12 hours prior. Screening for suitability of exercise was determined using a physical activity readiness questionnaire (PAR-Q) and was mandatory prior to beginning exercise. All experimental procedures were approved by the Samford University Institutional Review Board (IRB), andwritten and informed consent was obtained from each participant prior to data collection.

Table 1. Descriptive characteristics of the study participants.

Characteristic	Value*
Age, years	26.65±7.41(20-44)
Mass, kilograms	69.91±13.05(48.3-92.5)
Height, centimeters	173.91±11.41(153-188)
Arm span, centimeters	176.59±12.80(156.5-197)
Climbing experience, years	10.26±11.18(1.67-40)

*mean±SD(range)

Electromyography

Wired, surface EMG sensors (SX230) connected to a Bluetooth EMG System (PS900) (Biometrics Ltd., Newport, UK) was used to detect muscle activity of eight upper extremity and trunk muscles, including flexor digitorum superficialis (FDS), extensor carpi radialis longus(ECRL), biceps brachii (BB), triceps brachii (TB), anterior deltoid (AD), middle deltoid (MD), posterior deltoid (PD), and latissimus dorsi (LD). For all conditions, sensors were placed unilaterally on the right-side upper extremities and trunk. Prior to senor placement, the skin was cleaned with alcohol. Plastic adhesive strips were attached to each sensor and pressed firmly onto the skin. Athletic pre-wrap and sports tape was used to ensure adequate skin connection during activity and to reduce signal noise (**Figure 1**). The ground reference strap was placed on the right-sideulnar styloid. All electrodes were placed according to the surface EMG for noninvasive assessment of muscles (SENIAM) recommendations (**Table 2**).[7] Electrode placement was verified by having the participant perform submaximal contracts of each muscle using the standardized testing procedures described by Kendall et al.[8]

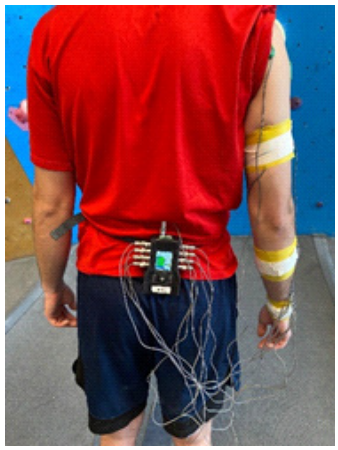

Figure 1. EMG set up for participants.

Table 2. EMG sensor placement for each of the muscles collected.

Muscle	Sensor Placement
Flexor digitorum superficialis	¾ of the forearm length from elbow, between radius and ulna; participant actively flexed fingers to confirm location
Extensor carpi radialis longus	1/3 of forearm length from elbow; participant actively extended and radially deviated wrist to confirm location
Biceps brachii	1/3 of arm length from acromion to fossa cubit; participant actively flexed and supinated elbow to confirm location
Triceps brachii	½ of arm between acromion and olecranon; participant actively extended elbow to confirm location
Anterior deltoid	1 finger width distal and anterior to acromion; participant flexed shoulder to confirm location
Middle deltoid	Greatest bulge of muscle from acromion to lateral epicondyle; participant abducted shoulder to confirm location
Posterior deltoid	In area 2 fingerbreadths posterior to acromion; patient abducted and extended shoulder to confirm location
Latissimus dorsi	4 cm below inferior angle of scapula, halfway between the lateral edge of torso and the spine; patient extended shoulder and depressed scapular to confirm location

Experimental Protocol

Data was collected at an indoor bouldering gym in Birmingham, Alabama. Data was collected on each participant in one visit, lasting approximately 30-minutes. Prior to testing, age, height, total body mass, arm span, and climbing experience were measured. EMG sensors were then placed on the participant and electrode placement was verified. Each participant completed four pre-set bouldering problems, each featuring different kinds of holds and moves common to bouldering. These problems were completed in the order self-selected by the participant andparticipants rested as needed between each problem. Participants were allowed to use climbing chalk for their hands and wear their own climbing shoes. Participants were given time to observe and feel the climbing holds on the route before climbing and were instructed to climb each problem how they would normally climb.

Bouldering Problems

The owner, head setter, and head team coach of the indoor bouldering gym, with over 30 years of combined setting experience,pre-set four bouldering problems that were completed by each participant, each with different holds and moves, as described below, to capture data on a variety of bouldering skills. All problems are a V2/V3 rating.The Biometrics EMG recording began at the start of the climb which was defined as the point where the climber leaves the ground with every part of the body and both hands are on the marked starting holdsand the completion of the attempt and ending of the EMG recording occurredwhen the finishing hold was gripped with both hands, as per IFSC-rules.[9]

Problem A: Purple problem (**Figure 2**)

This is a traverse style problem on a mild angle that progresses to a steeper angle at the top. The holds featured on this problem are midway between a "jug" and a "crimp" hold and with a smooth, small positive in-cut. The feet are large chip-style feet. This problem required some sequencing of hand holds and foot movement and was meant to capture a more endurance focused problem.

Figure 2. Problem A

Problem B: Black problem (**Figure 3**)

This problem is on the corner of two walls and is focused on body positioning and technique. The intent was to capture moves that involved "stemming," or pressing of an arm into a hold to create tension. This problem required some technical footwork and hip movement depending on the height of the climber, with taller climbers being able to stand and skip some holds while shorter climbers had to use each hold. Most climbers involved in this study skipped the diagonally angled slope hold on the tan wall and instead opted to go straight up from the large sloper style, which featured a prominent ridge in the middle, hold into the undercling above it.

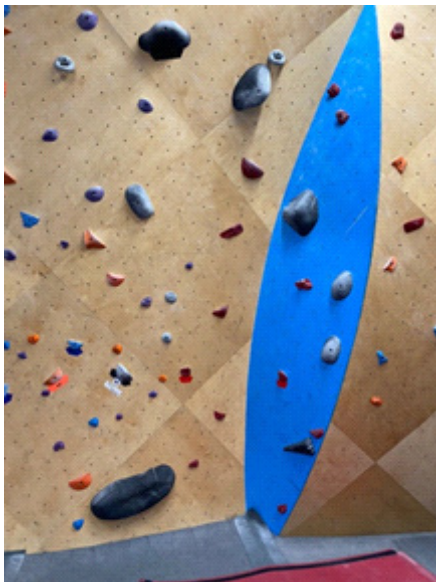

Figure 3. Problem B

Problem C: Blue problem (**Figure 4**)

This problem was considered to be the hardest problem by the routesetters and by the consensus of the participants and featured a mixture of slope and large flat holds. This problem attempted to capture the pulling power required for certain problems. The start involves a low hang in a squat position into a left hand gentle sloper, to capture a common start move. The moves are "reachier" for the average height or shorter climber and thus needed some footwork and pulling power.

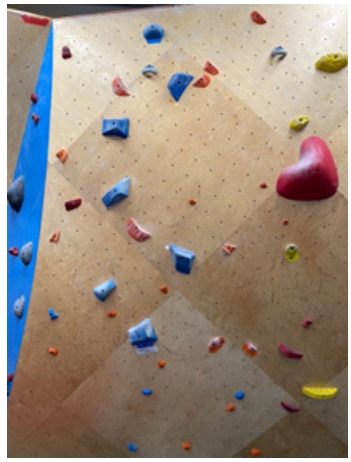

Figure 4. Problem C

Problem D: Green problem (**Figure 5**)

The fourth problem is a crimp problem with smaller footholds on a convex wall. The second move of the problem is considered the crux and involves comfort on mid-small sized feet and pulling from a pinch, (or crimp depending on how it was used) while standing into a further right crimp and then controlling the body's momentum.

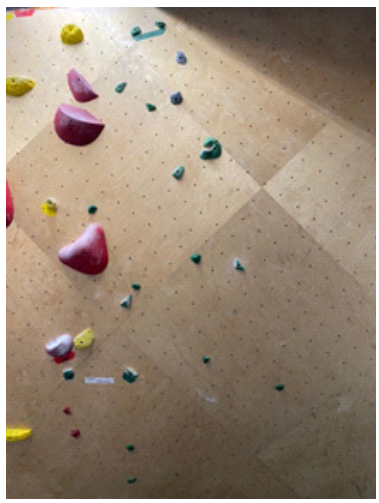

Figure 5. Problem D

Data Analysis

Reported data are mean values for each bouldering climb. All data was analyzed using Jamovi software (Version 0.9). The normalized mean EMG for each of the eight muscles was compared using repeated measures ANOVA with a $p<0.05$ level of confidence accepted as significant for all tests. For data showing a difference in the repeated measures ANOVA analysis, a tukey post hoc analysis was performed.

Results

A significant difference was found ($p<0.001$) with the repeated measures ANOVA. A tukey post hoc analysis showed significant differences in muscle activation between the anterior deltoid and flexor digitorum superficialis (p=0.038), anterior deltoid and latissimus dorsi (p=0.017), flexor digitorum superficialis and biceps brachii (p=0.022), triceps brachii and flexor digitorum superficialis (p=0.046), posterior deltoid and latissimus dorsi (p=0.029), and triceps brachii and latissimus dorsi (p=0.034). **Table 3** shows tukeypost hoc comparisons.

Table 3. Post hoc comparisons.

Comparison			
RM Factor 1	**RM Factor 1**	**Mean Difference**	**P_{tukey}**
AD	BB	-1.7725	0.397
	ECRL	-4.4425	0.305
	FDS	-7.2825	0.038*
	LD	-6.1075	0.017*
	MD	-1.0825	0.619
	PD	-2.3050	0.105
	TB	-1.0125	0.179
BB	ECRL	-2.6700	0.575
	FDS	-5.5100	0.022*
	LD	-4.3350	0.170
	MD	0.6900	0.996
	PD	-0.5325	0.994
	TB	0.7600	0.943
ECRL	FDS	-2.8400	0.201
	LD	-1.6650	0.841
	MD	3.3600	0.695
	PD	2.1375	0.615
	TB	3.4300	0.442
FDS	LD	1.1750	0.949
	MD	6.2000	0.172
	PD	4.9775	0.058
	TB	6.2700	0.046*
LD	MD	5.0250	0.058
	PD	3.8025	0.029*
	TB	5.0950	0.034*
MD	PD	-1.2225	0.863
	TB	0.0700	1.000
PD	TB	1.2925	0.190

Abbreviations: Flexor digitorum superficialis (FDS), extensor carpi radialis longus (ECRL), biceps brachii (BB), triceps brachii (TB), anterior deltoid (AD), middle deltoid (MD), posterior deltoid (PD), latissimus dorsi (LD).

*indicates <0.05

Muscle Activity (EMG) During Indoor Bouldering

Across the four bouldering problems, the activity of the examined muscles varied considerably (**Table 4**). This highest average EMG amplitude across all four climbs occurred in the flexor digitorum superficialis, latissimus dorsi, and extensor carpi radialis brevis.

Table 4. Mean EMG during four bouldering problems.

	Ant Delt	Bicep LH	ECR	FDS	Lat	MidDelt	PostDelt	Tricep
Climb A	3.73	5.62	11.40	12.08	11.61	4.67	6.82	4.58
Climb B	4.95	5.90	5.45	9.51	10.38	7.55	5.92	5.35
Climb C	5.07	8.74	10.52	14.49	9.87	4.91	7.25	6.19
Climb D	4.58	5.16	8.73	11.38	10.90	5.53	7.56	6.26
Average Muscle Activation	4.58	6.35	9.03	11.86	10.69	5.66	6.89	5.59
st dev	0.52	1.40	2.28	1.78	0.64	1.13	0.62	0.69

Discussion

As hypothesized, upper extremity and trunk muscle activity varied across the four bouldering problems. Certain muscles demonstrated low level of activity, while others demonstrated greater activity. Muscle activity also varied based on the bouldering problem (**Table 4**).

Knowledge of specific muscle activity during bouldering may help identify exercises that target specific muscles in people looking to improve their bouldering skills. Muscle activity can also help guide return to climbing decisions and best rehabilitation practices for an injured climber. It is challenging to compare the muscle activity produced during bouldering in the current investigation with other studies, as the intensity level and dynamic nature of bouldering differs based on the climbing task. MacLean et al.[10] examined the EMGof 12 upper extremity and trunk muscles of experienced and inexperienced climbers during a horizontal bimanual climbing activity and found the EMG amplitudes were higher in the inexperienced climbers. Thereduced muscle activityin experienced climbers is likely due to the increased efficiency experienced climbers demonstrate when climbing. This difference in muscle activity between climbers with different level of experience would need to be considered when recovering from a muscle injury or determining when it is safe to return to climbing after an injury. Since grip strength and forearm flexor strengthis associated with climbing ability, Watts et al.[11] compared forearm EMG response to maximum handgrip dynamometry with forearm EMG response to six different hand configurations during climbing. Surprisingly, there was a large difference in EMG activity of the forearm musculature during climbing and maximal effort dynamometry with the absolute peak forearm EMG for climbing being significantly greater than for maximal effort hand grip dynamometry. This suggests that the activation of forearm musculature differs between classic handgrip dynamometry and maintenance of hand grip during climbing, which may have implications for climbing specific training, rehabilitation, and safety consideration when returning to climbing after an injury. If grip dynamometry activates forearm musculature less than gripping during climbing, then climbing may be more effective at activating other muscles than classic rehabilitation exercises such as the latissimus pull down or a biceps curl. Future research is needed to test these theories. Nevertheless, the muscle activity levels during bouldering in the current study suggest bouldering may be a beneficial activity to developing strength of upper extremity and trunk musculature.

In our current study, the highest average EMG across all four climbs occurred in the flexor digitorum superficialis, latissimus dorsi, and extensor carpi radialis brevis. The importance of the forearm

musculature in climbing is supported by a study by Deyhle et al.[12] which found prefatiguingthe forearm musculature reduced climbing ability, supporting the importance of the forearm musculature in climbing ability. However, prefatiguing the shoulder adductors (*i.e.* latissimus dorsi) had no significant impact on climbing performance, suggesting the latissimus dorsi may not be as important to climbing success as the forearm musculature.[12]

Study limitations should be considered when interpreting the results presented. The main limitation of this study was the low study sample size. One could speculate that differences in the EMG activity between muscles would be more prominent with a greater statistical power. This research did not include all possible bouldering skills, holds, and moves. Also, this study only included climbers with a self-reported ability of at least a V-scale V4 (Fontainebleu 6A), and regularly boulder at least 2 days/week. EMG amplitude data may differ on less skilled climbers or climbers completing bouldering problems closer to their self-reported ability. In addition, while protocols were in place to standardize procedures, there are limitations associated with the collection and processing of EMG data, such as discrepancies in electrode placement and the ability of participants to reach their voluntary maximum during the test contractions used for normalization purposes. Furthermore, the current study only considered unilateral muscles from healthy participants. Importantly, the findings from this study should not be generalized to other populations or bouldering facilities.

The findings of the present study provide a foundation for designing a muscle conditioning program for climbers. There has been a steady rise in the popularity of climbing, and conditioning specific muscles may be useful at improving the climbers' ability and preventing injuries associated with climbing.

Prior to implementing bouldering problems into a rehabilitation program after an injury, the influence of various climbing problems on muscle activity in people with pain or injury should be investigated. Future research should be conducted to explore whether the prescription of climbing to treat pain is effective in terms of improving symptoms and not furthering injury progression.

Conclusion

The current study identified the activity of eight upper extremity and trunk muscles across four bouldering problems. The activity of the eight muscles varied greatly. The highest average EMG across all four climbs occurred in the flexor digitorum superficialis, latissimus dorsi, and extensor carpi radialis brevis. Significant differences in muscle activity were noted between the anterior deltoid and latissimus dorsi, flexor digitorum superficialis and biceps brachii, triceps brachii and flexor digitorum superficialis, posterior deltoid and latissimus dorsi, and triceps brachii and latissimus dorsi. This information may be useful in developing a strength and conditioning program for climbers, and to help guide the return to climbing criteria for climbers who have been injured. However, prior to recommending climbing as part of a rehabilitation program, the muscle activity requirements should be studied in an injured population.

Ethical Clearance: This research involving human subjects was approved by Samford University's Institute Review Board, approval number EXPD-HP-22-S-23.

Conflict of Interest: Nil

Source of Funding: Self

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Original Study

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Efficacy of Modified Constraint Induced Movement Therapy in Post-Surgical Ulnar and/or Median Nerve Repair Patients

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Abstract

Background: After upper extremity nerve repair, there occurs impairment in hand functions which represents a major problem in activities of daily living (ADL) for the patient. Therefore, the patients after peripheral nerve repair needs rehabilitation to improve their functional status. This study was conducted to determine the efficacy of modified constraint-induced movement therapy in subjects after nerve repair in upper extremity.

Methodology: 27 post-surgical subjects of ulnar and/or median nerve repair, aged 18-60 years, were included in the study as per the selection criteria. The subjects were randomly divided into two groups, Group A (n=14) and Group B (n=13) and were assessed for functional disability, integrated hand function, pain and muscle strength using DASH questionnaire, SHFT, VAS and BMRC muscle strengthening grading system respectively. Group A received Modified constraint-induced movement therapy along with conventional therapy. Group B received Conventional therapy alone. The subjects were given a total duration of intervention of 8 weeks, with 5 weekly sessions and were reassessed after 8 weeks.

Conclusion: The results of this study conclude that modified constraint induced movement therapy combined with Conventional physiotherapy is more effective when compared to Conventional therapy alone in improving muscle strength and integrated hand function, reducing pain and disability in subjects with nerve repair in upper extremity.

Keywords: Modified Constraint Induced Movement Therapy; Nerve Repair; Peripheral Nerve Injuries.

