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Study to Compare the Effects of Balance Exercises on Swiss ball and Standing, on Lumbar Reposition Sense, in Asymptomatic Individuals

Vivek Gaur*
Sukriti Gupta**
Manish Arora***

ABSTRACT

Background and Purpose: Swiss ball has been extensively used as an effective appliance that improves balance by providing unstable surface and thereby reinforcing the proprioceptive feedback from joints and muscles. The purpose of this study was to testify this very fact. Swiss ball exercises were tested against standing balance exercises in normative individuals to see the anticipated changes in proprioception and this data was compared with a control group to see the deviation away from placebo. **Methods:** Thirty normative, healthy subjects with sedentary lifestyle were recruited with informed consent and divided randomly into three different groups. Group A performed Swiss ball exercises while Group B performed standing balance exercises. Control group, Group C was asked to perform a random set of exercises not intended to improve lumbar proprioception. Lumbar reposition error was tested in all three groups with gravity inclinometer before the commencement of study and at its termination. **Results:** While comparing both sets of exercises, Group B with standing balance training showed a significant reduction in lumbar reposition error over the course of two weeks as compared to Group A with swiss ball training. Group C, the control group, showed no significant difference in initial data and last data obtained. **Conclusion:** The study proves that the specific lumbar reposition sense, a marker of balance, improves better with standing proprioceptive and balance exercises as compared to the swiss ball proprioceptive and balance exercises.

Key Words: Lumbar reposition sense; Reposition error; Swiss-ball balance training; Standing balance training.

INTRODUCTION

In the middle of the 20th century, when polyvinyl plastic age opened a new frontier in plastic industry, the initial trend was to use it to manufacture small toys and figurines. At the same time an Italian manufacturer, "Aquilino Casini", was working on his inventive technology of molding plastic, intending to make some larger objects for commercial use, and the first thing that he manufactured it was a round puncture-resistant "exercise ball!"[1].

The exercise ball or Swiss-ball gained popularity all over Europe and, shortly after, all over the world. It became an immensely popular sports product, especially among physical therapists.

Our study aims at finding a scientific proof behind the popular notion of using "Swiss Ball" balance exercises over standing balance exercises to improve the lumbar proprioception which plays a key role in maintaining erect posture and adequate balance in a normal, healthy adult.

Proprioception is the modality that provides feedback solely on the status of the body internally. This sense indicates whether the body is moving with required effort and where the body parts are located at specific time. Balance is an ability to maintain the centre of gravity of a body within the base of support with minimal postural sway[2]. It requires concurrent processing of inputs from multiple senses, including vision, equillibrioreception, pressure senses from different peripheral structures and proprioception while the motor system continuously acts to correct it. The product of continuous proprioceptive input is correct balance. A project completed by K.P. Granata and S.E. Wilson proposed that the spinal stability is influenced by posture, which in turn is the product of correct proprioceptive input[3].

Stability is the equilibrium achieved by some specific body part and, henceforth, proprioception becomes an important factor in determining balance[4].

The aim of the study was that comparing standing and Swiss-ball exercises to assess which one improves lumbar reposition sense and, thus,

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balance? Therefore, the study was done to see the importance of segmental involvement of spine and overall recruitment of body and compare its effects on lumbar proprioception and balance.

METHODS

An experimental method was used with thirty normal, healthy individuals recruited from SBSPGI, Dehradun, in the study. Subjects who were healthy and had no physical complaints were selected for the study. In particular all of them had sedentary lifestyle. Exclusion criteria for subjects involved, 1) Limited spinal ROM 2) Spinal pathology like disc problems and trauma 3) History of LBA or radiating pain 4) Subjects having any spinal deformity as scoliosis, kyphosis or lordosis 5) Subjects with hip deformity or knee deformity as genu varum or valgum 6) Limb length discrepancies 7) Subjects suffering from hamstring tightness and iliopsoas tightness.

The study included thirty subjects to whom detailed explanation of procedure was given and then informed consent was obtained. The thirty subjects were then randomly divided into three different groups. The subjects were informed in detail with the specific sets of exercises designed for them. Group A performed Swiss-ball balance training; Group B performed standing balance exercises; and group C, the control group was given random exercises not intended to improve proprioception and balance. Two weeks' exercise protocol was used with no reduction or addition of other sets of exercises.

Gravity inclinometer was used as a standard device to measure Lumbar Reposition Sense (LRS)[5]. Assessment of LRS with three trials at commencement of study followed by three trials at the end of study was done and the mean readings of both were noted.

Group A performed Swiss-ball exercises that included,

1. While seated on Swiss ball, balancing oneself on Swiss ball and then pushing it down on firm platform.
2. While seated on Swiss ball, balancing oneself on Swiss ball and then pushing it down on unstable platform.
3. While seated on Swiss ball, performing outreach activities.
4. While seated on Swiss ball performing forward and backward leaning.
5. While seated on Swiss ball, moving sideways.

Exercises were performed eyes closed as to block any visual feedback to maximize proprioception on work.

Group B performed standing balance exercises that included,

1. Standing on one leg with eyes closed.
2. Standing in tandem stance with eyes closed.
3. Tandem walk.
4. Jumping on trampoline.
5. Standing on wobble-board.

Exercises were performed eyes closed as to block visual feedback and, therefore, to maximize proprioceptive feedback.

Group C was instructed to perform some random exercises like bending arms, forearms and shoulder. All the exercises didn't include any activity of lumbar spine.

Statistics

SPSS software (version 16.0) was used to analyze the results. Intra-group analysis was done with one way ANNOVA to compare the mean value of initial LRS scores in all three groups. It was again used to compare the inter-group mean values of LRS reading between three groups prior to study and at the end of study after around two weeks. Paired-t test was used to compare the mean values of LRS reading at commencement of study and at the end of the study. A significance level of 0.05 was selected.

RESULTS

Thirty patients (mean age 22.2 ± 1.24) participated in this study. They were divided into three groups with 10 subjects in each group: Group A (Swiss-ball group, mean age 22.5 ± 1.26), Group B (standing group, mean age 21.9 ± 0.99); and Group C (control group, mean age 22.2 ± 1.47).

Statistical analysis of data revealed that the initial analysis done with one way ANNOVA to see the LRS reading between groups A, B and C at commencement of study established the baseline error for all the three groups. During initial recording a high margin of error was noted in Group B (standing group) at this stage. (Table 1, Figure 1).

Comparison of obtained data was again done at the end of 2nd week between the initial readings and end readings of Groups A, B and C. Group B had significantly reduced lumbar reposition error as obtained at the end of second week, thus justifying that the standing balance training reduced the baseline error marginally (Table 2, Figure 2). The two other groups, A and C (Swiss-ball group and

Table 1. Comparision between the LRS reading between Group A, B, and C at 0 week- (Anova)

Group	0 Week LRS Reading
A	1.53 ± 0.39
B	3.26 ± 1.68
C	1.79 ± 0.72
f-value	7.453
Significance	.003

N.S. = Not Significant. (p> 0.05) S = Significant (p< 0.05)

Table 1 shows the mean LRS reading taken at the commencement of study. It establishes the base-line value of LRS for all the three groups.

Figure 1. ANNOVA applied for comparing the initial readings of LRS, this establishes the baseline value of LRS for all the three groups.

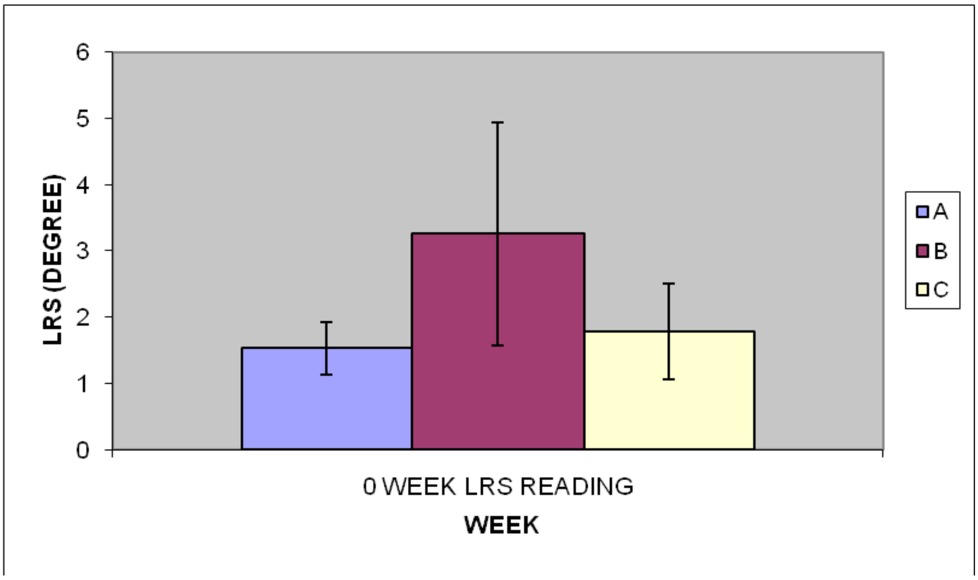

Table 2. Comparision between the LRS reading at 0 week and 2nd week between Group A, B, and C. (Anova)

	LRS 0-week reading	LRS 2-week reading
Group- A	1.53 ± 0.39	1.66 ± 1.70
Group- B	3.26 ± 1.68	1.12 ± 0.84
Group- C	1.79 ± 0.72	1.93 ± 0.69
f-value	7.453	1.219
Significance	S	NS

N.S. = Not Significant. (p> 0.05) S = Significant (p< 0.05)

Table-2 shows the ANNOVA test for inter-group comparison of baseline value of LRS reading at initial week and at the end of 2nd week.

Figure 2. Annova for week-0 and week-2

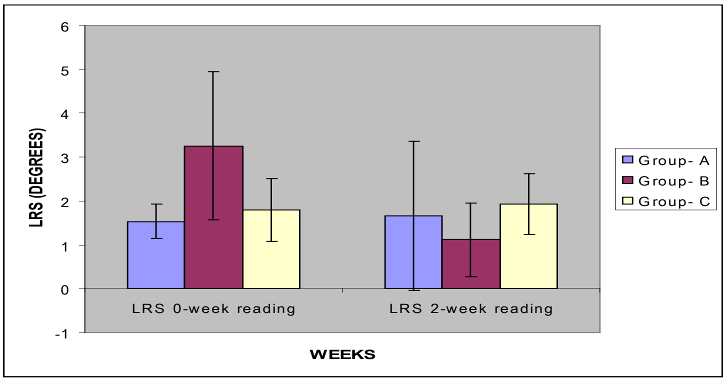

Figure 2 : ANNOVA Applied for comparing the initial readings of LRS and end reading of LRS. Figure demonstrates the marked reduction in Lumbar Reposition Error of Group B, the standing balance exercise Group.

control group) saw no differences in initial reading and reading at the end of two weeks, suggesting that with regards to lumbar proprioception, Swiss ball had no marked effects as compared to that of placebo (Table 3, Figure 3).