Introduction

Traumatic peripheral nerve damage is a significant clinical and public health issue that frequently results in severe functional loss and permanent disability[1]. Penetrating damage, crush, traction, ischemia, and less common mechanisms like heat, electric shock, radiation, blunt injury, and injuries from sharp objects are among the causes of traumatic peripheral nerve injury[1]. About 30% of major nerve injuries are caused by lacerations such as those caused by glass, knives, fans, saw blades, metal, or long bone fractures[2].

Epidemiological reported prevalence is 16.9 per 100,000 persons annually with an average age of 38.42 years and 68.20% incidence of males. The incidence of Ulnar nerve injuries is reported most common (3.86 per 100,000)[3].

The degree and location of the nerve injury as well as patient-related variables, all play a role when nerve function can be restored after injury[4]. Depending on

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the origin and extent of the injury, various peripheral nerve injuries exhibit varying effects. These include pain ranging from tingling to strong burning pain, numbness or altered sensations, muscle weakness in the affected body part, loss of function (such as difficulty using a hand or leg to complete tasks), and loss of active movement; Skin rashes, joint stiffness, and finally stress-related symptoms[5].

The simplest and most effective surgical option for severe axonotmesis and neurotmes is damage is still direct nerve repair with epineural micro sutures. A nerve repair is typically immobilized for up to 3 weeks post-operatively[6,7]. Even after surgical nerve repair following peripheral nerve injuries, the patients lack good recovery of functions. The resulting impairment in hand function after nerve repair represents a major problem in activities of daily living (ADL) for the individual patient. A multitude of physical therapy interventions have been proposed to be effective in post-operative management of epineural nerve repair, including therapeutic exercises, modalities, motor and sensory re-education of affected extremity. However, the purpose of this study was to investigate the utility of modified constraint-induced movement therapy in hand rehabilitation after median and ulnar nerve repair.

The focus of constraint-induced movement therapy is to improve the "learned non-use" condition suffered by individuals with central nervous system injuries such cerebral palsy or stroke. But there are limited sources available regarding the clinical evidence of role of modified constraint induced movement therapy in post-surgical nerve repair patients of upper extremity. In order to address this issue, this study was carried out to investigate if deafferentation of the healthy hand combined with intense, significant, and intentional use of the damaged hand can enhance hand function in these patients. This study also determines an effective rehabilitation technique in post-surgical nerve repair patients of upper extremity.

Methodology

This was a quasi-experimental study conducted at Outdoor Patient Department (OPD) of University College of Physiotherapy, Faridkot in the period between June 2022 to March 2023. A total of 27 post-operative subjects, both males and females, aged between 18-60 years, with unilateral ulnar and/or median nerve repair below elbow level due to road side accident, glass cut injury or assault were included and the subjects with brachial plexus injury, amputation of contra-lateral upper extremity, any previous history of peripheral nerve injury of upper extremity, reconstructive surgery procedure including nerve tube or grafts and nerve transfer surgery, nerve repair post neuroma formation, and mal-united or non-united fractures with segmental nerve loss or entrapped nerve of upper extremity were excluded from the study. The demographic data and informed consents were collected from each subject.

The subjects were assessed for muscle strength, integrated hand function, pain and functional disability using British Medical Research Council (BMRC) muscle strengthening grading system, Sollerman hand function test (SHFT), Visual Analogue Scale (VAS) and Disability of the Arm, Shoulder, and Hand (DASH) questionnaire respectively before and after the intervention. The subjects were randomly divided into two groups that is Group A (n=14) and Group B (n=13) and they were administered different programmes for rehabilitation after surgery. The duration of intervention programmes for both groups was eight weeks.

Interventions

The subjects in Group A were given Modified constraint-induced movement therapy along with conventional therapy. The subjects in Group B were given Conventional therapy alone. The techniques are mentioned below:

1. **Modified constraint-induced movement therapy:** After early immobilisation phase (1st to 3rd week post-operatively), the subjects in Group A were administered modified constraint-induced movement therapy 1 hour daily, 5 days per week for 4 weeks[8] (from 4th week to 8th week post-operatively) along with conventional therapy. Over the duration of the four-week intervention, subjects wore the splint/ binder to immobilise the healthy hand for the majority of their waking hours, with the exception of brief rest times or for hygiene reasons. During intervention sessions,

patients received training in reaching, grabbing, and manipulating essential items in daily living, as well as in dressing and undressing, using a spoon and fork to eat, grooming, and other crucial tasks with the use of affected hand while patients' healthy hand was immobilised with the splint/ binder.

2. **Conventional therapy**[9] Conventional therapy was done 5 times a week for 8 consecutive weeks (Table 1). Electrical stimulation, with exponential momentum, of the muscles that were partially or totally denervated, was started after 1 week of nerve repair for 15-20 min/day, 5 times a week for 8 consecutive weeks[10,11,12].

Table 1: The protocol for conventional therapy followed in both the groups.

A) Early post-operative phase (Week 1 – week 3)	
1. Protecting the sutures.	Immobilisation: - Bulky dressing for 2-3 days post-op. Splinting / Plaster of Paris for 3 weeks
2. Reducing post-op swelling	Positioning and elevation of affected upper extremity.
	Active assisted flexion/active extension of digits of affected upper extremity.
3. Managing pain	Positioning the affected upper extremity.
	TENS application proximal to site of nerve repair[13].
	Thermal modalities for decreasing muscle tone proximal to injured site.
4. Maintainingfunction in adjacent non-injured joints.	Active range of motion exercises of adjacent non-injured joints.
5. Maintaining and/or re-awakening cortical representation	Mirror therapy[14]
B) Early Intervention phase (Week 4 – week 6)	
1. Regaining motor function	Passive range of motion exercises of elbow, wrist and digits of affected upper extremity.
	Active assisted/Active range of motion exercises of elbow, wrist and digits of affected upper extremity.
	Active exercises of shoulder of affected side
2. Regaining sensory function	Sensory re-education[14,15]
3. Managing pain	Positioning of affected body part.
	TENS application.
4. Preventing contractures or correcting deformities	Splinting of affected hand according to need of the patients[16].
5. Improving function and activities of daily living	Displacing peg-boards with different sizes.
	Integration of affected hand in activities of daily living.
6. Optimizing the scar	Massaging the scar
C) Strengthening phase (Week 6 – week 8)	
1. Strengthening exercises	Progressive resistance training.

Results

The Statistical Analysis was done using SPSS (version 19) and Microsoft Excel 2010. The dependent variables were expressed by arithmetic means and standard deviation and tested using paired t-test within the group and unpaired t-test between the groups. The p-value of less than 0.05 was considered as significant.

Table 2: The Demographic profiles of subjects of both groups.

Demographic characteristic	Group A (n =14)	Group B (n = 13)
Age (in years) (Mean± SD)	27.64±7.948	31.62±15.591
Males, (n) %age	100%	85%
Ulnar nerve involvement, (n) %age	42.85%	46.15%
Median nerve involvement, (n) %age	28.57%	30.76%
Both nerves involvement, (n) %age	28.57%	23.07%

Table 3: Comparison of Scores of DASH, SHFT, VAS and MMT between two groups at baseline & follow-up (at 8th week).

Outcome Measure	Group-A (n=14)			Group-B (n=13)			Between groups	
	Pre-test	Post-test	Within group P-value	Pre-test	Post-test	Within group P-value	Pre-test P-value	Post-test P-value
DASH Score Mean±SD	84.81± 5.406	30.24± 7.960	<0.001	87.83± 5.717	49.27± 11.612	<0.001	0.1711, NS	<0.001
SHFT Score Mean±SD	16.57± 9.629	59.07± 11.256	<0.001	10.38± 6.063	26.62± 8.977	<0.001	0.0589, NS	<0.001
VAS Score Mean±SD	6.21± 1.477	2.64± 1.082	<0.001	7.00± 0.577	4.46± 0.967	<0.001	0.0851, NS	0.0001
MMT Score (Palmar abductors of thumb) Mean±SD	1.64± 1.151	4.29± 0.726	<0.001	1.38± 1.193	3.46± 0.877	<0.001	0.5721, NS	0.0132
MMT Score (Abductors of Digit 2) Mean±SD	1.50± 0.855	4.29± 0.469	<0.001	1.31± 0.480	3.46± 0.660	<0.001	0.4826, NS	0.0009
MMT Score (Abductors of Digit 5) Mean±SD	1.07± 1.207	3.71± 0.469	<0.001	0.85± 1.068	3.31± 0.947	<0.001	0.6131, NS	0.1651, NS
MMT Score (Adductors of Digit 5) Mean±SD	1.08± 1.038	3.08± 0.760	<0.001	1.08± 1.038	3.08± 0.760	<0.001	0.4116, NS	0.1606, NS

DASH- Disability of the Arm, Shoulder, and Hand (questionnaire); SHFT- Sollerman hand function test; VAS- Visual Analogue Scale; MMT- Manual Muscle Testing; SD- Standard Deviation; NS- Non-Significant.

Discussion

Following peripheral nerve injuries and repair, patients experience motor and sensory impairments that cause disability to use their upper limbs for daily activities. Even after surgical nerve repair following peripheral nerve injuries, patients lack good recovery

of function. This emphasizes the importance of effective treatment options in rehabilitation of post-surgical nerve repair patients that increases the recovery rate and decreases the disability. The aim of the study was to determine the efficacy of modified constraint-induced movement therapy in improving muscle strength and integrated hand function, reducing pain and disability in patients with nerve repair in upper extremity.

The findings of the present study indicated marked reduction in functional disability, pain as well as improvements in integrated hand function and muscle strength in terms of statistically significant difference (p value <0.001) DASH score, SHFT score, VAS score, MMT score of Thumb palmar abductors, Digit 2abductors, Digit 5 abductors and adductors on comparing the mean values of pre-intervention to post-intervention in both different interventional groups.

However, on comparing Group A and Group B, the results demonstrated that the performance of Modified Constraint Induced Movement Therapy along with conventional therapy in Group A was more efficient in reducing functional disability, pain as well as improving the integrated hand function and muscle strength of Thumb palmar abductors, Digit 2 abductors at the end of eight weeks than the performance of Conventional therapy alone in Group B. But none of the interventional program proved to be better than the other in improving muscle strength of Digit 5 abductors and adductors in Group A when compared with Group B. The findings of various previous studies done in similar area support the results of our study and are discussed below.

The statistically significant reduction in functional disability in terms of DASH score and improved hand manual dexterity with the use of Modified Constraint Induced Movement Therapy has been documented in the studies[8,17]. The reasons for the improvement may include, the use of injured limb for daily tasks and engaging in meaningful works. Paying more attention to the injured limb, and increasing environmental feedbacks from the injured limb to the brain are also considered for reducing functional disability in patients with nerve repair in upper extremity.

The role of maintaining engagement in meaningful home and work roles in reducing pain and disability in post-surgical upper extremity peripheral nerve repair due to better emotional and psychological status as well as improved grip, pinch, and functional evaluation outcomes is also addressed in previous researches[18,19].

The findings of different studies[18,19,20] showed the improvement in muscle strength with the use of physiotherapeutic rehabilitation programs in post-surgical median and/or ulnar nerve repair patients. Increased motor unit synchronisation, cross-transference, and higher motor unit activation are some of the proposed processes for increased muscle strength. Various researchers[12,14,21] also documented the use of low-frequency electrical stimulation in accelerated nerve regeneration and increased muscle strength. Electrical stimulation of denervated or partially denervated musculature delay the onset, and perhaps minimize the ultimate degree of denervation atrophy.

The studies done by various other researchers[18,23,24] also documented the reduced recovery in intrinsic hand muscles supplied by ulnar nerve. This may be because of the longer regeneration time of the injured ulnar nerve than that of the median nerve.

Our study has opened an interesting perspective for future clinical application and research in respect to hand rehabilitation in post-surgical upper extremity nerve repair patients. However, this study has limitations such as small sample size, no follow-up, evaluation of effect of modified constraint induced movement therapy on motor domains only and acute situation of the patients. Future studies with a larger sample size, a longer duration of treatment, patients with post-surgical management of nerve grafting or nerve transfer procedures, along with control comparison subjects, are necessary to determine the best scheme of rehabilitation for patients after nerve repair of upper extremity.

Conclusion

The present study concludes that Modified constraint induced movement therapy combined with Conventional physiotherapy is more effective in reducing disability and pain as well as in improving

integrated hand function and muscle strength, in patients with nerve repair in upper extremity than Conventional therapy alone.

Consent: Informed consent was received from all subjects in the study for the publication work in the journal.

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

Source of Funding: Self.

Conflict of Interest: Nil.

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Original Article

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Association of Sarcopenia with Physical Performance and Quality of Life in Older Adults

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Abstract

Background: Sarcopenia is a geriatric syndrome characterized by progressive and generalized loss of muscle mass and function. Sarcopenia constitutes a major health problem affecting millions of older adults around the world specially in countries like India where older population is too large. In India, one of the developing county there are none of the studies investigating the association of Sarcopenia with physical performance and Quality of Life where there is substantial growth in the aging population. Our study aims to explore association of Sarcopenia with physical performance and quality of life in older adults.

Method: It is an observational study. A sample size of 280 older adults of aged 60 or 60+year were taken from old age homes. Convenient sampling method was used. Sarcopenia was diagnosed using SARC-CalF and jamar handheld dynamometer using Asian working group of sarcopenia criteria. Physical performance was measured using short physical performance battery and quality of life were assessed using SarQoL questionnaire.

Result: 200 older adults were diagnosed with sarcopenia, their physical performance and quality of life were assessed, results of which suggested that 86% of older adults diagnosed with sarcopenia has a poor physical performance and quality of life overall score (mean) of SarQoL was 56.05, among the domains, Leisure activities had the lowest quality of life scores and fears were the highest. When analysed for a correlation between SARC-CALF and SPPB and SARC-CALF and SARQOL overall score, the results of which demonstrate that there was no correlation between them.

Conclusion: Results of the study provide evidence that older adults with Sarcopenia are likely to have poor physical performance and their quality of life is compromised. Study showed that there is no correlation of Sarcopenia with physical performance and quality of life.

Keyword: Sarcopenia, older adults, physical performance, quality of life

Introduction

Musculoskeletal disease is a major contributor to the global non-communicable disease burden,[1] particularly in countries with low middle income as they are currently undergoing a rapid demographic transition and aggressive growth of older populations.[2-3] Due to anatomical and physiological changes in skeletal muscles, older people frequently experience loss of muscle strength.[4] As person continuous to age, skeletal muscle is loss and there is decrease in its mass, and the speed and force of their contraction also reduces. This phenomenon is known as "Sarcopenia".[4]

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It is found that maximum muscle mass and strength are reached in the 20s and 30s. A gradual decline is followed by in the middle age. The loss of muscle mass advances from the age of 60 years.[4] In one study it is found that Sarcopenia can also be due to the loss of motor neuron fibers (denervation) and loss and degeneration of neuromuscular junctions; as a result, there is less muscles stimulation and the body losses its mass.[4] Till the dawn of the twenty-first century, sarcopenia was regarded as an age-related decline in muscle mass with little or no emphasis on Muscle strength and function.[5]

Stefanos Tyrovolas performed a study titled "Factor associated with skeletal muscle mass, Sarcopenia, and Sarcopenic obesity in older adults" In this study they state that sarcopenia syndrome has been related with the decile in type II muscle fibres which is replaced by lean mass of different kinds of tissues that has reduced capacity of synthesize protein, thereby leading to reduced muscle strength. Besides, previous studies suggest that sarcopenia correlates with poor health-related outcomes such as physical limitations, disability, increased mortality,[6-8] frailty, and poor quality of life in hospitalized and emergency care use.[8-10]

The Asian Working Group for Sarcopenia (AWGS) was formed recently, the aim of the group was to assess the suitability of existing sarcopenia definitions for diagnosis of populations from Southeast Asian countries such as Thailand, China, Japan, South Korea, Malaysia, Taiwan and Hong Kong but there were no research found that include Indian older adult population. According to Asian working group of Sarcopenia, Sarcopenia is define as "age-related loss of skeletal muscle mass plus loss of muscle strength and/or reduced physical performance," without reference to comorbidity.

Several research and studies has been performed in the field of sarcopenia in order to assess the clinical components of sarcopenia but each of these studies is focused on restricted clinical characteristics. Our study is to screen for Sarcopenia in older adult population and to find its association with Physical performance and quality of life.

Materials and methods

Our present study, aims to find association of sarcopenia with physical performance and quality of life in older adults. This study was observational study. In this study, 200 subjects diagnosed with sarcopenia of age 60 or 60+ year in the study fulfilling the inclusion criteria. The inclusion criteria comprised of SARC-CalF score more than 11/20 and Jamar handheld dynamometer scoring <26kg for men and <18kg for women indicates Sarcopenia according to AWGS criteria, age group of 60 or 60+ year and subject willing to participate whereas the exclusion criteria comprised of older adult with congenital deformity, neurological conditions like Stroke, traumatic brain injury, Spinal cord Injury, Parkinsonism and individual with recent Fracture. Subject were selected on the basis of simple sampling method. A written informed consent is taken from the subject in the language best understood by them. Purpose of the study and procedure are explained to the subjects. An assessment was taken to record their demographic details and other parameters.

Diagnosing sarcopenia with the help of SARC-CalF and jamar handheld dynamometer. The SARC-CalF questionnaire is a screening tool that can be easily apply by clinicians to identify probable sarcopenia. The SARC-CalF scale contains six objects: 1. Strength; 2. Walking assistance; 3. Rising from a chair; 4. Climbing stairs; and 5. Falls; 6. Calf circumference, with scores between 0 and 2. According to the 2019 Asian Working Group for Sarcopenia (AWGS) criteria, calf circumference cutoff value were 34 and 33 for men and women, respectively. When a score obtained is above the cutoff value, calf circumference is scored as 0; if the score is below the cut-off value, the score is 10. A positive screening for sarcopenia is indicated when a score of ≥11 points is obtained. To evaluate the hand grip strength of the subjects, Hydraulic type Jamar handheld dynamometer is used. Standard positioning recommended by AWGS 2019 is sitting with 90° elbow flexion for the Jamar dynamometer. As per the recommendation of AWGS, hand grip strength is measured by taking the maximum reading of atleast 2 trials using either both hands or the dominant hand in a maximum-effort applied by the subject and cutoffs for low muscle strength of handgrip is <28.0

kg for men and <18.0 kg for women. If the subject is diagnosed as Sarcopenia further assessment to be carried out.

The Short Physical Performance Battery (SPPB) was used to assess physical performance in older adults. The SPPB consist of tests which is used to assess physical performance by testing balance, strength, and gait. It includes three tests 1.Balance testing in three positions; 2. Lower limb strength is tested through getting up and sitting on a chair; 3. Gait is tested by walking speed at normal pace. Balance is measured by standing upright for 10 seconds, placing the feet together in three different positions; first side by side stand; second semi-tandem stand and third tandem stand. Strength is evaluated by performing task of getting up and sitting on a chair repeatedly for five times. Gait is evaluated by making the participant walk for 3 or 4 meters and measuring the time the individual takes to complete the walk. The SPPB total score ranges from 0 to 12 points and categorically evaluates performance in the tests using three of scores: 0–6 points (poor performance), 7–9 points (moderate performance), 10–12 points (good performance).

Sarcopenia-specific Quality Of Life (SarQoL) questionnaire was used to assess the quality of life of the participants. It is developed as a health-related quality of life tool for sarcopenia. The SarQoL questionnaire has a total 55 items and 22 questions, it calculates a total 7 domain scores and a total score, the score ranges from 0 and 100 points each. The domains are as follows: 1. Physical and mental health, 2. Locomotion, 3. Body composition, 4. Functionality, 5. Activities of daily living, 6. Leisure activities, 7. Feelings of fear.

Results and discussion

The demographic data and study results are documented in (table 1). A total of 280 older adults were taken from old age homes in Mumbai and Thane, among which 200 were diagnosed with sarcopenia. Age criteria was 60 and 60+, in which the mean age group found was 67 years. The results of physical performance assessed using short physical performance battery suggest that 86% of sarcopenic subjects were poor physical performer, 13% were moderate physical performance and 1% has good physical performance, this results clearly represents that majority of sarcopenic subjects were poor physical performer. Magdalena I Tolea1James egalvin 1–3 conducted a study on sarcopenia and impairment in cognitive and physical performance in which they found that Sarcopenia captures early-stage changes in muscles that can affect one's physical functionality.[11] In another study it was found that functional impairment and disability are linked to sarcopenia after adjustment for age, race, BMI, health behaviors, and comorbidity.[12]

The result of quality of life assessed using SarQoL questionnaire suggest that Leisure activities had the lowest quality of life scores and fears were the highest. In 2012, Kull *et al.*[13] found a reduced quality of life in two domains (i.e. physical function and vitality) assessed using SF-36 questionnaire in sarcopenic subjects. Two other studies found that sarcopenic subjects presented poorer general health and physical functioning scores.[14]

For association of sarcopenia with physical performance and quality of life, spearmen correlation test was done, results of which suggest that there is no correlation between SARC-CalF and SPPB and SARC-CalF and SarQoL overall score. In addition, 2 recent studies, with older adults of Mexico City and Taiwan, found a significant negative bivariate association between sarcopenia and quality of life.[15,16] Understanding the correlates of sarcopenia with physical performance and quality of life may lead to preventative programs and is therefore of great importance from a public health perspective.

Table 1: Demonstrates demographic data and results of tests

Demographic Data	Mean ± SD
AGE	67.34±5.61
GENDER	
MALE	84
FAMLE	116
SARC-CalF	12.56±0.74
Hand Grip Strength	
MALE	8.67±3.45
FEMALE	4.70±2.51
SPPB	5.25±1.20
SarQoL OVERALL SCORE	56.05±5.36

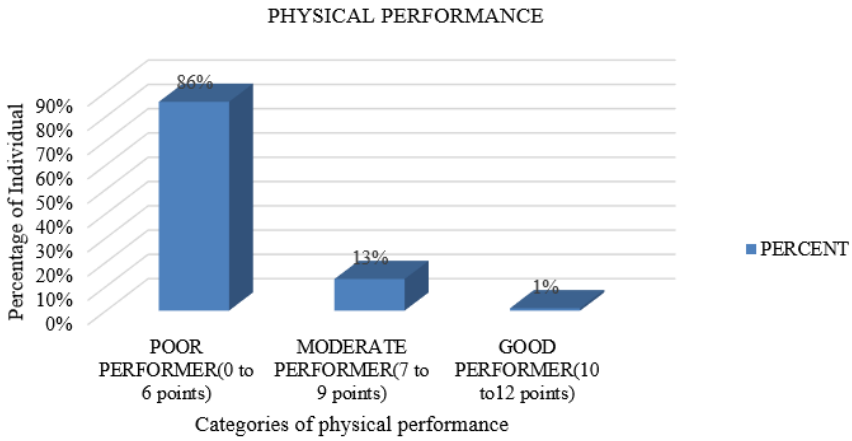

Figure 1 In above bar diagram, X-axis represent the categories of physical performance assessed using SPPB and Y-axis represents the percentage of individuals diagnosed with sarcopenia

Table 2: Demonstrate SarQoL domains score + overall score and Mean±SD of each score

Domains	N	Score	Mean±SD	Maximum Score
D1. Physical and mental health	200	44.67-68.87	55.41±3.27	100
D2. Locomotion	200	40.55-75	48.36±7.09	100
D3. Body composition	200	41.25-75	54.55±3.45	100
D4. Functionality	200	46.15-75	64.00±3.99	100
D5. Activities of daily living	200	40.76-81.67	48.52±7.21	100
D6. Leisure activities	200	33.25-66.5	44.89±5.08	100
D7. Fears	200	54.36-89.76	83.73±3.19	100
Overall score	200	45.67-72.97	56.05±5.37	100

Interpretation The overall score (mean) of SarQoL was 56.05 (45.67-72.97), among the domains, Leisure activities had the lowest quality of life scores 44.89 (33.25-66.5), and fears were the highest 83.73 (54.36-89.76)

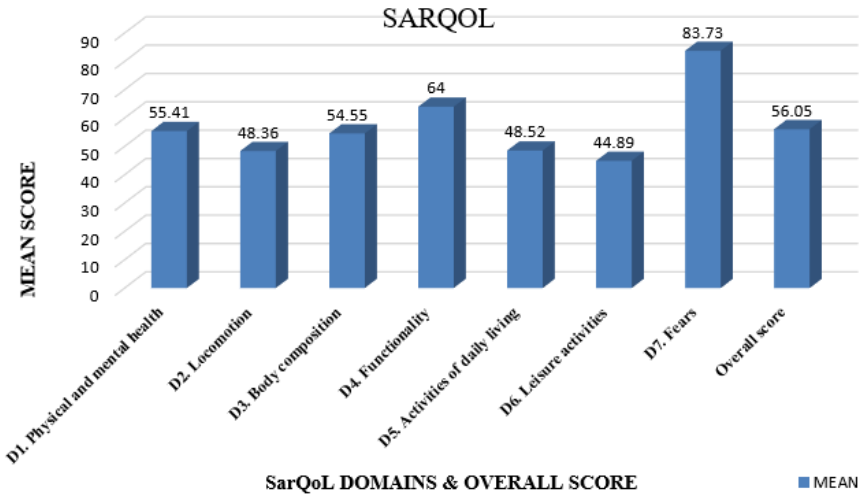

Figure 2 In the above bar diagram, X-axis represents each domains and overall score of SarQoL and Y-axis represents the mean score

To assess the normality of the data, statistical analysis using QQ plot was performed. The results of which demonstrated that the data was not distributed

normally. Hence, to assess the data for its correlation and since the data is not normal, Spearman rank correlation was administered.

The score of variables of SARC-CalF, SPPB and SarQoL overall score were represented in the form of ranking using Rank Average method. The results of which is suggestive of no correlation between SARC-CalF and SPPB and SARC-CalF and SarQoL overall score.

Table 3 Demonstrates Spearman's correlation between SARC-CalF and SPPB

Coefficient	-0.058
N	200
T statistic:	0.81802
DF:	198
p value	0.41433

α=0.05 (Assume)

Inference Since p-value > α. So there is no correlation between the ranks of SARC-CalF& SPPB

Table 4 Demonstrates Spearman's Correlation between SCAR-CalF and SarQoL overall score

Coefficient	0.00487
N	200
T statistic:	0.06859
DF:	198
p value	0.94539

α=0.05 (Assume)

Inference Since p-value > α. So there is no correlation between the ranks of SARC-CalF & SarQoL overall score

Conclusion

Results of the study provide evidence thatolder adults with Sarcopenia are likely have poor physical performance and their quality of life is compromised. This study helps to easily screen Sarcopenia in older adults and to understand the impact of Sarcopenia on physical performance and quality of life.

Conflict of interest: Nil.

Ethical clearance: Ethical clearance has obtained from DPOS Nett college of physiotherapy, Thane which comes under Maharashtra university of health science, Nashik.

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Original Article

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Assessment of Foot Deviations and Associated Foot Injuries and its Effect on Foot Functional Activity among Amateur Adolescent Female Kathak Dancers in Selected Dance Schools in Bengaluru

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Abstract

Background & purpose: Kathak is a north Indian classical dance form that requires fast rhythmically sophisticated footwork and fast turns, which puts the dancers at risk of foot injuries. Any foot deviations or reduced foot function are associated with an increased risk of a foot injury. This study aims to assess foot deviations and related foot injuries and their effect on functional activity and create awareness among kathak dancers about foot position and its risk factor for injury. Methods: This study included 100 recruited subjects based on the inclusion and exclusion criteria. Demographic data and other variables were collected and recorded, and measures like foot posture and function indexes were used.

Results: The foot posture index mean and SD of the left feet for the subjects recruited in the present study were 1.83 and 1.43 and of the right feet were 1.89 and 1.54 respectively. The overall foot functional index score mean and SD, for the subjects recruited in the present study were 9.76 and 10.39.

Conclusion: The present study concluded by stating that the foot posture index was normal and didn't have restrictions on foot usage while performing the kathak dance form. Whereas with the foot function index, it was observed that the pain experienced by subjects was severe which restricted their activity pattern and hindered their dance performance.

Key Words: Kathak Dancers, Foot Posture, Foot Function Index, Adolescent Females, BMI.

Introduction

Kathak is a classical dance form from north India characterized by fast, rhythmically sophisticated footwork, quick turns, delicate hand positions, and storytelling.[1] Kathak dancers are barefoot, and but because they wear ankle bells and their technique emphasizes stamping and sharp rhythmic shifts, kathak can produce quite a clatter.[2] The lower leg, ankle, and foot form the terminal portion of the lower extremity kinetic chain. The foot and ankle provide a base of support that aids in postural stability and flexibility.[3,4] Kathak dance is an art that combines athleticism with artistry. The demands placed on dancers' lower extremity leaves them at risk for musculoskeletal injuries. The foot and ankle

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of a dancer are particularly vulnerable to injury and represent 34% to 62% of all injuries reported.[3] The lower extremity chain bears responsibility for critical daily functions, the most essential being weight bearing and ambulation. Many activities require the lower extremities to react to these forces by pronating or supinating the hindfoot.[5] The nature of the dancer's feet causes the ankle to be forced into extreme plantar flexion. Hence, the kathak dancer is repetitively placing the ankle in an unstable position.[6]

In order to prevent abnormal weight-bearing loads, proper biomechanics is crucial for a dancer to prevent abnormal weight-bearing loads. Primary and secondary kinetic chain dysfunctions are common in dancers. Rear-foot and forefoot deformities, excessive ankle and great toe range of motion, pes cavus, and planus all contribute to injuries at the foot and ankle, continuing up through the kinetic. Most of these dysfunctions come into play when the dancer turns or lands from a jump. Many jumps in dance require them to land on one foot. This often gives the dancer a disadvantage that often leads to injury.[7-9] The foot posture index (FPI) is a diagnostic clinical tool to quantify the degree to which a foot can be considered in a pronated, supinated, or neutral position. It is intended to be a simple method of scoring the various features of foot posture into a single quantifiable result, which indicates overall foot postures. Foot posture is considered an essential component of musculoskeletal assessment in clinical practice and research. It defines normal and potentially 'abnormal' foot types.[10] Foot posture index is a clinical diagnostic tool with which we quantify the static posture of the foot. It is a simple and rapid method and has demonstrated good reliability.[11] FPI consists of 6 validated, criterion-based observations of the rear foot and forefoot of a subject standing in a relaxed position. The hind foot is assessed via palpation of the head of the talus, observation of the curves above and below the lateral malleoli, and the extent of the inversion/eversion of the calcaneus. The observation of the forefoot consists of assessing the bulge in the region of the talonavicular joint, the congruence of the medial longitudinal arch, and the extent of abduction/ adduction of the forefoot on the rear foot. Any variation in the foot posture of kathak dancers from neutral may predispose them to lower extremity injuries.[12]

Foot posture is considered to be an important component of musculoskeletal assessment in clinical practice and research. It defines normal and potentially 'abnormal' foot types.[10] Foot posture index is a clinical diagnostic tool with which we quantify the static posture of the foot. It is a simple and rapid method and has demonstrated good reliability.[11] FPI consists of 6 validated, criterion-based observations of the rear foot and forefoot of a subject standing in a relaxed position. The rear foot is assessed via palpation of the head of the talus, observation of the curves above and below the lateral malleoli, and the extent of the inversion/eversion of the calcaneus. The observation of the forefoot consists of assessing the bulge in the region of the talonavicular joint, the congruence of the medial longitudinal arch, and the extent of abduction/adduction of the forefoot on the rear foot. Any variation in the foot posture of kathak dancers from neutral may predispose them to lower extremity injuries.[12]

Foot Function Index (FFI) was developed in 1991 to measure the impact of foot pathology on function in terms of pain, disability, and activity restriction.[13] It is a self-administered index of 23 items divided into 3 sub-scales. Both total and sub-scale scores are produced.

Therefore, there is a need to assess foot posture to understand the effect of dancing on the feet and to reduce their risk of sustaining foot injuries and its impact on foot functional activity. This study aims to assess the foot posture in kathak dancers and its effect on foot functional activity.

Objectives of the Study:

1. To assess the foot deviations and associated injuries among kathak dancers
2. To measure foot functional activity among amateur adolescent female kathak dancers

Methodology

Materials and Methods Source of Data: Selected kathak dance schools in Bengaluru.

Definition of Study Subjects: Subjects age group 13 to 17 years' amateur adolescent female kathak dancers in a selected dance school in Bengaluru.

Inclusion and exclusion criteria:

Inclusion criteria:

- Adolescent female kathak dancers
- 5-6 hours of practice per week
- Normal BMI – 18.5-24.9Kg/m2
- Subjects willing to participate and ready to sign the consent form.

Exclusion criteria:

- Trauma of lower limb, spine, and abdomen (last 3 months)
- Surgery of lower limb, spine and abdomen (last 3 months)
- Subjects with neurological dysfunction, musculoskeletal dysfunction, psychiatric or dermatological conditions.
- Subjects with gynecological conditions
- Subjects who had already participated in a similar kind of study

Method of data collection:

Sample design: Purposive sampling technique

Sample size: 100 samples calculated from prevalence studies.

Materials required:

- Consent form
- Screening form
- Stationeries

Duration of the study: Data was collected over a period of approximately 6 months and 15 days' time.

Procedure: Investigator personally contacted selected dance schools in Bengaluru and obtained permission from concerned authorities to conduct a study and obtained signed consent from the subjects. Subsequently, after obtaining the permission the investigator explained the details and purpose of the study to the subjects, and subjects were screened for foot deviation using Foot Posture Index (FPI) to document the associated foot injuries. Demographic data of all subjects with the duration of exposure per week was obtained prior to the initiation of the study and the subjects fulfilling the inclusion and exclusion criteria were recruited for the study and the study continued.

Outcome Measures: Foot Function Index: The FFI (questionnaire) consists of 23 self-reported items divided into 3 subcategories on the basis of patient values: pain, disability, and activity limitation. The patient has scored each question on a scale from 0 (no pain or difficulty) to 10 (worst pain imaginable or so difficult it requires help), which best described their foot over the past week. The pain subcategory consisted of nine items and measured foot pain in different situations, such as walking barefoot vs. walking with shoes. The disability subcategory consisted of nine items and measured difficulty performing various functional activities because of foot problems, such as difficulty climbing stairs. The activity limitation subcategory consisted of five items and measured limitations in activities because of foot problems, as such staying in bed all day. Recorded on a visual analogue scale (VAS), scores ranged from 0-100, with higher scores indicating the worst pain. Both total and subcategory scores were calculated.

Result Analysis

Descriptive statistics:

All the categorical variables were presented in the form of frequency tables and graphs wherever necessary. The quantitative variables were summarized using Mean ± standard deviation with 95% confidence interval.

The data collected in the study were analyzed statistically and presented as follows: The categorical variable like age was presented in the form of frequency tables along with graphs.