Table 3. Comparision between the final and initial reading of LRS between group A, B, and C. (Paired T-test)

	GROUP-A	GROUP-B	GROUP-C
0-WEEK	1.53 ± 0.39	3.26 ± 1.68	1.79 ± 0.72
2-WEEK	1.66 ± 1.70	1.12 ± 0.84	1.93 ± 0.69
t-VALUE	-.242	3.014	-.414
SIGNIFICANCE	NS	S	NS

N.S. = Not Significant. (p> 0.05) S = Significant (p< 0.05)

Table-3 shows the intra-group comparison with paired-t test between the initial LRS reading and LRS reading at the end of exercise protocol. A high significance level of group B suggests marked improvement in Lumbar Reposition error with standing balance exercises.

Figure 3. Paired t-test for week 0 and 2

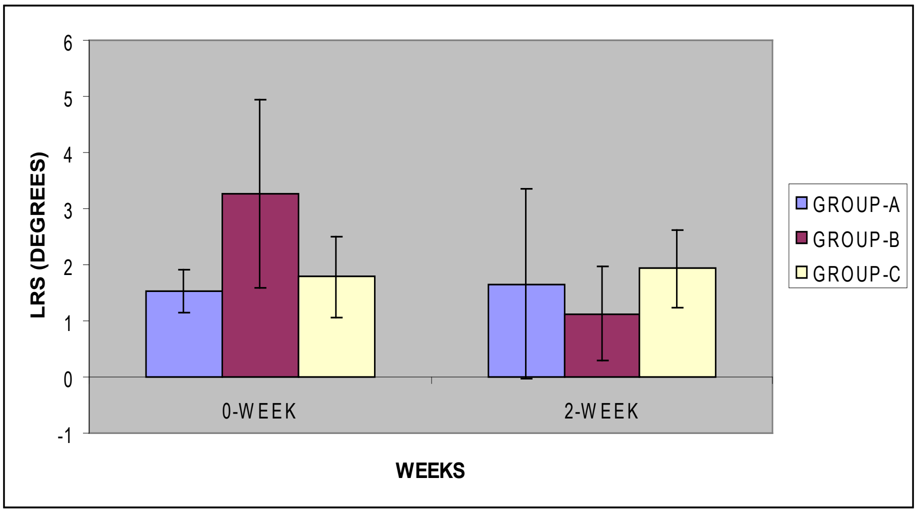

Figure 3 : Paired t-test applied for evaluating the intra-group LRS reading at the commencement of study and at the end of 2 weeks. The marked reduction of 2nd week LRS reading as compared to baseline LRS value suggests Group B with standing balance training had better improvement of proprioception.

DISCUSSION

Popularity of Swiss ball since the past few decades has made it a common tool for recreational activity as in gymnasiums, spas, and houses, as a therapeutic tool in clinics; in general fitness routines, athletic training; and in alternative exercises like Yoga and Pilates. The versatility of the device makes it a common tool in various activities, viz. physical therapy and exercises as well. It has been used in weight-lifting programs and in gynecology too[6].

Earlier studies and some present studies have validated Swiss ball as a tool of choice for strengthening as well as muscle activation purpose. Swiss ball as compared to other conventional devices is said to increase the amplitude of EMG signals during abdominal exercises, which has been attributed to the proprioceptive input[7].

Studies have claimed that the abdominal and back muscles are constantly engaged and active in order to maintain proper posture and balance on the ball[8, 9]. A report published in 2001 by Scibek, J.S., and K.M. Guskiewicz, et al. has stated that the core stability is improved by the inclusion of Swiss ball training into an existing training program.[10].

Peoples who are in favor of Swiss ball as a more suitable device for exercise regimens have argued that the adaptations following these exercises occur primarily in the nervous system[11].

Many studies claime the suitability and usefulness of Swiss ball as an alternative to conventional exercise regimen, but, to date, on the ground of reality, their contribution to enhance physical performance still remains uncertain. Therefore, there is a greater need of further studies that demonstrate its effectiveness to enhance physical performance.

Though some studies also suggest that prolific and universal use of Swiss balls in physical therapy and athletic preparation demands further investigation to validate their use in physical training programs[12].

One such research which incorporates the use of more reliable tools like EMG presents a different idea altogether. A study published in Dynamic Medicine, Gregory J Lehman and Trish Gordon et al., has provided groundwork by clarifying that replacing an exercise bench with a Swiss ball is not a guarantee for increased trunk muscle activation, and, in fact, individuals respond differently to unstable surfaces. They observed that if the justification of incorporation of Swiss ball is an aid to “train the core”, i.e. recruit agonist-antagonist trunk muscles, then this can’t be supported by the results of their study[13].

Furthermore, a study conducted by Gregory J Lehman has stated that individual factors may play a big role in how muscle activation levels are affected by the addition of an unstable surface. He stated that in all trunk muscles they included in their study, viz. upper and lower erector spinae, rectus abdominis, external oblique, and lower abdominal stabilizers, there were no differences in muscle activation levels between altered surface conditions, either labile surface like Swiss-ball or stable grounds[14].

Our study bears the same idea where a significant improvement in lumbar proprioception has been induced with two weeks of standing proprioceptive exercises. This is presumably because of involvement of whole trunk and lower limb musculature and joints which add up to a sum total of proprioception.

Therefore, our study confirms that using a Swiss ball as an efficient device that improves the core stability is rather a concept that is restricted to specific muscles and also not generalized to whole population.

The clinical significance emerges from the evidence based practice for involvement of standing proprioceptive exercises for subjects with normal back muscle strength and no biomechanical faults.

This study may be utilized by rehabilitation clinicians when designing a rehabilitation program for acutely suffering young population. During this, it should be remembered that merely adding the labile surface as provided by Swiss ball doesn’t always increase the load on neuromuscular system in every patient and individual responses to it vary greatly[14].

If the aim of a therapist is to rehabilitate or prevent low back injury, then sound biomechanically justified or clinically proven rehabilitation protocols should be advocated. Kavcic et al. provides biomechanical support for ground based simple exercises to adequately train the spinal stabilizers while minimizing the compressive/shear penalty and ensuring adequate spinal stability[15].

Limitations of the study

1. The study was done in normative asymptomatic population and not in the patients.

2. The comparison was done between simple standing and Swiss-ball exercises. But more detailed explorations are needed for the same with varying modifications of these tools.

3. Limited trials of two weeks were undertaken; a longer duration of trial phase is required in future

studies.

Future scope

1. A series of experimentations are needed to compare the same effects in subjects with balance disorder.

2. The study addresses the requirement of correct exercise prescription.

3. Prolonged study duration may yield a significant result of same study in people with proprioceptive/ balance problems.

4. The subject range of this study was narrow; involvement of more subjects for the same study will certainly reduce the chances of possible errors.

CONCLUSION

While comparing Swiss ball training with standing balance training, it emerged that standing balance training is more effective in providing proprioceptive feedback. The comparison of Swiss-ball training and standing balance training with control group additionally ruled out any difference other than placebo.

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Comparative Study of a Structured Progressive Exercise Program and McKenzie Protocol in Individuals with Mechanical Cervical Spine Pain

Poonam Singh*
Kapila Gupta**

ABSTRACT

Introduction: Cervical spine pain is a common musculoskeletal disorder. There is lack of clarity in the superiority for specific application of various exercise protocols. Structured exercise protocols are commonly prescribed by physiotherapists and few also advocate McKenzie protocol as being effective. **Aim of the Study:** To compare a structured exercise protocol with McKenzie protocol for patients suffering from chronic mechanical cervical spine pain. **Methodology:** Thirty subjects, 15 in each group, were selected from hospitals and clinics in and around Noida and NCR on the basis of inclusion and exclusion criteria and were divided randomly. One group was assessed and given McKenzie protocol and the other group was assessed and given a structured exercise therapy protocol for three weeks. **Design:** Experimental pre-test / post-test design. **Data Analysis:** Using SPSS 17.0 "t" test was applied to compare the pain and neck disability index values in pre and post interventions. A p value of < 0-05 was selected as the level of significance. **Results:** Independent t–test values, i.e., 1.980 and .645 were not significant for pain and neck disability index, respectively, between both the groups. **Conclusion**: There is no significant difference in pain checked by visual analog scale and disability by Neck Disability Index, between the McKenzie method and structured exercise protocol for patients with mechanical cervical spine pain.

Key Words: Mechanical neck pain; cervical spine; McKenzie protocol.

INTRODUCTION

Cervical spine pain is a common musculoskeletal disorder among people today accounting for a significant disability. Little more than 50% of people suffer from neck pain at some point of time in their life[1,2]. Mechanical neck pain is a general term which covers pain originating from stress and strain of soft tissues around the vertebral column. Many interventions are useful in conservative management of neck pain. Physiotherapy interventions mainly deal with modalities, exercises, ergonomic advice and manual therapies. Out of these the role of exercises is generally well accepted but not proved specifically. There are various interventions of exercise therapy, namely static resisted exercises, proprioceptive exercises, McKenzie protocol, postural exercise, and dynamic exercise etc, but they lack evidence from research[3,4].

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Aim

To find out whether improvement in mechanical cervical spine pain patients is more if they follow McKenzie cervical spine protocol than a structured exercise therapy program.

Scope

Studies on structured exercise protocols and on McKenzie protocol for cervical spine pain are limited in Indian patient population, and there is a need to look for a better exercise protocol to help this patient population better.

MATERIALS AND METHODS

Subject: Thirty number of subjects with 15 in each group were selected from hospitals and clinics in and around NOIDA and NCR

Inclusion criteria

- Age: 30-60 years.
- Sex both males and females.
- History of neck pain for more than three months.
- VAS more than 3.
- NDI > 20%.

Exclusion criteria

- History of trauma to cervical spine.
- Carotid bruit.

- Rheumatoid arthritis
- Vertebro basilar insufficiency
- Signs of cord compression
- Known infection
- Neoplasm of head and neck.
- Vertigo/dizziness (BPPV).
- Referred pain from viscera.

Sampling

Method of selection: Sample of convenience with systematic assignment between two groups. Informed consents taken in written. Of all 40 patients 30 patients were selected as per the inclusion and exclusion criteria and were randomly divided into group A and group B on the basis of chit pick up system. Ten patients were excluded from the study because of the following reasons.

Lower NDI value at base line=4

Ongoing infection=2

Signs of cord compression=2

Vertigo/Dizziness=2

Of total 30 selected, 17 were females and 13 males.

Instruments and tools used

A) Independent variables

(i) Structured exercise program: 10-12 reps for three sets twice daily for 3 weeks. (passive stretching exercises done as warm up)

Supine lying upper limbs elevated above head to reduce cervical lordosis.

- Supine lying pressing against plinth.
- Chin tucks in supine lying(towel roll under the lordosis of the neck).
- Chin tuck and neck flexion in supine lying.
- Neck flexion to look at toes.

Extension exercises-prone lying

- Looking in front prone lying without chin lift.
- Looking up with chin lift.
- Neck extension with out forearm support.
- Neck extension with forearm support.
- Right upper limb stretched in front with neck extension & rotation to right.
- Left upper limb stretched in front with neck extension & rotation to left.
- Both upper limbs stretched out with extension of neck.
- Sphinx posture.