Table 1: Age Distribution of the subjects

Age (years)	Frequency	Percent
11 - 15	78	78.0
16 - 20	22	22.0
Total	100	100.0

Table 1: The data presented showed out of 100 subjects studied 78% subjects were in 11-15 years old and 22% were in 16-20 years old.

Table 2: Distribution of BMI

	Mean	SD	Minimum	Maximum
BMI (Kg/m^2)	21.19	2.25	18	34

Table 2: the present study showed out of 100 subjects recruited BMI 21.9 mean and 2.25 SD.

Table 3: Duration of practice/week of the subjects

	Mean	SD	Minimum	Maximum
Duration of practice/ week	5.54	0.56	4	7

Table 3: the present study showed out of 100 subjects recruited duration of practice/ week. 5.54 mean and 0.56 SD.

Table 4: Distribution of foot posture index (right)

Posture Foot (Right)	Frequency	Percent
Normal	94	94.0
Pronated	2	2.0
Supinated	4	4.0
Total	100	100.0

Table 4: the present study showed out of 100 subjects recruited 94% normal, 2% pronated, 4% supinated right foot posture.

Table 5: Distribution of foot posture index (left)

Foot posture (Left)	Frequency	Percent
Normal	97	97.0
Supinated	3	3.0
Total	100	100.0

Table 5: The present data showed out of 100 subjects recruited 97% normal and 3% supinated left foot posture.

Table 6: Distribution of mean and standard deviation of both feet.

	Mean	Std. Deviation	Minimum	Maximum
Foot posture (Left) - total score	1.83	1.436	-1	7
Foot posture (Right) - total score	1.89	1.543	-1	7

Table 6: The present data showed out of 100 subjects studied mean and SD foot posture index (left) 1.83 and 1.43, mean and SD foot posture index (right) 1.89 and 1.54.

Table 7: Distribution of total pain score

	Mean	SD	Minimum	Maximum
Total pain score	5.48	5.94	0	25

Table 7: The data presented showed out of 100 subjects studied mean and SD 5.48 and 5.94 of total pain score.

Table 8: distribution of total difficulty score

	Mean	SD	Minimum	Maximum
Total difficulty score	3.96	4.87	0	23

Table 8: The data presented showed out of 100 subjects studied mean and SD 5.48 and 5.94 of total difficulty score.

Table 9: distribution of total disability score

	Mean	SD	Minimum	Maximum
Total disability score	0.32	1.03	0	5

Table 9: The data presented showed out of 100 subjects studied mean and SD 0.32 and 1.03 of total disability score.

Table 10: Distribution of total foot function index

	Mean	SD	Minimum	Maximum
Overall total	9.76	10.39	0	41

Table 10: The data presented showed out of 100 subjects studied mean and SD 9.76 and 10.39 of total foot functional index score.

Discussion

The present study was conducted to assess foot deviations and associated foot injuries and its effect on foot functional activity among amateur adolescent female kathak dancers. The age distribution of 78 subjects out of 100 was between 11-15 years and 22 was between 16-20 years. As per the inclusion and exclusion criteria subjects were recruited for study and assessed through foot posture index followed by foot function index.

As according to literature review a study conducted for adaption of kathak dancers reported that the dance form needs intense foot muscle work and coordination for the performance. A study conducted on common injuries in various dance forms stated that clinical investigation followed up appropriate diagnosis and treatment minimize the risk factor and injury.

A similar study conducted found that with time kathak dancers start developing certain postural deviations at foot which can lead to hyper pronation. These changes if not treated on time may lead to various degenerative changes, in the foot and ankle thus leading to instabilities and an also make them susceptible to foot and ankle injuries, shin pain, etc. thus, the study recommended that the dancers should be educated and trained about the foot problems associated with kathak dance form and their prevention.

The subjects recruited for the present study showed BMI mean and SD 21.19 and 2.25 respectively. The duration of practice/week mean, and SD was 5.54 and 0.56 respectively. The foot posture index mean and SD of the left feet for the subjects recruited in the present study was 1.83 and 1.43 and of the right feet was 1.89 and 1.54 respectively. The overall foot functional index score mean and SD for the subjects recruited in the present study was 9.76 and 10.39.

Conclusion

The present study concluded stating that foot posture index was normal and it didn't have restriction of foot usage while performing kathak dance form. Whereas with foot function index it was observed that the pain experienced by subjects was severe which restricted their activity pattern and hindered their dance performance.

Further Scope of the Study:

Recommendation on prescribing exercise to improve foot function and dance performance.

To prescribe appropriate rehabilitation measures with foot care for the subjects who are willing to return to perform kathak.

Limitations:

Sample size could have been more.

Male kathak dancers could also have been considered.

Study did not aim to prescribe exercises for subjects at risk of injury.

Conflict of Interest: There was no personal or institutional conflict of interest for this study.

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Effectiveness of Virtual Reality Training on Upper Limb Motor Function in Stroke Patient's: A Randomized Control Trial

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Abstract

Stroke survivor has a poor quality of life (QOL) and by and large dependent on their activities of daily living (ADL). Rehabilitation of motor function is a prerequisite for enhancing QOL in stroke patients. Hence, a more novel approach to the rehabilitation of stroke patients is the need of the hour. One such approach which is gaining attention in recent times is virtual reality (VR) training.

Aim of the study: To evaluate the effectiveness of virtual reality training on Fugl-Meyer assessment (FMA) upper Limb (UL) motor function in stroke patients.

Study design: Randomized control trial (RCT) - parallel group design, single-blind study.

Methods: Forty eligible stroke patients were selected and assigned randomly either into VR training (Group A) or motor relearning program without a VR system. The training was provided for six weeks, five sessions per week. FMA-UL motor function was evaluated at the beginning of the study before the commencement of the treatment and again after six weeks following the completion of the entire treatment sessions.

Results: There was a significantly higher improvement in the FMA-UL motor function in VR training; the mean difference in the improvement was 11.25 points compared to the motor relearning program performed without VR environment, the mean difference was 7.10 points.

Conclusion: It is concluded that VR training was effective in improving FMA-UL motor function in stroke patients.

Keywords: stroke; virtual reality training; motor relearning program; motor recovery; Fugl-Meyer Assessment.

Introduction

Stroke is a grave public health problem globally. According to a global burden of disease (GBD) study, it is the second leading cause of death worldwide.[1] In India due to a significant transition in the demographic, epidemiological, and economic background in the past two decades the life expectancy of stroke patients has increased.[2] It is identified that the majority of stroke survivors (55% to 75%) have motor deficits and poor quality of life (QOL).[3] Increased life expectancy combined with poor QOL is a predicament for stroke survivors. Stroke patients have difficulty in motor control, fine motor skills,

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and task coordination abilities ultimately resulting in poor independence and QOL.[3] The systemic review of stroke patients carried out by Saposnik G et al has inferred that conventional therapy approaches like Proprioceptive neuromuscular facilitation (PNF) and motor relearning programs have shown only modest improvement in stroke patients.[4] Therefore the novel approach to rehabilitation is the need of the hour in managing this condition. An approach gaining attention in recent times is virtual reality training (VRT). Virtual reality (VR) ambiance is created by the virtual reality system. It is a computer-based technology that aids the patients to interact with a multisensory stimulated environment and get real-time feedback on performance. The interactive games are designed in such a way as to provide the patient with real-life scenarios and activities relevant to daily living.[5] The software provide essential factors prerequisite for motor learning including frequency, intensity, repetition, and task-specific activities at the same time make the patient feel involved in the rehabilitation.[4] Motor recovery of stroke patients is physiologically based on neuroplasticity and central nervous system reorganization. These mechanisms are enhanced by relearning through physiotherapeutic training. It is demonstrated that both intact and injured brains have shown reorganization of the cerebral cortex following learned motor tasks.[6] This is enhanced by enriched environments and repetition of a task. Research has demonstrated that movement of the affected arm and leg has been found to cause greater recruitment of the ipsilateral (unaffected), contralateral (affected) cortex as well as cortical rim of the lesion. There is modest evidence suggesting the enhancement of neuroplasticity following virtual reality (VR) training. The interesting finding is VR specifically improves ipsilesional hemisphere representation. The advantage of VR is that therapists can manipulate the patient's virtual perceived environment by up scaling and down scaling or completely altering the movements seen in their virtual environment from the patient's performed movement. This discordant feedback is found to be an important factor in the greater activation of the motor cortex compared to non-discordant feedback.[5] Previous studies have shown that upper limb recovery is comparatively less than lower limb. As the research area is novice, more work is needed to analyze the motor recovery between VR training and conventional motor relearning programs in stroke patients, Therefore the present study aimed to evaluate the effectiveness of VR training on FMA upper limb (FMA-UL) motor function in stroke patients.

Methods

Participants:

Forty stroke patients were selected based on the study criteria and randomly divided into two groups viz. experimental (group A) and active control (group B). The experimental group was treated with virtual reality training whereas the active control was trained with a motor relearning program.

Study design

This randomized controlled trial carried out in the department of Bethany Navajeevan College of Physiotherapy, Thiruvananthapuram, Kerala from March 2019 to May 2020.

Ethical clearance:

The study was approved by the institutional human ethics committee of Bethany Navajeevan College of Physiotherapy.

Informed consent:

Written consent for participation was taken from each patient before the commencement of the study.

Group allocations and concealment:

The group allocation was done by the block randomization method. The block size was four and therefore by six sequences allocation was made.

Sample size estimation:

It was estimated by the sample size calculation software. The level of significance was fixed at 0.5% and statistical power was 80%. The dropout rate was fixed at 20%.

Selection criteria:

Inclusion criteria

- Post-stroke patients aged 25 to 60 years.
- Only unilateral stroke patients were selected.

- Stroke duration between 3 to 9 months.
- Patients with the first episode of stroke.
- Only middle and anterior cerebral artery involvement confirmed by computerized tomography (CT) was selected.
- Both ischemic and hemorrhagic strokes were confirmed by CT.
- Brunnstrom recovery stages of 3 & 4.
- Able to bring the affected hand to month (to ensure that participants can fit in to play the virtual game).
- No major cognitive or perceptual impairments that limit participation in therapy.
- Patients who could stand and walk independently enough to participate in the virtual reality program.

Exclusion criteria:

- Medically unstable patients.
- Associated orthopedic ailments that interfere with participation in the treatment.
- Patients have vertigo and difficulty in standing activities.
- Patients who had posterior cerebral artery involvement.
- Associated neurological conditions that affect the safety of study patients like central nervous system vasculitis, intracranial tumors, intracranial aneurysm, multiple sclerosis, or arteriovenous malformation.
- History of seizure disorder one month or longer after stroke.
- Associated cardiopulmonary or metabolic disorder.
- Patients with psychiatric illness and depression that interfered with treatment.
- Change in the oral spasticity medications two weeks before the onset of the study and getting botulinum toxin 'A' injection in the affected arm 3 months before the study.
- History of the spinal cord injury, traumatic brain injury, or spontaneous subdural or epidural hematoma.

Study procedure:

After randomization, the motor function of the upper extremity was evaluated by the Fugl-Meyer assessment (FMA). The upper extremity training was given for 6 weeks. Each week 5 sessions of treatment were given and each session lasted for 45 minutes. The experimental group was trained with VR whereas the control group was treated with a motor relearning program. Post-test FMA was carried out after the completion of the entire treatment sessions. The patients were not bewaring of the treatment groups. The evaluation was carried out by the third person, a physiotherapist who has more than 15 years of experience in the FMA evaluation and had no idea about the study procedure.

Fugl-Meyer assessment (FMA):[7,8]

The motor function of the upper limb was evaluated by movement, coordination, and reflex action of the shoulder, elbow, forearm, wrist, and hand. Items in the motor domain were obtained from Twitchell's 1951 based on the motor recovery of stroke patients and also integrate Brunnstroms stages of motor recovery. Scoring was based on direct observation of performance. Scores were based on the patient's ability to complete the item. It was a 3-point ordinal scale where '0' represents cannot perform '1' denoted partial performance and '2' represents full performance. The total possible score for upper extremity motor function was 66.

Interventions:

Motor relearning program:[9,10] It comprised various tasks involved in functional activities of the upper limb such as opening/ closing of bottle lids, drinking water in a glass, arrangement of puzzles, manipulation of glass water in various directions, picking up of small objects from one container to other, turning doors & hand grips as well as turning the pages of books and so on. It was planned according to the motor deficits of each individual. If patients were not able to complete the task, it was fragmented into smaller parts so that it was easy to perform. Each task was repeated 10 to 15 times on the affected side. The task gradually progressed to difficult and more complicated activities. For example, to enhance the grasping task, initially larger ball was used (tennis ball) whereas after improvement smaller ball was used to train the activity. The task was arranged in such a way that it utilizes wrist flexion/ extension,

supination and pronation, the opposition of the thumb, and bimanual exercises. Special emphasis was placed on reaching and manipulation activities with holding objects.

- Virtual reality training:

It was provided by Nintendo Wii (N-Wii) software video games.[11,12,13] Five games were selected from the Wii sports and Wii flit packages for upper limbs. It consisted of tennis and punches out for upper limb activities, light-rope tension, and tilt table, and heading for balance training; each game was trained for 3 sets with five minutes intervals between sets.

Tennis play involved hitting the ball with remote control of Wii by moving the body forward and backward while maintaining the supporting surface. In tilt table play, patients were told to hold the ball simultaneously shifting the weight forward and backward, to right and left. The tightrope tension game consisted of maintaining stability in the balance board by moving either right or left. In the punch-out game, the patients were instructed to kick the competitor either forward-backward or upward-downward using his/her upper extremity and Wii remote control and nun-chuck equipment. The Wii upper limb training involved the movements of shoulder flexion, extension, and rotation elbow flexion & extension wrist supination & pronation as well as different degrees of wrist flexion &extension combined with thumb flexion in most of the activities. Heading, tightrope tension, and tilt table used the weight transfer and shifting training. All five sports required full body motor and balance.

The therapist was standing near the affected side of the patient. Support was provided during times of difficulty that is when the patients pretended to fall. The session was terminated when the patient felt fatigued and had shoulder, arm, or hand pain. To minimize light sensitivity and seizure risk the training was administered in a dark light environment. Treatment video records were shown to the patient for motivation and to enhance performance.

Data Analysis & Results

The mean age of the group 'A' patients was 52.45±6.24 years and it was 53.65±5.87 years for group 'B'. There was no significant difference in age between groups. The majority of patients were male, in group 'A' 65%, and in group 'B', 85%. There was no significant difference in the gender distribution between groups. Right-side involvement was common, in group 'A' at 65% and in group 'B' at 75%. Both groups were homogeneous with respect to side involvement. The majority of the study patients had ischemic stroke group 'A'-80% and group 'B' 70%. The other basic details of the patients are shown in Table-1. There was a significant improvement in the FMA motor recovery in group 'A' from 24.90±3.84 to 36.15±3.15 following the completion of treatment. Likewise, there was a significant improvement in the FMA upper limb motor recovery from 25.60±3.93 to 32.70 ±3.97 following treatment in group 'B' patients as shown in Table 2. Between groups analysis showed (Table 3) that there was a significantly higher improvement in FMA- upper limb motor recovery in group 'A' patients compared to group 'B' patients. The mean difference in the improvement in group 'A' patients was 11.25 whereas it was 7.10 for group 'B' patients.

Table 1: Basic character of the study patients

	Group - A		Group – B		t/z/x^2	p
AGE (M S.D)	52.45	6.24	53.65	5.87	0.63	0.535
Gender (N, %)						
Male	13	65	14	70	0.33	0.739
Female	7	35	6	30		
SIDE (N, %)						
Right	13	65	15	75	0.68	0.496
Left	7	35	5	25		
Type of stroke (N, %)						

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Ischemic	16	80	14	70	0.72	0.471
Hemorrhagic	4	20	6	30		
Site of involvement (N, %)						
LACA	4	20	4	20	40.56	0.001*
LMCA	9	45	6	30		
RACA	6	30	8	40		
RMCA	1	5	2	10		
Duration (M,S.D)	5.75	2.24	6.10	2.22	0.52	0.601
Burnnstrom stage (N, %)						
3	8	40	10	50	0.62	0.530
4	12	60	10	50		

M-mean,SD- standard deviation, N-Number, LACA- Left anterior cerebral artery, LMCA-Left middle cerebral artery, RACA-Right anterior cerebral artery, RMCA- Right middle cerebral artery, t/z/x^2-test statistics, 'P' –probability ,* significant.

Table 2: FMA- upper limb motor recoveries- between group comparisons

	Group A				**Group B**			
	Shapiro-Wilk		**M**	**S.D**	**Shapiro - Wilk**		**M**	**S.D**
	Value	**P**			**Value**	**P**		
Pre	0.190	0.019	24.90	3.84	0.261	0.001*	25.60	3.93
Post	0.153	0.564	36.15	3.15	0.270	0.006*	32.70	3.97
t/z	3.94				3.97			
P	0.001*				0.001*			

M-mean, SD- standard deviation, t/z- test statistics, 'P' –probability,* significant.

Table 3: FMA- upper limb motor recovery- between group comparisons

Per post difference	**Shapiro-Wilk**		**M**	**S.D**	**Z**	**P**
	Value	**P**				
Group A	0.176	0.328	11.25	1.65	4.86	0.001*
Group B	0.299	0.001*	7.10	2.31		

M-mean, SD- standard deviation, z- test statistics, 'P' –probability * significant.

Discussion

The present finding shows that motor recovery of stroke patients measured by FMA-UL was significantly improved following treatment in both groups. But the magnitude of improvement was significantly higher in VR training compared to the motor relearning group. The mean difference in the improvement of FMA-UL in VR training was 11.25 points whereas it was 7.10 points in the motor relearning program. Therefore it is demonstrated that VR training was very much effective in improving upper limb motor functions in stroke patients. The present finding is correlated well with the study done by Schuster-Amft C et al, which demonstrated significantly higher improvement in upper limb function following VR training in comparison to conventional physiotherapy.[14] Page SJ et al have estimated that an improvement of 4.25 to 7.25 points in the FMA-UL score is minimal clinical improvement.[15] But Hiragami S et al have identified that the minimal clinically important difference for the FMA-UL score is 12.4 points.[16] Arya KN has found that a difference in FMA-UL score between 9 to 10 points is a clinically significant improvement.[17] In the present work, the

improvement achieved in the motor recovery of UL is not only statistically significant but also a clinically significant improvement. In the motor relearning group of the present study, training was performed without a VR system, the improvements achieved were statistically significant but it was not the clinically significant improvement. It is quite evident that VR training is superior to motor relearning programs without a VR platform. The greater improvement in upper limb motor control in VR training could have been due to an enriched environment for goal-oriented tasks. There is a possibility of discordant feedback in VR an additional merit of this type of training. Many studies have shown that VR enhances post-training ipsilesional representation in the cerebral hemisphere.[5,6] The additional advantage of a motor relearning program by VR is that the tasks are progressed to the next level by simple and easy manipulation. Visual feedback is a vital factor in motivating patients to carry out activities in a better way. In the present investigation, the effectiveness of VR training on the UL motor function was only attempted but in future works, its influence on the lower limb motor function, sensation, & balance can be studied. In the present work, immersing VR training was not done as it cannot be suitable for all patients. It is further recommended to study the influence of VR training on the organization of the nervous system by more sophisticated measures in future endeavors.

Conclusion

It is concluded that VR training was effective in improving FMA-UL motor scores in stroke patients. It is suggested to evaluate VR training on lower limb motor function, sensation, and balance in future studies. It is also recommended to investigate the influence of VR training on structural nervous system reorganization in future endeavors.

Conflict of Interest: Nil

Source of Funding: Self

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Original Research

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To Determine the Efficacy of Mulligan Mobilisation and Muscle Energy Technique in Sacroiliac Joint Dysfunction: A Single Blinded, Randomized Clinical Trial

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Abstract

The Sacroiliac Joint Dysfunction may lead to hypermobility or hypomobility at the joint, resulting in pain and irritation. Patient complains of dull aching pain on the affected side. The pain increases during the activities while turning, sitting, bending or acquired standing posture.

The pain gets referred to either groin, gluteal region or the posterior aspect of the thigh. With or without associated numbness, in groin region and pain on one side is more common than bilateral. This Sacroiliac joint dysfunction can be managed conservatively using physical agent modalities such as electrotherapy, laser therapy, ultrasound, longwave, rest, exercises, or using manual mobilisation.

Purpose Of the Study: To determine the effectiveness of Mulligan Mobilisation and Muscle Energy Technique in Sacroiliac Joint Dysfunction.

Material And Method Used: 700 subjects were screened to include 72 subjects with diagnosis of sacroiliac joint dysfunction and further were haphazardly divided into two groups viz. Muscle Energy Technique therapy group and Mobilisation group via block randomization, depending on severity of pain (mild, moderate, severe) using lottery method.

Results: The values of Visual Analogue Scale, Modified Oswestry Disability Questionnaire and Pain Pressure threshold within the group were analysed using Paired t-test and between the groups were analysed using Independent t-test.

Conclusion: MET and Mobilisation both techniques are operative in treatment of Sacroiliac Joint Dysfunction.

Keywords: MET (Muscle Energy Technique); VAS (Visual Analogue Scale); MODI (Modified Oswestry Disability Questionnaire); SIJD (Sacroiliac Joint Dysfunction).

Introduction

The sacroiliac joints are part synovial joint and part syndesmosis. The pelvic girdle provides support and protection to the abdominal organs and transmits force from the head, arms, and trunk to the lower extremities. Seven joints are formed by the pelvic bones: lumbosacral, sacroiliac, sacrococcygeal, symphysis pubis, and the hip. [29]

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The ability to have movement at these joints is very important. The sacrum is a complex bone formed by the parts of the sacral vertebrae: body, vertebral arches, and costal elements called ala. The sacrum has six articulating surfaces: superiorly with the body and the two articular processes of the fifth lumbar vertebra to form the lumbosacral junction, bilaterally with the two ilia at the sacroiliac joints, and inferiorly with the coccyx. The sacroiliac joints and symphysis pubis have no muscles that control their movements but the muscles do provide the pelvic stability. The symphysis pubis is a cartilaginous joint. The sacrococcygeal joint is a fused line united by a fibrocartilaginous disc. The most efficient manipulation technique, aimed at correcting the dysfunction results in joint improvement as well as periarticular muscle inhibition.[3] In SIJD, numbness, groin pain can occur. Pain on unilateral side is more common. [4] Sacroiliac joint pain is more common in pregnant women [4] SIJD is treated conservatively (electrotherapy, laser therapy, ultrasound, longwave, rest, exercises, and manual mobilisation) [6]

Material and Method

Research Design and Ethics: The research is single blinded, two group having parallel (non-crossover) design. A total of 72 suitable participants were haphazardly distributed among controlled group-the MET and conformist physiotherapy group (METCp group) and experimental group-Mobilisation and conformist physiotherapy group (MTCp group) via block randomization, dependent on pain severity i.e., mild, moderate and severe. Blocks had odd numbers with a 3 ×12 (72) grid, suggesting a total of three blocks with 12 rows each. Further subject's distribution into each block was done via computerized sequential randomization technique. Subsequently, subjects were allocated to controlled group (METCp) and experimental group (MTCp) using opaque sealed envelope.

Muscle energy technique application -The METCp group underwent the MET combined with conformist physiotherapy. MET was applied for anterior and posterior innominate rotation.

Mobilisation Application: The MTCp group received MT combined with conformist physiotherapy.

Objective

1. To determine the efficiency of mulligan mobilization in SIJD.
2. To determine the efficiency of muscle energy technique in SIJD.

Methodology

Sample size - 72 subjects having clinical diagnosis of SIJD were randomly allocated to two groups.

Study Design

Quasi experimental control design

Inclusion Criteria

- participants with medical diagnosis SIJD (posterior innominate and anterior innominate)
- pain and tenderness at PSIS, Sacral Sulcus, Ilia
- pain in the paraspinal muscles, gluteal or groin region, and radiating to either leg
- age between 30-50 years
- both male and female
- pain lasting for less than 1 year
- positive special test for SIJD
- those willing to participate in the study

Exclusion Criteria

- subjects with clinical disorder where therapeutic ultrasound is contraindicated
- subjects with clinical disorder where therapeutic longwave diathermy is contraindicated
- dermatitis
- neoplasm
- pregnancy
- acute tuberculosis
- patients having pre-existing medical conditions such as fractures, inflammatory diseases, pregnancy, inflammatory bowel disease and malignancy.

Outcome Measures

1. Visual analog scale
2. Modified Oswestry Disability Index
3. Calibrated pain pressure algometer

Statistical Analysis

Statistics was performed using the software IBM SPSS version 29.0.0.0(241)

Procedure

After completing all assessments and obtaining baseline measures, the intervention was conducted. Participants were randomly assigned to the METCp group and the MTCp group. Each participant went for three sessions per week that continued for 4 weeks. Demographic data (Name, weight, height, BMI) were taken. Tenderness and range of motion was checked. Schober's test was used to determine the lumbar range of motion. Muscle flexibility was checked and muscle strength was checked using manual muscle testing. Patients underwent seated flexion and standing flexion test and Gillet test and long sitting test to identify the SIJD. Pain intensity was measured using Visual analog scale and quality of life was measured using modified Oswestry Disability questionnaire. Pain intensity was measured using a calibrated digital pain pressure algometer (NK-500).

Result

The values of VAS, MODI and Pain Pressure threshold within the group were analysed using Paired t-test and between the groups were analysed using independent t-test.

The mean ± SD of Group A for VAS variable (baseline) is 5.6 ± 2.8 and post treatment is 3.4 ± 24. The mean ± SD of Group A for MODI variable (baseline) is 24.9 ± 11.2 and post treatment is 15.7 ± 8.1. The mean ± SD of Group A for Pain Pressure variable (baseline) is 24.1 ± 14.5 and post treatment is 32.1 ± 18.2. The mean ± SD of Group B for VAS variable (baseline) is 5.4 ± 25 and post treatment is 3.9 ± 2.8. The mean ± SD of Group B for MODI variable (baseline) is 25.6 ± 10.3 and post treatment is 20.3 ± 11.0. The mean ± SD of Group B for Pain Pressure variable (baseline) is 23.2 ± 10.9 and post treatment is 27.3 ± 13.0.

Table 1. Data analysis within the Group A

Within Group A

Variable	Baseline Mean±SD	4 Weeks Mean±SD	S.E. Mean	95% % CI of Difference	t	p Value
A	5.6 ± 2.8	3.4 ± 2.4	0.2	1.9 to 2.7	11.3	<.001
B	24.9 ± 11.2	15.7 ± 8.1	1.3	6.6 to 11.9	7.1	<.001
C	24.1 ± 14.5	32.1 ± 18.2	1.0	-10.1 to -6.1	-8.3	<.001

Table 2. Data analysis within the Group B

Within Group B

Variable	Baseline Mean±SD	4 Weeks Mean±SD	S.E. Mean	95% % CI of Difference	t	p Value
A	5.4 ± 2.5	3.9 ± 2.8	.2	1.2 to 1.8	9.7	<.001
B	25.6 ± 10.3	20.3 ± 11.0	.6	4.1 to 6.6	8.5	<.001
C	23.2 ± 10.9	27.3 ± 13.0	1.0	-6.1 to -2.1	-4.2	<.001

Table 3. Data analysis between the Group A and Group B

Between The Groups

Variable	Timeline	Group A Mean±SD	Group B Mean±SD	S.E. Mean	95% % CI of Difference	t	p Value
VAS	Baseline	5.6 ± 2.8	5.3 ± 2.4	0.6	-.9 to 1.400	0.4	0.691
VAS	4 weeks	3.3 ± 2.4	3.9 ± 2.8	0.6	-1.7 to 0.6	-0.9	0.374
MODI	Baseline	24.9 ± 11.2	25.6 ± 10.3	2.5	-5.7 to 4.4	-0.3	0.794
MODI	4 weeks	15.6 + 8.1	20.2 + 11	2.2	-9.1 to -0.004	-2.0	0.05
Pain pressure	Baseline	24 ± 14.5	23.1 ± 10.8	3	-5.1 to 6.8	0.3	0.777
Pain pressure	4 weeks	32.1 ± 18.1	27.3 ± 13	3.7	-2.5 to 12.2	1.3	0.199

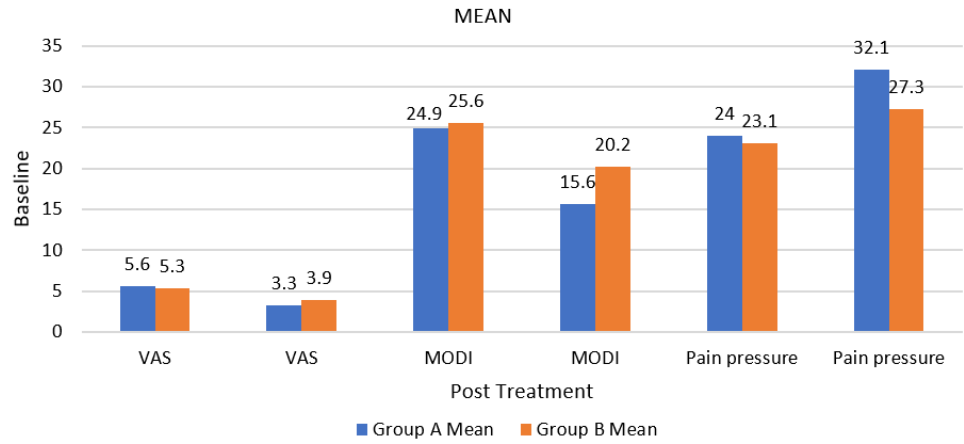

Fig 1. Comparison of Mean Baseline and post treatment between group A and group B.

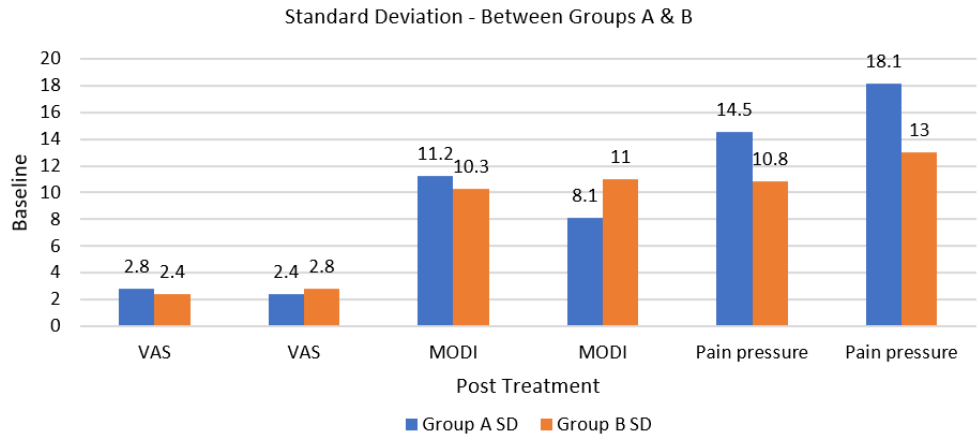

Fig 2. Comparison of Standard deviation Baseline and post treatment between group A and group B.

Discussion

In this study we examined the effect of MET and MT on pain and disability in subjects with SIJ dysfunction. The subjects were assessed twice, pre intervention and post intervention through VAS, MODI and Pain Pressure thresholds. The variations observed during the study are significant as within group evaluation revealed substantial improvement of pain and disability in Group A than Group B, whereas statistically no significant difference was showed when compared the readings between Group A and Group B from 0 day to 10th day of intervention.

Conclusion

MET and Mobilisation both techniques are effective in treatment of SIJD.

Conflict of Interest/ Source of Funding: Nil

Source of Funding: Self Funded

Ethical Clearance: We certify this research was in agreement with the principles stated by ethical committee of Singhania University.

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A Pilot Study "To Derive the Normal Values of Single Breath Count in Young Healthy Adults"

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Abstract

Introduction: Pulmonary function tests such as spirometer and peak expiratory flow rate are the standard measures to test lung volumes and capacities; but generally there is a lack of such equipment in emergency departments. Hence there is a need for an easier, quicker and convenient outcome measure in such set-ups. Single breath count (SBC) can be a simple assessment method in such clinical settings. However no studies for normal values of SBC in young Healthy adults were found during the search for literature.

Objective: The objective of this study was to estimate normal value of SBC in Healthy young adult population.

Results: 100 participants were enrolled from 18-24 years of age in the study. The mean SBC was 39(±7) and 41(±9) in females and males respectively. The SBC had a significant positive correlation with age at r=0.3, p value 0.0051 and height at r=0.28, p value 0.0038. The SBC had a non-significant negative correlation with BMI and weight.

Discussion: The results show that SBC was influenced significantly by gender (males>females), age and height of the individuals. However BMI and weight did not seem to influence the SBC.

Conclusion: SBC is a test which is easy to perform and appears to correlate well with standard measures of pulmonary functions. We estimated the normal values of SBC in young healthy adults which can be used in the clinical set up.

Key Words: Single Breath Count; Young adult; Gender; Height; Age

Introduction

Respiratory system is a biological system consisting of organs and structures used for respiration- exchange of gases through alveolar membrane in humans.[1] Pulmonary ventilation is the flow of air between the lung and theatmosphere.[1] Pulmonary ventilation is recorded by the movement of air in the lungs.[2] Apart from FEV & FVC, arterial blood gas analysis (ABG), slow vital capacity (SVC), Peak expiratory flow rate, Functional residual capacity, plethysmography and Single breath count can be used to assess lung function.[3] The technique Spirometry measures the rate of air flow and estimates lung volumes and capacities[2]. Pulmonary Function tests such as lung volumes are used for the screening and evaluating respiratory functions and its physiological parameters. Single breath count (SBC) test is defined as maximum numeral an individual can count in normal speaking voice after a maximal effort inhalation in cadence with a metronome set at 2 counts/ second. Single breath count test is a method by which

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lung volumes and capacities are measured. In this test the participants are advised to count numbers as far as they can in a normal speaking voice, after a maximal inspiration.[7] Previous studies have correlated PEFR and SBC in normal adults[6] and derivednormograms of SBC among healthy pediatric population[7] but no previous study has been done to assess normal values of SBC in young adults. This correlates well with the forced expiratory volume (FEV).[8]

The various factors influencing lung volumes and capacities are Gender, Body built, Posture, Occupation and Athletic participation.[1]

Lung volume tests are the most definite way to measure how much air the lungs can hold. The commonly used measures include forced expiratory volume in one second (FEV1), forced vital capacity (FVC) and the ratio of the two (FEV1/FVC).[1]

Previous studies have evaluated the validity of SBC as a measure of assessment in acute exacerbation of asthma[4] and its accuracy to determine low vital capacity.[5]

As phonation is directly related to respiratory system, SBC test can be used to evaluate pulmonary functions.[9]

SBCis an inexpensive method of assessment which requires a digital metronome. The digital metronome can be replaced with a metronome app or an analog watch. Considerable patient cooperation and the ability to count in English is required for the performance of SBC. However it is still easier to perform as it does not require any specific breathing technique like other PFT's. Studies have shown a good correlation between SBC and standard PFT.[7]A set of normal values needs to be established prior to using the SBC test in clinical set-ups. SBC is a quick tool for bedside assessment and can be easily communicated by providers. Thus, this study attempts to identify the normative values of SBC among normal healthy adults aged 18-24years.