(Detailed exercise protocol is given in the Appendix)

Out of the above exercises, prescription may include few on the basis of patient assessment and examination. The dosage may be increased as part of progression.

(ii) McKenzie protocol: 10-15 reps, thrice per week for three weeks [5].

B) Dependent Variables

- Pain intensity on----VAS-10 cm.
- Neck Disability Index [6]
- Other equipment- simple goniometer.

Proceedure

Patients as per inclusion and exclusion criteria were selected as sample of convenience and divided into two groups randomly by using pick chits method. For group A, structured exercise protocol was given and for group B McKenzie protocol was given. Baseline data was collected using VAS and NDI. The protocol were given and followed for a period of three weeks and second reading for VAS and NDI was taken.

Design of the study

Experimental pre test post test design.

01	X1	02
01	X2	02

METHODOLOGY

Subjects were selected on the basis of inclusion criteria and were randomly allocated to two groups A and B using pick chits method.

Group A- Group under structured progressive exercise protocol

Group B- Group under McKenzie protocol.

Data was collected twice pre and post intervention.

All dependent variables have good intrarater reliability and frequently used for research purposes.

Participants were given the following instructions:

- Follow the taught exercise regimen twice daily with three sets of ten repetitions of each exercise.
- Report the change in pain in your VAS index.

Photograph 6.1; Axial Extension with arm elevation and scapula adduction

Photograph 6.2; Prone, over head arm elevation with head rotation to same side

Photograph 6.3; Scapular adduction movement

Photograph 6.4; Structured exercise passive trapezius stretching

Photograph 6.5; Mckenzie extension mobilization

Photograph 6.6; Mckenzie head retraction with therapist overpressure

- Please contact -9999784846 in case of any query or increased pain.

Ooutcome measures

- Visual Analog scale (VAS)
- Neck disability Index(NDI)

Data analysis

Descriptive statistics such as Mean and Standard Deviation were used to summarize the data. Repeated Measure ANOVA was used to see mean significant difference between the groups at various points of time. However, independent t test was used to see mean significant difference between the two groups and paired t-test was used for significant difference within both groups. A "p" value of less than 0.05 was considered as statistically significant. SPSS statistical package version 17 was used to carry out the above analysis.

DISCUSSION

The results of the study shows that both structured progressive exercise protocol and McKenzie protocol for mechanical cervical spine pain prove to be

RESULTS

Table 1. Descriptive values of dependent variables in both

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
VASA-Pre ex	15	2.00	10.00	7.1333	2.09989
VASB- Post ex	15	.00	5.00	2.4000	1.59463
NDIA-Pre ex	15	20.00	60.00	35.1800	14.32930
NDIB-Post ex	15	4.00	22.50	11.9607	6.25505
VASC-Pre mck	15	6.00	9.00	7.3333	1.11270
VASD-post mck	15	.00	3.00	1.3333	1.34519
AGEA-Ex Grp	15	30.00	65.00	41.2000	11.25801
AGEB-Mck Grp	15	27.00	65.00	39.4667	14.25716
NDIC-Pre Mck	15	20.00	48.00	34.0000	9.03960
NDID-Post Mck	15	.00	28.00	10.0667	9.50539

Table2. Dependent variables between the two groups

Parameter	Independent-t value	Significance level
Pre Intervention VAS	-.326	.747
Post Intervention VAS	1.980	.058
Pre Intervention NDI	.270	.789
Post Intervention NDI	.645	.524

effective individually, but the result of independent t test is statistically not significant.

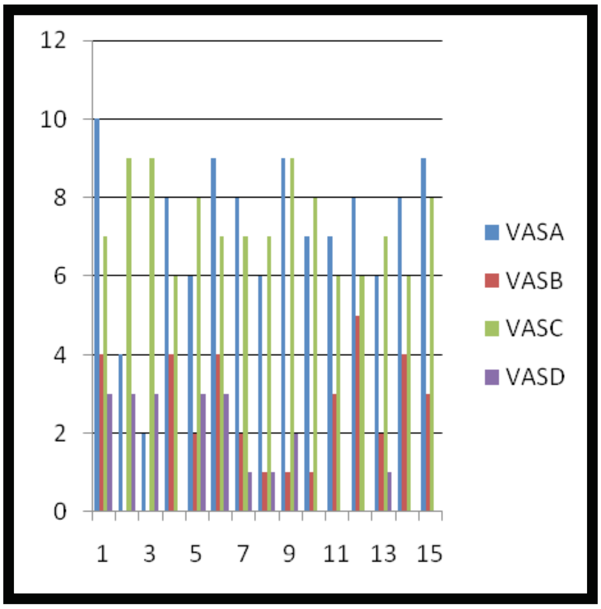
Neck pain is a common feature which originates from abnormal functional patterns of the soft tissues of the neck. Normal function of the cervical spine depends on strength, recruitment capacity, coordination, and proper flexibility of neck muscles, which also have a close relationship with other adjacent muscle groups, e.g.; shoulder scapula and head. Anatomically and functionally, the cervical column is divisible into two segments-superior segment and inferior segment-as advocated by I A Kapandji [7]. Thus, in structured exercise protocol we classified patients into upper, i.e., Occiput, C1, C2 involvement or lower cervical spine, C3 to C7.

Visual Analog Scale (VAS) changes – Visual Analog Scale shows significant improvement within the group analysis but there is no significant difference between the two groups. Thus, as both the groups showed significant improvement after the intervention, neither intervention proved to be superior in producing effective change in VAS.

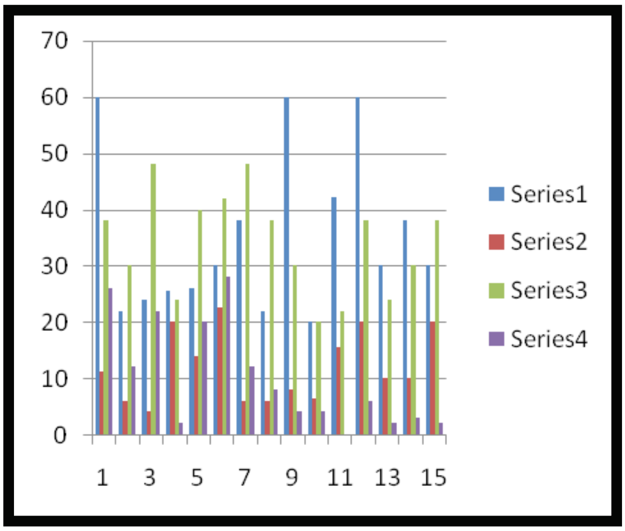
A study by Gorel et al published in J Rehabil Med 2002 also gave similar results where there was improvements seen in the groups given general exercise and McKenzie protocol [8].

Neck disability index (NDI) changes – Neck disability index shows significant improvement within the group analysis but there is no significant difference between the two groups. Thus as both the groups show significant improvement after the intervention, neither intervention proved to be

Graph 9.1; Vas changes in study



Graph 9.2; Changes in ndi in the study



superior in producing effective change in NDI

The results of this study are in line with the results of previous studies done on McKenzie, comparing it with various other physiotherapy and manual therapy treatment techniques, where also manual therapy and general exercise therapy was as effective as McKenzie protocol for low back pain [9]. Janda, s upper crossed syndrome [10] which is a well known pathology for the cervical spine, advocates a very specific stretching and strengthening program of the specific muscles across the cross. Recent study [11,19] confirmed that the deep cervical flexors lose endurance in chronic neck pain and need active and dynamic exercise protocol to be prescribed for this muscle group. It has also been reported in literature that there is deficit in feed forward control of cervical flexor muscles during voluntary arm movements and postural problems need specific muscle groups to be trained [12,20]. Thus, it is always useful to prescribe a combined pattern involving both neck and arm movement. A normal day-today activity also most commonly involves this pattern as well.

Since the study was conducted for a short-term period of three weeks only, long-term effects could not be studied. Various interventions and events occurring during the follow-up period may have an impact that is beyond the control of the researchers and can, therefore, interfere with the long-term results and, perhaps, obliterate differences.

Howard Makofsky advocated Occivator which is a postural correction exerciser for forward head posture. In physiotherapy, other than that, there are various other techniques like Alexander technique which emphasizes on the correct posture and advocates posture correction technique. The neck pain task force has also concluded that conventional neck pain physiotherapy skills are effective and they work more than the other alternative therapies [13]. They have further suggested a grading system for neck pain and for the first two grades, physiotherapy exercise program has been recommended [14].

Neck pain is not very often well defined. Recently in his PhD thesis Dr. Kees Vos defines neck pain as any pain originating from the cervical spine that can be caused by dysfunction of the intervertebral discs, ligaments, zygapophyseal joints, or soft tissue structures [15].

Conventional exercises used in physiotherapy have equal potential if they are prescribed after sound clinical reasoning for individuals with mechanical cervical spine pain. All exercises prescription may be done after thorough assessment and sound clinical reasoning.

Thus, conventional physiotherapy exercises along with McKenzie methods are effective in the management of neck pain. Many contemporary findings are supportive of various other physiotherapy interventions as well as these interventions for neck pain treatment non invasively [16,17].

Posture of the shoulder girdle is closely linked to cervical posture and needs to be addressed in the presence of neck pain [18]. Loss of postural control/ function of particular scapular muscles such as serratus anterior, rhomboids, and lower trapezius is a common clinical finding. Basic Kendall MMTs, individual muscle length testing, and observation of scapular function during scapulo-humeral rhythm will help detect aberrant motion and function.

Recent study [19] have confirmed that the deep cervical flexors lose endurance in chronic neck pain, and need active and dynamic exercise protocol to be prescribed for this muscle group. It has also been reported in literature that there is deficit in feed forward control of cervical flexors muscles during voluntary arm movements [20]. Thus it is always useful to prescribe a combined pattern involving both neck and arm movement. A normal day-today activity also most commonly involves this pattern as well. A study by Gorel et al published in J Rehabil Med 2002 also gave similar results where there was comparable improvement seen in the groups given general exercise and McKenzie protocol [21].

Long-term studies may be planned which may be able to establish the optimal parameters for the exercise prescription. The clinical reasoning aspects can also be studied further in this patient population. Treatment based and pathology based sub grouping of cervical spine pain can be studied in future studies.

CONCLUSION

Null hypothesis is accepted. There is no significant difference in pain checked by visual analog scale and disability by Neck Disability Index between the McKenzie method and structured exercise protocol for patients with mechanical cervical spine pain.

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Relationship of Age, Gender and Routine Physiotherapy with Depression among Elderly People in a Multidisciplinary In-patient Geriatric Care Ward: A Cross-Sectional Study

Vaishali K*
Senthil P. Kumar*
Vijaya Kumar*
Prabha Adhikari**

ABSTRACT

Background: The number of elderly is continuous growing thus increasing the scope and demands for geriatric care in a multidisciplinary model. The medical conditions associated with ageing and various disorders pose a challenge to the palliative health care professionals, especially physical therapists who are responsible for addressing physical and functional dimensions of care. **Purpose:** The objective of this study was to assess the prevalence of depression among elderly people admitted in a hospital. **Materials and methods:** Fifty four elderly people with age and gender (male-20, female-34) were assessed by the physical therapist using Geriatric Depression Scale-Short form (GDS-SF: 15-item version), where a score >5 out of a total 15 suggested presence of depression. The patients were undergoing regular physiotherapy in terms of group physical activity, yoga, general mobility exercises, and breathing exercises. The setting included a physician, physical therapist, yoga therapist, dietitian, nurse, and a counselor. Data analysis was done for comparing the depression scores between genders and medical diagnoses, and then correlated with person's age using SPSS version 11.5 at 95% confidence interval. **Results:** The overall prevalence of depression among the study population was 66.7%. Overall, the depression scores among the study participants were low (8 ± 3.82). The depressed elderly had a score of 10.11 ± 2.76 compared to non-depressed elderly (3.77 ± 1.26) which was statistically significant. There was no significant difference in GDS-SF (15) scores by gender (male-8.1 ± 4.66, female- 7.94 ± 3.31), but was significant for medical diagnoses (gastro-intestinal, pulmonary, metabolic and musculoskeletal). **Conclusion:** There was a high prevalence of depression among the elderly and their depression scores were less, which might be attributed to their subclinical depression status. Those who underwent regular physical therapy had lesser scores than their counterparts. The study findings have important implications for designing future prospective designs of clinical trials on physiotherapy interventions for depression.

Keywords: **Ageing; rehabilitation; end-of-life care; psychosocial factors; physiotherapy**

INTRODUCTION

According to World Health Organization [1], an elderly person is defined as one having age of 65 years or greater [2]. Years later, Denton and Spencer [3] confirmed either 60 or 65-years cut-off could be used as an entry point into old age using life table's method.

WHO estimated that there are 41 million elderly in India, making up 7% of the total population in 1991 [4]. The recent advancements in medical health care have led to a continuing rise in the number of elderly, leading to 'population aging' and increased hospital demands [5] and need for better health care delivery. Major problems identified among the elderly include a range of medical diseases and disorders comprising of orthopedic, neurological, cardiac, pulmonary, metabolic and multi-systemic conditions that require multidisciplinary management to address biological, psychological and social aspects of care [6]. Rajan et al [7], in their National Sample Survey (NSS) found that the elderly in India had specific health-related concerns about general feeling, living arrangements, living support, social security, health, nutrition, their involvement in social and religious matters, views of old age homes and, particularly, life preparatory measures. Another recent NSS study by Husain and Ghosh [8] found that there is a steady worsening of health status among elderly and this might be attributable to the negligence in health care provision and policies in India.

Major issues that influence the accuracy of reported history, patient co-operation during assessment and treatment procedures, patient adherence to prescribed home programs are the psychosocial problems that often may be associated with the primary biomedical condition, either as a cause or effect [9].

The psychosocial issues in elderly are anxiety,

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depression, fear, grief, social isolation, memory loss, bereavement, suicidal tendencies, dementia [10], frustration, disinheritance, suspicion, hopelessness, disregard inhuman treatment [11].

The point prevalence of depression among elderly population in a community-based sample was found to be 27% and, of the 27% reporting depressive symptoms, 19% were diagnosed as suffering mild dysphoria, 4% symptomatic depression, 2% dysthymia, 1.2% a mixed depressive and anxiety syndrome, and 0.8% major depression [12]. Jhingan, et al [13] found that amongst depressed elderly patients in India, only 28% of the patients had recovered, 30% had partially recovered, 23% had relapsed, 6% had been continuously ill, 11% had died, and 6% had comorbid dementia. Depression was also found to be the leading cause for the greater suicidal rates among the elderly compared to the national rates in India4 and had a huge negative impact on the elderly person's quality of life [14,15].

Amongst many psychosocial factors, depression was considered as the singlemost important barrier to effective inplementation of therapeutic programs in elderly population [16]. Major depressive disorder is a potentially debilitating condition that often is unrecognized or undertreated in the elderly [17] and its onset in old age bears a different prognosis than when occurring in middle age [18]. Depp and Jeste [19]. concluded that the most frequent significant correlates of the various definitions of successful aging were age (young-old), nonsmoking, and absence of disability, arthritis, and diabetes. Moderate support was found for greater physical activity, more social contacts, better self-rated health, absence of depression and cognitive impairment, and fewer medical conditions. Gender, income, education, and marital status generally did not relate to successful aging. Among these and many other factors, depression was the only uncontrollable predictor variable that affected the quality of subjective and objective definitions of successful aging [20].

Ganguli et al [21] studied a community sample of 1554 elderly (above 55 years age) in North India for depression, using the Hindi version of Geriatric Depression Scale, and they found higher overall prevalence rates than in other countries. It was also associated with cognitive impairment and functional decline among the elderly. Prakash et al [22] found that 18% of their subjects had depression and 11% had other mental disorders. Patients with mental disorders had suffered more recent stressful life events. Among life events, conflicts in family (16%) and unemployment of self or children (9%) was reported by elderly psychiatric patients. Other reported life events in psychiatric diagnosed elderly were conflict in family (7%), illness of self (6%) or family members (5%) and death of family members (5%) or close relatives (4%). Biswas et al [23] found that the prevalence of depression and common mental disorder was 31.5% in Vellore, India.

The objectives of this paper were (1) to evaluate the levels of depression amongst institutionalized elderly and (2) to assess the relationship of influencing factors such as age, gender, and physiotherapy intervention with the reported levels of depression.

MATERIALS AND METHODS

This observer-blinded, cross-sectional study was approved by the Institutional Ethics Committee, Kasturba Medical College, Mangalore and was registered in Clinical Trials Registry- India, under trial registration number UTRN- 020846127-2001200876203.

We performed a convenient sampling of elderly people admitted in Kasturba Medical College Hospital, Attavar, Mangalore, and a written informed consent was obtained prior to their screening and participation in the study.

The elderly people were considered for participation in this study if they were age above 65 years, either gender admitted in Ashraya Geriatric Day Care Center of the *hospital*, with a mini-mental state examination score greater than 2324 and absence of history of medically diagnosed neurological disorder. (Table 1)

The study setting was a multi-disciplinary in patient ward where the admitted elderly people undergo regular physiotherapy (group exercises- free active movements of all joints, breathing exercises- deep relaxed diaphragmatic breathing; balance training-unipedal stance, tandem stance and figure-of-8 walking; functional training- sit-to-stand, squatting, stairs climbing). The choice of physiotherapy intervention was done based upon patient's existing physical, mental, and functional status and it was routinely administered, ensuring that it should not cause any discomfort.

The selected participants were then administered Geriatric Depression Scale- Short Form (GDS-SF), a 15-item self-report or clinician-administered measure (each item has responses 'yes' or 'no') (Table 2) developed for evaluating depression and was previously studied for its model stability[25], suitability [26], acceptability [27], accuracy [28], screening performance [29], psychometric properties [30], construct validity [31], diagnostic validity [32], criterion-based validity [33], reliability [33] for use in elderly population in palliative care settings [34].Ferraro and Cheminski [35] established the normative data for GDS-SF:15 where a score of >5 out of a total 15 suggested presence of depression. The elderly person's demographic data- age, gender, medical diagnosis and physiotherapy details-were also obtained. The outcomes were collected by postgraduate students in physiotherapy who were blinded from the study objectives.

Data analysis

Comparisons between gender, diagnoses, and physiotherapy (cases) versus no physiotherapy groups (controls) for their depression total scores on GDS-SF:15 were done using independent t-test. Correlation with age was done using Karl-Pearson correlation co-efficient. Odds' ratios were estimated after using Chi-square test for categorical association. All analyses were done at 95% confidence interval using statistical package for social sciences SPSS version 11.5 for Windows.

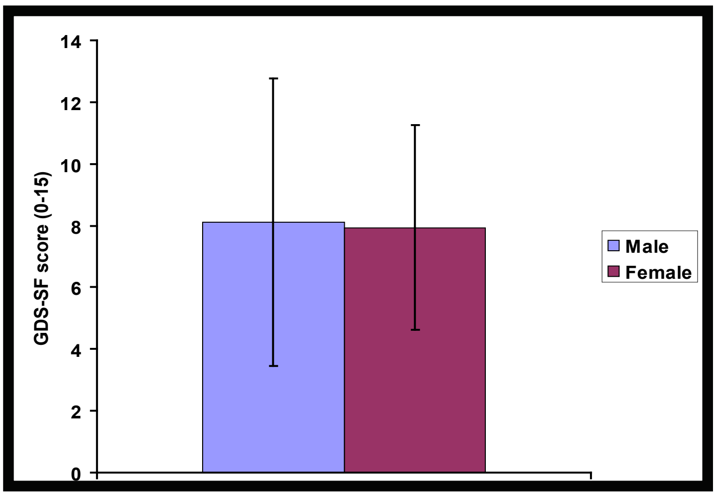
RESULTS

Amongst a total of 83 in patients screened between the years 2006 and 2010, 82 consented and, finally 54 were included (cases- 38 and controls- 16) for our assessment.

Table 1. Overall demographic details of elderly people who participated in the study

Variables		Value
Sample size		54
Age (years)		68.48 ± 12.17
Gender	Male	20 (37%)
	Female	34 (63%)
Clinical diagnoses	Cardiac	2 (3.7%)
	Dermatological	10 (18.5%)
	Gastro-intestinal	2 (3.7%)
	Metabolic	4 (7.4%)
	Musculoskeletal	8 (14.8%)
	Multiple disorders	14 (25.9%)
	Neurological disorders	8 (14.8%)
	Psychiatric	2 (3.7%)
	Pulmonary	2 (3.7%)
	Vascular	2 (3.7%)
Undergoing regular physiotherapy	Yes	38
	No	16

Figure 1. Comparison of GDS-SF scores between genders

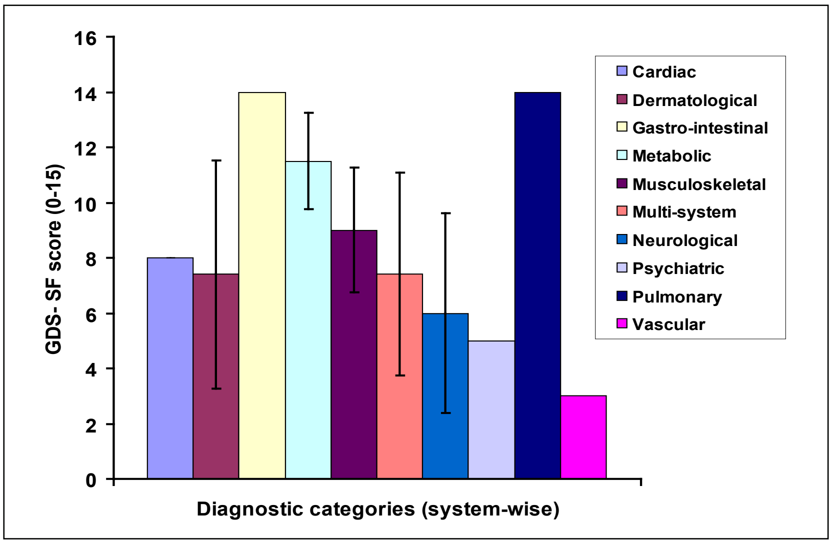


The male elderly (8.1 ± 4.66) had higher scores of depression than their female counterparts (7.94 ± 3.31) which was not significant (p=.885).