Objective

The objective of this study was to establish normal value of Single Breath Count- a simple cost effective and quick assessment tool in Healthy young adult population.

Method

This is an observational study including healthy students of the Physiotherapy institute an academic health centre.

Inclusion criteria: study participants were healthy individuals from the age of 18 to 24 years who were able to understand the instruction and count numbers in English

Exclusion criteria: Participants were those who had a medical record or whose interview suggested any respiratory infection were excluded from the study. Participants who were not fluent in counting numbers in English or had any speech anomalies were also excluded from the study.

Methodology: demographic data like age, gender, height (centimeter) and weight (kilogram) were noted.

Materials: SBC was explained and measured by the examiner using a standard digital metronome.

Verbal informed consent was taken from all the participants. The procedure was explained and demonstrated by the researcher.

The participants were asked to take a deep breath and count as far as possible in their normal speaking voice in a single inspiration without taking another breath while exhaling. The pace was set with a digital metronome set at 2 beats per second. Both visual and auditory cues were provided[7]. The participant started counting from number 1 till the next inhalation. Three attempts were performed &recorded. The best performance was considered for final data analysis. One minute rest was provided between the consecutive performances.

Sample size: 238 students of the institute were identified as attending the college at the time of data collection. Hence using the formula for sample size calculation for finite population as above. The sample size was calculated to be 148 participants formula

$$\text{Sample size} = \frac{\frac{z^2 \times p\,(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p\,(1-p)}{e^2 N}\right)}$$

N = population size • e = Margin of error (percentage in decimal form) • z = z-score

p = Percentage of population/ population proportion

Thus the calculated sample size was 148 participants.

148 students were randomly selected from the 238 attending students to participate in the study. However, 13 students reported having upper respiratory tract infection at the time of data collection. Another 29 students didn't agree for participating in the study, 3 students were in the post covid phase and 3 students reported as being asthmatic. Thus the data collected from 100 participants were subjected to data analysis.

Results

The data was analyzed using SPSS and the descriptive analysis was done and presented as means, percentages and standard deviations.

The data was subjected to Kolmogorov-Smirnov test for normality. The resultshowed that the data was normally distributed with the value of the K-S test statistic (D) was 0.09661 and with p=0.2892. Therefore Parametric tests like student t test, Karl Pearson correlation were used for further data analysis.

The calculations were performed at 95% confidence interval with p<0.05 being considered statistically significant.

The participants included 78 girls and 22 boys with a mean age of 21 years respectively and mean SBC of 39(±7) & 41(±9) respectively. The z score for the population proportion for gender distribution was significant with z-value 7.9196 and p-value<.00001. The number of female participants was found to be significantly higher than males. The peak single breath count of male participants was significantly higher than the female participants at a p-value of 0.05

Table 1 shows the demographic data and the frequency distribution of the participants across the ages.

A weak positive correlation existed between peak SBC and age with an r=0.3. The correlation though technically weak was statistically significant for the sample with a p value 0.005.

A weak positive correlation existed between peak SBC and height with r=0.28. The correlation though technically weak was statistically significant for the sample with a p value 0.004. A weak negative correlation existed between SBC vs BMI with r= -0.0033, the correlation was technically weak and statistically insignificant for the sample with a p-value

0.976. A weak positive correlation existed between SBC vs weight with r=0.1 ; the correlation was technically weak and statistically insignificant for the sample with a p-value 0.171.

The mean of the three attempts of SBC were 35,37and 37 for attempt 1, attempt 2 and attempt 3 respectively. The mean SBCs were not significantly different from each other.3 participants had a history of smoking. Analysis to identify the effect of smoking on SBC was not undertaken as only 3 participants gave the history of cigarette smoking.

Table 1: Demographic data and Frequency Distribution of participants across the ages

Age	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**Total**
N (%)	11	12	15	14	16	16	16	100
Females	9	10	9	13	12	15	10	
N(%)	(82)	(83)	(60)	(93)	(75)	(94)	(62)	
Males	2	2	6	1	4	1	6	22
N%	(18)	(17)	(40)	(7)	(25)	(6)	(38)	
BMI	22	22	22	21	23	21	24	22
SD	(4)	(3)	(4)	(4)	(4)	(4)	(5)	(4)
PRavg	40	34	39	36	40	40	44	39
SD	(4)	(5)	(7)	(8)	(7)	(6)	(8)	(7)

Discussion

The purpose of this study was to identify the mean SBC among healthy adult individuals from18 to 24 years as no similar studies were found during the search for review of literature. Most of the studies have been on hospitalised patients. This study focuses in deriving the normal values and its correlation with physiological parameters like gender, age, height, weight and BMI. This is essential if SBC has to be used in clinical set up as a tool to screen individuals for any discrepancies in respiratory function among adults. Our study demonstrates the variation between the readings of SBC with respect to age, gender, height and weight. The number of females in this study was significantly higher than the males as the participants were all students pursuing Bachelors or Masters in Physiotherapy and this is a field which is dominated by females. The SBC was significantly higher among the males as compared to females. This result is supported by studies which suggest that men have higher lung volumes than women.

There was a positive correlation between the age, height and weight and SBC which states that as the age height and weight increases there was an increase in the SBC. SBC was directly proportional to age, height, weight and level of physical activity in the included age group. This result is concurrent with other studies which also report similarly. Literature and previous studies state that there is a positive correlation between the age height built and lung volumes.[1,7]. Various studies suggest that smoking would affect lung functions and decrease lung volumes.[10] However this analysis was not undertaken in our study as only 3 out of 100 participants gave history of smoking. Previous reviews suggest that smoking may influence the lung function which may influence the SBC.

Conclusions

SBC is an extremely simple test to perform which is also concurrent with various other lung function tests. The study intended to estimate the range of normal values for SBC among young healthy adults.

The small sample size however maybe a limitation of the study. The participants included in the study were from various states of the country such asKarnataka-47, Maharashtra-25, Goa-15, Tamil Nadu-2, Rajasthan-2 Andhra Pradesh-4 and Gujarat-1. Thus we would like to conclude that these results maybe generalized to these states of India. However the unequal distribution of participants across the states maybe a drawback as it was a single site study. However studies in future maybe undertaken using larger sample size and covering other parts of the country too.

Conflict of interest: The authors have no conflict of interest to declare.

Source of Funding: Self

Ethical Clearance: Has been undertaken by the Institutional Ethics Committee, SDM College of Medical Sciences and Hospital, Dharwad.

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Original Article

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Assessing the Fitness of Physiotherapy Postgraduate Students Coping with the Future Job Demand

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Abstract

Background & purpose: Physical fitness is a state of health and well-being and, more specifically, the ability to perform aspects of sports, occupations, and daily activities. Physical fitness is generally achieved through proper nutrition, moderate-vigorous physical exercise and sufficient rest. The study's objectives were to measure the upper limb and lower limb flexibility, strength of upper limb, lower limb and aerobic fitness of the Postgraduate students in Bengaluru using tests and to assess the coping of Postgraduate physiotherapy students towards the job demands, physical exercise and fitness.

Method: This study included subjects between the ages of 21 – 30 years of physiotherapy postgraduate students. Subjects were recruited based on inclusion and exclusion criteria. It was a descriptive cross-sectional study of 117 subjects. Demographic data were collected, Nordic musculoskeletal questionnaire, Physical Activity Readiness - questionnaire (PAR-Q) and Physiotherapy student occupational health and safety questionnaire was used, and BMI, skinfold, waist to hip ratio, shoulder flexibility test, sit and reach test, push-up test, single leg wall sit test and Harvard step test were used to find the level of physical fitness.

Results: Self-perceived fitness level among 117 subjects was 16.2% good, 68.4% moderate, and 15.4% poor. It was observed that the prevalence of neck trouble in the last 12 months was 50.42%, trouble during the last 7 days was 34.18 %, and ADL affected in the last 12 months was 13.67%.

Conclusion: The present study showed that self-perceived fitness was moderate level, and health-related fitness evaluation findings showed poor fitness among physiotherapy postgraduate students. There was the highest prevalence of musculoskeletal disorders at the neck. The musculoskeletal pain seen among postgraduate students may affect their task performance and hinder work efficiency.

Keywords: Physical Fitness, Physiotherapy Postgraduate Students, Skinfold, Sit And Reach Test, Push-Up Test.

Introduction

Physical fitness is a state of health and well-being and, more specifically, the ability to perform aspects of sports, occupations, and daily activities. Physical fitness is generally achieved through proper nutrition, moderate-vigorous physical exercise and sufficient rest.

Physical fitness is a set of health- or skill-related attributes. The degree to which people have these attributes can be measured with specific tests.[1]

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Physical fitness is one of the core preconditions of health. We cannot imagine a person being healthy without being physically fit. Physical fitness therefore has to be addressed.[2]

The rapid socioeconomic and demographic changes have led to a diversification of physical exercise/sport, with different objectives and research on various forms of satisfaction. Physical exercises are commonly defined as "fitness", "exercise", "conditioning", "resistance training", or better, "fitness training". A range of activities is conducted in fitness centres, such as Gym resistance training activities, Group fitness activities, and Functional fitness activities. In the last decade, the activities that undergo fitness have evolved.[3]

Physical therapists receive education in ergonomics but are at risk for musculoskeletal injuries associated with patient handling. A prospective cohort study found a 1-year incidence of 20.7% for WMSDs in any body region among 882 physical therapists. Therapists who transferred patients 6 to 10 times per day had odds of low back WMSDs that were 2.4 times higher than those who did not transfer patients.[4]

Physiotherapists are required to transfer patients from bed to mobilize for training functional activity, engage in activities disorders, and provide strength and flexibility training for restoration of ADL activity. They are also needed on the field for sports teams and athletes to train the individual to return for track events. However, in the curriculum and guidance on enhancing their physical fitness academic experience, no attention is given to physical activity to improve fitness through appropriate activities for physiotherapy students. As role models for practising Physiotherapy, it is essential that their healthy lifestyle will lead without any injuries while handling the patient population.

Therefore, physical therapists must have an optimal level of physical fitness to meet their future job demands in the health care delivery system. They also serve as role models for practising healthy lifestyle behaviours. It is essential to expose students to the profession's needs in their future employment settings.[6-8]

Physiotherapists provide rehabilitative care in various disabling conditions intending to restore, maintain and promote functions. Interventional skills involve a lot of "hands-on" techniques, repetitive movements, prolonged standing and challenging postures. Transferring and lifting patients are risk factors for low back pain.

Physical therapists are among health professionals who are more likely to experience postural disturbances due to their demands on the musculoskeletal system, such as maintaining static and dynamic postures for extended periods and movements that overload the spine. Exposure to these activities begins during undergraduate physiotherapy training. Other training-related activities, such as prolonged sitting during lectures or independent study, practical classes that involve practising diagnostic tests and therapeutic techniques and workplace ergonomics training, may also increase the risk of low back pain.[5]

Physical fitness is an essential part of human functionality related to health and well-being. In a typical definition of health-related physical fitness, many components are measured, such as cardio-respiratory endurance, muscle endurance and strength, flexibility and body composition.[9] Self-perception of one's physical fitness is a multi-dimensional phenomenon. The concept of self-perceived is usually divided into physical, emotional, cognitive and social areas. Previous research needed to be more conclusive on the association between self-perceived and measured physical fitness. Few studies report no association between self-perceived and measured physical fitness.[10]

Hence fitness plays a significant role in the life of physiotherapists. One should be fit so that one can treat the patient easily. The present study attempts to assess the perception of physiotherapy postgraduate students towards job demands, physical exercise and fitness. The study aims to determine the association between self-perceived and measured fitness among Postgraduate physiotherapy students in Bengaluru.

Objectives of the Study:

- To measure the upper limb and lower limb flexibility, strength of upper limb, lower limb, and aerobic fitness of the postgraduate students in Bengaluru.
- To assess the coping of physiotherapy Postgraduate students towards job demands, physical exercise and fitness.

- Finding the association between self-perceived and measured fitness among Postgraduate physiotherapy students in Bengaluru.

Methodology

a. Source of data:

Physiotherapy Postgraduate students in Bengaluru.

b. Definition of study subjects:

Physiotherapy Postgraduate students from 6 selected colleges in Bengaluru.

c. Inclusion Criteria:

- Age of the respondents >18 years.
- Physiotherapy Postgraduate students.
- Subjects who are willing to participate and ready to sign a consent form.

d. Exclusion Criteria:

- Subjects with neurological dysfunction, musculoskeletal dysfunction, Respiratory disorder psychiatric disorder.
- Subjects with gynaecological conditions.
- Subjects who had already participated in a similar kind of study.
- People with disabilities.
- Comorbid conditions.

e. Method of collection of data:

- Sampling method: done in 2 stages,

  1st stage: colleges were selected on a convenient basis.

  2nd stage: Students were selected using the purposive sampling technique based on inclusion and exclusion criteria.
- Sample size: subjects matching up inclusion and exclusion criteria from selected 6 colleges.

f. Material required:

- Consent form.
- creening form.
- Questionnaire forms.
- Stationaries.
- Skinfold caliper.
- Sit and reach box.
- Stopwatch.
- Step or platform 50.8 cm high.
- Metronome.

Duration of the Study: Data were collected over 3 months and 12 days (approx.).

Procedure:

A cross-sectional study was conducted after obtaining an ethical clearance from the college authorities using a previously validated standardized Nordic musculoskeletal questionnaire to assess the prevalence of the musculoskeletal disorder among Postgraduate physiotherapy students in Bengaluru. The physical activity data were collected using a structured questionnaire called Physical Activity Readiness (PAR-Q) and Physiotherapy student occupational health and safety questionnaire. It contained questions relating to general demographics such as age, sex, height, and weight. Physical fitness was measured using standard clinical tests such as body mass index, skinfold and hip waist circumference measurement. Flexibility was tested separately for the upper and lower limb using the shoulder flexibility test and sit and reach test. Push-up test and Single-Leg Wall Sit Test were used to measure the strength and the Harvard step test for aerobic fitness.

Detailed analysis of results.

The data collected for the study was entered in MS word and MS Excel 2013 and analyzed using R software version 4.1.0. The data collected for the study were analyzed statistically in the following two ways,

Descriptive statistics: All the categorical variables were presented as frequency tables and graphs wherever necessary. The quantitative variables have been summarized using mean ± standard deviation with a 95% confidence interval. In case data were not normally distributed, it was summarized using the median and interquartile range.

Inferential statistics:

- The Chi-Square test was used the result was considered statistically significant whenever $P \leq 0.05$.

Table 1: Distribution of Physical Activity Readiness - Questionnaire (PAR – Q).

	Percent	
	Yes	No
Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?	0.9	99.1
Do you feel pain in your chest when you do physical activity?	3.4	96.6
In the past month, have you had chest pain when you were not doing physical activity?	0.9	99.1
Do you lose your balance because of dizziness or do you ever lose consciousness?	7.7	92.3
Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?	12.8	87.2
Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?	1.7	98.3
Do you know of any other reason why you should not do physical activity?	1.7	98.3

Table 2: The Prevalence of Musculoskeletal Disorders in the Neck.

Pain and Disability	Nature of musculoskeletal disorder	Number (n=117)	Prevalence (%)
Trouble in last 12 months (such as ache, pain, discomfort, numbness)	Yes	59	50.42
Trouble during last 7 days	Yes	40	34.18
ADL affected in last 12 months. (e.g., job, housework, hobbies) because of this trouble	Yes	16	13.67

Table 3: Distribution of the Number of years and hours per week of work exposure.

	No. of years	Hours per week
Mean	4.7326	20.14
Std. Deviation	1.74803	10.520
Minimum	0.25	2
Maximum	9.00	48

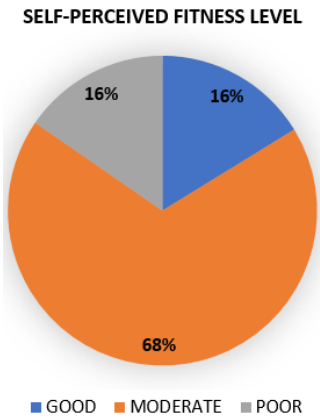
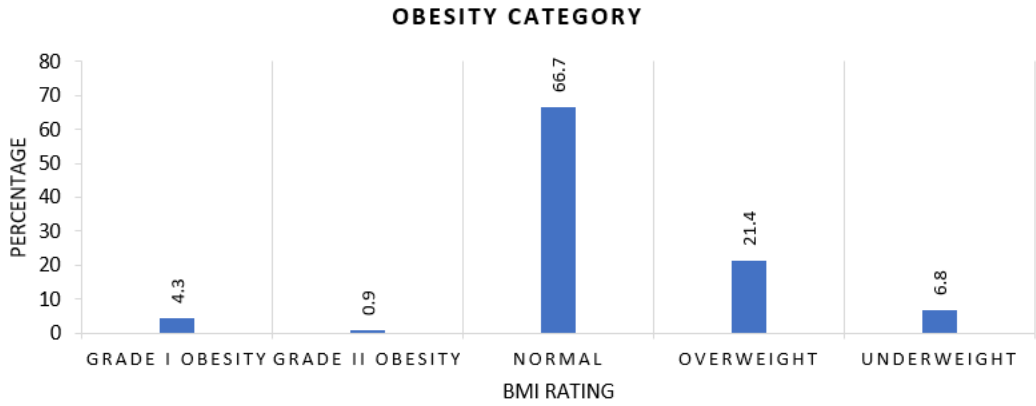


Figure 1: Graphical representation of distribution of self-perceived fitness level.