Table 2. Geriatric depression scale- short form (GDS-SF) items and their responses

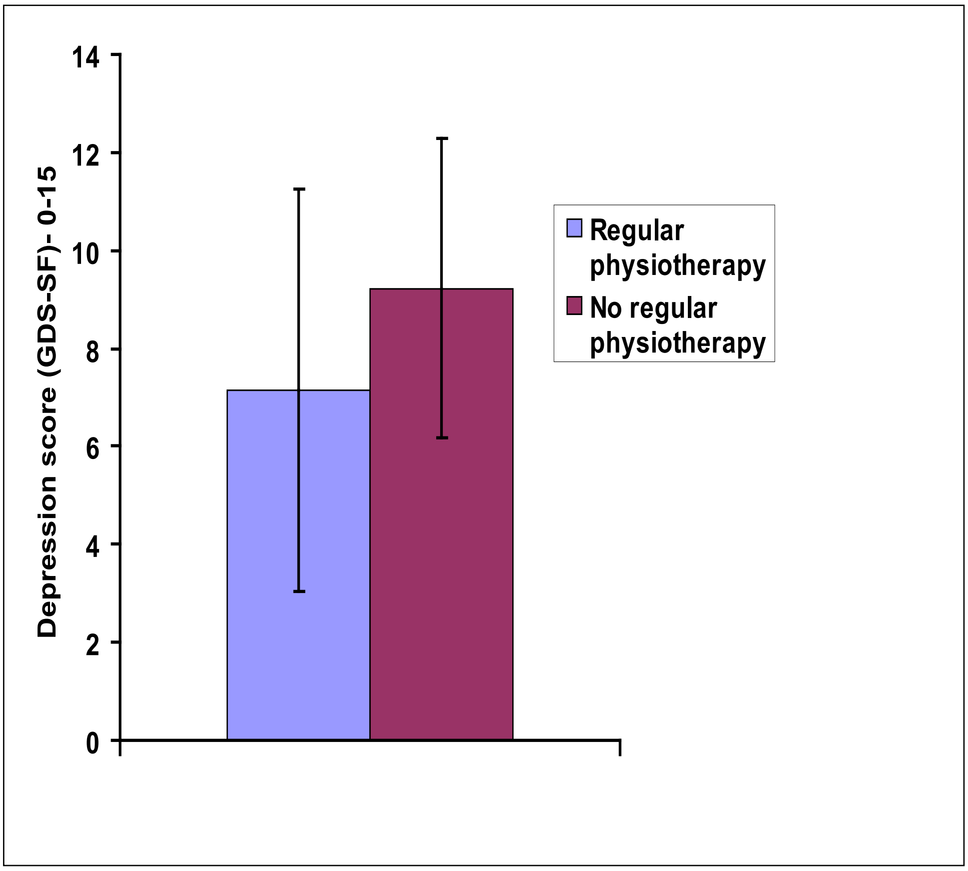
Scale- items	Responses Number of people (%)
Item-1	Yes-40 (74.1%) No-14 (25.9%)
Item-2	Yes-26 (48.1%) No-28 (51.9%)
Item-3	Yes-32 (59.3%) No-22 (40.7%)
Item-4	Yes-38 (70.4%) No-16 (29.6%)
Item-5	Yes-28 (51.9%) No-26 (48.1%)
Item-6	Yes-20 (37%) No-34 63%)
Item-7	Yes-32 (59.3%) No-22 (40.7%)
Item-8	Yes-34 (63%) No-20 (37%)
Item-9	Yes-40 (74.1%) No-14 (25.9%)
Item-10	Yes-30 (55.6%) No-24 (44.4%)
Item-11	Yes-20 (37%) No-34 (63%)
Item-12	Yes-28 (51.9%) No-26 (48.1%)
Item-13	Yes-22 (40.7%) No-32 (59.3%)
Item-14	Yes-36 (66.7%) No-18 (33.3%)
Item-15	Yes-32 (59.3%) No-22 (40.7%)
Total GDS-SF interpretation	Normal- 18 (33.3%) Depressed- 36 (66.7%)
Total GDS-SF corrected score (mean SD)	8 ± 3.82

Figure 2. Comparison of GDS-SF scores between clinical diagnoses



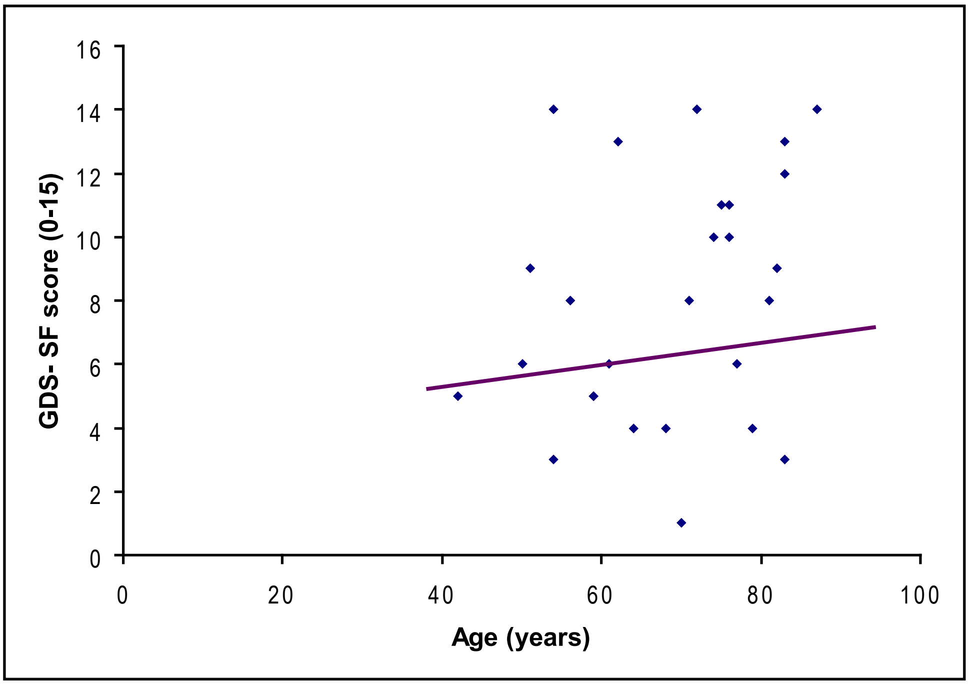
The elderly people with gastro-Intestinal problems and pulmonary conditions had highest GDS-SF depression scores (14), followed by those with metabolic disorders (11.5 ± 1.73) and musculoskeletal disorders (9 ± 2.26).

Figure 3. Comparison of depression scores between elderly people who underwent regular physiotherapy versus who did not



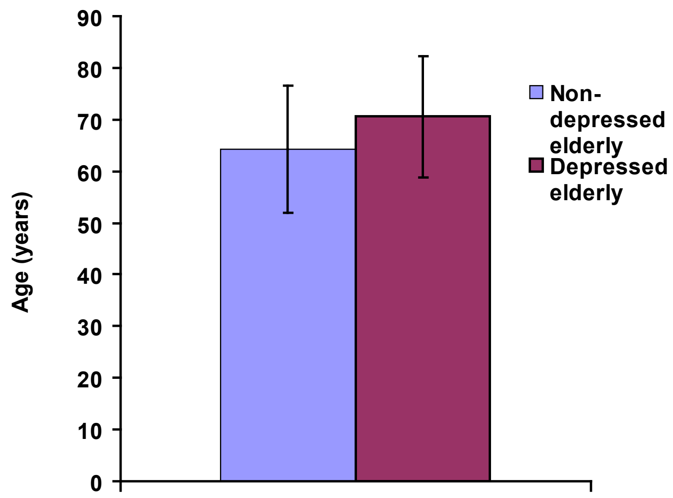
The depression score of elderly people who did not undergo regular physiotherapy (9.43 ± 3.46) were higher than those who underwent regular physiotherapy (7.39 ± 3.85), but this difference was not statistically significant (p=.076).

Figure 4. Relationship between age and depression (GDS-SF score)



There was a statistically significant (p=.04) but weak positive correlation (r=.280) found between age and depression scores on GDS-SF.

Figure 5. Comparison of age between depressed and non-depressed elderly people



The age of depressed elderly (70.61 ± 11.73 years, N= 36) was more than the non-depressed elderly (64.22 ± 12.23 years, N= 18), but was not statistically significant (p= .069).

Table 3. Geriatric Depression Scale-short form (GDS-SF) categories (normal or depressed) and association with regular physioytherapy

		Underwent regular physiotherapy N (%)	
		Yes	No
Geriatric depression score- short form (GDS-SF) category N (%)	Normal	17	1
	Depressed	15	21
Total		32	24

Odd's ratio for elderly people who underwent physiotherapy to have lesser depression score was 23.8 (17x21/15x1).

DISCUSSION

Geriatric services are the need of the hour [36] in a brave, new, transparent health world [37]. The real challenges of caring for the elderly in 2030 will involve: (1) making sure society develops payment and insurance systems for long-term care that work better than existing ones, (2) taking advantage of advances in medicine and behavioral health to keep the elderly as healthy and active as possible, (3) changing the way society organizes community services so that care is more accessible, and (4) altering the cultural view of aging to make sure all ages are integrated into the fabric of community life [38].

The reason this study utilized GDS-SF instead of Depression Anxiety Stress Scales and Post-traumatic Stress Disorder Checklist, which are frequently recommended for mental health screening, is that the Geriatric Depression Scale accurately predicts a diagnosis of depression in community cohorts [39]. The reason why this study found higher depression scores for elderly people with pulmonary disorders was due to higher prevalence of pulmonary disorders in this age group [40]. Elderly with musculoskeletal disorders also scored higher on depression scores since the association of physical disability with depression was well known [41], especially for lower limb problems since they impair mobility and balance. The second highest score for depression was in those elderly with metabolic disorders which reiterated the findings of Bove et al [42] that psychosocial factors influence the metabolic parameters in elderly.

Promotion of psychosocial health of the elderly is often regarded as played by psychological counselors and social workers [43], and targeted cognitive rehabilitation programs produce long-term improvements in psychosocial functioning in elderly population [44].

One of the hypothetical mechanisms for depression in elderly people was vascular disease, which disrupts mood regulation circuits in the brain, thereby decreasing its ability to respond to stressful events [45]. Depression in turn has direct influence on immune mechanisms [46] and it can thus indirectly cause other systemic illnesses, as observed in this study population.

Elderly inpatients have a wide spectrum of depressive disorders with different psychosocial, medical and treatment profiles [47]. Future studies of depression in old age should include all patients with clinical depression.

CONCLUSION

There was a high prevalence of depression among the elderly and their depression scores were less, which might be attributed to their subclinical depression status. Those elderly who underwent regular physical therapy had lesser scores than their counterparts. The study findings have important implications for designing future prospective designs of clinical trials on physiotherapy interventions for depression.

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Conflicts of interest:
None identified and/or declared.

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Forward Reach Distance as a Measure of Dynamic Stance Postural Control under Six Different Sensory Conditions in Neurologically Intact Adults: A Descriptive Study

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ABSTRACT

Objective: To establish the forward reach distance values in six different sensory conditions for neurologically intact adults. In addition, we intended to compare the forward reach distance value of sensory accurate condition with sensory inaccurate conditions in neurologically intact adults. **Participants:** One hundred and fifty community dwelling, healthy subjects aged between 20 and 50 years participated in the study. **Measures:** Functional Reach Test (FRT). **Results:** Descriptive statistics was used to find the forward reach distance values under six different sensory conditions. We found a decline in the forward reach distance values as the somatosensory and visual inputs were inaccurate. **Conclusion:** In neurologically intact adults, the dynamic stance postural control is dependent on the interaction of the somatosensory, visual and vestibular systems.

Key Words: Functional Reach Test; Forward reach distance; Sensory conditions; Neurologically intact adults.

INTRODUCTION

Postural control is defined as the ability to control the body's position in space for the dual purposes of stability and orientation. Postural stability is the ability to maintain the position of the body, and specifically, the centre of body mass (COM), within specific boundaries of space, referred to as stability limits. Stability limits are boundaries of an area of space in which the body can maintain its position without changing the base of support. Postural orientation is the ability to maintain an appropriate relationship between the body segments, and between the body and the environment for a task [1,2]. Postural control has two components: adaptive and anticipatory postural control. Adaptive postural control involves modifying sensory and motor systems in response to changing task and environmental demands, while anticipatory postural control involves pre-tuning sensory and motor systems for postural demands based on previous experience and learning [3,4].

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Postural control is usually maintained by interaction between sensory and motor mechanisms [5]. Somatosensory system provides information about the relationship of body segments to one another and even they report information about the body's position and motion in space with reference to supporting surfaces [6]. Vestibular system provides information about the position and movements of the head with respect to gravity and inertial forces [7]. Visual inputs report information regarding the position and motion of the head with respect to surrounding objects. In addition, it provides a reference for verticality [8-10]. Motor system includes intrinsic stiffness of muscles, background muscle tone and postural tone, i.e. activation of antigravity muscles. Furthermore, postural control depends on the generation, scaling, and coordination of muscle force with respect to the available sensory inputs [11].

Multiple measurement tools have been established to assess postural control and its various components [12,13]. Romberg's test, plumb line and postural grid system have been used to measure the postural stability. With moving platform, posturographic analysis, postural sway and centre of pressure excursion have been measured in order to find the desired postural stability under six different sensory accurate and/or inaccurate conditions. In sensory accurate or inaccurate state, sensory inputs to central nervous system (CNS) are present, absent or challenged in order to maintain the desired postural stability [14]. Similarly, Clinical Test for Sensory Interaction in Balance (CTSIB) measures the influence of sensory interaction on postural stability in standing [15]. Among the clinical tools available to measure dynamic postural control, Functional Reach Test (FRT) has been reported for its reliability and validity. It is a clinical tool that measures the forward reach distance, whilst maintaining the dynamic stance postural control. The value of forward reach distance as measured by FRT, is documented when all the sensory systems are accurate [16]. But, there are no retrievable data available to measure the forward reach distance when one or more sensory inputs of somatosensory, vestibular and visual systems are inaccurate, i.e. absent or challenged.

The aim of the study was to examine the dynamic stance postural control in six different sensory conditions for neurologically intact adults. The objective of the study was to establish the forward reach distance values under sensory accurate and inaccurate conditions for neurologically intact adults. In addition, we intended to compare the forward reach distance value of sensory accurate condition with sensory inaccurate conditions in neurologically intact adults.

METHODS

Subjects:

This descriptive study was approved by Physiotherapy Departmental Scientific Committee, Kasturba Medical College, Manipal University, Mangalore, and was conducted in community settings, i.e. homes in Mangalore. The neurologically intact adults aged between 20 and 50 years were contacted and explained about the purpose of the study. Informed consent was obtained from the interested participants, seeking their active participation in the study. The participants were excluded from the study if they had vertigo, ankle sprain and musculoskeletal dysfunction, such as low back pain and/or lower limb fracture within three months' duration. The descriptive characteristics such as age, gender, height (cm), weight (kg), hand dominance, arm length and BMI were obtained from the participants.

PROCEDURE

The participants were instructed and demonstrated about the FRT under six different sensory conditions. It is a sensory accurate or inaccurate state in which sensory inputs to CNS are present, absent or challenged in order to maintain the desired postural stability. Under sensory accurate condition, all the sensory inputs such as somatosensory, vestibular and visual systems are available to the CNS, whereas, one or more sensory inputs to CNS are absent or challenged in sensory inaccurate conditions. The six different sensory conditions were as follows. 1) standing on stable surface with eyes opened; 2) standing on stable surface with eyes closed; 3) standing on stable surface, eyes open, with visual illusionary state; 4) standing on unstable surface with eyes opened; 5) standing on unstable surface with eyes closed; and 6) standing on unstable surface, eyes open with visual illusionary state. To provide an unstable surface and a visual illusionary state, three-inch high-density foam (Figure 1) and visual conflict dome (Figure 2) were used, respectively. In order to provide a visual illusionary state to the participants, the visual conflict dome (2′′×2″ dome, painted black with centre white spot) was moved by the observer while asking the participants to fix their gaze on a centre white spot of the dome. Participants stood on a stable surface with eyes open under sensory accurate condition, i.e. all the somatosensory, vestibular and visual inputs were present. With sensory inaccurate conditions, any one of the sensory inputs was absent or challenged. To provide a somatosensory inaccurate state, participant stood on an unstable support, i.e. foam. Under visual inaccurate conditions, visual inputs were absent and challenged with eyes closed and visual illusionary states, respectively (Figure 3).

The participants' dominant arm was preferred to perform FRT. To measure the forward reach distance, a standard measurement tape was placed on the wall, and adjusted at the shoulder height of the participants. The participants initially stood on a stable surface, and, later on an unstable surface with feet-shoulder distance apart, and with the arm raised to 90^0 flexion so that the acromion process was at the level of zero measurement point. The arm length was calculated by measuring the distance between the acromion process and the tip of the third knuckle with the standard measurement tape. They were instructed to reach as forward as possible, without changing their base of support. The forward reach distance was computed by subtracting the arm length from the actual distance reached. Each participant performed three trials in six different sensory conditions, and average of the three trials was considered to measure the forward reach distance under each sensory conditions.

Data Analysis

The descriptive characteristics of the participants such as demographic data and forward reach distance are presented as Mean ± SD. Karl Pearson's correlation coefficient was used to compare the demographic variables under the six different sensory conditions. As a multiple level comparison, Bonferroni test was used to compare the forward reach distance values under different sensory conditions among the age groups ranging 20-29 years, 30-39 years, and 40-50 years. The statistical analysis was performed using

SPSS-13 version.

RESULTS

Among the 150 subjects who participated in the study, 77 were males and 73 were females. In the 53 participants aged between 20 and 29 years, 20 were males and 33 were females. Under the age group between 30 and 39 years, 30 were males and 20 were females. Of the 45 participants aged between 40 and 50 years, males and females were 27 and 18, respectively. All the participants were right-hand dominants except six participants. Table 1. represents the demographic data of the participants. Table 2 shows the forward reach distance values for different age groups under six different conditions.

Our study found that there was a decline in the forward reach distance values with inaccurate somatosensory and visual inputs. Table 3. shows the correlation of FRT values under six different sensory conditions. It was also found that the age group 30-39 years had significantly more reach than the age group of 20-29 under all 6 conditions. Table 4. shows the correlation of FRT values under six different sensory conditions with the demographic variables of the participants.

DISCUSSION

Interaction between sensory and motor systems helps in maintaining the static and dynamic postural stability. Sensory inputs from each of the somatosensory, vestibular and visual systems play a major role in maintaining postural control. In addition, these sensory inputs modify the motor outputs in order to attain a desired postural stability. This study provided values of forward reach distance in sensory accurate and inaccurate conditions for neurologically intact adults. Furthermore, this study also found that there was a very high correlation among the six different levels of sensory conditions. Additionally, the functional reach distance value in a sensory accurate condition was comparable to the earlier work by Duncan PW, et al [16].

When the sensory accurate state was compared to visual absent state, i.e. condition 2, there was a decline in forward reach distance value, and this value was further reduced in visual conflict sensory state, i.e. condition 3. In visual absent sensory state, the postural control was mainly dependent on somatosensory and vestibular inputs. The visual conflict dome created a visual illusionary state, resulting in a visual-vestibular mismatch, which means the dynamic postural control was wholly dependent on somatosensory inputs in condition 3. Nashner's protocol may further support this

Fig 1. Three inch high density foam

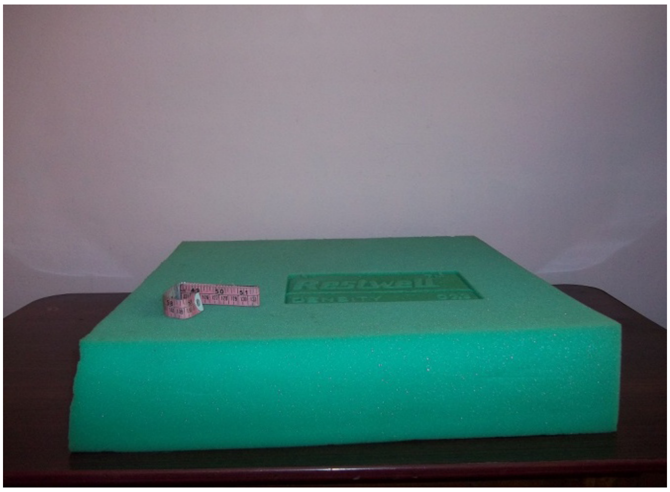
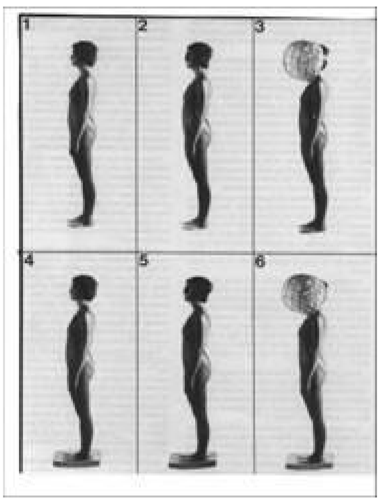


Fig 2. Visual conflict dome

Fig 3. Adapted from Insight into Otolaryngology 1988; 3: 2



hypothesis. In Nashner's protocol, the postural sway was measured in similar sensory conditions, and found to be increased in sway velocity for visual conflict sensory condition than visual absent sensory condition [17,18].