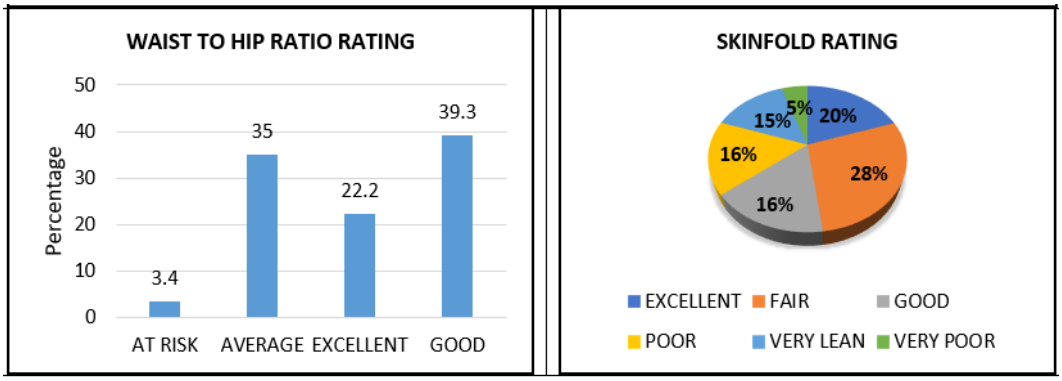
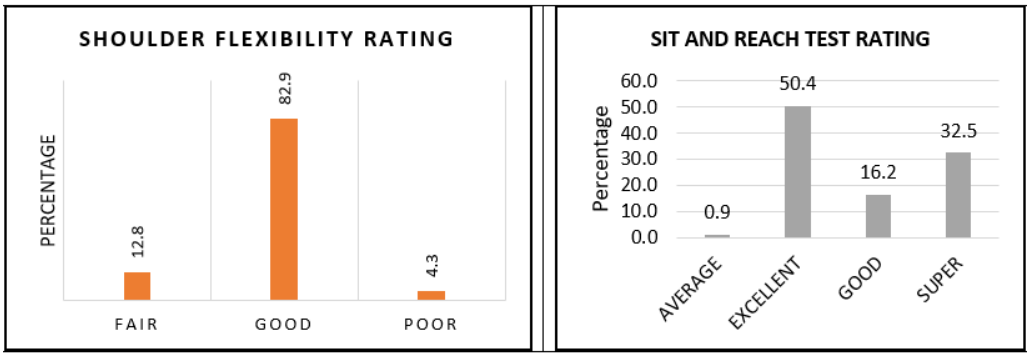


Figure 2: Graphical representation of: (a) obesity category, (b) distribution of Waist to Hip ratio, (c) distribution of skinfold measurement.



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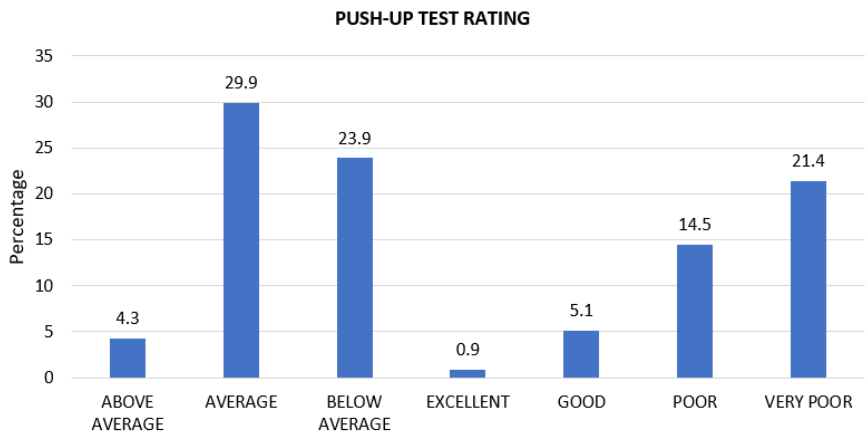

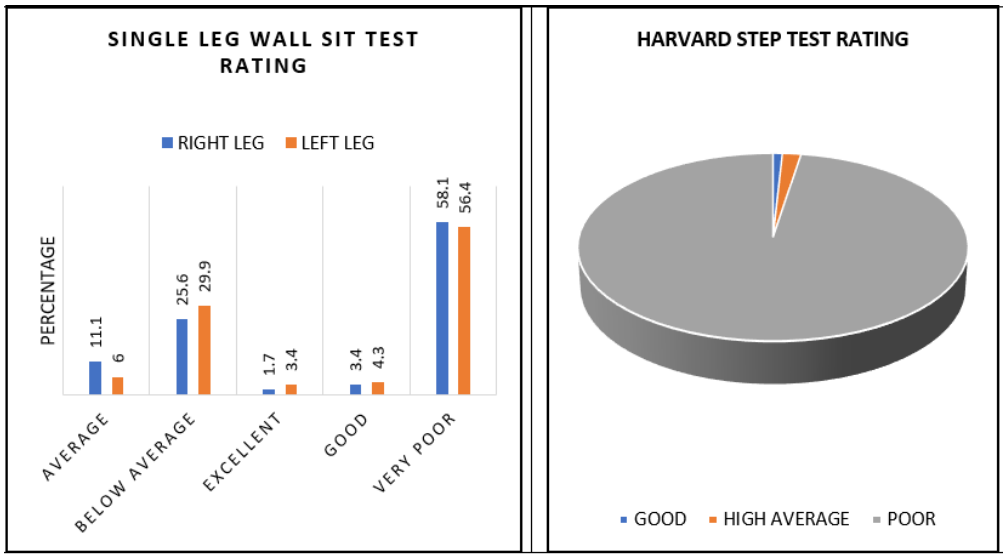

Figure 4: Graphical representation of distribution of: (a) push up test rating, (b) single leg wall sit test rating, (c) Harvard step test rating.

Table 4: Distribution of mean, standard deviation, median of push up test, single leg wall sit test (right leg) and Single leg wall sit test (left leg).

	Mean	SD	Median	Q1	Q3	IQR
Pushup test	11.97	10.48	10	4	20	16
Single wall sit test (Rt. Leg)	21.86	15.90	16.87	11.1	31.32	20.22
Single wall sit test (Lt. Leg)	22.38	17.10	17.48	10.4	29.73	19.33

Discussion

A cross-sectional study was conducted to measure physical fitness among physiotherapy postgraduate students from selected colleges on a convenient basis. 117 subjects were recruited for the study per the inclusion and exclusion criteria. The study included subjects between the ages of 21-25 years were 86 subjects and 26-30 years were 31 subjects. The gender distribution of the present study was male respondents 29 and female respondents 88. Subjects recruited for the study were 37 from 1st year MPT and 80 from 2nd year MPT. Demographic data of subjects were recorded, a screening tool -Nordic musculoskeletal questionnaire was used to record the musculoskeletal discomforts of the subjects, occupational health and safety questionnaire was used for information on occupational health. Physical fitness evaluation conducted. The variables used were BMI, skinfold, waist-to-hip ratio, shoulder flexibility test, sit and reach test, push-up test, single leg wall sit test and Harvard step test. Physical activity was recorded using the physical activity readiness questionnaire (PAR – Q). Findings of variables, along with demographic data recorded and analyzed.

In a research, the features of self-reported occupational injuries and musculoskeletal problems were compared with age. The study result suggested that younger subjects were at higher risk of developing WRMDs. In contrast, older subjects were prone to develop WRMDs and a risk factor for injury.

A study conducted among postgraduate students to estimate the prevalence of low back pain concluded with a significant prevalence of LBP among physiotherapy interns and postgraduates.

Earlier studies suggested that the study population rated their fitness substantially higher than that estimated by treadmill performance. Self-reported fitness was found to be poorly correlated with physiologic fitness.

The present study observed that out of 117 subjects studied, 73.5% were 21 - 25 years, and 26.5% were 26 – 30 years. The gender distribution of subjects recruited for the study was 24.8% male and 75.2% female. Self-perceived fitness level among 117 subjects

was 16.2% good, 68.4% moderate, and 15.4% poor. It was observed that the prevalence of neck trouble in the last 12 months was 50.42%, trouble during the last 7 days was 34.18 %, and ADL affected in the last 12 months was 13.67%. The number of years of work was 4.73 & 1.74, and hours per week were 20.14 & 10.52 mean and standard deviation. The BMI category of the subjects was 4.3% Grade I obesity, 0.9% Grade II obesity, 66.7% normal, 21.4% overweight, and 6.8% were of underweight. Skinfold measurement rating of the subjects was 19.7% excellent, 28.2% fair, 16.2% good, 16.2% poor, 14.5% very lean and 5.1% very poor. Waist to hip ratio distribution of the respondents was 3.4% at risk, 35% average, 22.2% excellent and 39.3% good. The shoulder flexibility of the subjects was 12.8% fair, 82.9% good, and 4.3% poor. Sit and reach test showed 0.9% average, 50.4% excellent, 16.2% good and 32.5% super. Push up test was 4.3% above average, 29.9% average, 23.9% below average, 0.9% excellent, 5.1% good, 14.5% poor and 21.4% very poor. Single leg wall sit test (right leg) was 11.1% average, 25.6% below average, 1.7% excellent, 3.4% good, and 58.1% very poor. Single leg wall sit test (left leg) was 6% average, 29.9% below average, 3.4% excellent, 4.3% good and 56.4% very poor. Harvard step test to evaluate aerobic endurance was 0.9% good, 1.7% high average and 97.4% poor.

Conclusion

The present study showed moderate self-perceived fitness and health-related fitness evaluation findings showed poor fitness among physiotherapy postgraduate students. There was the highest prevalence of musculoskeletal disorders at the neck.

The musculoskeletal pain seen among postgraduate students may affect their task performance and hinder work efficiency.

Further Scope Of The Study:

The present study was focused to,

- Evaluate self-perceived and health-related fitness.
- The study lacked intervention to improve fitness and quality of life among physiotherapy postgraduate students.
- Further designing of fitness modules to enhance physical fitness and minimize the risk of work-related musculoskeletal disorders.

The present study had been found that there should be a need to add fitness regime in curriculum to improve physical fitness.

Limitation:

- The sample size could have been of a larger population.
- The study can be of a cross-sectional study to cover all the colleges offering the postgraduate program, whereas the present study recruited 6 colleges conveniently.

Conflict Of Interest: There was no personal or institutional conflict of interest in this study

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Ethical Clearance: Ethical clearance was taken from R.V. COLLEGE OF PHYSIOTHERAPY, Bengaluru.

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Original Study

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Assessment of Depression, Anxiety and Stress among the Undergraduate Physiotherapy Students

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Abstract

Background: Today, psychological morbidities such as depression, anxiety and stress are most common psychiatric health issues worldwide. Stress in medical education especially among the undergraduate students has become a global phenomenon nowadays. According to WHO, depression is the most common mental disorder, characterised by sadness, loss of interest or pleasure, feelings of guilt or low self-worth, low energy and poor concentration and disturbance in sleep or appetite, Anxiety disorders are characterised by excessive fear and worry and related behavioural disturbances and stress is defined as a state of worry or mental tension caused by a difficult situation. This study is important to identify the risk factors of depression, anxiety and stress among the undergraduate physiotherapy students, as it affects their health as well as their academic achievements. The aim and objective of this study is to assess depression, anxiety and stress among the undergraduate physiotherapy students by using DASS-21 scale.

Methods: This is an observational study was conducted in a Physiotherapy College in Maharashtra. The total duration of this study was 6 months from October 2022 to March 2023. Data was collected from 43 undergraduate physiotherapy students from first year to fourth year by using a DASS-21 questionnaire.

Conclusion: Psychological illness in the form of depression, anxiety and stress have been reported in substantial proportion of undergraduate. Depression has been reported in 76.74% of students, while anxiety and stress were found in 86.05% and 83.72% respectively. Organized interventions should be initiated to prevent excessive psychological illness among undergraduate physiotherapy students.

Key Words: Depression, Anxiety, Stress, DASS-21, Undergraduate Physiotherapy students.

Introduction

Today, psychological morbidities such as depression, anxiety and stress are most common psychiatric health issues worldwide. Stress in medical education especially among the undergraduate students has become a global phenomenon nowadays. During the first year, due to academic and emotional factors while in subsequent years, patient care and physical factors are more remarkable.[1]

Generally, the competitive academic environment, excessive working hours, lack of recreational activities, lack of peer support, staying away from home and financial problems are the common reasons of depression, anxiety and stress.[2]

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Depression is extremely dominant and widespread problem across the nation. According to WHO, depression is the most common mental disorder, characterised by sadness, loss of interest or pleasure, feelings of guilt or low self-worth, low energy and poor concentration and disturbance in sleep or appetite.[1]

According to WHO, Anxiety disorders are characterised by excessive fear and worry and related behavioural disturbances. Symptoms are severe enough to result in significant distress or significant impairment in functioning[4]. It is considered as a state of uneasiness, feeling of fear and dread; feel restless and tense and have a rapid heartbeat. It is a bodily response to a perceived danger that could be real or imaginary and triggered by an individual's thoughts, beliefs and feelings.[1]

Generally, according to WHO stress is defined as a state of worry or mental tension caused by a difficult situation. Stress is a natural human response that prompts us to address challenges and threats in our lives[4]. Academic stresses develop the sense of competition and motivation among students and encourage learning. However, sometimes this stress produces anxiety and feelings of helplessness, leading to the stress related disorders and adversely affecting academic and non-academic performance.[1]

Failure to detect the psychological disorders may lead to increased mental illness, morbidity with undesired effects throughout their career and lives. Early detection of such problems shortens the duration of the episode and lessens the social impairment in long term.[2]

Material and Methods

1. This study is an observational study was conducted among the undergraduate physiotherapy students at College of Physiotherapy in Maharashtra. The sample size estimated for this study is 43. The duration of the study was 6 months from October 2022 to March 2023. The sample technique used in this study was convenient sampling technique. The sample was calculated by utilizing the standard formula:

$$n = \frac{Z^2 1-\alpha/2 \times p \times (1-p)}{d^2}$$

where, p= proportion, d= absolute precision and Z1-α/2= 1.96 for 95%.

The Inclusion criteria for this study was undergraduate physiotherapy students from first year to fourth year and the students who gave the consent. Those students who do not gave consent was excluded from this study. This study was carried out by using the Depression Anxiety Stress Scale (DASS-21) which is a 21 item questionnaire, this is a self-reported scale having a set of all these three states depression, anxiety and stress.

Result and Discussion

The study which was undertaken for the assessment of Depression, Anxiety and Stress among the undergraduate physiotherapy students has yielded the following results.

A total number of 43 undergraduate physiotherapy students participated in the study. The survey response rate was 100%. Mean age of participants was 20.27 ± 1.57 (18 – 24) years. Around 35 (81.40%) students were female and 8 (18.60%) were male (Table no. 1). DASS-21 questionnaire was used to collect the frequency of depression, anxiety and stress.

Data were interpreted as Depression was present in 20 (46.52%) undergraduate physiotherapy students were as 10 (23.26%) involved mildly, 10 (23.26%) moderately and absent in 23 (53.49%) (Table no. 3).

Anxiety was present in 25 undergraduate physiotherapy students. Those who had anxiety been categories as, students with mild anxiety were 6 (13.95%), moderate 17 (39.53%) and severe 2 (4.65%) and was absent in around 18 (41.86%) undergraduate physiotherapy students out of 43 (Table no.4).

Similarly, Stress was present in 8 (18.61%), involved students categories according to DASS ranking criteria, those students who mildly involved in stress are 7 (16.28%), 1 (2.33%) involved moderately and was absent in 35 (81.40%) undergraduate physiotherapy students as shown in the (Table no. 5).

It is observed that Depression, Anxiety and Stress among undergraduate physiotherapy students was 76.74%, 86.05% and 83.72% respectively. They were calculated through adding all the categories like mild, moderate, severe of each of the variable (i.e. DASS).

In the present study, 43 subjects were taken in which 8 are males and 35 are females. The age of subjects varies from 18 to 24. The subjects from first year to fourth year of undergraduate physiotherapy students were taken. DASS-21 questionnaire was given to the students to assess the depression, anxiety and stress among the undergraduate physiotherapy students.

Depression is extremely dominant and widespread problem across the nation. According to WHO, depression is the most common mental disorder. Anxiety is a bodily response to a perceived danger that could be real or imaginary and triggered by an individual's thoughts, beliefs and feelings.[1] Stress produces anxiety and feelings of helplessness, leading to the stress related disorders and adversely affecting academic and non-academic performance.[1] Early detection of such problems shortens the duration of the episode and lessens the social impairment in long term.[2]

The study on "ASSESSMENT OF DEPRESSION, ANXIETY AND STRESS AMONG THE UNDERGRADUATE PHYSIOTHERAPY STUDENTS". The result showed that it was supporting the aim which was "The assessment of the depression, anxiety and stress among the undergraduate physiotherapy students by using DASS-21 scale."

Conclusion

Psychological illnesses in the form of depression, anxiety and stress have been reported in substantial proportion of undergraduate. Depression has been reported in 76.74% of students, while anxiety and stress were found in 86.05% and 83.72% respectively. Organized interventions should be initiated to prevent excessive psychological illness among undergraduate physiotherapy students. There is a need to establish prevention programs and to bring out evidence based psychological health promotion by organizing psychological sessions for undergraduate physiotherapy students.