The values of forward reach distance in somatosensory inaccurate state (conditions 4, 5 and 6) were reduced significantly when compared to the somatosensory accurate conditions (conditions 1, 2 and 3). The reason may be due to the fact that the information about the postural orientation provided by the somatosensory system was compromised, so that the visual and vestibular systems had to play a role in maintaining the postural control. The above mentioned information was supported by Dietz et al.[19] In their study, it was found that the muscle responses to vestibular signals were about ten times smaller than the somatosensory responses induced by displacement of feet. Furthermore, studies have also shown that the muscle response latencies to visual cues signalling sway are quite slow, in the order of 200 milliseconds, in contrast to the somatosensory responses that are activated in response to support surface translations which is 80-100 milliseconds. Thus, nervous system preferentially relies on somatosensory system for controlling body sway when imbalance is caused by rapid displacement of support surface [19,20]. According to Shumway-Cook and Horak, the body sway was least in somatosensory accurate condition where support surface orientation inputs are accurately reporting the body's position in space, regardless of the availability and accuracy of visual inputs. But the sway was more when support surface orientation is no longer available as an accurate source of orientation information [21].

Table 1: FRT values for the demographic variables in different age groups

Demographics	Age Group	Number	Mean (SD)	Confidence Interval
Height (cm)	20-29	53	166.17 (7.94)	163.98-168.36
	30-39	52	162.77 (7.74)	160.61-164.92
	40-50	45	163.47 (7.53)	161.20-165.73
	20-50	150	164.18 (7.85)	162.91-165.45
Weight (kg)	20-29	53	60.91 (10.07)	58.13-63.68
	30-39	52	61.52 (9.44)	58.89-64.15
	40-50	45	63.42 (9.37)	60.61-66.24
	20-50	150	61.87 (9.64)	60.32-63.43
Body Mass Index	20-29	53	21.97 (2.55)	21.26-22.67
	30-39	52	23.22 (3.25)	22.31-24.13
	40-50	45	23.82 (3.24)	22.85-24.79
	20-50	150	22.96 (3.10)	22.46-23.46
Arm length (cm)	20-29	53	60.38 (3.84)	59.32-61.44
	30-39	52	60.75 (3.53)	59.77-61.73
	40-50	45	59.96 (3.64)	58.86-61.05
	20-50	150	59.79 (3.66)	59.79-60.97

The results of our study also stated that the postural control was mainly dependent on vestibular inputs in sensory conditions 5 and 6. Similarly, the Clinical Test for Sensory Interaction in Balance (CTSIB) also supports the above mentioned statement [22]. When the sensory conditions 5 and 6 were compared, the value was less in condition 6, suggesting that postural control was solely dependent on the inputs from semicircular canals. In sensory condition 5 where the somatosensory system was inaccurate and the visual system was absent, subjects relied upon vestibular system to maintain the postural orientation. In sensory condition 6, the vestibular system was alone accurate and rest of the sensory systems were inaccurate, but, the movement of visual conflict dome would have created a mismatch between visual and vestibular systems, thus the decreased forward reach distance value in sensory condition 6 [15]. Literature on Vestibulo-Ocular Reflex (VOR) also suggests that the gaze stability and postural stability are mainly dependent on the interaction between the visual and vestibular systems. When these systems are in a state of mismatch, poor postural control may be anticipated [23].

We also attempted to examine the correlation between forward reach distance values and the demographic variables, and found no high correlation except the height of the subjects. We may hypothesis that the anthropometry of the human body, particularly the spinal leverage, would have helped the taller individuals to reach at the far distance. The study by Chaffin DB, et al [24] may further favor for this hypothesis. In their study, it

Table 2. Participants in different age groups, and their FRT values under six different sensory conditions

Sensory Conditions	Age Group	Number	Mean (SD)	95% Confidence Interval
SSEO	20-29	33[a]	36.92 (3.61)	35.64-38.20
		20[b]	38.44 (4.69)	36.25-40.64
		53[c]	37.49 (4.09)	36.37-38.62
	30-39	22[a]	35.37 (5.88)	32.76-37.98
		30[b]	39.03 (5.28)	37.05-41.00
		52[c]	37.48 (5.78)	35.87-39.09
	40-50	18[a]	34.10 (4.80)	31.71-36.49
		27[b]	36.51 (5.91)	34.17-38.85
		45[c]	35.55 (5.56)	33.87-37.22
SSEC	20-29	33[a]	35.02 (4.22)	33.53-36.52
		20[b]	36.19 (3.90)	34.36-38.02
		53[c]	35.46 (4.10)	34.33-36.60
	30-39	22[a]	33.61 (5.48)	31.18-36.04
		30[b]	36.91 (4.98)	35.05-38.78
		52[c]	35.52 (5.40)	34.01-37.02
	40-50	18[a]	32.62 (4.63)	30.32-34.93
		27[b]	34.50 (5.63)	32.27-36.73
		45[c]	33.75 (5.28)	32.16-35.34
SSEOVC	20-29	33[a]	33.08 (4.33)	31.55-34.62
		20[b]	34.92 (4.23)	32.93-36.90
		53[c]	33.78 (4.35)	32.58-34.97
	30-39	22[a]	32.49 (5.49)	30.05-34.93
		30[b]	36.01 (4.12)	34.47-37.56
		52[c]	34.52 (5.02)	33.12-35.92
	40-50	18[a]	30.47 (4.07)	28.45-32.50
		27[b]	32.39 (5.82)	30.08-34.69
		45[c]	31.62 (5.22)	30.05-33.19
SUSEO	20-29	33[a]	31.29 (5.06)	29.46-33.12
		20[b]	33.43 (4.3)	31.37-35.49
		53[c]	32.11 (4.88)	30.75-33.47
	30-39	22[a]	30.83 (5.29)	28.48-33.18
		30[b]	34.68 (4.90)	32.85-36.52
		52[c]	33.05 (5.38)	31.56-34.55
	40-50	18[a]	28.59 (4.24)	26.48-30.70
		27[b]	30.98 (6.03)	28.60-33.37
		45[c]	30.03 (5.46)	28.38-31.67
SEC	20-29	33[a]	29.74 (4.83)	28.02-31.45
		20[b]	32.71 (4.46)	30.62-34.80
		53[c]	30.86 (4.87)	29.51-32.20
	30-39	22[a]	29.61 (5.41)	27.21-32.02
		30[b]	33.60 (4.98)	31.74-35.46
		52[c]	31.91 (5.49)	30.38-33.44
	40-50	18[a]	27.01 (4.65)	24.69-29.33
		27[b]	29.28 (6.45)	26.72-31.83
		45[c]	28.37 (5.85)	26.61-30.13
SUSEOVC	20-29	33[a]	27.83 (5.27)	25.96-29.70
		20[b]	31.26 (4.46)	29.17-33.35
		53[c]	29.12 (5.21)	27.69-30.56
	30-39	22[a]	28.10 (5.49)	25.66-30.53
		30[b]	32.41 (5.37)	30.41-34.42
		52[c]	30.59 (5.78)	28.98-32.20
	40-50	18[a]	25.23 (4.16)	23.16-27.30
		27[b]	27.23 (6.92)	24.49-29.97
		45[c]	26.43 (6.00)	24.63-28.23

[a]-Female,[b]-Male,[c]-Total

was stated that the reach motion posture was affected by the anthropometric characteristics of the human body. Thus, short stature subjects may have less reach motion than tall stature subjects.

We found a decreased reach distance value in the age group between 30 and 39 compared to the age group between 20 and 29. The reason for the same remains unclear. The probable reasons may be due to the followings: Firstly, there were a slightly higher percentage of males (20%) than females (15%) in the age group 30-39, but females (22%) were more compared to males (13%) in age group 20-29. This was supported by an earlier study addressing that females tend to reach less distance than males due to the limb muscular contractility and narrower shoulder width[24]. Secondly, despite the fact age

Table 3. Correlation of FRT values among six different sensory conditions.[a]

	SSEO[b]	SSEC	SSEOVC	SUSEO	SUSEC
SSEC[c]	.949(<.0001)	-	-	-	-
SSEOVC[d]	.876(<.0001)	.899(<.0001)	-	-	-
SUSEO[e]	.813(<.0001)	.841(<.0001)	.957(<.0001)	-	-
SUSEC[f]	.759(<.0001)	.789(<.0001)	.925(<.0001)	.972(<.0001)	-
SUSEOVC[g]	.707(<.0001)	.743(<.0001)	.895(<.0001)	.977(<.0001)	.947(<.0001)

[a]-Karl Pearsons correlation values expressed as R(P), [b]-Standing on stable surface with eyes open, [c]-Standing on stable surface with eyes closed. [d]-Standing on stable surface with eyes opened using visual conflict dome, [e]- Standing on unstable surface with eyes open, [f]-Standing on unstable surface with eyes closed. [g]-Standing on unstable surface with eyes opened using visual conflict dome.

Table 4. Correlation of FRT values in six different sensory conditions with the demographic variables of the participants.[a]

	SSEO	SSEC	SSEOVC	SUSEO	SUSEC	SUSEOVC
Height	.311(<.0001	.265 (<.001)	.307 (<.0001)	.276 (<.001)	.245(<.002)	.268(<.001)
Weight	.101(<0.220)	.108(<.190)	.216(<.008)	.233(<.006)	.222(<.006)	.257(<.001)
BMI[b]	-.102(<.215)	-.063(<.441)	.037(<0.649)	.081(<.325)	.090(<.276)	.117(<.154)
Arm length	.146(<.075)	.134(<.103)	.181(<.026)	.161(<.050)	.140(<.088)	.121(<.139)

[a]- Karl Pearsons correlation values expressed as R(P), [b]-Body mass index.

group that 20 and 29 were the student population, 90 % of them scored less on activity index, whereas the age group between 30 and 39 scored better on similar ratings. The age group of 40-49 showed a decline in mean reach distance despite more number of male participants. This may be due to the fact that there is not much difference in reach distance obtained between male and female participants above 40 years of age. We warrant caution with above mentioned reasons since the number of participants were less in each groups.

Limitations

The limitations of the study are as follows: Firstly, the participants aged above 50 years were not included in this study since age-related sensory, neuromuscular and musculoskeletal degenerative changes may affect their postural control and stability, thus increasing the risk of falling. Future studies should recruit the subjects who are aged above 50 years. In addition, their postural stability may be compared with subjects who are aged below 50 years in order to obtain the role of aging on dynamic stance postural stability. Secondly, the participants were asked to stand with feet shoulder width apart. In order to measure the desired dynamic stance postural stability, the stance with feet close together condition may be applied in the future study. Thirdly, the limited number of participants was recruited from the single geographical location. In further studies, multi-centre trials should be conducted with large sample size in order to confirm our study findings.