Table 1: Gender wise distribution of study population.

Gender	No. of subjects	Percentage
Male	8	18.60
Female	35	81.40

Table 2: Distribution of study population according to Year of studying.

Year	No. of subjects	Percentage
First	20	46.51
Second	7	16.28
Third	11	25.58
Fourth	5	11.63

Table 3: Distribution of study population according to Severity of depression.

Severity of depression	No. of subjects	Percentage
Normal	23	53.49
Mild	10	23.26
Moderate	10	23.26

Table 4: Distribution of study population according to Severity of Anxiety.

Severity of Anxiety	No. of subjects	Percentage
Normal	18	41.86
Mild	6	13.95
Moderate	17	39.53
Severe	2	4.65

Table 5: Distribution of study population according to Severity of Stress.

Severity of Stress	No. of subjects	Percentage
Normal	35	81.40
Mild	7	16.28
Moderate	1	2.33

Table 6: Gender wise Prevalence of Depression, Anxiety and Stress.

	Prevalence		
Gender	**Depression**	**Anxiety**	**Stress**
Male	7(87.5)	6(75)	7(87.7)
Female	26(74.29)	29(88.57)	29(82.86)
Overall	33(76.74)	35(86.05)	36(83.72)

Ethical Clearance: Obtained from the ethical committee of College of Physiotherapy.

Source Of Funding: Self.

Conflict Of Intrest: Nil.

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Study of Knowledge and Attitudes towards Respiratory Hygiene and Respiratory Exercise in School-Aged Children, According to Gender: A Cross-Sectional Survey Study

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Abstract

Background: As the COVID-19 epidemic began in 2019 in Wuhan, China, and spread quickly to numerous nations. Therefore, in order to curb the spread of this disease, the government has implemented various preventative measures, such as social distance, using napkins when sneezing or coughing, avoid hand contact with those who are ill, etc. Children attending large gatherings since schools have resumed operations as per government directives, making them susceptible to the transmission of Covid-19. In order to stop the spread of the pandemic among children, it is important to evaluate how school-aged children understand the respiratory exercises and preventative measures recommended by the Government of India.

Methodology: The knowledge and attitudes of school-going youngsters were evaluated using a cross-sectional survey research. A thorough assessment of the literature led to the formulation of the survey's google form questionnaire, which included 17 questions in the knowledge and attitude domains. Snowball sampling was used to distribute the survey questionnaire to 800 students in North Indian schools. Only 673 students were included in the survey due to the inclusion and exclusion criteria.

Results: Among 673 students, 404 students were females (22.965±2.899) and rest were males (22.186±3.772). Our study shows that both the domains' knowledge (t-stat 3.024) and attitude (t-stat 3.420) are highly significant as the p-value is <0.001. The correlation between both domains shows that both domains are positively and highly significantly correlated as the r-value is 0.44.

Conclusion: The precautionary steps that the Indian government implemented have had a positive influence on students' lives and knowledge, and they are taking excellent care of themselves.

Keywords: Knowledge, Attitude, Respiratory Exercises, Respiratory Hygiene.

Introduction

Beginning in Wuhan, China, late in December 2019, COVID-19 pandemic swiftly spread to more than 200 countries globally[(1)]. By September 26, 2022, there were 44,583,360 confirmed cases of COVID-19 in India, along with 528,611 fatalities. As of September 2022, 2,179,427,825 doses of the vaccine had been administered in India[(2)].

Studies suggests that SARS-CoV2 is an airborne disease spread through respiratory droplets, fecal-

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oral, bloodborne, mother-to-child, and animal-to-human transmission. And Common symptoms include influenza-like fever, runny nose, cough, sore throat, malaise, and neurological manifestations [1,3,5].

Conversely, Children may remain asymptomatic, with most symptoms detected through laboratory testing. COVID-19 primarily affects the lung and respiratory system, causing dyspnea low blood oxygen saturation, and respiratory failure, necessitating mechanical ventilation [1, 3, 4].

Antiviral medications, psychotherapy, supportive care, oxygen support, and mechanical ventilator use may be suggested as part of the medical treatment [6-9].

Studies have also shown that People of all ages experience reduced physical activity due to sedentary lifestyles and lack of awareness [11]. According to studies, Respiratory rehabilitation improves respiratory status by reducing oxygen demand, increasing consciousness, and reducing complications and hospital stay duration [10].

In their strategy to stop the spread of Covid-19, WHO and The Centers for Disease Control and Prevention (CDC) have incorporated a few preventative measures, such as vaccination drives, home quarantine or isolation, and social seclusion from others.

Proper face masks, face shields, and hygiene measures are crucial for preventing community spread and reducing healthcare burden. Cover mouth and nose with tissues, discard used tissues, and wash hands periodically with soap and water [12].

This is especially for minor populations and people with comorbidities like DM, obesity, IHD, cancer, post-surgery, and COPD[3]. According to government guidelines, Schools resume after long break, requiring checks on minor populations' knowledge of respiratory hygiene, exercises, and protective barriers like handwashing and face masks.

Several studies conducted to check the knowledge, attitude of respiratory hygiene among school going students. A study conducted by *Monica Lazarus et al.* (Journal of Advanced Medical and Dental Sciences Research, 2021) on school going children of Jabalpur concluded that Campaigns for health education and public awareness that are aimed at the general public can improve children's attitude about epidemic and encourage better crisis management techniques[13].

Methodology

A cross-sectional survey was done to assess the knowledge and attitude of school-going children regarding respiratory hygiene and respiratory exercises on the basis of Gender.

A survey questionnaire was formulated after a detailed review of the literature. There were 17 Questions in 2 domains: Knowledge, Attitude domain. Each participant's response was assigned a score: a Maximum point was assigned to the most appropriate response, while zero points were assigned to the least appropriate or don't know type of response.

1st domain consists of 7 multiple choice questions used to check the knowledge of children regarding face mask, respiratory exercises, and hand hygiene. In this section, 3 questions were on respiratory exercises, 3 on respiratory hygiene and 1on hand hygiene. The total scoring for this section is 0 - 28 and each question have a scoring of 0 – 4.

The 2nd domain consisted of 10 multiple choice questions to assess the behavior of children about use of face masks, hand hygiene, vaccinations, and why respiratory exercises are useful in COVID-19. In this domain, 2 questions were on respiratory exercises; 2 on respiratory hygiene; 2 on vaccination and 4 on hand hygiene. The total scoring for this section is 10-50, and each question with scoring of 1 to 5.

Each domain is divided into 3 categories: poor, average, and good based on scores obtained by the students. The score card is:

Knowledge	**Attitude**
Poor: 0 – 9	Poor: 0 – 17
Average: 10 – 18	Average: 18 – 35
Good: 19 – 28	Good: 36 – 50

Snowballing sampling design was used to circulate the questionnaire and was circulated via google form. After approval from IEC, we approached schools from 4 states and 2 union territories of North

India via email, and consent was obtained from parents via a google form link, followed by the administration of a questionnaire by participants.

The study was conducted between January-March 2022 which includes voluntary participation of school-going children who registered at secondary schools, can comprehend English, and are equipped to enter details on a google form eligible for the study. Specially-abled students or those with reading and comprehension issues, who did not have access to Google Forms were excluded from this study. Only those participants who accomplished the inclusion criteria and gave their consent were included in this study.

The calculated sample size was 650, determined by using a margin of error of 5% and a Confidence interval (CI) of 95%. To account for errors and non-respondents, we enrolled a larger sample size of 800 students.

Data Collection:

We distributed this questionnaire to about 800 students, and 60 of them didn't respond. There were 740 responses in total, of which 67 participants dropped out from the study. Therefore, only 673 students out of 740 were taken into account for further analysis using JASP.

Results

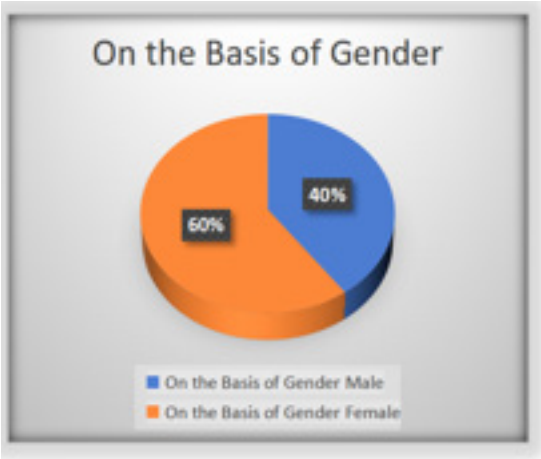


Figure 1: Showing the demographic details of participants shows that 40% of students were male while 60% were female.

Table 1: Shows the Descriptive Analysis of Knowledge, Attitude based on the Gender of the participants

	Knowledge		Attitude	
	Female	**Male**	**Female**	**Male**
Valid	404	269	404	269
Mean	22.965	22.186	42.733	41.424
Std. Error of Mean	0.144	0.230	0.214	0.341
Std. Deviation	2.899	3.772	4.305	5.600
Skewness	-0.834	-1.475	-0.687	-1.370
Std. Error of Skewness	0.121	0.149	0.121	0.149
Kurtosis	0.777	3.266	0.732	2.552
Std. Error of Kurtosis	0.242	0.296	0.242	0.296

According to the table no. 1:

- Females with n=404 with mean value of Knowledge is 22.965±2.899 and that of Attitude is 42.733±4.305 while males with n=269 with mean value of knowledge is 22.186 ± 3.772 and Attitude is 41.424±5.6.
- Males (Kurtosis= 3.266) have good knowledge than females (Kurtosis = 0.777).
- Males (Kurtosis= 2.552) have good attitude towards respiratory hygiene and respiratory exercises than females (Kurtosis= 0.732).

Table 2: Shows the Independent t-test and p-values of Knowledge and Attitude Domain.

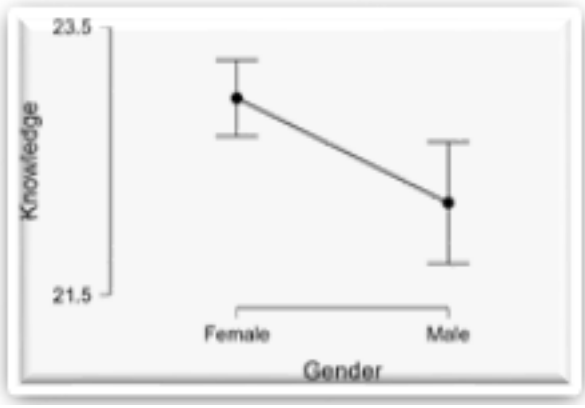
Independent Samples T-Test			
	t	**df**	**p**
Knowledge	3.024	671	0.003
Attitude	3.420	671	< .001

According to table no. 2:

- Knowledge domain is significant (p-value=0.003) between males and females.
- Attitude domain is highly significant (p-value=0.001) between males and females.

Figure 2: Showing the graphical representation of Knowledge, Attitude based on the Gender of the participants

Knowledge



Attitude

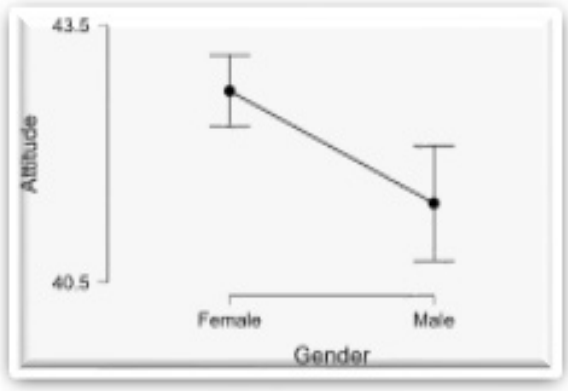


Table 3: shows the Correlational Study between Knowledge and Attitude

Knowledge-Attitude		
Pearson	r	0.441
	p	<.001
Spearman	rho	0.325
	p	<0.001
Kendall	tau B	0.243
	p	<0.001

According to table no. 3:

- Knowledge and Attitude both are positively related to each other as the r value is 0.441.

Discussion

The novel coronavirus epidemic 2019 was first identified in China in December 2019, and it has since rapidly spread throughout the world [13]. Studies suggested that school-going children, older adults, and people with comorbidities are at high risk of Covid-19 spread. As the disease is spread through respiratory droplets so the government has implicated few protective measures to control the spread of the disease. And these are as follows: Maintain social distancing, wear a face mask, make use of hand sanitization, etc.

So, in the current study, we check the knowledge and attitude of school-going children towards respiratory hygiene or towards the preventive measures that are implicated by the government of India and respiratory exercises.

As per the Education Ministry of Education reported guidelines Schools should concentrate on the most vulnerable children, such as those with special needs and those whose families have been directly touched by COVID-19-related mortality or illness. Directives have been issued to ensure that the children's dietary needs are met [14].

In this study, we circulated a questionnaire that was composed of 2 domains having 17 questions in total and circulated it among students.

For the knowledge section:

The Knowledge section consisted of 7 questions among them 3 questions were on respiratory exercises, 3 questions were on respiratory hygiene and 1 question was on hand hygiene.

According to our study, in total, about 88.7% of students have good knowledge while only 10.698% of students have average knowledge and approximately 0.59% of students have poor knowledge about the use of respiratory exercise; the importance of using a face mask, and hand hygiene technique.

Our study shows that, out of these 673 students, approximately 60.03% (n=404) of students were females with a mean value of 22.965±2.899 and 39.97% (n=269) students were males with a mean value of 22.186 ± 3.772.

Study shows that there is highly significant difference between the knowledge of male and female of safety measures (precautionary measures) as the t-stat value is 3.024 and the p-value is 0.003.

According to the current census, out of 404 female students, 91.58% of students have good knowledge about precautionary measures for Covid-19 and respiratory exercises as they scored between the range of 19-28. And 8.416% of females have average knowledge about the use of face masks and respiratory exercises.

Out of 269 male students, 84.38% of students have good knowledge; 14.13% of students have average knowledge; while 0.59% of students have poor knowledge about the preventive measures that were implicated by the Government of India and respiratory exercises.

According to our study, Males have good knowledge than females as the male students have a Kurtosis value of 3.266 while females have 0.777. This can be due to the reason that males always have an interest in exploring more about something new while females always indulge in other activities and they don't much bother about what is going on in the environment and how it is spreading.

For the Attitude Section:

This section consisted of 10 multiple-choice questions to check the behavior of students regarding the preventive measures implemented by the Government of India to control the spread of this pandemic.

According to our census, 91.38% of students have good attitude while 8.469% students have average attitude towards respiratory exercise and respiratory hygiene.

The data shows that there is a significant difference the attitude of males and females regarding the respiratory hygiene that were implicated by the government of INDIA and the respiratory exercise that were used to control the pandemic spread as the t- stat value is 3.420 and the p-value is <0.001.

According to *Alula SB, Dejene EM, Terefe ML, Abinet AS, and Bazie M. et al (2018)* advocated -More than half of elementary school children have a positive attitude, and the majority of study subjects have adequate knowledge about hand washing [15].

As per our study, out of 404 females, 94.059% of females have good attitude towards respiratory hygiene and respiratory exercises while 5.94% females have average attitude towards the preventive measure that were implicated by Government of India to control the spread of Covid-19 pandemic and respiratory exercises.

And out of 269 male students, 87.36% of students have a good attitude, 12.267% of students have average attitude, and 0.37% students have poor attitude towards precautionary measures of Covid-19 and respiratory exercises.

According to our study, male students have good attitude towards Covid-19 as the kurtosis value of male is 2.552 while that of females is 0.732. this can be due to the reason that males are more interactive with each other and have more interest in exploring more about new things.

Correlational Study:

Our study shows a positive and highly significant (p-value <0.001) correlation between the knowledge and attitude of school-going children which means that the knowledge and attitude of students are directly proportional to each other (Pearson correlational coefficient, r value is 0.441). This also suggests that as the knowledge of school-going children increases about the precautionary measure and respiratory exercise, their attitude will automatically change in a positive way towards the precautionary measure implicated by the government of India and respiratory exercises which will further help in the control of the Covid-19 pandemic.

According to the study of *Sanaa Al ahdab (2021),* among the 706 respondents, there is a strong and positive association between knowledge and attitudes (as the Pearson correlation coefficient approximately 0.2). This confirms that better attitudes and knowledge are important. In a prior investigation on the H1N1 pandemic, similar degrees of connection between these variables were observed. Therefore, health authorities should prioritize increasing public awareness and knowledge of COVID-19 while simultaneously stepping up their efforts to improve health services [13].

Limitation of the study:

The convenience mode of sampling design should be used to rule out some errors. As the study

was conducted in North India, the sample size should be large. And study should cover other regions of India to get the overall idea of the whole over India.

Conclusion

The majority of students included in our study have good knowledge of the need for respiratory exercise and precautionary measures for Covid-19 while a few students have average knowledge about this. And a good number of students have a positive attitude towards COVID-19 and the use of face masks and vaccination along with this respiratory exercise while few students have an average attitude. This suggests that precautionary measures that were implicated by the government of India have created a good impact on students' life and their knowledge and they are doing well to protect themselves.

Recommendations:

To spread the knowledge and change attitude of students all over India, Government should take camps and indulge students in nuked natak to spread the knowledge about COVID-19 so that students can protect themselves from Covid-19 and their families too.

Conflict of Interest: The researchers affirm that they do not have any conflict of interest.

Acknowledgment: We would like to thank all participants who took part in this study.

Source of Funding: Self

Ethical Clearance: It was obtained from Ethical Committee of ISIC, New Delhi.

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