Implication

The forward reach distance under six different sensory accurate and inaccurate conditions may provide reference values for neurological patients with postural dysfunction due to impaired sensory integration. Furthermore, these values may be used as prognostic indicator for the patients who are undergoing sensory-motor training aimed at improving postural control.

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Normative value for the unsupported upper limb exercise test in asymptomatic individuals: A cross-sectional study

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ABSTRACT

Objective: Thestudy aimed to provide normative value for the unsupported upper limb exercise testas a baseline data for comparison with disease subjects. **Design:** A cross –sectional study.Settings: Department of Physiotherapy, Manipal College of Allied Health Sciences, Manipal University, Bangalore. **Materials and Methodology:** Thirtyasymptomatic individuals with the age group of 20-30 years were included in the study, Unsupported Upper Limb Exercise test (UULEX) and Modified Upper Limb Exercise test (MUULEX) were performed by subjects seated erect in a straight-backed chair with both feet's on the floor facing the wall on which the UULEX chart was mounted. The weight of the bar was increased each minute from 500gm to 1kg to 1.5kg to 2kg. The MUULEX test was performed with the progression of 100gm.Each subject progressed through this test until he or she indicated an inability to continue. **Measurements:** Student paired 't' test for the pre and post changes in the variables (Heart Rate, Respiratory Rate, Weights) for each of the groups. Unpaired 't' test was used analysis between the two groups. **Conclusion:** MUULEX test is found to be better than UULEX test in eliciting symptom limited exercise performance much earlier with lesser weights

Keywords: Upper Limb Exercise Test, Heart rate,

INTRODUCTION

Homo sapiens is best described by three characteristics; brain size, upright biped position and highly developed use of the upper extremities and hands. The arms are used much differently than legs. Although the latter are used for posture and locomotion, the former require significant action against gravity which ranges from work (typing, painting) to sports (karate, baseball), but most importantly involves our daily care (eating, grooming, cleaning). Respiratory rate

Tangri and wolf et al studied the breathing pattern of seven patients while they tied their shoes or combing their hair. The patients developed an irregular, shallow, rapid pattern of breathing while performing the activity. Thus upper arm elevation results in dyssynchronous thoracoabdominal excursion and dyspnoea at an earlier time and at lower VO_2max than the more metabolically demanding leg exercise[1]. Takashi et al developed a new unsupported upper limb exercise test for patients with chronic obstructive pulmonary disease (COPD).The test was a reproducible and acceptable for patients with COPD to evaluate upper limb function in these patients[2].

Normative value for the unsupported upper limb exercise test is not available. So the current study would aim to provide a baseline data for comparison with disease subjects. Efficient assessment and treatment of upper limb endurance of the normals and the abnormals would not be possible since the calibration for the test involves progression using 500gm weights. Thus, there is a need to modify the test to increase the sensitivity for application in pulmonary rehabilitation programs. The purpose of the study is to establish normative value of weights for the upper limb endurance in normal subjects, to increase the sensitivity of the unsupported upper limb exercise test through modification of the test by using 100gm weights and to compare the findings of unsupported upper limb exercise test with the modified test for changes in heart rate, respiratory rate and weights used.

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METHODOLOGY

The study is a cross sectional study design. The inclusion criteria was asymptomatic individuals with the age group of 20-30 years and exclusion criteria were subjects with the history of smoking, history of neck, shoulder and back pain and subject who is performing regular exercises.

Unsupported Upper Limb Exercise test (UULEX)

Subject was seated erect in a straight-backed chair with both feets on the floor facing the wall on which the UULEX chart was mounted. A pillow was provided for back support. The UULEX chart consisted of eight horizontal colour strips of paper pasted on the board of 0.84 wide and 1.20m high. Each strip was 0.84m wide and 0.08m high and the distance between the centers of the strips was 0.15m.Each strip had a clearly visible stage number. The color of the strips from stage1 (bottom) to stage 8 (top) were dark blue, red, yellow, light green, pink, orange and light blue, respectively. The first level was adjusted to be at the level of patient's by altering the position of UULEX chart on the wall. The highest level the patient could reach was recorded.

The resting heart rate and respiratory rate were recorded. The subject held a light plastic bar (0.2kg) and moved it during the exercise test. The gauge of the bar was 25mm, and length was 0.84m. The subjects were allowed 10mins rest period to acclimatize before the test. The highest stage the subject could reach without excess forward trunk movement was recorded. A 2 minute warm-up was performed using a 300gm bar, which was moved from the waist with both hands to stage number 1 and back to the waist at a constant rate of 30 times per minute, set by an metronome. After the warm-up, the subject lifted the bar to the next colored level (stage2) at the same rate for 1 minute.

This pattern of reaching to progressively higher colored stage for 1minute continued until maximum height was reached. the subject then continued to raise the bar to this maximum height, but the weight of the bar was increased each minute from 500gm to 1kg to 1.5kg to 2kg.Each subject progressed through this test until he or she indicated an inability to continue. If a subject completed all the work levels before indicating the need to stop, this test was not considered a measure of peak unsupported arm exercise capacity. The level of the maximum height reached and the particular weight bar used is recorded[3].

Modified Upper Limb Exercise test (MUULEX)

The test procedure is similar to UULEX with the weights being increased from 500gm with the progression of 100gm till subject is unable to perform the test.

Data analysis

Data was analyzed through student paired t test for the pre and post changes in the variables (HR, RR, Weights) for each of the groups. Unpaired t test was used analysis between the two groups. The variables were taken as dependent measures and the groups were taken as independent measures and p value was set as <0.05 for level of significance. It was analyzed with SPSS version 14.0.

RESULTS

Of the 30 subjects included in the study, 15 males and 15 females participated in the study. Comparison between between Unsupported Upper Limb Exercise test (UULEX) and Modified Unsupported Upper Limb Exercise test is shown in Table 1. The comparison between weights of UULEX and MUULEX is shown in Table 2. Table 3 shows the comparison within subject in modified and normal groups.

DISCUSSION

The study was done with cross sectional study design, data shows baseline heart rate and respiratory rate were similar between normal UULEX and modified UULEX. This shows the homogeneity

Fig 1. UULEX chart and weighted plastic bars

Fig 2. Starting position of UULEX test

Fig 3. Maximum position reached during UULEX test

of the subjects in the study. Statistics indicate there was no influence of the order of intervention.Pre and post heart rates following the test were significantly increased in both the groups. Three reasons attributed to increase in heart rate are exercise with smaller muscle groups of the arm resulted in pronounced rise in sympathetic tone. When arm and leg exercise periods are compared on the basis of equal oxygen uptakes, the work per unit section area of muscle will be higher for arm exercise, which may be a contributing factor to the remarkably high sympathetic tone which may be elicited. Secondly during exercise with vertically elevated forearm blood flow and deep venous oxygen saturation were lower and lactate production larger than at exercise with the arm horizontal. It is probable that the increased lactate concentration is a result of both increased production and decreased dilution because of lowered blood flow due to increased peripheral resistance and finally the cardiovascular response is largely attributable to an increase in sympathetic tone which, in turn, is known to be associated with an increased contractility and rate of fiber shortening in the myocardium. Thus myocardial oxygen consumption is increased during arm exercise with elevated arms.

Pre and post respiratory rate also showed significant increase in both the groups. This might be due to two mechanisms such as at rest, the diaphragm is the dominant active inspiratory muscle, displacing the abdomen and increasing intra abdominal pressure while raising the lower rib cage and decreasing pleural pressure. During exercise, the inspiratory accessories are progressively recruited to assist the diaphragm and elevate the ribcage. Unsupported arm exercise may be more limiting than leg exercise due to derecruitment of the shoulder girdle muscles from their ventilatory contribution, and shifting the ventilatory work to the diaphragm. And arm elevation results in changes in the impedance of the torso, ribcage or abdominal wall. Such changes would require diaphragmatic work to meet ventilatory demand.

Table 1

	Group	N	Mean	SD	t	P*
MpreHR	Modified	30	77.0000	3.59118	1.02700	0.309
	Normal	30	78.0667	4.40950		
MpostHR	Modified	30	90.4667	10.87463	1.14700	0.256
	Normal	30	93.6000	10.27082		
MpostHR3	Modified	30	84.6667	8.37621	0.88900	0.378
	Normal	30	86.5333	7.87722		
MpreRR	Modified	30	19.5333	2.86156	0.34200	0.734
	Normal	30	19.2667	3.17244		
MpostRR	Modified	30	24.2667	4.54049	0.28200	0.779
	Normal	30	24.6000	4.61332		
MpostRR3	Modified	30	21.6667	3.67971	0.10500	0.917
	Normal	30	21.7667	3.69233		

***Statistically not significant**

Table 2

	Group	N	Mean (SD)	t	p
Mwt	Modified	30	653.33 (150.82)	5.58	0.001
	Normal	30	1266.67 (583.29)		

Mean data shows for modified exercise group achieved 700gms and normal exercise group achieved 1000gms at the end of the test.

The subjects in modified UULEX stopped the exercise due to fatigue which might be due to increased lactic acid accumulation impairing further progression of exercise test. The mean weight lifted during termination of exercise was 700gms. Comparison of post heart rate and respiratory rate between groups did not show significant difference. Normal exercise test was started with 500 Gms and gradually adding 500 gms weight. The increase in weights for the modified test was 100gms from 500gms.The mean weight achieved during end of normal endurance test was 1000gms.The subjects in the modified test reached the symptom limited maximum (fatigue) with the cardio respiratory response (heart rate, respiratory rate) similar to the

Table 3

Group		Paired difference Mean (SD)	t	p
Modified	MpreHR – MpostHR	-13.5 (10.15)	-7.26	0.001
	MpreHR - MpostHR3	-7.66 (8.31)	-5.06	0.001
	MpostHR - MpostHR3	5.8 (4.91)	6.47	0.001
	MpreRR - MpostRR	-4.73 (2.95)	-8.8	0.001
	MpreRR - MpostRR3	-2.13 (2.46)	-4.75	0.001
	MpostRR - MpostRR3	-2.6 (2.88)	4.94	0.001
Normal	MpreHR - MpostHR	-15.53 (8.39)	-10.13	0.001
	MpreHR - MpostHR3	-8.47 (5.96)	-7.78	0.001
	MpostHR - MpostHR3	7.07 (6.34)	6.10	0.001
	MpreRR - MpostRR	-5.33 (3.69)	-7.92	0.001
	MpreRR - MpostRR3	-2.5 (3.25)	-4.22	0.001
	MpostRR - MpostRR3	2.8 (2.83)	5.49	0.001

Analysis shows a significant increase in post exercise heart rate and respiratory rate when compared with base line, in both the groups.

subjects in the normal UULEX. Thus modified test with increments of weights with 100gms is efficient in eliciting symptom limited response than the normal UULEX with increments of 500gms.

CONCLUSION

MUULEX test is found to be better than UULEX test in eliciting symptom limited exercise performance much earlier with lesser weights. This improved sensitivity of the MUULEX test will have a important implication for assessment and treatment in pulmonary rehabilitation programme.

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